SALINE WATER PURIFICATION TECHNOLOGY AT HOUSEHOLD LEVEL AND LOW-COST DURABLE HOUSING TECHNOLOGY FOR COASTAL AREAS OF BANGLADESH

STAKEHOLDER CONSULTATION REPORT

APRIL - SEPTEMBER 2018

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

GREEN TECHNOLOGY CENTER

KICT
KOREA INSTITUTE of CIVIL ENGINEERING and BUILDING TECHNOLOGY

GTAT Glory And Technology

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1. INTRODUCTION

1.1 PROJECT BACKGROUND

Over the last few decades, climate change has been a much-discussed topic in the international arena. We are experiencing the impact of climate change through exacerbated extreme weather events which are affecting our everyday life directly.

To address climate change and its impacts, an international treaty called “The United Nations Framework Convention on Climate Change (UNFCCC)” was adopted at the Rio Earth Summit in 1992. UNFCCC entered into force in March 1994 and launched negotiations to strengthen the global response to climate change, resulting in the adoption of the Kyoto Protocol in 1997 which binds developed countries to emission reduction targets. Parties to the Convention continue to meet regularly to take stock of the progress in implementing their obligations under the treaty and to consider further actions to address the climate change threat.

To mitigate climate change and to adapt to its impacts, UNFCCC’s continual negotiation process focuses on a number of topics. One of the topics is Climate Technology where the Parties discuss ways to promote and cooperate in the development and transfer of technologies which reduce GHG emissions.

In 2010, the COP 16 established the Technology Mechanism which consists of two bodies – a policy arm, Technology Executive Committee (TEC), and an operational arm, Climate Technology Centre and Network (CTCN).

The CTCN was established in December 2010, at COP 16 in Cancun, Mexico. The Center (CTCN Secretariat) is placed in the UN City of Copenhagen and is hosted by UNIDO and UNEP. The CTCN consists of two parts: a center—a coordinating entity located in the UN City Copenhagen—and a worldwide network of organizations that delivers CTCN services—both virtually and actually. In short, the center operates the network, and together they constitute the CTCN.

CTCN promotes accelerated development and transfer of climate technologies at the request of developing countries for energy-efficient, low-carbon and climate-resilient development. It also provides technical assistance (TA) in response to requests submitted by developing countries via their nationally-selected focal points, or National Designated Entities (NDEs). Upon receipt of such requests, the Centre quickly mobilizes its global Network of climate technology experts to design and deliver a customized solution tailored to local needs.

In line with this opportunity, Bangladesh, one of the most vulnerable countries to climate change, submitted a request to CTCN on 12 September 2016 for technical assistance (TA) in designing and delivering saline water purifying technology and saline resistant low-cost durable housing technology which is compatible and affordable at the household level.

Due to sea-level rise, saline water intrusion is increasing in the coastal region of the country significantly while fresh water flow from the upper riparian countries is gradually decreasing. As a result, most of the land areas are becoming saturated with saline water, and potable water is becoming scarcer. Collecting fresh water is becoming a major task for the women and children in poor households. Technical assistance is required to install desalination plants or other desalination technologies at affordable prices in the households. Low-cost climate resilient housing is another important issue concerning the coastal people of Bangladesh. The houses made of traditional materials and techniques are vulnerable to the extreme weather events. Low-cost salinity-proof structures are essential for the poor communities living along the coastal belt.

Against this background, the Centre has informed its global Network of climate technology experts and organizations to express their interest to design and deliver sustainable solutions to the above needs. Finally, the Center has awarded a consortium of three Korean technical institutions namely, Green Technology Center-Korea (GTC-K), Korea Institute of Civil Engineering and Building Technology (KICT), as well as Glory and Tech (GAT) with a project entitled, “Technical assistance for saline water purification technology at household level and low-cost durable housing technology for coastal areas of Bangladesh”. The overall objective of the TA include the following:

- Identification and introduction of household level desalination technologies and low-cost salinity proofed housing options
- Capacity building of communities on proposed technology solutions
- Design and develop a GCF project (concept note) to replicate or scale-up pilot(s) nationally

1.2 STAKEHOLDER ENGAGEMENT

The first activity of the TA is to engage the relevant stakeholder of Bangladesh. Stakeholder engagement is the most important ingredient for a successful project delivery. Stakeholders could be defined as people or groups who are directly or indirectly affected by a project, as well as those who may have interests in the project and/or the ability to influence its outcome, either positively or negatively.

In this project, the stakeholder engagement is planned in two phases. First phase is to engage the national level stakeholders. The objectives are to introduce the project to relevant stakeholders, understand the challenges and problems they are facing, and collect input from their previous experiences and on-going efforts. Also, it is to gain consensus on key issues and thus increase the ownership of the project. To this end, an inception workshop was organized in Dhaka where relevant public and civil society stakeholders were invited.

The second phase is to engage the district level stakeholders. This is also to introduce the project to the local stakeholders who are the direct beneficiaries of the

project, capitalize on stakeholders' experiences, and gain stakeholders' consensus on key issues to encourage them be more involved in the project. The district level meeting, initially planned in May but delayed due to Ramadan and the Monsoon season, was organized at Khulna Division in September 2018. Local government officers and NGOs were invited and consulted.

2. NATIONAL LEVEL STAKEHODLER ENGAGEMENT

2.1 INCEPTION WORKSHOP OVERVIEW

The Korean Technical Assistance team led by Mr. Changsun JANG, Deputy Director, the Green Technology Center, Korea (GTC-K) visited Bangladesh and held a national level inception workshop entitled, "Inception Workshop on Technical Assistance for saline water purification technology at household level and low-cost durable housing technology for coastal areas of Bangladesh" on the 3rd of April 2018, Tuesday, at the Chamely Conference Room of the Department of Environment in Agargaon, Dhaka.

More than 40 national level stakeholders from the government, governmental technical agencies, research institutes, international organizations, and NGOs were invited to the workshop. The list of the organizations is as follows:

Table 1. List of participating organizations

Type	Name
Government	Ministry of Environment and Forests
	Department of Environment
	Department of Public Health Engineering (DPHE)
Finance institutions	Palli Karma-Sohayak Foundation
	Bangladesh Climate Change Trust(BCCT)
Research and academic institutes	International Center for Climate Change and Development (ICCCAD)
	Center for Natural Resource Studies(CNRS)
	Bangladesh University of Engineering and Technology(BUET)
	Jagannath University
	Center for Environmental and Geographic Information Services(CEGIS)
International organizations	UNDP
Local communities	Khulna, Koyra
NGO	Action Aid
	Bangladesh Rural Advancement Committee(BRAC)
	Bangladesh Unnayan Parishad(BUP)

The main objectives of the workshop were to 1) create a common understanding and support of the project - its vision, goals, objectives and implementation plans, 2) Exchange knowledge and experiences on saline-water purification, climate resilience

housing technology, and local context, 3) Develop shared vision of the broader opportunities and benefits emerging from the project implementation and outreach, and 4) Receive suggestions for a successful implementation of the project.

The participants actively participated in the discussion and provided their views on the existing water and housing technologies and challenges in the coastal areas. (Please refer to annex 2 for the list of participants).

The workshop consisted of four (4) sessions:

A. Session 1: Workshop opening and introduction
B. Session 2: Low cost domestic climate-resilient housing technology solutions
C. Session 3: Saline water purification technology at household level
D. Session 4: Workshop closing and remarks

2.2 DISCUSSIONS

WORKSHOP OPENING AND INTRODUCTION

The participants were welcomed to register for the workshop and had lunch at 01:00pm. The dignitaries took seats at 02:00pm. The session 1 commenced with recitation from the Holy Quran.

Mr. Mirza Shawkat Ali, Director (Climate Change & International Convention), Department of Environment formally introduced the workshop, addressed all the guests and participants. On welcoming all to the occasion, Mr. Mirza Shawkat requested Dr. Rezaul Karim, Vice Chairman, Bangladesh Unnayan Parishad (BUP) to make an introductory remark.

Mr. Karim informed that he has been engaged in the CTCN mechanism for a long time. In addition, he is a member of the National CTCN Technical Committee formed by the Ministry of Environment and Forests (MoEF), Bangladesh. He mentioned that this is the first CTCN TA to be implemented in Bangladesh. He also mentioned that this workshop is expected to be a good platform for exchanging ideas with regards to the project between the Korean technical team and the Bangladesh expert groups along with the key stakeholder government agencies. He remarked that the most important part of the project is to identify the right water and housing technology viable at household level. He requested the Korean team to have good consultation with the local water and housing technology experts and community people to identify appropriate technologies. Finally, he urged every participant to actively contribute to the workshop, particularly in its technical sessions and wished a grand success.

Figure 1. Dr. Rezaul Karim, Vice Chairman, BUP delivers his opening remarks

DOE PRESENTATION ON CTCN SERVICES IN BANGLADESH

Mr. Mirza Shawkat Ali, Director (Climate Change & International Convention), Department of Environment (DOE) made a brief presentation on the basics of CTCN, its services and Bangladesh perspective.

Figure 2. Mirza Shawkat Ali, Director, Department of Environment makes his presentation

Mr. Mirza Shawkat shared the status of CTCN initiatives in Bangladesh and its challenges with the audience. To him, technology transfer is comparatively a less

talked about issue beyond climate change negotiation in Bangladesh. There hasn't been much of best practice cases of technology transfer initiatives in this country. Appropriate policies or strategies to build an enabling environment for technology transfer are absent. Another challenge is the lack of awareness among the stakeholders. Public and private sectors of the country are not yet aware of the opportunities of technology transfer.

Bangladesh prepared Technology Needs Assessment (TNA) in Climate Change Adaptation in December 2012. According to the TNA report, technological intervention is mainly needed in the agriculture and the water sector.

- Bangladesh NDE and its role

Mr. Mirza Shawkat informs that the Department of Environment is the National Designated Entity (NDE) of CTCN in Bangladesh. NDE is the body granted responsibility by the Conference of Parties (COP) of UNFCCC to manage technology collaboration activities supported through the CTCN. The Director General of the Department of Environment is the Focal Point of the NDE. The Focal Point manages the national submission process of technical assistance requests to the CTCN.

Bangladesh established a two-tier approval process for endorsing technology transfer projects. At first, **the CTCN Technical Committee** headed by the Director General of the Department of Environment will review the requests received. Selected projects will then be reviewed by the **Inter-Ministerial National CTCN Committee** headed by the Secretary of the Ministry of Environment and Forests.

With the help from the concerned organizations, DoE prepared and submitted 5 requests to CTCN for technical assistance. This project is the first CTCN TA request to be accepted for Bangladesh. The CTCN is currently also reviewing other requests submitted by DOE such as the monitoring and assessment of climate change impacts like sea level change, salinity intrusion and sedimentation submitted by Bangladesh Water Development Board (BWDB).

Finally, Mr. Mirza Shawkat thanks the Korean CTCN Technical Assistance Team for the first project mission in Bangladesh and for holding such an important workshop in the premise of the Department of Environment. He also conveys his heartfelt felicitation to the participants from different relevant public-private organizations.

RELEVANT EXPERIENCE SHARED BY PKSF

Dr. Fazle Rabbi Sadeque Ahmed, Director (Environment & Climate Change), Palli-Karma Sahayak Foundation (PKSF), an apex development organization of Bangladesh shared an in-depth institutional understanding and valuable experience with regards to coastal housing and water purification technologies in the coastal region. They considered these activities, not for private companies looking for profit, but to eradicate poverty of the people of the coastal area and to generate off-farm employment in the region. Based on the experience, PKSF underscored the importance of CTCN technical assistance (TA) in identifying and scaling up suitable technologies for sustainable coastal housing and water purification. Accordingly,

PKSF submitted the TA request on this issue to DOE, the CTCN NDE in Bangladesh. The DoE forwarded the request to the office of the CTCN in Denmark. This project is simply a positive response of the CTCN authority based on the submitted request. Dr. Fazle Rabbi shared the experience about how PKSF came up with the idea of having technical assistance from CTCN in coastal housing and water technology areas.

Figure 3. Dr. Fazle Rabbi Sadeque Ahmed, Director, PKSF is sharing relevant experience

GTC PRESENTATION ON CTCN TA PROJECT OVERVIEW

Mr. Chang Sun Jang, Team Leader, Korean Technical Assistance Team and also Deputy Director, The Green Technology Center-Korea (GTC) made a welcome note followed by a presentation on the project overview. In particular, Mr. Jang briefed on project objectives, background, scope and expected outcome along with a well-defined project implementation plan.

First of all, Mr. Jang welcomed the participants to the occasion and gives a short introduction of the center he represents. The GTC, established in 2013 as a national policy research center specializing in green climate technology is a technical organization affiliated with the Ministry of Science and ICT of the Republic of Korea. When the Paris Agreement went into effect on 4 November 2016, the importance of international cooperation for climate change technology transfer increased manifolds. Against this background, the GTC is developing a platform for Global Climate Technology Cooperation.

The GTC has three divisions including Center for Climate Technology Cooperation, Division of Policy Research and Division of Administration. One of the objectives of the Center for Climate Technology Cooperation is supporting Technical Assistance

(TA) and developing models for climate technology cooperation. Mr. Jang showed the green technology cooperation framework. According to the framework, the GTC currently supports major four areas such as identifying technology needs, designing projects, conducting feasibility study and linking financial resources. He gave a brief introduction of a similar CTCN TA project which entitles, “Catalyzing low-cost green technologies for sustainable water service delivery—Kenya.”

Figure 4. Mr. Changsun Jang, Korean Team Leader, makes his presentation on project overview

Mr. Jang gave an overview of the project. The project entitles, “Technical assistance for saline water purification technology at household level and low-cost durable housing technology for coastal areas of Bangladesh”. The initial TA request of PKSF identified 5 coastal districts as potential project locations:

- ✓ Khulna,
- ✓ Satkhira,
- ✓ Bagerhat,
- ✓ Chittagong and
- ✓ Cox’s Bazar.

Khulna, Satkhira, and Bagerhat Districts are the three most southerly districts within the Khulna Division. Chittagong and Cox’s Bazar Districts which are the part of Chittagong Division are also the main coastal districts most vulnerable to natural and climate change effects.

The duration is eleven months from January to November 2018. The project is under implementation by a consortium of three Korean reputed technical organizations:

- Green Technology Center-Korea (GTC-K),
- Korea Institute of Civil Engineering and Building Technology (KICT)
- Glory and Tech (GAT)

The project has three specific objectives. The objectives are:

- Identification and introduction of i) household level desalination technologies and ii) low-cost salinity proofed housing options
- Capacity building of communities on proposed technology solutions
- Design and develop GCF project (concept note) to replicate or scale-up pilot(s) nationally

Mr. Jang explained the project activities and deliverables with an implementation calendar.

2.3 OUTCOMES OF THE WORKSHOP

The workshop with a thorough discussion of the options and challenges to address the sustainable, low-cost housing and water technology issues in coastal Bangladesh has come up with a number of valuable outcomes. The outcomes of the workshop have taken two distinct shapes—recommendations and decisions.

RECOMMENDATIONS – INCEPTION WORKSHOP

The stakeholder participants have put forward some recommendations for consideration by the responsible authorities:

1. **The Korean technical team should consult with PKSF, particularly its concerned management professionals and local officials who were engaged in preparing this CTCN TA proposal. They are believed to have valuable ground level experience on the issues concerned.**
2. **Some community people have traditional knowledge and wisdom about low-cost housing and water purification technology which will be highly valuable in identifying the viable and sustainable technologies for the two sectors at a household level. They need to be actively engaged in this TA project.**
3. **Already there are many housing, and water purification technologies which are in practice at the community level. These technologies can be carefully checked whether they fit into a household level.**
4. **Concerned government agencies, donor agencies, and even local NGOs have carried out research addressing housing and water problems existed in the coastal region of the country. The research reports should**

be carefully reviewed. Consultation of the existing literature will help develop a better understanding to find the better technology solutions to the problems.

5. **Technology solutions may vary from region to region. Most probably, the viable housing and water technologies of Khulna, Satkhira, and Bagerhat might be different from those of Chittagong and Cox's Bazar just because of variation in geomorphology. It should be kept in mind while carrying out a site visit and community consultation.**
6. **Consultation meeting may be held with the media people of the coastal region. Sometimes they write investigative reports on water purification and housing problems. They might have valuable knowledge and experience on the issues concerned.**
7. **There might be a consultation meeting with the representatives of the local NGOs who are working for a long time to address the water and housing problems of coastal Bangladesh. They have valuable practical knowledge and documentation. These might have highly useful in this project.**

3. DISTRICT LEVEL STAKEHOLDER ENGAGEMENT

3.1 OVERVIEW

During the inception mission and the inception workshop, it was advised by the Ministry of Environment and the Department of Environment to narrow down the target site for the technical assistance project. Among the five (5) target regions initially mentioned in the request, Bagerhat and Satkhira were recommended by the Ministry of Environment as sites that have more imminent needs of technology solutions, since these areas are considered as the most vulnerable areas in Bangladesh. Khulna division is one of the eight divisions of Bangladesh. It comprises administrative districts, namely Bagerhat District and Satkhira District.

With the coordination of the Department of Environment in Dhaka, the local level kick-off meeting was held on the 11th of September 2018 at the Department of Environment Khulna Division Office. The objective of this meeting was to introduce the TA project to the local stakeholders. The objective, activities, and implementation plan and expected outcomes were explained to the participants of the meeting. Also, the expectation of the participants was shared and discussed.

The participants were as following:

Table 2. List of participants

Type	Name
DOE Khulna Division Office	Md. Habibul Haque Khan, Director of DOE Khulna Division Office and the staffs
Nowabenki Gonomukhi Foundation	Mr. Sadar Zia Uddin
	Mr. SM Mahabub Alam
KICT	Dr. Tae hyeob SONG

	Dr. Chansoo JEON
GAT	Mr. Dong Jin YANG
	Ms. Jiwon KIM
	Mr. Woo-seok LEE
Rodem Foundation	Mr. Du-suck HONG
	Mr. David Halder
CTCN Media team	Mr. Mohammad Hasan

The Nowabenki Gonomukhi Foundation is a non-profit management organization accelerating finance for the rural community. It works in areas related to women empowerment, income generation, food security, employment creations, biodiversity conservation, climate resilience, and small-scale SMEs at the grass root level. It is a partner organization of PKSF with experience in providing clean water to the coastal areas of Satkhira and Bagerhat District. Under the advice of the PKSF, NGF participated in the kick-off meeting and the site survey conducted after the meeting.

3.2 DISCUSSION

The project team gave a presentation on the CTCN Technical Assistance Project, its background, objective, detailed activities, and timeline. Mr. Dong Jin YANG, the mission leader of the water technology part of the TA explained thegoal of this technical assistance (TA) which is to review and propose a desalination technology at the household level. Dr. Tae Hyeob SONG gave a presentation of the objective and detailed activities as the mission leader of the housing technology part of the TA. Both mission leaders asked the DOE of Khulna Division for support during the implementation of the TA and for facilitated access to the local sites to gather information and data. The field study for the target sites was scheduled to be conducted during this mission and the detailed plan of site visit was shared and explained during the meeting.

Figure 5. Kick-off meeting at the Department of Environment Khulna Division Office

Md. Habibul Haque Khan, the Director of the Department of Environment Khulna Division Office, welcomed the project. Md. Khan explained that in urban areas the provision of safe water is a challenge. The increasing prevalence of droughts is affecting surface water and shallow tube wells and the situation might deteriorate with the climate change. Meanwhile, the coastal areas are affected by the salinity intrusion from rising sea levels which limits the availability of fresh surface and groundwater. Therefore, tube well is not appropriate due to the excess salinity of the groundwater. Deep tube well might contain fresh water, but it has a high concentration of iron and arsenic. Therefore, the local residents rely on the rainwater and pond water which contains virus and bacteria. The problem of drinking water is not only for the people with low-income but for all the communities in the region. In Khulna Division, many water supply improvement projects are being carried out. While there is extensive support in strengthening climate resilience of the region, many projects focus on the urban and peri-urban areas. He insisted that there should be additional focus on the rural area of the Khulna Division.

Figure 6. Kick-off meeting at the Department of Environment Khulna Division Office

Mr. Uddin and Mr. Alam of NGF informed about the activities they carried out in the Satkhira and Bagerhat district. They set up water treatment plans for purifying water and serving pure drinking water to the habitants of the Satkhira district. The water purifying plant was established using reverse osmosis process. The technology was tested by BUET and certified by BSTI. NGF has been monitoring marketing and maintaining the project and machines for more than 4 years.

To conclude, Md. Habibul Haque Khan, the Director of the Department of Environment Khulna Division Office, welcomed the project and expressed his full support. He also added that he wishes smooth implementation of the TA and from the outcome of the TA, he expects the people of the coastal area could have improved access to clean and safe water and living environment.

3.3 OUTCOMES OF THE MEETING

KEY CONSIDERATIONS - DISTRICT LEVEL MEETING

The meeting was concluded with active participation of the attended stakeholders. Following were the key considerations identified during the meeting to be taken into account during the implementation of the TA:

1. **There are high demands in the coastal region, especially in the rural area, for easily applicable and manageable water treatment technology and housing technology.**
2. **In the rural areas of the coastal zone, many NGOs are active in installing water treatment facilities. When selecting the project sites for potential piloting, the ongoing and existing projects need to be considered in order to avoid duplication or collision.**
3. **The problem of water quality in the coastal zone is not limited to its salinity but also related to iron, arsenic, and other impurities. Though some of these problems are not directly related to climate change issue, these issues amplify the overall health problem caused by water.**
4. **The past and on-going projects faced various obstacles during the implementation: absence of the source of financing to cover the operating and maintenance (O&M) cost; capacity and experience to conduct the O&M; risk of low social acceptance to new technology; and low public awareness on the water quality.**

ANNEX

ANNEX 1. AGENDA OF THE INCEPTION WORKSHOP

Date: 03 April 2018, Tuesday
Venue: Chamely Conference Center, Department of Environment, Dhaka

Time	Item/Session	Speaker
14:00	**Opening** - Opening Remarks	Dr. Rezaul Karim Vice Chairman, BUP
(Session 1) Introduction		
14:10	**Workshop Introduction:** CTCN Technology Transfer Initiatives in Bangladesh under UNFCCC	Mr. Mirza Shawkat Ali Director (CC & IC), DoE
14:30	**Group Photo and Break**	
14:40	**PKSF Experience on coastal housing and saline water purification in rural Bangladesh: Submission of Technical Assistance request to NDE, Bangladesh**	Dr. Fazle Rabbi Sadeque Ahmed Director (Env. & CC), PKSF
14:50	**Presentation on CTCN TA project overview** - Project Activities overview (Project objectives, background, scope, expected outcome) - Project Implementation Plan	Mr. Chang Sun Jang, Deputy Director, Green Technology Center
(Session 2) Low cost domestic climate-resilient housing technology solutions		
15:05	**Available housing technology in the local context : Its problems and on-going efforts**	Mr. Md. Abu Sadeque, Peng Director, HBRI
15:20	**Presentation on possible housing technology options**	Dr. Chang-U Chae, Senior Research Fellow, KICT
15:40	**Discussion** - Discussion on necessary actions, how project results and outputs can support the local context	
16:10	Tea Break	
(Session 3) Saline water purification technology at household level		
16:20	**Available desalination technology in the local context: its problems and on-going efforts**	Engr. Md. Saifur Rahman, Superintending Engr., DPHE
16:40	**Presentation on possible desalination technology options**	Dr. June Seok Choi, Senior Research, KICT
17:00	**Discussion** - Discussion on necessary actions, how project results and outputs can support the local context	
17:30	Closing remarks (on behalf of GTC)	Mr. Chang Sun Jang, Deputy Director, Green Technology Center
17:35	Speech of the Chief Guest	Mr. Abdullah Al Mohsin

		Chowdhury Secretary, MoEF
17:40	Closing remarks by the Chair	Dr. Sultan Ahmed Director General, DoE

ANNEX 2. PARTICIPANTS LIST OF THE INCEPTION WORKSHOP

No	Name & Designation	Organization	
1.	Mr. Abdullah Al Mohsin Chowdhury Secretary in Charge	Ministry of Environment and Forests, Bangladesh	Chief Guest
2.	Dr. Sultan Ahmed Director General	Department of Environment	Chair
3.	Mr. Changsun JANG Team Leader	CTCN Technical Assistance Team, South Korea	Guest of Honor
4.	Dr. Nurul Quadir Additional Secretary	Ministry of Environment and Forests, Bangladesh	Special Guest
5.	Mr. Mirza Shawkat Ali Director Climate Change & International Convention	Department of Environment	Signed/=
6.	Mr. Ziaul Haque Director Air Quality Management	Department of Environment	Signed/=
7.	Mr. Saifur Rahman Senior Engineer	Department of Public Health Engineering (DPHE)	Signed/=
8.	Ms. Omaina Rahman Director	Unicom Intellext Ltd.	Signed/=
9.	Md. Saiful Alam Director	Earth Sand (BD) Limited	Signed/=
10.	Mr. Makame Mahmud Assistant to Director	International Center for Climate Change and Development	Signed/=
11.	Mr. Mokhlesur Rahman Executive Director	Center for Natural Resource Studies (CNRS)	Signed/=
12.	Mr. Md. Yusuf Mehedi Assistant Director	Bangladesh Climate Change Trust (BCCT)	Signed/=
13.	Dr. Apurbo K. Podder Assistant Director	Bangladesh University of Engineering and Technology (BUET)	Signed/=
14.	Dr. Abu Taib Mohammed Shahjahan Associate Professor	Bangladesh University of Engineering and Technology (BUET)	Signed/=
15.	Ms. Rabeya Khanum Student	Jagannath University, Dhaka	Signed/=

	Department of Social Work		
16.	Mr. Md. Abdul Mojid Sarder A Community Leader of the Coastal Region	Koyra, Khulna	Signed/=
17.	Mr. Abu Sumon Climate Change Specialist	UNDP Bangladesh	Signed/=
18.	Dr. Fahmida Khanom Director (NRM)	Department of Environment	Signed/=
19.	Dr. Fazle Rabbi Sadeque Ahmed Director	Palli Karma-Sohayak Foundation (PKSF)	Signed/=
20.	Mr. Q. S. I. Hashmi Additional Director General	Department of Environment	Signed/=
21.	Mr. Abu Sayed Md. Faysal Research Associate	Center for Environmental and Geographic Information Services (CEGIS)	Signed/=
22.	Mr. Md. Anjum Islam Associate Officer Monitoring and Documentation	Action Aid Bangladesh	Signed/=
23.	Mr. AKM Rafiqul Islam Deputy Director (NRM)	Department of Environment	Signed/=
24.	Ms. Mayeesha Azhar Research Assistant Environment, Sustainability and Energy	UNDP Bangladesh	Signed/=
25.	Mr. Arif M. Faisal Programme Specialist	UNDP Bangladesh	Signed/=
26.	Ms. Nazria Islam Senior Manager Disaster Management and Climate Change	Bangladesh Rural Advancement Committee (BRAC)	Signed/=
27.	Mr. Samar Krishna Das Assistant Director (Publicity)	Department of Environment	Signed/=
28.	Dr. Rezaul Karim Chairman	Bangladesh Unnayan Parishad	Signed/=
29.	Ms. Inhye Bak Researcher	The Green Technology Center-Korea (GTC-K)	Signed/=
30.	Mr. Yunchal Uoo Consultant	Korea Institute of Civil Engineering & Building Technology (KICT)	Signed/=
31.	Mr. Dipesh Kanti Datta Assistant Vice President Saad Musa Group, Chittagong	The Green Technology Center-Korea (GTC-K)	Signed/=
32.	Mr. June-Seok Choi Consultant	Korea Institute of Civil Engineering & Building Technology (KICT)	Signed/=

33.	Mr. Chang-U Chae Head, National Green Building Center	Korea Institute of Civil Engineering & Building Technology (KICT)	Signed/=
34.	Ms. Sanghee Kim Professional	Korea Institute of Civil Engineering & Building Technology (KICT)	Signed/=
35.	Mr. Tae Hyeob Song	Korea Institute of Civil Engineering & Building Technology (KICT)	Signed/=
36.	Mr. Zoung Wan Kim Consultant	The Green Technology Center-Korea (GTC-K)	Signed/=
37.	Mr. Samar Krishna Das Assistant Director (Publicity)	Department of Environment	Signed/=
38.	Mr. Md. Harun Or Rashid Assistant Director (International Convention)	Department of Environment	Signed/=
39.	Ms. Dilruba Akter Assistant Director (Climate Change)	Department of Environment	Signed/=
40.	Mr. Muhammad Selim Hossain Program Officer Joint Crediting Mechanism Secretariat	Department of Environment	Signed/=
41.	Mr. Md. Anamul Haque Rafi PA to Director (Climate Change)	Department of Environment	Signed/=
42.	Mr. Md. Jalal Uddin Office Assistant	Department of Environment	Signed/=

ANNEX 3. AGENDA OF THE DISTRICT LEVEL MEETING

Date: 11 September 2018, Tuesday
Venue: Department of Environment, Khulna Division Office, Khulna

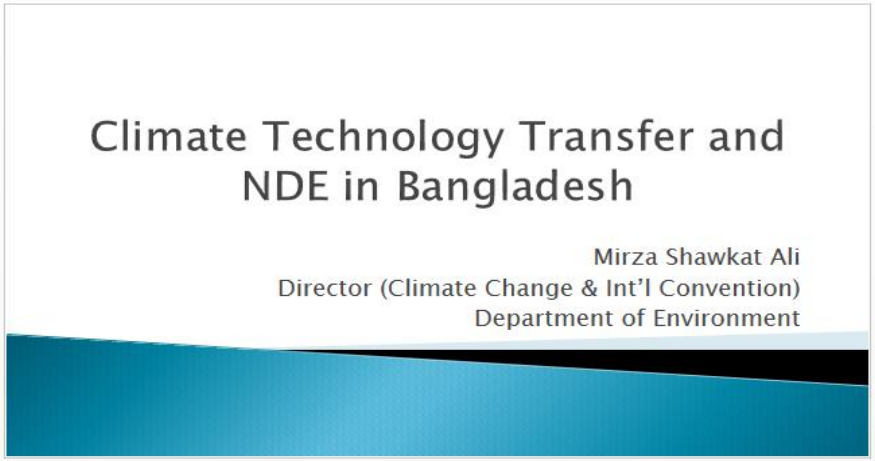
Time	Item/Session	Speaker
10:00- 10:10	**Opening** - Opening Remarks	Md. Habibul Haque Khan Director, DoE Khulna Division
10:10-10:25	**Presentation on CTCN TA project overview**	Dong Jin YANG, Researcher, Glory & Tech.
10:25-10:40	**Possible Desalination Technology options**	Dong Jin YANG, Researcher, Glory & Tech.
10:40-11:00	**Possible Housing Technology options**	Tae hyeob SONG, Senior Researcher, KICT
11:00-11:30	**Discussion**	Moderator : Md. Habibul Haque Khan Director, DoE Khulna Division

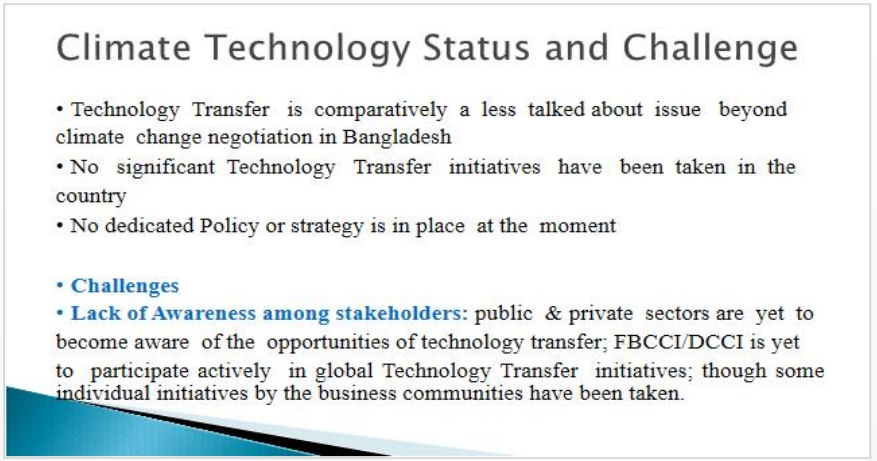
ANNEX 4. PARTICIPANT LIST OF THE DISTRICT LEVEL MEETING

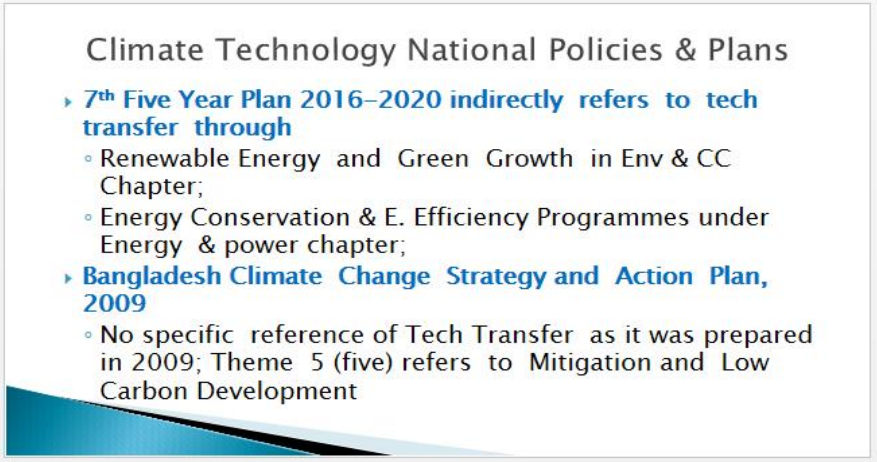
No	Name & Designation	Organization	
1.	Md. Habibul Haque Khan Director	Department of Environment Khulna Division Office	Signed/=
2.	Deputy Director	Department of Environment Khulna Division Office	Signed/=
3.	Mr. Sardar Zia Uddin Head of Monitoring, Evaluation & Documentation Cell	Nowabenki Gonomukhi Foundation(NGF)	Signed/=
4.	Mr. SM Mahabub Alam Project Coordinator	Nowabenki Gonomukhi Foundation(NGF)	Signed/=
5.	Tae hyeob SONG, Senior Researcher	Korea Institute of Civil Engineering and Building Technology	Signed/=
6.	Chansoo JEON, Researcher	Korea Institute of Civil Engineering and Building Technology	Signed/=
7.	Dong Jin YANG, Researcher	Glory & Tech.	Signed/=
8.	Jiwon KIM, Researcher	Glory & Tech.	Signed/=
9.	Woo-seok LEE, Researcher	Glory & Tech.	Signed/=
10.	Mr. Du-suck HONG	Rodem Foundation	Signed/=
11.	Mr. David Halder	Rodem Foundation	Signed/=
12.	Mohammad Abu Sadeque PEng	Affordable Housing Specialist R&D wing Lead Developer Ltd.	Signed/=
13.	Mr. Mahbubur Rahman Ujjal	Friendship	Signed/=
14.	Mr. Kazi Amdadul Hoque	Friendship, Director-Strategic Planning and Head of Climate Change Adaptation and Disaster Management	Signed/=

ANNEX 5. PRESENTATION MATERIALS

Presentation of Bangladesh Department of Environment(NDE)







Bangladesh TNA

- Bangladesh prepared Technology Needs Assessment
  - Mitigation TNA (October 2011)
    - Bangladesh TNA mainly covered mitigation Technology needs in Power and and Energy Sector
  - Adaptation TNA (December 2012)
    - Bangladesh TNA covered adaptation Technology needs in Agriculture and Water Resources

3

Climate Technology National Policies & Plans

- **7th Five Year Plan 2016–2020 indirectly refers to tech transfer through**
  - Renewable Energy and Green Growth in Env & CC Chapter;
  - Energy Conservation & E. Efficiency Programmes under Energy & power chapter;
- **Bangladesh Climate Change Strategy and Action Plan, 2009**
  - No specific reference of Tech Transfer as it was prepared in 2009; Theme 5 (five) refers to Mitigation and Low Carbon Development

4

Technology Transfer under UNFCCC

- The COP, by decision 1/CP.16, decided to establish a Technology Mechanism, comprising;
  - A Technology Executive Committee (TEC) and
  - A Climate Technology Centre and Network (CTCN)

5

The National Designated Entity (NDE)

- The COP has invited Parties to nominate their NDEs for the development and transfer of technologies
- NDE will serve as National Entities for the development and transfer of technologies;
- Act as focal points for interacting with CTCN regarding request from developing country Parties about their technology needs;

6

NDE and its Focal Point

- Department of Environment is the NDE of CTCN in Bangladesh
- Director General, Department of Environment is the Focal Point of the NDE
- Manages the national submission process of technical assistance requests to the CTCN

7

Two Tier National Approval/Endorsement of Technology Transfer requests

- Bangladesh has established a two tier approval process for endorsing the technology transfer projects:
- **An inter-ministerial National CTCN Committee** headed by the Secretary, Ministry of Environment and Forests; and
- **A CTCN Technical Committee** headed by the Director General, Department of Environment.

8

Request Incubator Programme

- DoE has participated to the Request Incubator Programme of CTCN
- Under the incubator programme DoE organized an Inception Workshop, a two day long training workshop and a daylong National Consultation Workshop on CTCN Request.
- With the help of the concerned organizations DoE has prepared and submitted 05 requests to CTCN for technical assistance.

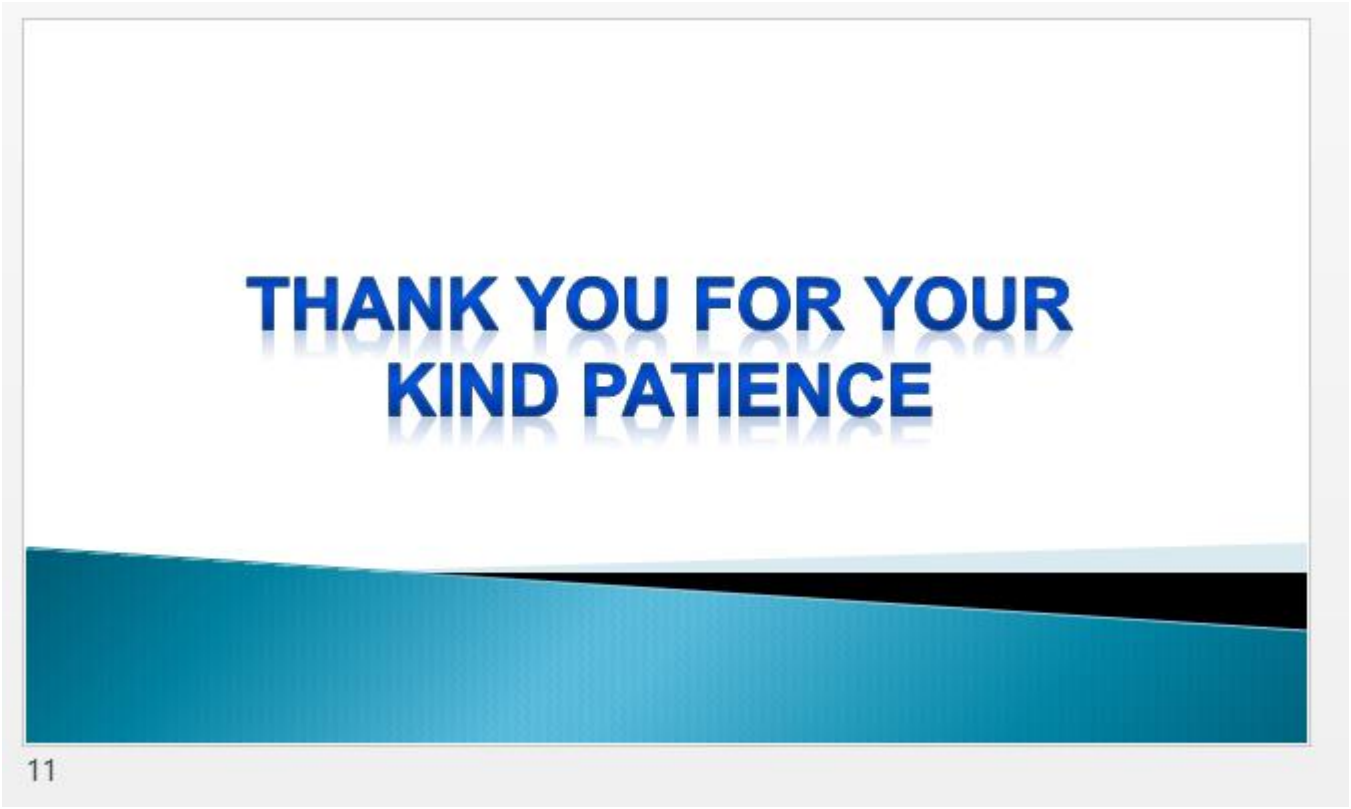
9

CTCN Technology Requests/proposals

- Among those 05 proposals, the CTCN has primarily agreed to support the following 03 proposals:

1. Technical assistance for saline water purification technology at household level and low-cost durable housing technology for coastal areas of Bangladesh. (Submitted by PKSF
2. Development of a certification course for energy managers and energy auditors of Bangladesh. (Submitted by SREDA)
3. Technology for Monitoring & Assessment of Climate Change Impact on Geo-morphology (Sea level rise/fall, Salinity, Sedimentation etc) in the Coastal Areas of Bangladesh. (Submitted by BWDB).

10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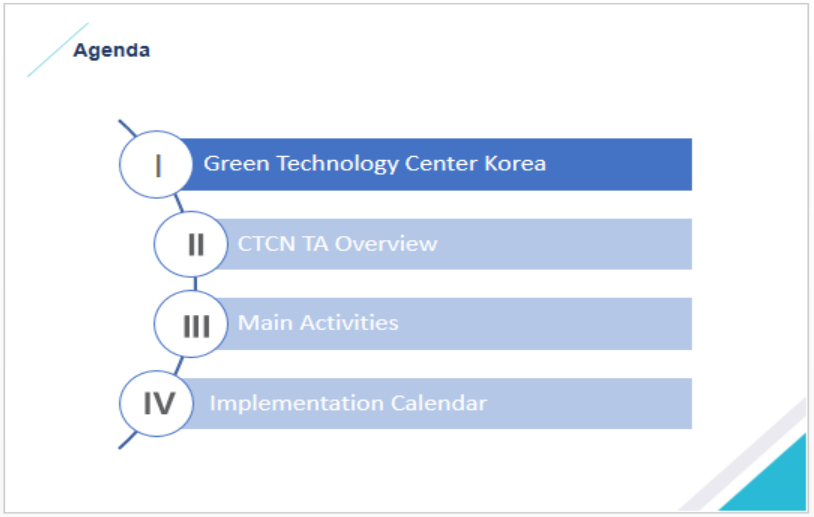
11

Presentation on the Project Overview – Green Technology Center

1



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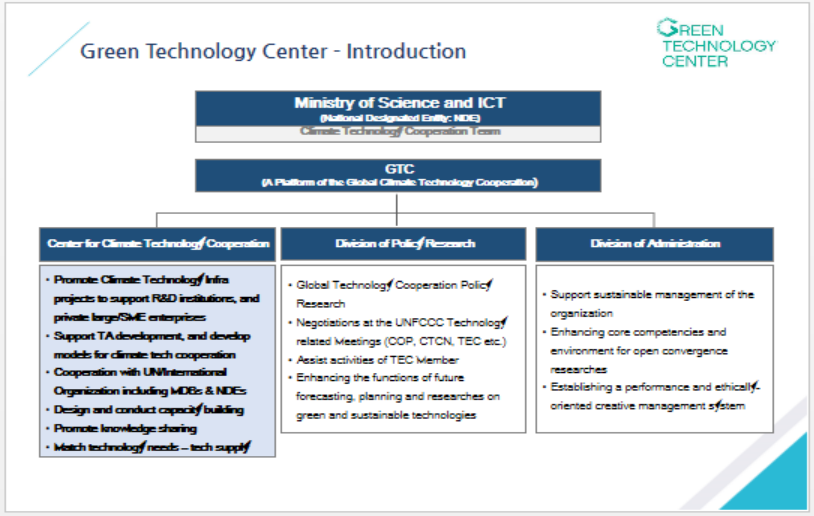

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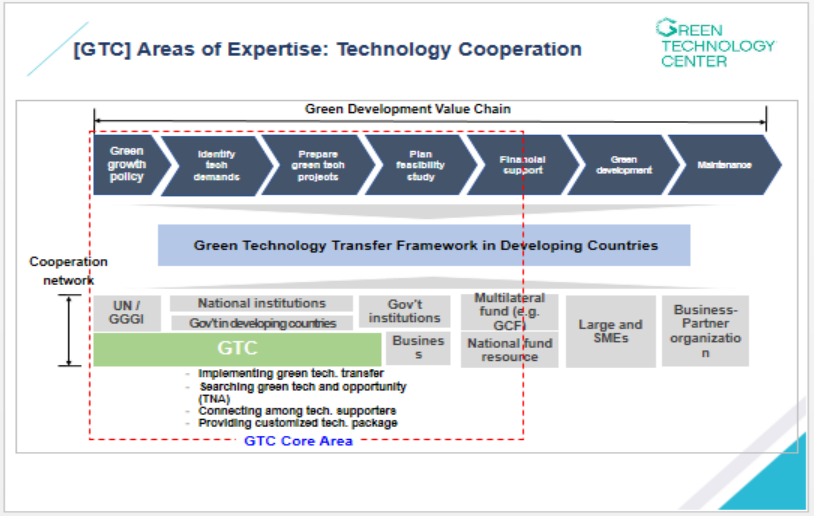


4

[Case 1] CTCN TA Project (Kenya)

Response to a technical assistance from Kenyan National Designated Entity (NDE) on implementation of the low-cost green technologies in water sector

Project Overview

Project Title	Catalyzing low-cost green technologies for sustainable water service delivery – Kenya
Time Frame	5 months from the contract date (December 2016 – May 2017)
Language	English
Objective	Adaptation
Target	• **PPP business model** development and **capacity building** to develop sustainable green water resource technology such as pumping systems based on renewable energy
Country partners	Water Services Trust Fund of Kenya Kenya Industrial Research and Development Institute (NDE)

Project Consortium Structure

5

[Case 2] GCF PPF Program (Bhutan)

As a model of South-South cooperation in the climate technology sector, planning to link the result of a pilot (ITS) to the GCF project (ITS, BRT).

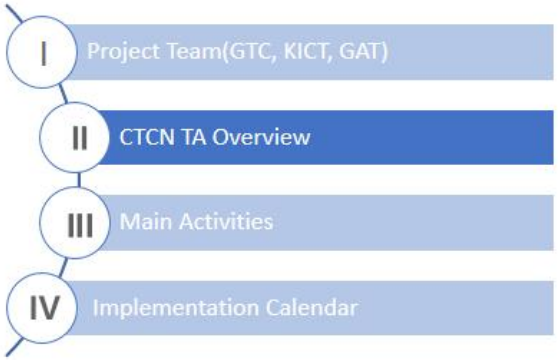
6

[Case 3] Korea R&D Institutes' Technology (CCU) Transfer

To facilitate KIGAM's Carbon Capture Utilization (CCU) technology transfer to developing countries, planning to design and develop the CCU project in collaboration with international organizations

7

Agenda



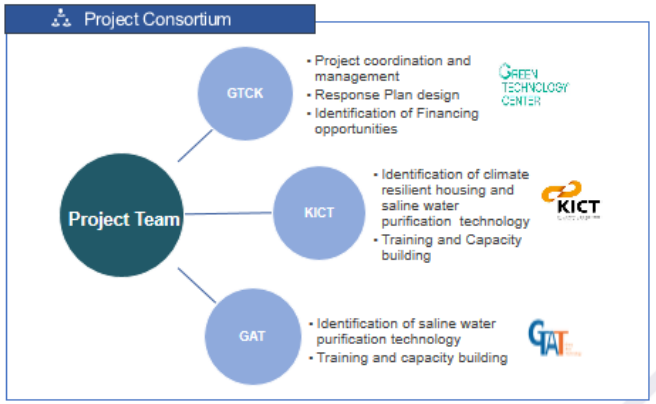
8

CTCN TA Overview

Title	Technical assistance for saline water purification technology at household level and low-cost durable housing technology for coastal areas of Bangladesh
Consortium	• Green Technology Center-Korea (GTC-K) • Korea Institute of Civil Engineering and Building Technology (KICT) • Glory and Tech
Duration	11 months, Jan. 2018 ~ Nov. 2018 (tbc)
Background	▪ **NDE** (Department of Environment, Bangladesh) and Proponent (the **Palli Karma-Sahayak Foundation (PKSF)**) requested and submitted this Technical Assistance to the CTCN seeking the support for the climate vulnerable coastal areas of Bangladesh
Objective	▪ Identification and introduction of i) household level **desalination technologies** and ii) low-cost **salinity proofed housing** options ▪ **Capacity building** of communities on proposed technology solutions ▪ Design and develop **GCF project(concept note)** to replicate or scale-up pilot(s) nationally

9

CTCN TA Overview - Project Consortium



10

CTCN TA Overview - stakeholders in Bangladesh

Stakeholder in Bangladesh

Main Stakeholder

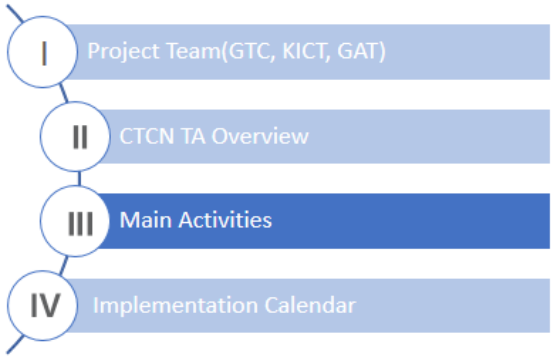
- **(NDE)** Department of Environment
- **(TA request)** Palli Karma-Sahaya Foundation(PKSF)
- **(Project location)** Local Government (Khulna, Satkhira, Bagerhat, Chittagong, Cox's Bazar)

Relevant Stakeholder (expert group)

- Ministry of Housing and Public Works
- House Building Research Institute, HBRI
- Bangladesh University of Engineering and Technology, BUET
- Department of Public Health Engineering, DPHE
- Bangladesh Rural Advancement Committee, BRAC

11

Agenda



12

CTCN TA - Main Activity

Main Activities
Activity 1 : Development of a **response plan**
Activity 2 : District **stakeholders engagement** in the process
Activity 3 : Identification and prioritization of the most promising and low-cost domestic climate resilient **housing technology solutions** for the local conditions
Activity 4 : Identification and prioritization of the most promising and low-cost technologies for **purification of saline water** at household level are
Activity 5 : **Building capacities** of communities on proposed technology solutions
Activity 6 : Support to **identifying financing opportunities** to upscale deployment of technologies identified
Activity 7 : Final report

13

CTCN TA – Output and Deliverable (1/5)

ACTIVITY	Deliverable
Output 1: CTCN Response Plan designed	
Activity 1.1: Detailed desk study Activity 1.2: Inception mission in Bangladesh Activity 1.3: Development of Response Plan	• CTCN Response Plan • Two page CTCN Impact Description
Output 2: District stakeholders engaged in the process	
Activity 2.1: National level inception workshop Activity 2.2: District level kick-off meetings	• Reports on the stakeholder consultations • Project inception report

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CTCN TA – Output and Deliverable (2/5)

ACTIVITY	Deliverable
Output 3: The most promising and low-cost domestic climate resilient housing technology solutions for the local conditions are identified and prioritized	
Activity 3.1: Technology solution review and identification	• Fact finding report
• *Review on the existing reports and references* • *Survey the environment of target areas(major materials and structural types of the housing)*	
Activity 3.2: Field study	• Stakeholder consultation and site visit report
• *Investigate on the current status of building infrastructure(defects and deterioration of housing)* • *Examination of the local conditions of building infrastructure(production and supply of building materials)*	
Activity 3.3: Description of technology options Activity 3.4: Technology prioritization Activity 3.5: Detailed information and instructions	• Recommendation for conceptual and operational design information for low-cost housing technology solutions (in English and Bengali)
• *Suggestion of alternatives for prototype of housing(materials and components)* • *Technology prioritization for the alternatives (in terms of feasibility and cost)*	

15

CTCN TA – Output and Deliverable (3/5)

ACTIVITY	
Output 4: The most promising and low-cost technologies for purification of saline water at household level are identified and prioritized	
Activity 4.1: Technology solution review and identification	• Fact finding report on technologies for purification of saline water at household level
• *Review of the existing reports and references* • *Survey of the environment of target areas(raw water quality, water supply requirement, etc.)*	
Activity 4.2: Field study	• Stakeholder consultation and site visit report
• *Investigation of the current status of saline water treatment* • *Examination of the local conditions of current water supply practices*	
Activity 4.3: Description of technology options Activity 4.4: Technology prioritization Activity 4.5: Detailed information and instructions	• Conceptual and operational design information for purification of saline water at household level (in English and Bengali)
• *Suggestion of alternatives for prototype of saline water treatment (devices and processes)* • *Technology prioritization for the alternatives (in terms of feasibility and cost)*	

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CTCN TA – Output and Deliverable (4/5)

ACTIVITY	INVOLVED TEAM MEMBERS
Output 5: Building capacities of communities on proposed technology solutions through training and pilot site identification	
Activity 5.1: Training	• Set of training materials • Training report
• *Tentative dates : August (2days)* • *Location : Dhaka* • *Target audience : central(NDE, NDA) and local government officials, international and bilateral donor organizations, potential private stakeholders, and etc.* • *Proposed agenda :* ✓ *capacity building on desalination and housing technology* ✓ *Linking technology to climate finance (project design, development process)*	
Activity 5.2: Pilot site identification	• List of potential sites for piloting of the proposed solutions
• *Recommendation from the government of Bangladesh on potential pilot sites* • *Selection of the sites from the perspective of proper access to the target sites, sustainable supply of required materials, and possibility of scale up of the project*	

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CTCN TA – Output and Deliverable (5/5)

ACTIVITY	INVOLVED TEAM MEMBERS
Output 6: Support to identifying financing opportunities to upscale deployment of technologies identified	
Activity 6.1: Development of private sector engagement strategy Activity 6.2: Development of rationale for GCF involvement Activity 6.3: Development of general concept document to present to development aid agencies and private investors Activity 6.4: Development of GCF concept note	• General project concept document • GCF Concept note
• *Design project based on the technical review conducted in the previous stages* • *Develop and scale up GCF project in line with the GCF 6 investment criteria* • *Preparing concept note in consultation with PKSF(GCF Direct Access)* • *Leverage other co-financing resources*	
Activity 6.5: Stakeholder consultation and presentation	
Output 7: Final Report	
Activity 7.1: Final Closure Report	• Final Closure Report

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Agenda

I. Project Team(GTC, KICT, GAT)

II. CTCN TA Overview

III. Main Activities

IV. Implementation Calendar

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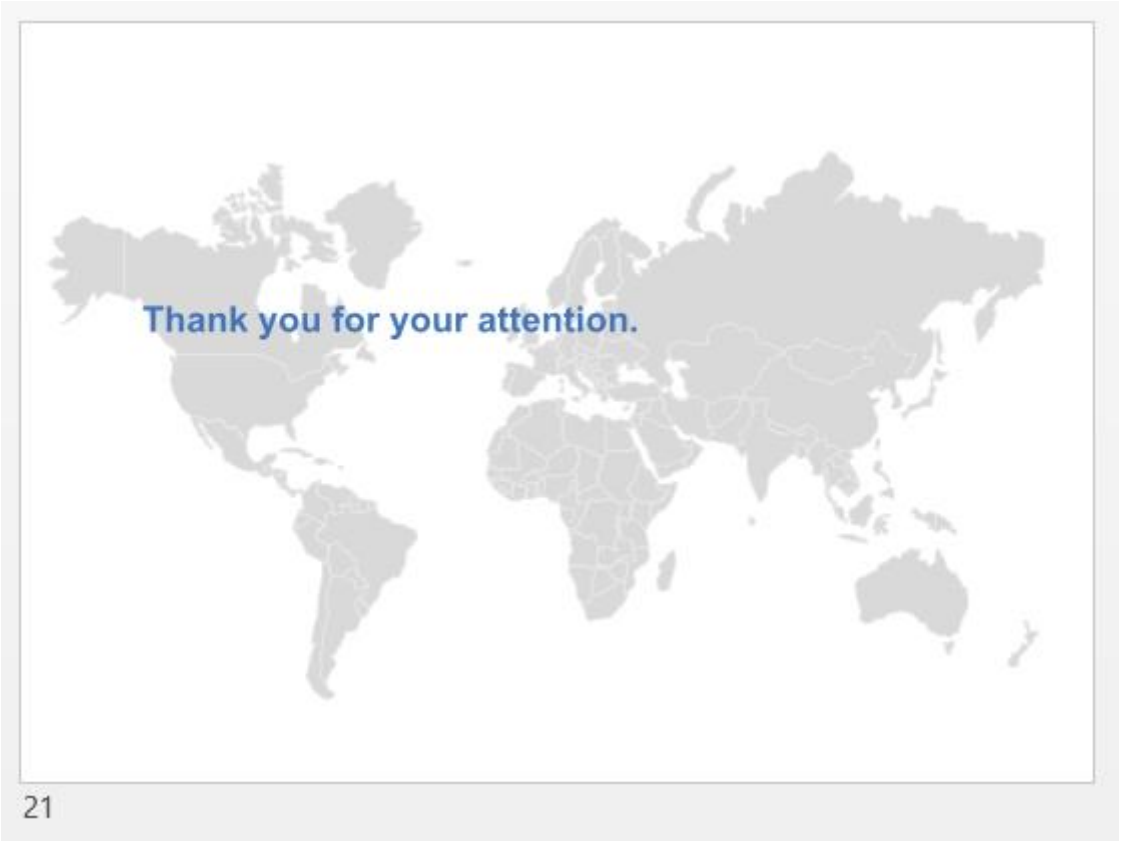
Implementation Calendar

	Activities	Month										
		12	1	2	3	4	5	6	7	8	9	10	11
Output 1. Development of Response Plan	1.1 Detailed desk study												
	1.2 Inception mission in Bangladesh												
	1.3 Development of Response Plan												
Output 2. Stakeholder Engagement	2.1 National level inception workshop												
	2.2 District level kick-off meetings												
Output 3. Climate resilient housing technology solutions	3.1 Technology solution review and identification												
	3.2 Field study												
	3.3 Description of technology options												
	3.4 Technology prioritization												
	3.5 Detailed information and instructions on the prioritized solutions												
Output 4. Purification of saline water technology solutions	4.1 Technology solution review and identification												
	4.2 Field study												
	4.3 Description of technology options												
	4.4 Technology prioritization												
	4.5 Detailed information and instructions on the prioritized solutions												
Output 5. Capacity Building	5.1 Training												
	5.2 Pilot site identification												
Output 6. Identifying financing opportunities	6.1 Development of private sector engagement strategy												
	6.2 Development of rationale for GCF involvement												
	6.3 Development of general concept document												
	6.4 Development of GCF concept note												
	6.5. Stakeholder consultation and presentation												
Output 5. Final Report	7.1 Final report												

20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21

Presentation on possible housing technology options - KICT

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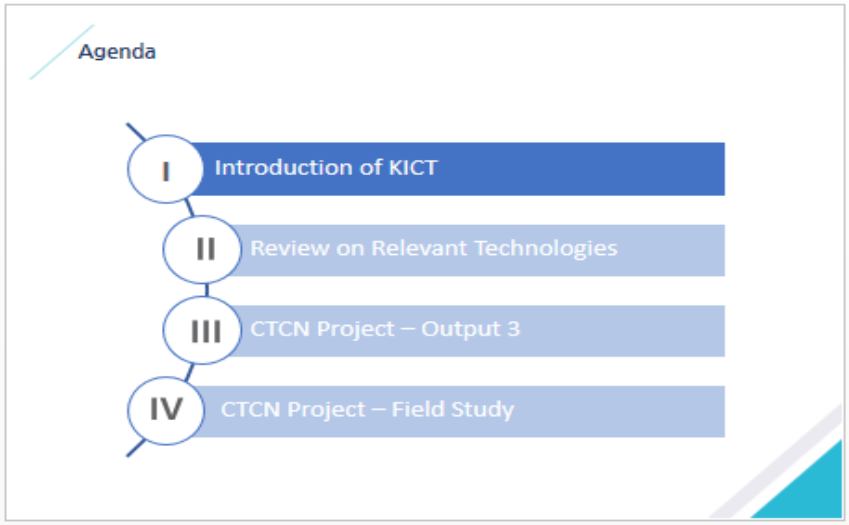


2

3

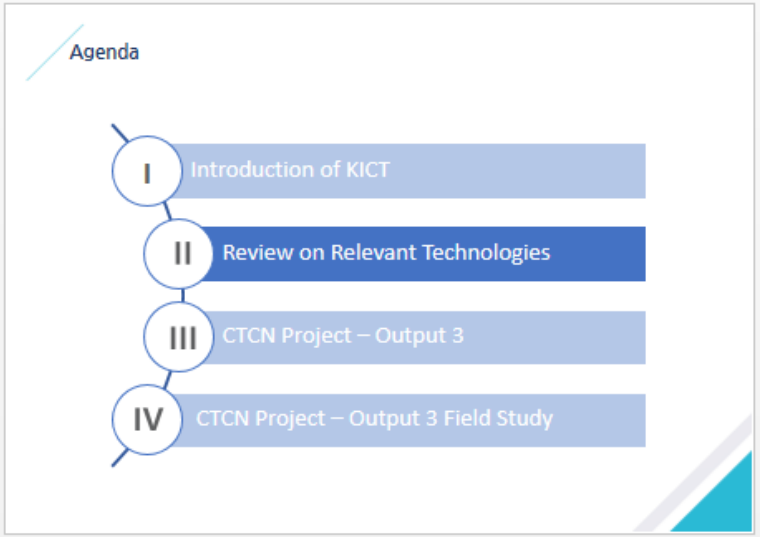
4


[KICT] Main Technology
KICT
Policy Making for Construction Industry
Asphalt with low cost and low carbon
Cable-stayed bridges with Ultra High Performance Concrete
Rapid reconstruction of substructure
BIM GIS
Creation and management of ecological river
Next-generation seawater desalination technology
Zero-carbon green building
Building-customized fire safety technologies

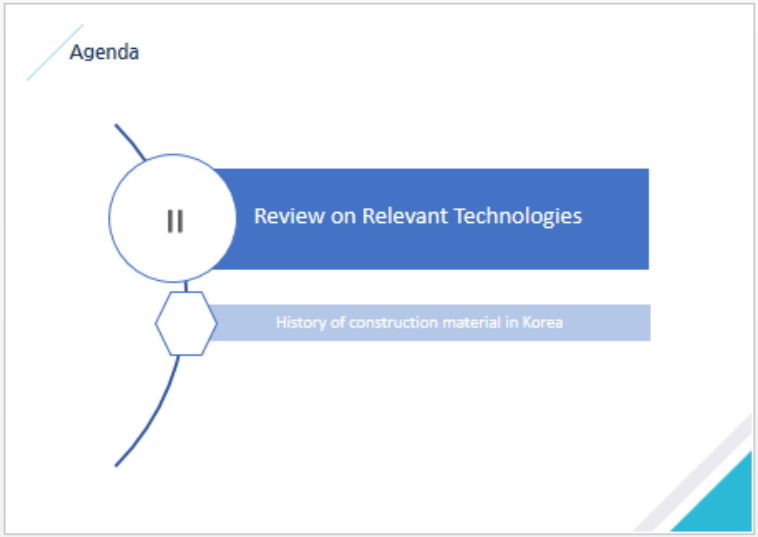
5


[KICT] Building and Urban Research Institute
KICT
Building Energy
Enhancing Energy Efficiency
• Efficient Building Element and System
• Amendment of Energy Regulation
• Highly Efficient Parts
• Nearly Zero-carbon Green Home
• Green Building Centre
Building Environmental
Sound Residential Environmental
• Enhancing Regulation for Heat, Light, IAQ & Sound
• Building Regulation for Sound Insulation in Apartment Housing
• Establishment of IAQ Criteria for Buildings
• Building Related Criteria
Building Facility
Enhancing System Efficiency
• Operation & Control System for Building Energy Management
• Heating Controller & Meter
• BEMS Based on Micro Smart Grid
• Energy Information Management Centre
Urban & Ecology
Harmonizing City & Environment
• Criteria & Guideline for Roof Greening Technology
• Sector Based Greening Effect Analyzing Methodology
• Environmental Ecological Planning Process
• Policy for Ecological Area Ratio
Building Materials
Developing High Performance Materials
• Evaluation for Building Materials and Products
• Criteria for Recycled aggregate
• Fire Safety Criteria
• Functional Concrete Criteria
• Korean Standardization for Building Products
• Policy for Construction Waste Management
• Low Carbon Construction Materials
Planning & Design
Harmonizing Human & Space
• Design Standardization
• Modular Coordination for R.C. and Steel Structure
• One-day Housing
• Han-ok Model Development
• Remodeling system
Building Structural Eng.
Safe Building & Safe Technology
• Building Evaluation
• Repair and Strengthening of the existing Building
• Composite Slab Development
• Earthquake Related Research
• Artificial Land for Public Housing

6


Agenda
I Introduction of KICT
II Review on Relevant Technologies
III CTCN Project – Output 3
IV CTCN Project – Output 3 Field Study

7


Agenda
II Review on Relevant Technologies
History of construction material in Korea

8

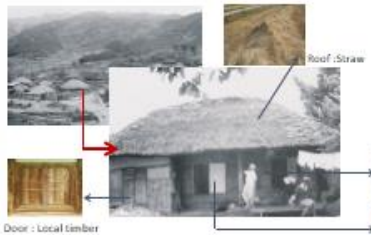
History of Construction Material in Korea

Construction Materials

1940' ~ 1950'

Major Social Issues
- Liberation, the Korean War

< Thatched-roof house >



	1950's
Total Population (Ten thousand people)	2,498
Per capita birth rate	5 persons
Population Density (person/km2)	-
GDP(One hundred million dollars)	-
GNI per capita (US $)	79
Economic growth(%)	-
Major industries	Agriculture

9

History of Construction Material in Korea

Construction Materials

1960' ~ 1970'

Major Social Issues
- the beginning of Saemaeul Movement and Industrialization

< Slate-roof house >

	1970's
Total Population (Ten thousand people)	3,088
Per capita birth rate	4.5 persons
Population Density (person/km2)	320
GDP(One hundred million dollars)	82
GNI per capita (US $)	255
Economic growth(%)	9.05
Major industries	Light industry

10

History of Construction Material in Korea

Construction Materials

1980'

Major Social Issues
- Seoul Olympic, Democratization, Apartment

	1970's
Total Population (Ten thousand people)	3,743
Per capita birth rate	2.8 persons
Population Density (person/km2)	378
GDP(One hundred million dollars)	633
GNI per capita (US $)	1660
Economic growth(%)	9.76
Major industries	Light industry, Heavy industry

The real beginning of Apartment culture in the 1980's

11

History of Construction Material in Korea

Construction Materials

1990'

Major Social Issues
- The New Town Construction, and Heavy chemical industry

Reinforced concrete structures

	1990's
Total Population (Ten thousand people)	4,341
Per capita birth rate	1.5 persons
Population Density (person/km2)	438
GDP(One hundred million dollars)	2,702
GNI per capita (US $)	6,303
Economic growth(%)	6.6
Major industries	Heavy and chemical industries, Automotive industry

- A Low-rise apartment(below the fifth floor) – the beginning of a high-rise apartment(over the fifteen floor)
- Construction of 4 major new towns(Il-san, Bun-dang, Pyeongchon, Jung-dong) – Satellite towns in Seoul
- A short supply of construction materials consequence of rapid housing supply – imported from China

12

History of Construction Material in Korea

Construction Materials

2000'

Major Social Issues
- Informatization, Prevention of Global Warming

The beginning of application for environmental-friendly materials

	2000's
Total Population (Ten thousand people)	4,613
Per capita birth rate	1.3 persons
Population Density (person/km2)	464
GDP(One hundred million dollars)	5,308
GNI per capita (US $)	11,292
Economic growth(%)	4.2
Major industries	Information & communications, semiconductor, service industry

- High-rise apartment(over the fifteen floor) – The beginning of super high-rise apartment(over 25-stories)
- Spread of high-rise apartment throughout the country
- An explosion of interest in improving residential conditions – Insulation, Noise and indoor air etc.

13

History of Construction Material in Korea

Construction Materials

2010'

Major Social Issues
- Energy-saving, Improvement of welfare

Using of low Carbon and high insulation Materials

	2010's
Total Population (Ten thousand people)	4,858
Per capita birth rate	1.2 persons
Population Density (person/km2)	485
GDP(One hundred million dollars)	10,160
GNI per capita (US $)	20,562
Economic growth(%)	2.5
Major industries	Information & communications, services (by internet)

- Application of High insulation Materials for Energy-saving
- Minimization of using Cement

14

Agenda

II Review on Relevant Technologies

Project Experiences

15

[KICT] Project Experience -Myanmar Project

Project Overview

Project Title	Low-radiation complex insulation technologies in Myanmar
Time Frame	2017.08. ~ 2017. 12. (5 months)
Objective	• to assist our partner company "Prime Enertek" to be ready for a new business in Myanmar and other around countries with the low emissivity hybrid insulation that was developed considering the climates and regulations, etc in the countries.
Outcomes	1) Technical improvement of low emissivity hybrid insulation 2) Performance evaluation of emissivity hybrid insulation 3) Certified by the Ministry of Construction and related associations in Myanmar 4) Patent application and technology transfer of low emissivity hybrid insulation

Application on Technologies

[Sample house in Myanmar]

16

[KICT] Project Experience -Myanmar Project

Project Overview

Application on Technologies

[Production of Sample House]

Temperature sensor installation]

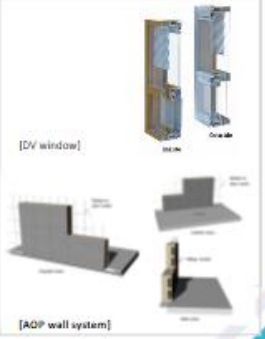
17

[KICT] Project Experience -Uzbekistan Project

Project Overview

Project Title	Demonstrative Rural House Project using Energy Saving Technologies in Uzbekistan
Time Frame	2017.05. ~ 2017. 12. (8 months)
Objective	In Uzbekistan, which is frequently affected by earthquakes, there is little use of thermal insulation. Recently, the problem of energy shortage due to mass supply of rural housing has been raised, and it is aimed to develop a rural housing system to solve this problem
Outcomes	1) Structural development of low-cost rural housing that satisfies seismic performance of Uzbekistan 2) Development of wall system aiming at improvement of insulation performance of 30% or more 3) Implementation of test house and post monitoring 4) Present prototype

Application on Technologies



[DV window]

[AOP wall system]

18

[KICT] Project Experience -Uzbekistan Project

Project Overview

Application on Technologies

19

[KICT] Project Experience -Uzbekistan Project

Project Overview

Application on Technologies

20

[KICT] Project Experience -Uzbekistan Project

Project Overview

Application on Technologies	

21

[KICT] Project Experience - Rwanda Project

Project Overview

Project Title	**Local construction material for energy efficient & affordable housing in Rwanda**
Time Frame	2009 – 2012 (4 years)
Objective	1) Construction plan for low-cost housing utilizing local ingredients to improve the living environment of Rwanda's low-income group. 2) Selection of the most appropriate materials through Rwanda's field survey and use the materials blending, process development and construction method utilizing. 3) Composition of houses and present a standard model 4) Through technical development mentioned above, technical education for public officials at Kigali University, government officials are included in collaboration with the Rwanda expert training program
Outcomes	1) Residential environment and climate environment survey in low - income regions of Rwanda. 2) Survey on building material distribution in the region of Rwanda that can be used as building materials and component analysis. 3) Fabrication and technical education of manufacturing equipment for building material at the pilot stage for manufacturing optimum building materials 4) An optimal housing model suitable for the region of Rwanda

Application on Technologies

[Application to the housing sector in Rwanda]

Processing to stabilize the bottoms of the housing inside and around

Soil packing in Housing complex

22

[KICT] Project Experience - Rwanda Project

Project Overview

Field Study

[Status on low-income housing in Rwanda]

- Batsinda (2007)

- Project Name: Low Cost Housing
- Location: Kinyinya, Kigali, Rwanda
- Building Area: 48m²
- Number of Stories: 1 Floor
- Structure: Earth Brick Masonry
- Number of Users : 4~8 people

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[KICT] Project Experience - Rwanda Project

Project Overview

Field Study

[Status on low-income housing in Rwanda]

- Embankment

- Stylobate

- Roof-upside

- Finishing with Bricks

- Finishing with Spray coat

- Roof-downside

24

[KICT] Project Experience - Rwanda Project

Project Overview

Field Study

[Status on low-income housing in Rwanda]

- Opening -front
- Opening - side
- Opening - vent
- Using local material
- Water tank
- Water supply

25

[KICT] Project Experience - Rwanda Project

Project Overview

Field Study

[Status on low-income housing in Rwanda]

- waterway
- Voltameter
- Indoor ceiling
- Bedroom –left side
- A window in bedroom
- Bedroom –right side

26

[KICT] Project Experience - Rwanda Project

Project Overview

Field Study

[Status on low-income housing in Rwanda]

- Main Room
- Shower room & Kitchen

- Regarding the insufficient living area, the residents of Batsinda are living in extended space on their own.
  -> extension through remodeling
- The living area per capita for Batsinda model complex is 6 m²(the minimum area standard suggested by housing studies is 10 m²)
- The model housing of Batsinda was developed regardless of culture and characteristic in Rwanda.

27

[KICT] Project Experience - Rwanda Project

Project Overview

Field Study

[sampling of construction material in Rwanda]

- Sampling of Sand at Masaka
- Sampling of clay at Kamony
- Sampling of clay at Kamony
- Sampling of celite at Kamony

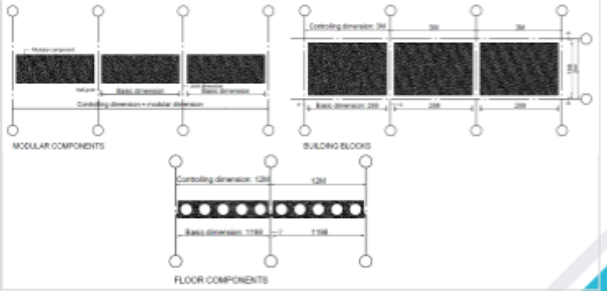
28

[KICT] Project Experience - Rwanda Project

Project Overview

Affordable Housing

[Methodology : Modular design]



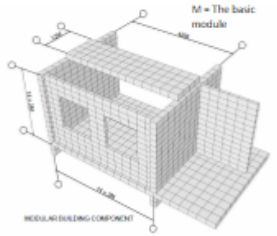
29

[KICT] Project Experience - Rwanda Project

Project Overview

Affordable Housing

[Methodology : Modular design]



[Suggestion]

- To suggest a plan for easy remodeling using local construction materials
- To suggest the way of application with interior finishing
- To suggest the way of application with floor finishing
- To suggest the way of application with ceiling finishing

30

Agenda

I Introduction of KICT

II Review on Relevant Technologies

III CTCN Project – Output 3

IV CTCN Project – Field Study

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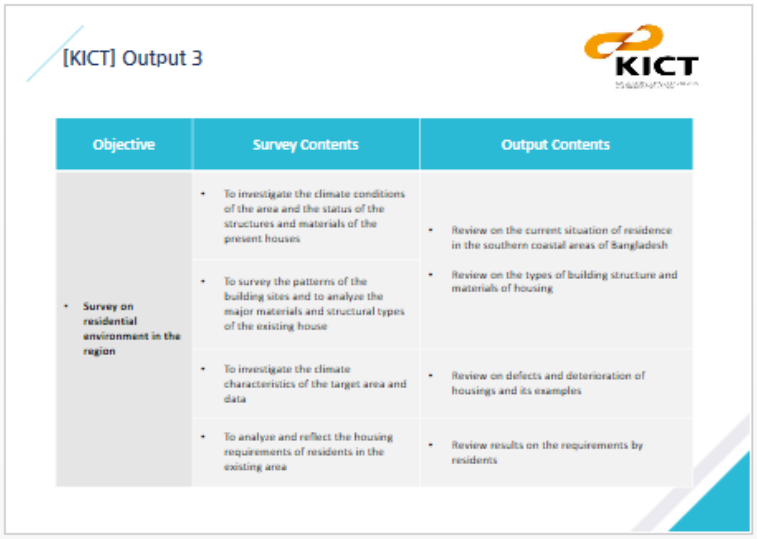
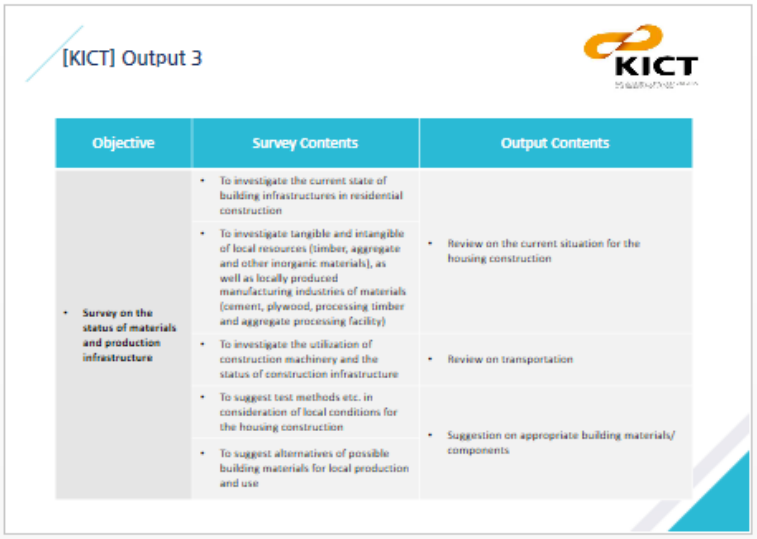
[KICT] Output 3 implementation schedule

Objective	Month											
	12	1	2	3	4	5	6	7	8	9	10	11
• Survey on residential environment in the region												
• Survey of building standard and system												
• Survey on the status of materials and production infrastructure												
• Suggestion on the appropriate housing and a plan for pilot applications												
• Capacity building												
• Final presentation												

32


[KICT] Output 3
KICT
Objective
Survey Contents
Output Contents
Survey on residential environment in the region
To investigate the climate conditions of the area and the status of the structures and materials of the present houses
To survey the patterns of the building sites and to analyze the major materials and structural types of the existing house
To investigate the climate characteristics of the target area and data
To analyze and reflect the housing requirements of residents in the existing area
Review on the current situation of residence in the southern coastal areas of Bangladesh
Review on the types of building structure and materials of housing
Review on defects and deterioration of housings and its examples
Review results on the requirements by residents

33


[KICT] Output 3
KICT
Objective
Survey Contents
Output Contents
Survey on the status of materials and production infrastructure
To investigate the current state of building infrastructures in residential construction
To investigate tangible and intangible of local resources (timber, aggregate and other inorganic materials), as well as locally produced manufacturing industries of materials (cement, plywood, processing timber and aggregate processing facility)
To investigate the utilization of construction machinery and the status of construction infrastructure
To suggest test methods etc. in consideration of local conditions for the housing construction
To suggest alternatives of possible building materials for local production and use
Review on the current situation for the housing construction
Review on transportation
Suggestion on appropriate building materials/ components

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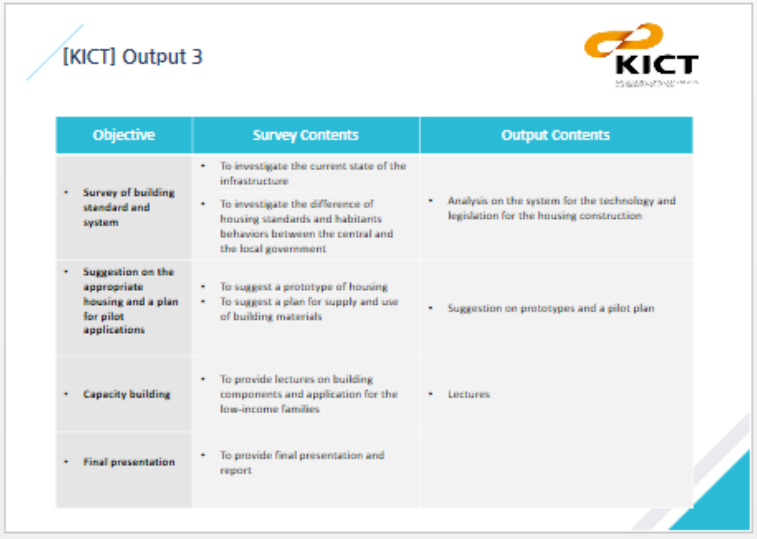
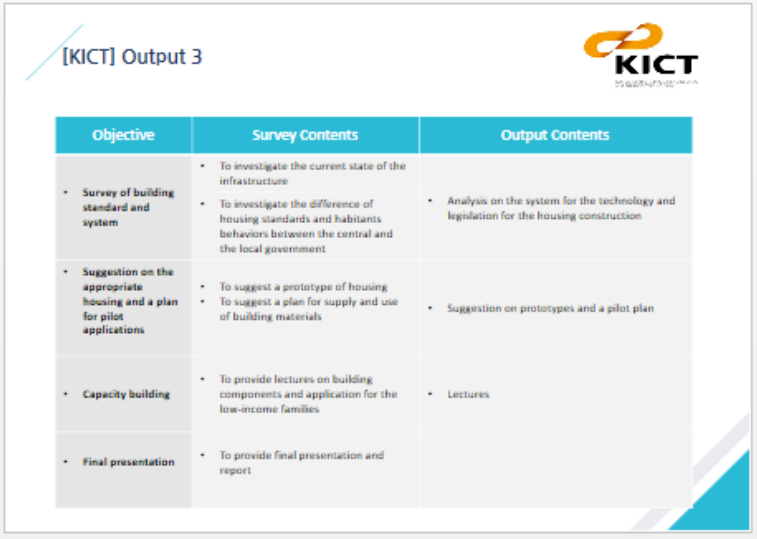

[KICT] Output 3
KICT
Objective
Survey Contents
Output Contents
Survey of building standard and system
To investigate the current state of the infrastructure
To investigate the difference of housing standards and habitants behaviors between the central and the local government
Analysis on the system for the technology and legislation for the housing construction
Suggestion on the appropriate housing and a plan for pilot applications
To suggest a prototype of housing
To suggest a plan for supply and use of building materials
Suggestion on prototypes and a pilot plan
Capacity building
To provide lectures on building components and application for the low-income families
Lectures
Final presentation
To provide final presentation and report

35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Agenda

I Introduction of KICT

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IV CTCN Project – Field Study

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[KICT] Field Study

Purpose : Deriving alternatives through climate environment and current residence study

Item	Contents	Main Contents	Purpose of Field Study
Environment	Climate	- Humidity and Precipitation	- Derive appropriate architectural form
	Soil	- Salt concentration	- Analysis of construction material availability
	Water	- Salinity, pH	- Utilization of construction work
Resource	Aggregate and soil	- Rocks, Coarse aggregate, Fine aggregate, Clay etc	- Utilization of construction materials
	Wood and other	- Trees, reeds, etc.	- Utilization of construction materials
Residential Environment	Type of housing	- Main building materials (wall, roof, floor) - Structure type	- Set up on remodeling direction
	Ventilation	- Openings and windows - Cooking fuel and form	- Interior material composition
Accessibility and others	Infrastructure	- Road, Electricity, Manpower	- Set up on Construction Direction

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[KICT] Field Study - Conditions for selecting site

1. Scale of the site	• Household unit: 50 ~ 100 households • Population standard: 200 ~ 500 ※ It is hard to identify the village structure on selected region, but it can be selected as the minimum unit of the village. However, the composition of the housing should be in the form of a resident village and the distance between houses must be close by to each others.
2. Location of site	• Three locations (three villages) on each regions (3 for Bagerhat, 3 for Satkhira) • Three villages must have different features of ground type (e.g. coastal wetland, flat land and hilly land) • Six villages at least in two regions.
3. Field survey contents	(1) Town survey contents • Survey of accessibility from main road to town (road type, road width, size of movable vehicles, etc.) • Road form and soil survey in the village • Measurement of chloride content for soil and underground water (Concrete chloride content measuring equipment - KICT equipment) • Measurement of pH and chloride contents for surrounding water and rivers (pH meter - KICT equipment) • Drainage (sewage) facility

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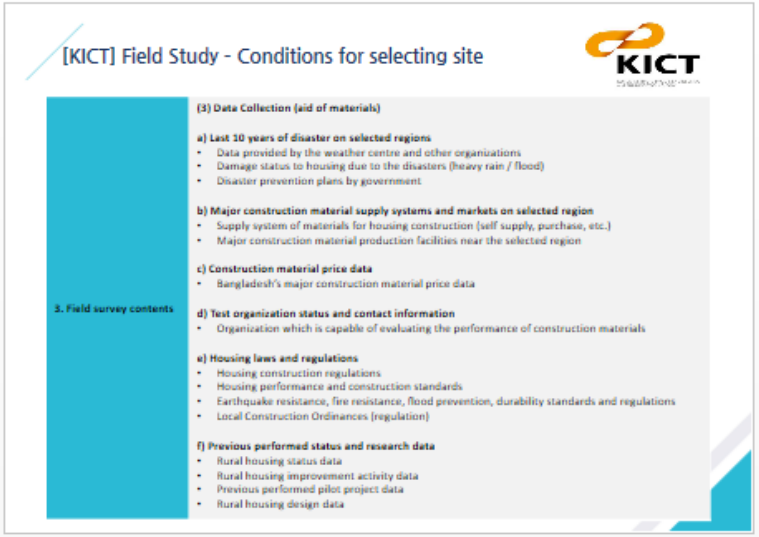
[KICT] Field Study - Conditions for selecting site

3. Field survey contents	(2) Housing survey contents a) Housing structure • Main structure type of the house (wood, masonry, soil erection, etc.) • Analysis of major causes of aged housing (analysis of causes such as salt and weathering) • Analysis of aging type (size and shape of cracks, size and shape of exfoliations etc.) • Current status and maintenance of old structure • Current status of internal space division (average area and number of rooms) • Presence of floor and ceiling (ceiling finish) • Difference in height between the main building and the ground (presence of canopy) b) Housing type • Average number of residents (survey on family composition) • Fuel usage patterns for meals • Exhaust and ventilation methods • Configuration and materials of windows and doors • Sleeping type (floor, bed, etc.) • Indoor finishing (cement, soil, wood, tree branches, etc.) • Indoor floor finishing (soil, cement, wood, board, tile, etc.) • Indoor shoe usage c) Residential facilities • Use of water (water supply facilities or direct use of underground water) • Electricity supply (voltage and main use of electrical appliances) • Location and types of toilet (indoor, outdoor)

40


[KICT] Field Study - Conditions for selecting site
KICT
3. Field survey contents
(3) Data Collection (aid of materials)
a) Last 10 years of disaster on selected regions
Data provided by the weather centre and other organizations
Damage status to housing due to the disasters (heavy rain / flood)
Disaster prevention plans by government
b) Major construction material supply systems and markets on selected region
Supply system of materials for housing construction (self supply, purchase, etc.)
Major construction material production facilities near the selected region
c) Construction material price data
Bangladesh's major construction material price data
d) Test organization status and contact information
Organization which is capable of evaluating the performance of construction materials
e) Housing laws and regulations
Housing construction regulations
Housing performance and construction standards
Earthquake resistance, fire resistance, flood prevention, durability standards and regulations
Local Construction Ordinances (regulation)
f) Previous performed status and research data
Rural housing status data
Rural housing improvement activity data
Previous performed pilot project data
Rural housing design data

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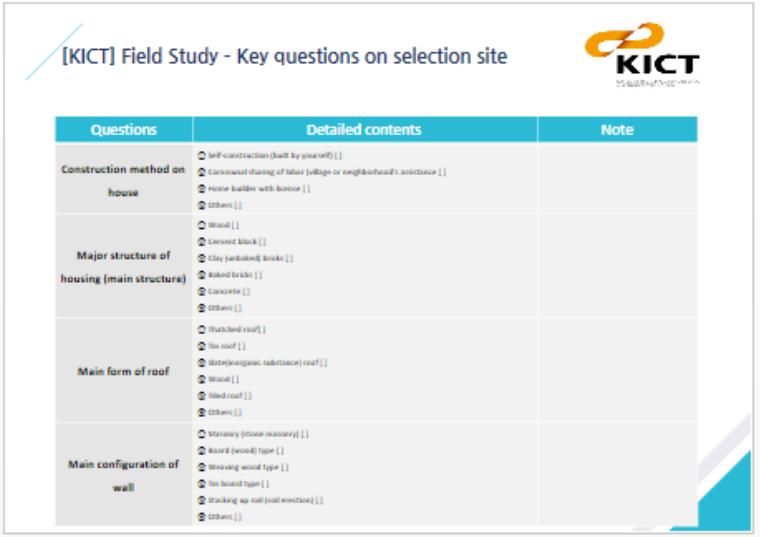
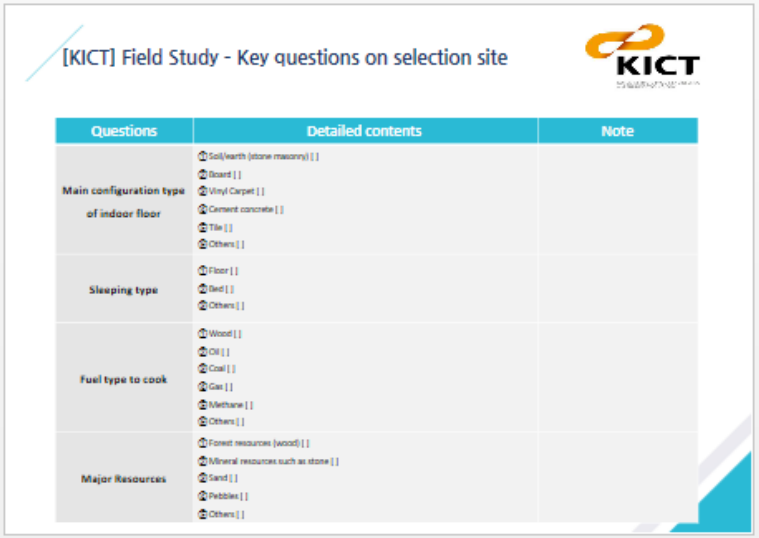
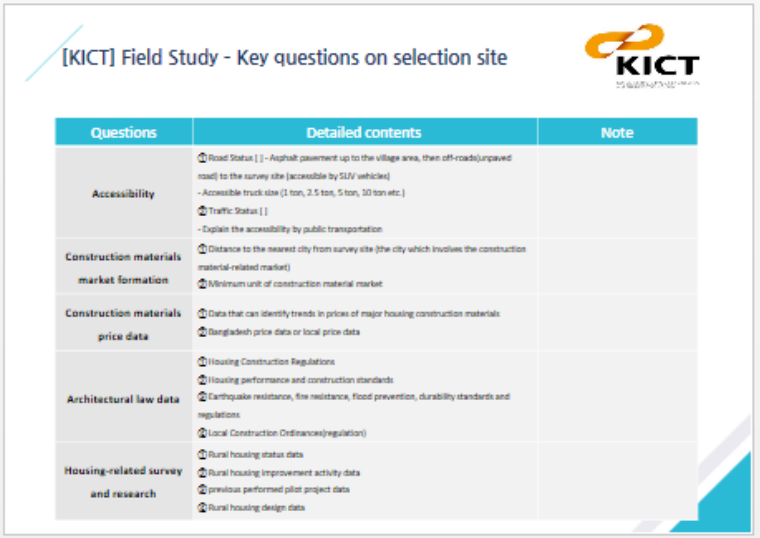

[KICT] Field Study - Key questions on selection site
KICT
Questions
Detailed contents
Note
Construction method on house
Major structure of housing (main structure)
Main form of roof
Main configuration of wall

42


[KICT] Field Study - Key questions on selection site
KICT
Questions
Detailed contents
Note
Main configuration type of indoor floor
Soil(earth (stone masonry) [ ]
Board [ ]
Vinyl Carpet [ ]
Cement concrete [ ]
Tile [ ]
Others [ ]
Sleeping type
Floor [ ]
Bed [ ]
Others [ ]
Fuel type to cook
Wood [ ]
Oil [ ]
Coal [ ]
Gas [ ]
Methane [ ]
Others [ ]
Major Resources
Forest resources (wood) [ ]
Mineral resources such as stone [ ]
Sand [ ]
Pebbles [ ]
Others [ ]

43


[KICT] Field Study - Key questions on selection site
KICT
Questions
Detailed contents
Note
Accessibility
Road Status [ ] - Asphalt pavement up to the village area, then off-roads(unpaved road) to the survey site (accessible by SUV vehicles)
- Accessible truck size (1 ton, 2.5 ton, 5 ton, 10 ton etc.)
Traffic Status [ ]
- Explain the accessibility by public transportation
Construction materials market formation
Distance to the nearest city from survey site (the city which involves the construction material-related market)
Minimum unit of construction material market
Construction materials price data
Data that can identify trends in prices of major housing construction materials
Bangladesh price data or local price data
Architectural law data
Housing Construction Regulations
Housing performance and construction standards
Earthquake resistance, fire resistance, flood prevention, durability standards and regulations
Local Construction Ordinances(regulation)
Housing-related survey and research
Rural housing status data
Rural housing improvement activity data
previous performed pilot project data
Rural housing design data

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[KICT] Direction on housing development

- Setting up on the development direction through the field study which analyze on environment and infrastructure
- Optimize on local resources (manpower/materials), profitability secure (review on cost analysis)

Direction on housing development	
Step 1	Analysis of field environment and sampling on available resources
Step 2	Analysis of the resource composition (collaboration with a local agency)
Step 3	Alternative study on material composition (main constituent materials) and basic design
Step 4	Experiment with components under national standards. (In the absence of standards, relevant international standards may apply)
Step 5	Presentation of alternatives
Step 6	Application on site (future application)

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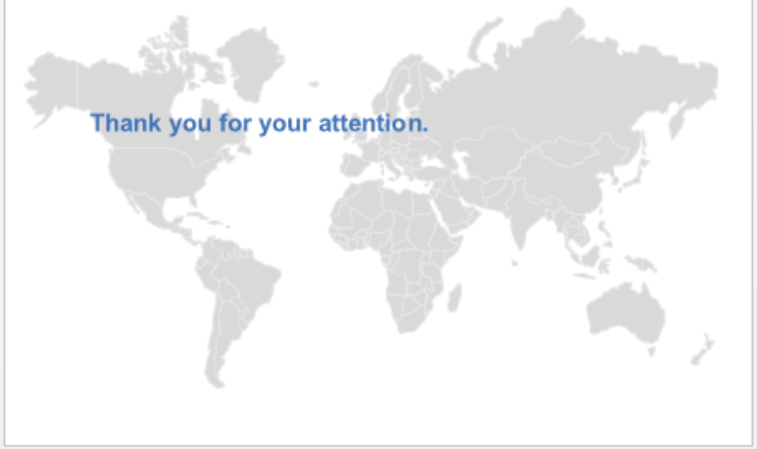

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Presentation on possible desalination technology options – KICT/Glory & Tech.

1

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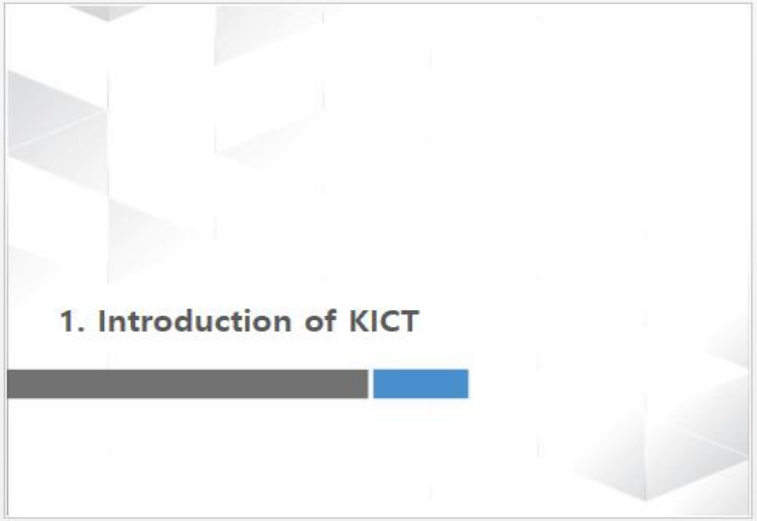

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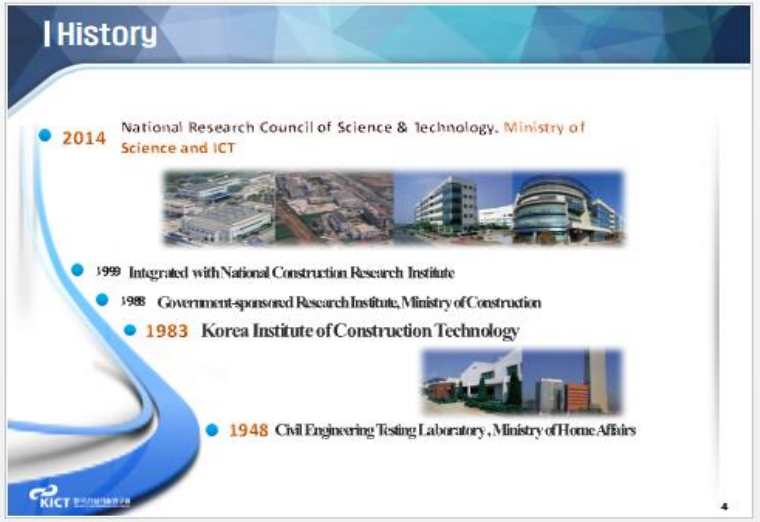
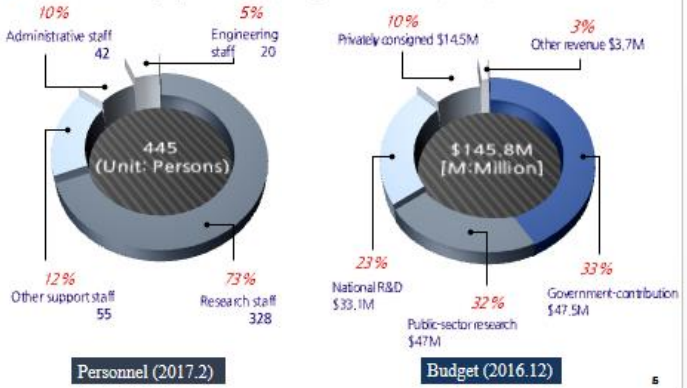


4

General Introduction

Personnel & Budget

- Total Executives & Employees **898** (2017.2) / Budget **146 million USD** (2016.12)

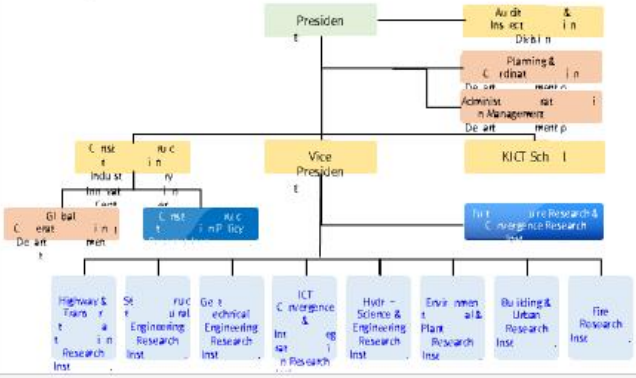


5

Organization and Research areas

Organization Chart

- Ten Research Institutes, Three Departments, One Division, One School & One Center
  - Reorganized to become a task-oriented institute



6

Environmental and Plant Research Institute

- **Research Areas**
  - Water/Wastewater Treatment Plant, Modular Technologies for LNG Plant, Water Quality Control, Odor Control in Sewer Pipes as well as Researches Solutions to Social Issues (Algal Bloom, Sinkholes etc.)
- Personnel: 83 (2017)
- Annual Budget: 11.2 million US Dollars (2016)

7

2. Project team

8

Team member (KICT)

Dr. June-Seok Choi

- Role: **Team Leader**
- Position: Senior Researcher
- Ph.D. at Korea University (South Korea)
- More than 20 yrs experience
- Expert area: Desalination (RO, FO, MD, PRO)

Dr. Tae Mun Hwang

- Role: **Desalination expert**
- Position: Research Fellow
- Ph.D. at Yonsei University (South Korea)
- More than 15 yrs experience
- Expert area: Desalination (RO, MD, PRO)

Dr. Yun Chul Woo

- Role: **Desalination scientist**
- Position: Researcher
- Ph.D. at University of Technology Sydney (Australia)
- More than 8 yrs experience
- Expert area: Desalination (MD, FO, RED, CDI)

9

9

Team member (Glory and Technology, GAT)

Dr. Soon-Ho Park

- Role: Team Leader
- Position: CEO
- Ph.D. at Seoul National University (South Korea)
- More than 20 yrs experience
- Expert area: Desalination (SWRO, BWRO)

Dr. Dong-Jin Yang

- Role: Desalination expert
- Position: Research Director
- Ph.D. at Seoul National University (South Korea)
- More than 10 yrs experience
- Expert area: Desalination (EDI, CDI)

MS. Hang-young Park

- Role: Coordinator
- Position: Researcher
- B.S. at Seoul National University (South Korea)
- Expert area: Environmental Planning, English

10

10

Team member (Kookmin University)

Prof. Sangho Lee

- Role: **Desalination expert**
- Position: Professor
- Ph.D. at Seoul National University (South Korea)
- More than 20 yrs experience
- Expert area: Desalination (RO, FO, MD, PRO)

Dr. Yong-Jun Choi

- Role: **Desalination expert**
- Position: Research Professor
- Ph.D. at University of Science & Technology (South Korea)
- More than 10 yrs experience
- Expert area: Desalination (RO, MD, PRO)

11

11

3. Project experience

12

KICT

13

Oversea experience - Case

President's House in Africa Tanzania: Small water treatment facility

- May 16, 2017 Transportation of small-scale water purification units
- May 18, 2017 Equipment power connection and watering
- May 19, 2017 Administrator training and quality assurance delivered
- May 20, 2017 Visit to the senior officials of the Water Authority of Tanzania

14

14

Desalination experience – RO

Development of Large Scale Seawater Desalination Plant

SWRO plant
(2007 – 2013)

- 1,000 m^3/d
- Flux = 22 LMH
- Salt rejection = 99%

Developed by **Dr. J. –S. Choi**

15

15

Desalination experience - MD/PRO

Membrane distillation: 400 m^3/d

Pressure retarded osmosis : 200 m^3/d

SWRO: 1,000 m^3/d

Valuable resource recovery (Li recovery: 1 m^3/d)

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Desalination experience - MD/PRO

Development of Large Scale MD/PRO Desalination Plant

MD

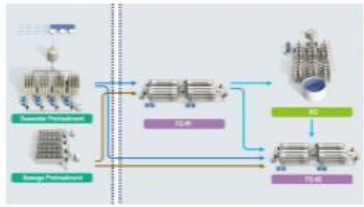
PRO

17

17

Desalination experience – FO

Development of Large Scale FO-RO Hybrid Plant (1,000 m^3/d)



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Desalination experience

Mokmbul Primary School(Cambodia)
Drinking Water 20m^3/d (Jan. 2017)

Tirumkavt Primary School(Cambodia)
Drinking Water 20m^3/d (Dec. 2016)

School/Village Water Supply Facility

New Hope School(Cambodia)
Drinking Water 20m^3/d (Jul. 2017)

Joy & Disciple Kindergarten(Cambodia)
Drinking Water 20m^3/d (Aug. 2017)

20

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4. Desalination for Bangladesh

21

Status of water sources in Bangladesh

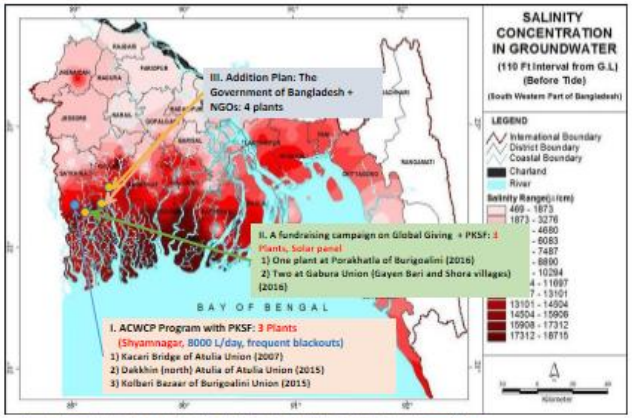
- Most common water sources for coastal areas:

Drinking water source	Source of original water	Level of option
Household-based rainwater harvesting system	Rainwater	Household based
Community-based rainwater harvesting system	Rainwater	Community based
Pond sand filter	Rainwater	Community based
Sharing of functional tubewells	Groundwater	Neighbourhood
Pond water	Rainwater	Neighbourhood

- In remote coastal areas, people travel up to 3 - 4 km to fetch fres h water.
- Both surface and groundwater sources are unsuitable for human consumption mainly because of microbial contamination & high salinity, respectively.

22

Status of water sources in Bangladesh



Source: Quarterly Report on Access to Clean Water for Coastal People (in Bangladesh) Program(2017)

23

Why desalination?

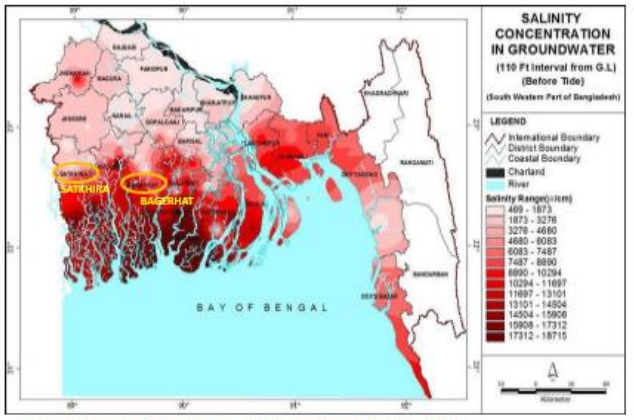
- Among available water sources, only 12% can be utilized to drinking water.
- The lack regular community-based monitoring and maintenance.
- The availability of water greatly fluctuates throughout the year.
- Thus, the option of desalination is getting more attention as one of the only climate resilient solutions in the area.

24

5. Future works

27

Investigation of costal areas in Bangladesh



Source: Quarterly Journal of Indian Pulp and Paper Technical Association 21(3):111-117 - July 2009

28

Training

- To design a potential desalination application for household level
- To optimize the potential application for each area
- How to maintain a sustainable water supply the potential application?

29

KICT

Thank you for your attention

GTAT GREEN TECHNOLOGY CENTER CTCN CLIMATE TECHNOLOGY CENTRE & NETWORK

30

Presentation on the available housing technology in the local context – HBRI

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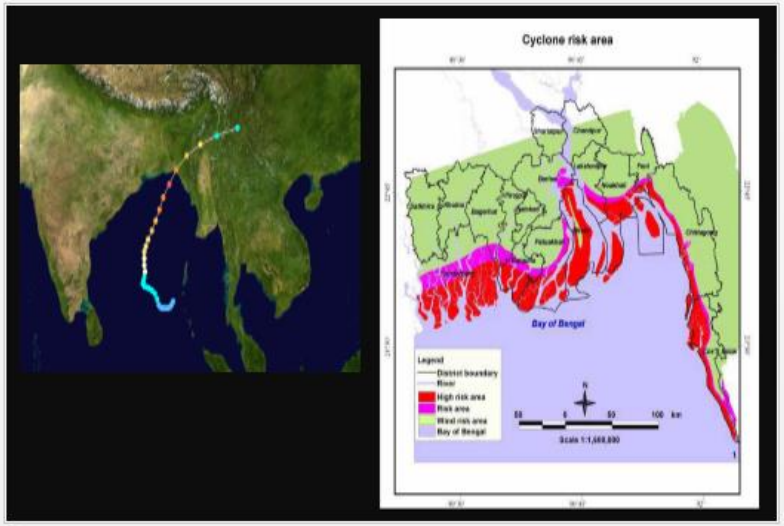
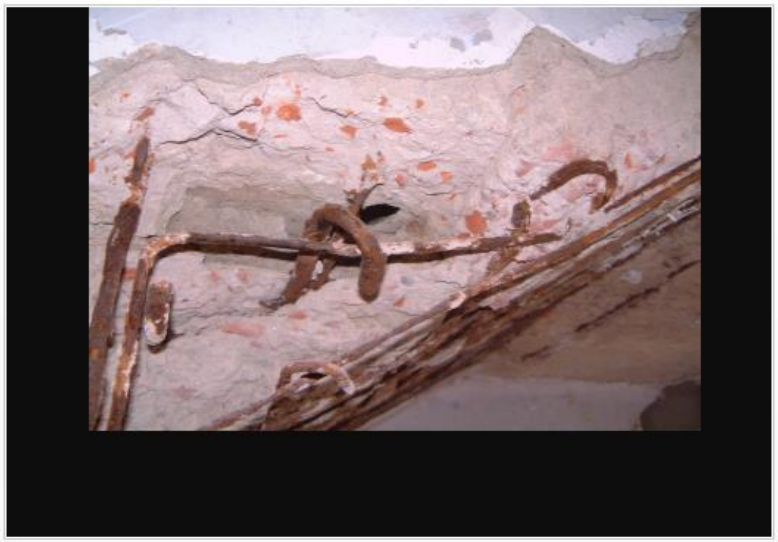
2

3



4


Jhenaidah
Rajbari
Faridpur
Comilla
Magura
Munshiganj
Shariatpur
Madaripur
Chandpur
Jessore
Narail
Gopalganj
Lakshmipur
Feni
Barisal
Noakhali
Khulna
Satkhira
Pirojpur
Bagerhat
Jhalokati
Patuakhali
Legend
0 cm SLR
32 cm SLR
88 cm SLR
5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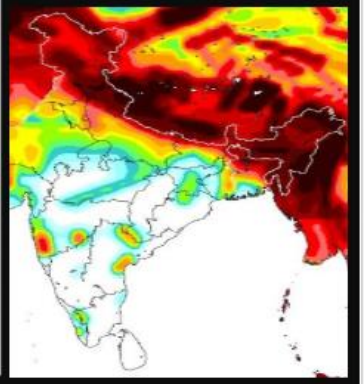
95% of earthquakes occur along the edges of the interacting plates



11

Prevailing policy documents:

- National Housing Policy
- Standard Guideline for Rural Housing in Disaster Prone Areas of Bangladesh
- 7th Five Year Plan
- Perspective Plan

7th Five-year plan:

Housing and Building Research Institute will focus on bringing innovation including alternatives to traditional bricks with a target of achieving zero use of agricultural top soil for brick production, and standardization of new construction materials through research.

Prime Minister's directives for HBRI:

- An intense initiative has to be undertaken to publicize the HBRI's act of innovation regarding new building materials.
- Introduce ferro-cement as building construction technology.
- Research initiative to replace burnt brick with block made from river-dredged soil.

12

Bangladesh and COP21

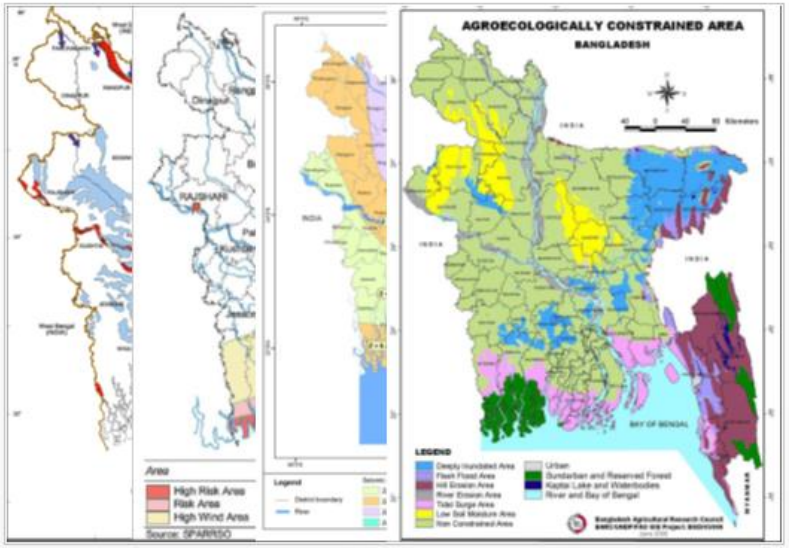
In its INDC (Intended Nationally Determined Contributions) Bangladesh pledged an unconditional 5% greenhouse gas emissions cut by 2030, adding that with financing and technology support it will cut emissions by 15%.

Sustainable Development Goal-11

Make Cities and Human settlements Inclusive, Safe, Resilient and Sustainable.

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

13



14

FOCUS AREA CONSIDERED IN STANDARD GUIDELINE

Design catalogue is prepared based on four broader regions of Bangladesh; considering the predominant natural extremities that occur in the respective areas and can be considered as the determinant force for shaping the mode of habitation. The four focal areas that are considered :

- **Coastal Area**
- **Flood plain/ Char Area**
- **Haor Area**
- **Hilly Area**

15

CURRENT PRACTICES OF HOUSING IN DIFFERENT AREAS

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COASTAL AREAS

PREVAILING PRACTICES:

- Use of RCC posts and metal frames are common.
- CGI sheet as wall and roofing material is dominant in structure.
- Corrosion of CGI sheets are very much evident in all the houses.
- Stilt housing is found in some areas.
- Rain water harvesting in houses is a common feature in the Rakhain community.

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COASTAL AREAS

Existing Local Practices in Coastal Regions

18

COASTAL AREAS

Nachnapara Housing

Houses by INGO

INGO Housing

Rakhain Community Houses

19

COASTAL AREAS

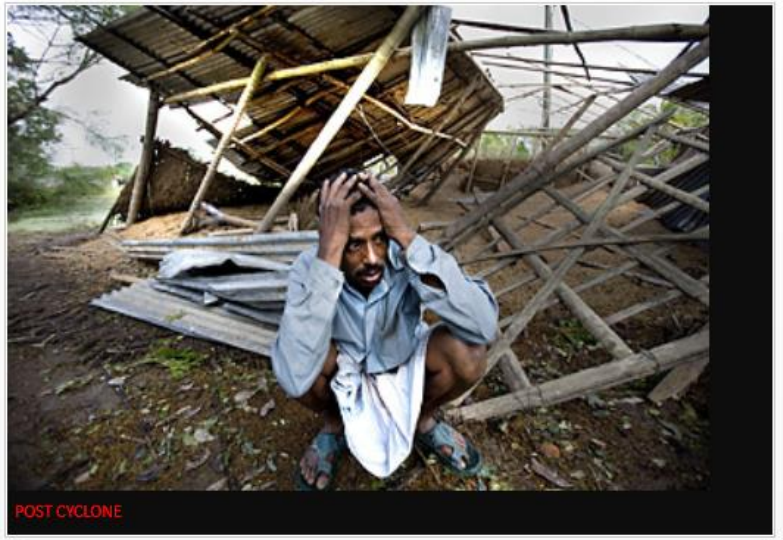
Chungapasha Government Housing

Housing by AVAS, Speed Trust & Action Aid

20


HOUSES BUILT BY INGO ON AGRICULTURAL LAND
USE OF CGI SHEET IN COASTAL AREA

21


POST CYCLONE

22


POST CYCLONE

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POST CYCLONE

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PRE REHABILITATION

25


COASTAL AREAS
After Cyclone and Surge

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COASTAL AREAS
Findings:

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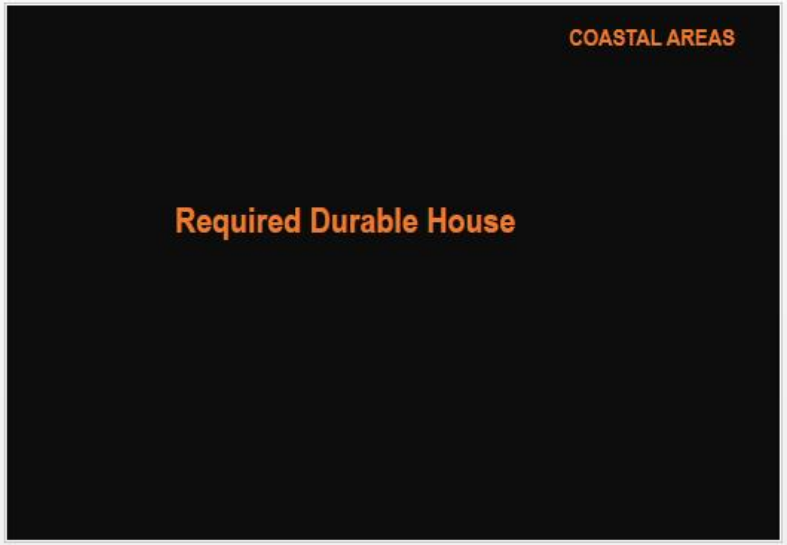
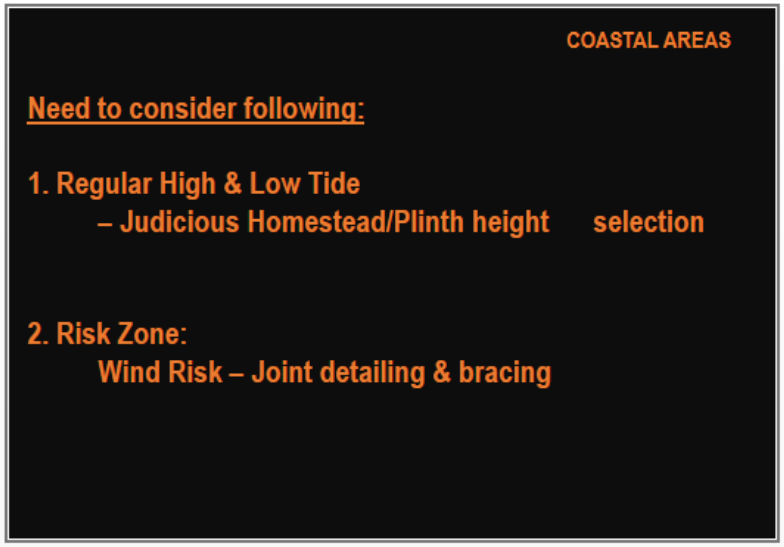

COASTAL AREAS
Required Durable House

28


COASTAL AREAS
Need to consider following:
1. Regular High & Low Tide
– Judicious Homestead/Plinth height selection
2. Risk Zone:
Wind Risk – Joint detailing & bracing

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COASTAL AREAS
3. Low Risk – Wind plus low surge height – Joint detailing, bracing & plinth height & erosion
4. High Risk – Wind plus high to very high surge height - Joint detailing, bracing & plinth height & erosion & stilt and/or surge resilient structure and envelope

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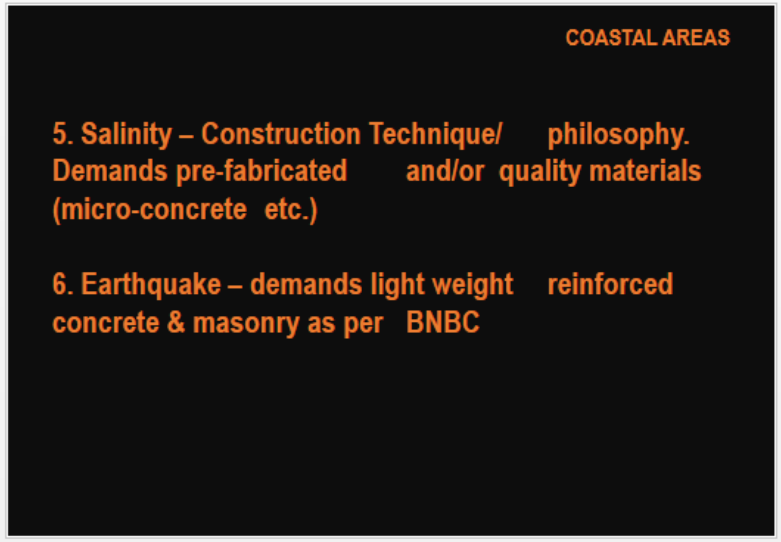
COASTAL AREAS
5. Salinity – Construction Technique/ philosophy. Demands pre-fabricated and/or quality materials (micro-concrete etc.)
6. Earthquake – demands light weight reinforced concrete & masonry as per BNBC

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FLOOD PLAIN AND CHAR AREAS
PREVAILING PRACTICES
• Gable roof
• Raised homestead
• Reqd. Plinth height
• CGI sheet as roofing and wall material
• Bamboo/RCC post
• Locally available material for wall and roofing.

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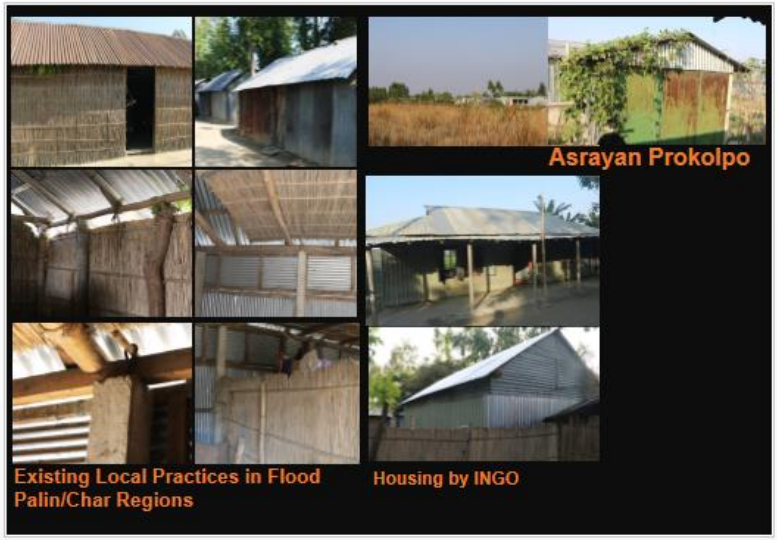

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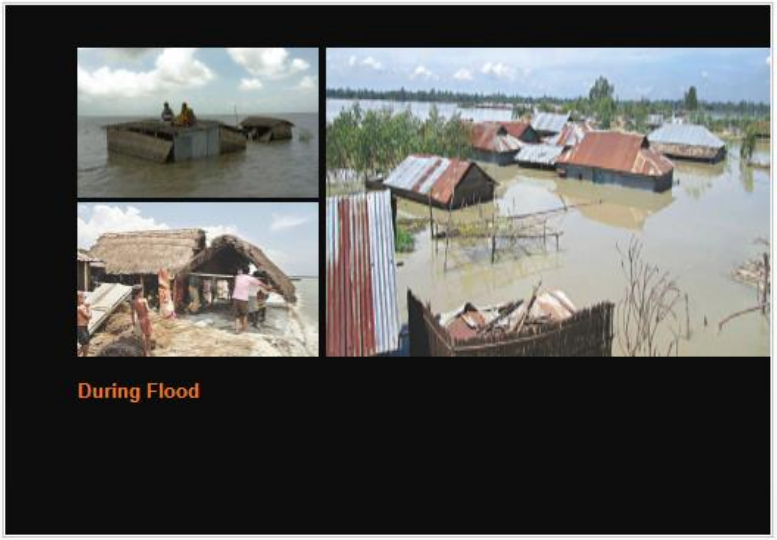

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FLOOD PLAIN AND CHAR AREAS

ISSUES IDENTIFIED:

- Movable structure is needed for Char & River-bank erosion area
- Prefabricated building elements
- Durable Technology
- Structural members joint details
- Introducing bracing elements
- Plinth raising

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HAOR AREAS

PREVAILING PRACTICES

- Mostly single storied and hipped roofed type.
- RCC post and metal/wooden frames.
- CGI/plain metal sheets are used as wall and roofing material.
- Windows are absent.
- Maximum plinths are kutcha.
- Bamboo mats/ tarpaulins are used under roofs in order to mitigate the heating.

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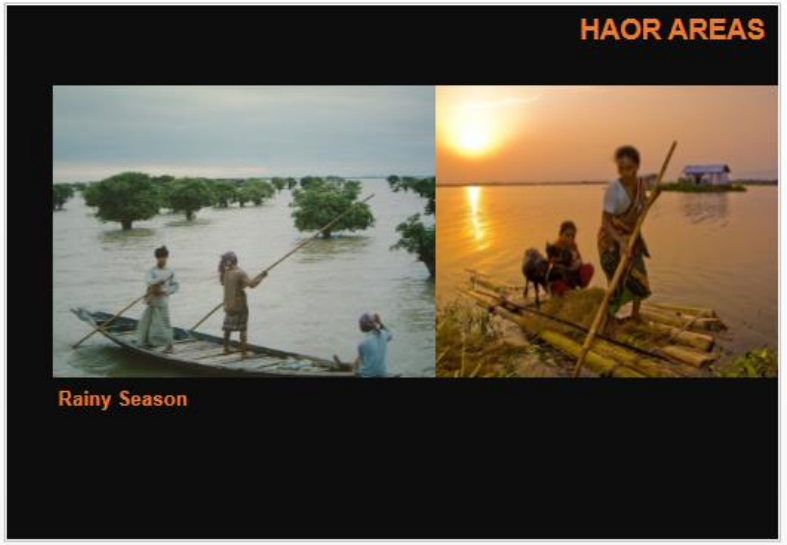
HAOR AREAS
Thatch roof
Ecor with mud
Bamboo
CGI sheet
Vegetation for Plinth protection
Wood
Barak house at "president palli
Kacca house at "Hail haor"

37


HAOR AREAS
Rainy Season

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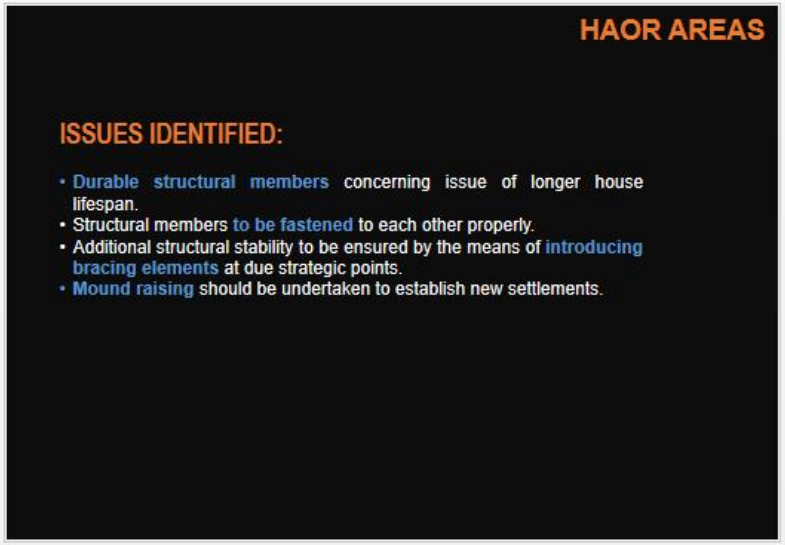
HAOR AREAS
ISSUES IDENTIFIED:
• Durable structural members concerning issue of longer house lifespan.
• Structural members to be fastened to each other properly.
• Additional structural stability to be ensured by the means of introducing bracing elements at due strategic points.
• Mound raising should be undertaken to establish new settlements.

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HILLY AREAS
PREVAILING PRACTICES
• Primarily crafted of natural plant materials.
• New interventions like introduction of CGI sheet and metal strap Joineries could be observed
• Houses get decayed by various environmental forces like rain, heat, dew etc.
• Good performance in terms of cross ventilation.
• Highly skilled craftsmanship.

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Introduced Housing by Different NGOs
EXISTING LOCAL PRACTICES IN HILLY REGIONS

41


Land Slides and Flush Flood

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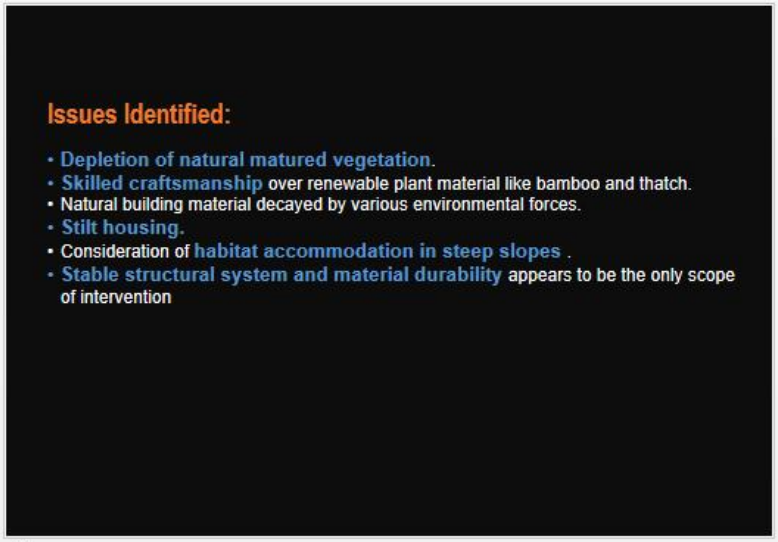
Issues Identified:
• Depletion of natural matured vegetation.
• Skilled craftsmanship over renewable plant material like bamboo and thatch.
• Natural building material decayed by various environmental forces.
• Stilt housing.
• Consideration of habitat accommodation in steep slopes .
• Stable structural system and material durability appears to be the only scope of intervention

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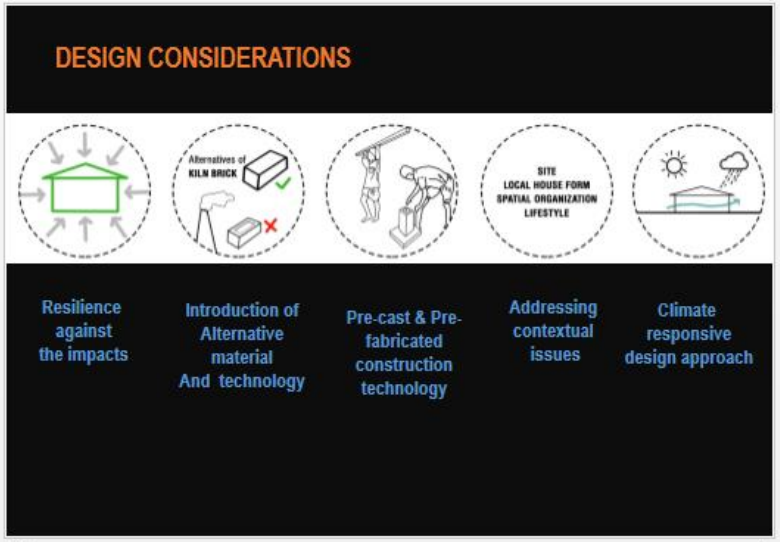
DESIGN CONSIDERATIONS
Alternatives of KILN BRICK
SITE
LOCAL HOUSE FORM
SPATIAL ORGANIZATION
LIFESTYLE
Resilience against the impacts
Introduction of Alternative material And technology
Pre-cast & Pre-fabricated construction technology
Addressing contextual issues
Climate responsive design approach

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GLIMPSE OF DESIGN IDEAS

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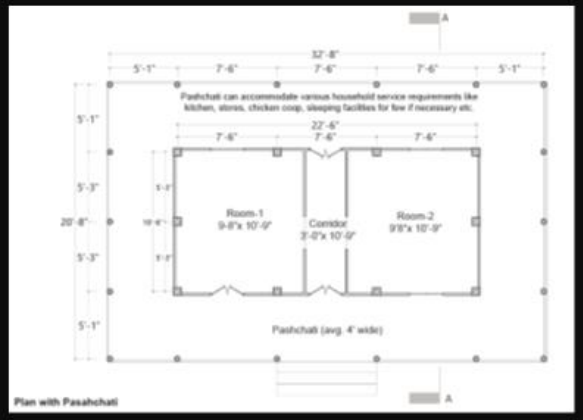
EXAMPLE OF FRAME STRUCTURE



Plan with Pasahchati

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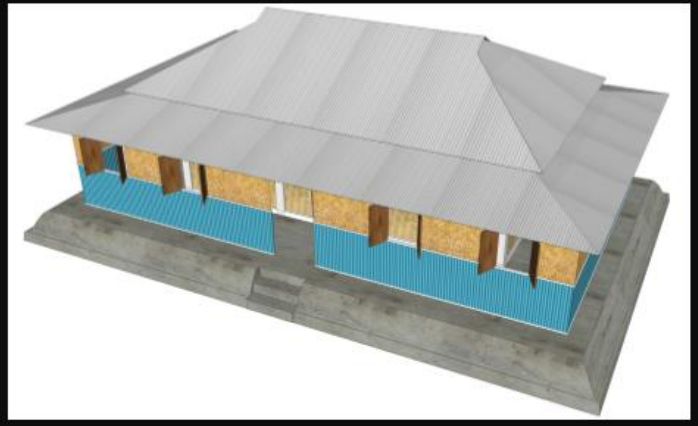

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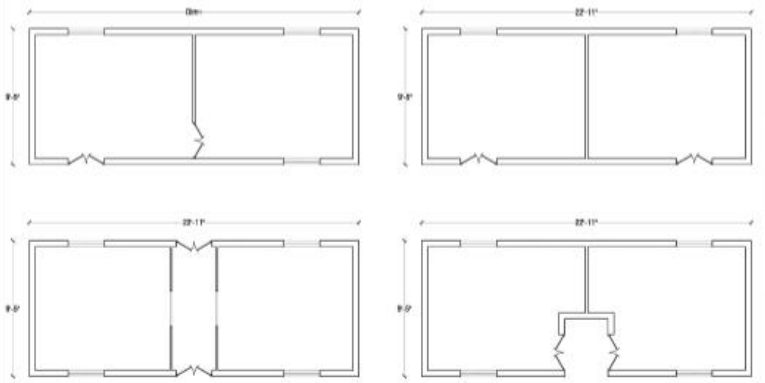
EXAMPLE OF LOAD BEARING STRUCTURE



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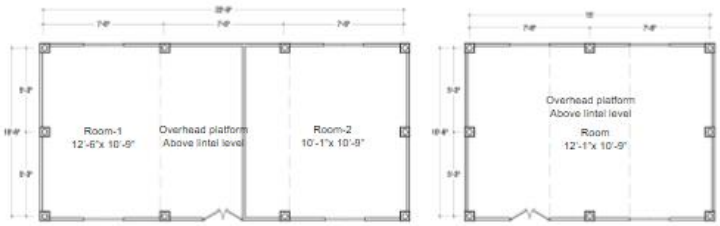
PROPOSITIONS

- **No use of CGI sheet** on roof for this area
- Salinity of water. necessitates for **pre-fabricated building elements**
- Bracing elements must be introduced at various points of house.

- Proposed Materials
  - **Durable House:** More durable building elements, like Prefabricated Ferrocement/RCC elements, sand cement blocks, CSEB etc.
  - **Emergency Shelter/Transitional Houses:** Bamboo mat/CGI Sheet(Not as roofing material),

50

EXAMPLE OF FRAME STRUCTURE



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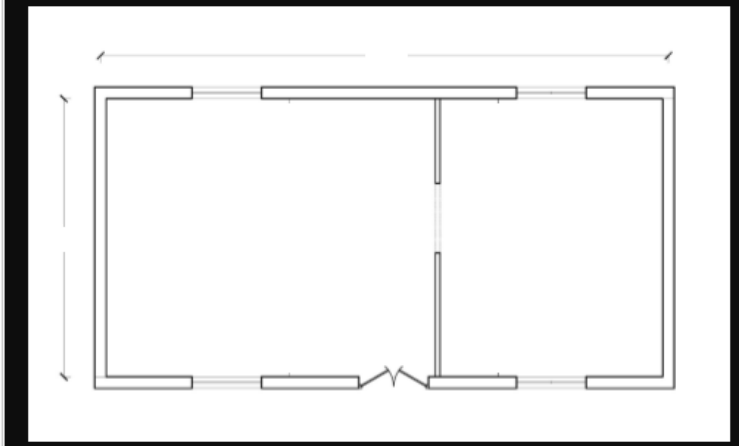
EXAMPLE OF LOAD BEARING STRUCTURE



Plan Model 1

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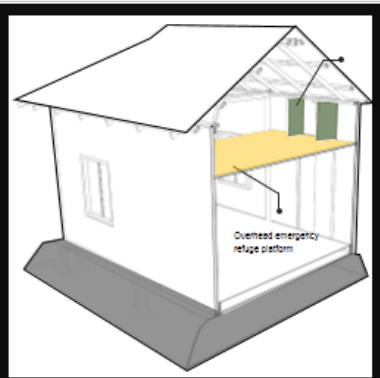

Sectional Perspective showing Emergency Platform with Escape Door

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PROPOSITIONS

- **Removable structure** is needed for Char area
- Plinth **raising**

Proposed Materials

- **Durable House:** More durable building elements **but removable and portable**, like Prefabricated Ferrocement/RCC elements, Ferrocement walling elements, CGI
- **Emergency Shelter/Transitional Houses:** Bamboo mat/CGI Sheet

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DESIGN FOR HAOR AREAS

Plan

Plan with Additional Verandah

56

Complete House Form of Frame Structure with Hipped Roof

57

PROPOSITIONS

- **Removable structure**
- **Plinth raising**
- **Slope protection**

Proposed Materials

- **Durable House:** More durable building elements **but removable and portable**, like Prefabricated Ferrocement/Rcc elements, Ferrocement walling elements, CGI
- **Emergency Shelter/Transitional Houses:** Bamboo mat/CGI Sheet

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Ecological Engineering Measures for Slope Protection

Vetiver

Geo bags protection

Slope for Vetiver plantation

Vetiver plantation

Locally available vegetation and Geo bags with vegetation

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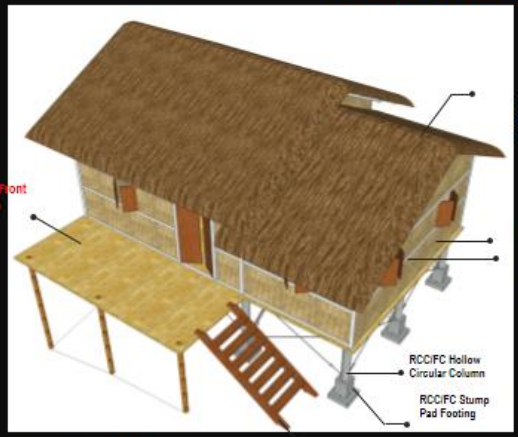
DESIGN FOR HILLY AREAS



Complete Built Form

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PROPOSITIONS

- **Not too much intervention** in terms of design and materials
- **Ferro-cement/RCC post** can be introduced.

Proposed Materials

- **Durable House:** More durable building elements, like Prefabricated Ferrocement/RCC elements

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Multi Storey Structure

1.Vertical Circulation
2. Service
3. Semi-public Circulation
4. Public
5. Private
6. Future Extension

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Perspective View

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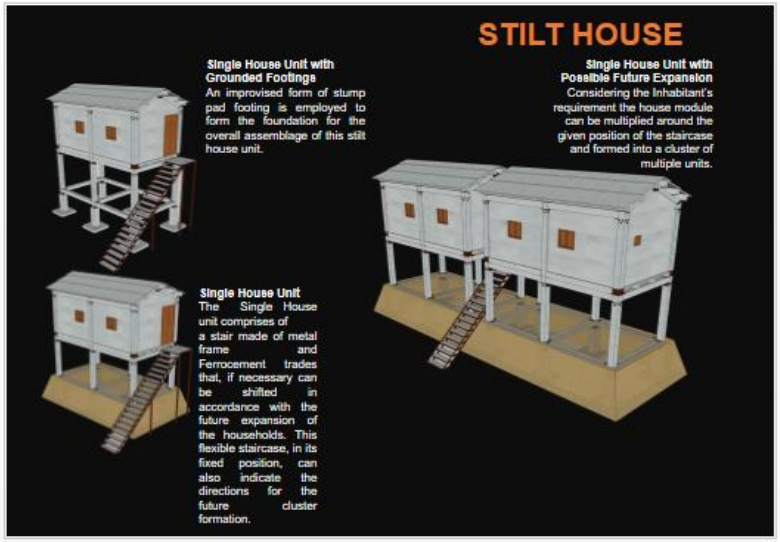

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Specification for Facade Elements

SL	Material	Description	Specifications	Cost	Image
1.	Ferrocement a)Cast-in-situ b)Pre- Cast	• Ferrocement is ideally suited for thin wall structures as the uniform distribution and dispersion of reinforcement provide better crack resistance, higher tensile strength to-weight ratio, ductility and impact resistance. • Ferrocement elements can be divided into two categories based on the construction procedure- •Cast-in-situ ferrocement includes the process of constructing the element in the particular site. •Its difficult to maintain the size, shape and thickness of the element. •Labor charge is high. •Assembling cost is high in this type of construction. • Ferrocement pre cast element can be constructed at convenient places (e.g. factory, workshops) and transported to the sites . • Its easy to move from the places of manufacturing to the construction site. • Labor charge is comparatively low. •Less efforts are required to maintain the size, shape and thickness of the element. •In order to avoid the issues related to salinity in coastal areas pre cast ferrocement elements can be proved to be more preferable.	•Cement :Sand=1:2. •Sylhet Sand having F.M 2.2- 2.6 is used as fine aggregate. •W/C=0.45. •Iron wire mesh= 2-layers of 18 BWG or 20 BWG with 1/2" opening. •Skeleton rod=8mm(both way) @2'c/c •Cement :Sand=1:2 •Sylhet Sand having F.M 2.2- 2.6 is used as fine aggregate. •W/C=0.36-0.45 •Iron wire mesh= 2-layers of 18 BWG or 20 BWG with 1/2" opening. •Skeleton rod=8mm(both way) @2'c/c	Cost per unit= 135 Tk/sft Cost per unit= 120 Tk/sft	 
2.	3D Panel	• 3D panel is a prefabricated panel, which consists of a super-insulated core of rigid expanded polystyrene, sandwiched between two sheets of steel welded wire fabric mesh. •2.5mm diameter galvanized steel truss wire is pierced through the polystyrene core at offset angles for	•Total thickness of mortar(Cement: Sand=1:3) on interior and exterior faces = 62.5 mm •Sylhet Sand having F.M 2.2- 2.6 is used as fine aggregate. •W/C= 0.45 •Diameter of welded wires= 2.5 mmg •Thickness of expanded	Cost per unit=182 Tk/sft	

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SL	Material	Description	Specifications	Cost	Image
3.	Sandwich Panel	The sandwich panels are consisted of two thin ferrocement layers, reinforced with one layer of iron wire mesh, with core(middle part)made of Expanded Polystyrene Sheet.	•Total thickness of the concrete(cement: sand=1:3) on interior and exterior faces = 25 mm •Sylhet Sand having F.M 2.2-2.6 is used as fine aggregate. •W/C= 0.45 •Iron wire mesh= 18 BWG with ½ " opening. •Thickness of expanded polystyrene sheet(density= 16kg/m3)= 56.25 mm •Total finishing thickness= 87.5mm	Cost per unit= 135 Tk/sft	
4.	Compressed Stabilized Earth Block (CSEB)	•Compressed stabilized earth block (CSEB) or a compressed soil block, is a building material made primarily from dredged soil compressed at high pressure to form blocks. •The dredged soil is being collected from Kapasakha, Shurma and Feni river.	•Size: 9.5" ×4.5" ×3" •Compressive strength: 1000psi (dhaka soil) and 650 psi(kapasakha soil). •Mix proportion:10% cement and 90% dredged soil.	Cost per unit= 3,282 Tk/cum	
5.	Thermal Block	•Thermal block is the composition of Expanded Polystyrene Sheet and Mortar(Cement and Sand). •Commonly used as facade material. •Improves the thermal property of indoor environment. Can be used in frame structures. •Lightweight though reduces overall mass of the structure.	•Cement:Sand= 1:4 •Sylhet Sand having F.M 2.2-2.6 is used as fine aggregate. •Size: 9.5" ×4.5" ×2.75" •Compressive strength: approximately 750 psi.	Cost per unit=135 Tk/sft	
6.	CLC Block	• Cellular Light Weight Concrete (CLC) is a version of light weight concrete that is produced like normal concrete under ambient conditions. •It is 50% Lighter than normal brick.	•Size: 20" ×8" ×4"	Cost per unit= 9,788.82 Tk/cum	

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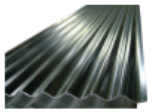
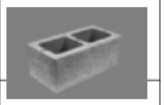
SL	Material	Description	Specifications	Cost	Image
7.	Organic/ Bamboo mat plastered/plastered)	Typically in kutcha houses; semi-pucca often have bamboo mat walls. Organic jute stick, carkin grass) have a lifespan of 2-3 bamboo matt 4-5 years. Decay can get food. In food of high depth and moderate damage begins in the lower part of walls and weakens the walls and eventually results damage. Flood with strong currents can panels and wash them away, leading to partial complete loss, especially if the connections to weak.	•Size: can be of any effective size.	•Cost per unit= 20 Tk/sft(non-plastered) •Cost per unit= 80/ Tk/sqm(plastered)	
8.	CGI Sheet	CGI or Corrugated Galvanized Iron is material composed of sheets of hot-deep galvanized mild steel, cold-rolled to linear corrugated pattern in them. The corrugations increase the bending sheet in the direction perpendicular to the corrugations, but not parallel to them. each sheet is manufactured longer in its direction. CGI is lightweight and easily transported. Corrugated iron is equivalent roof.	•Minimum Thickness= •Approximately Weight bundle =55 kg •Width of Sheet =8/5 mm (Tolerance +/- 10 mm) •Length per bundle approximately =/12 feet.	•Cost per unit= 127 Tk/sft	
9.	Sand Cement Hollow Block	•These blocks are produced by combining sand and cement .Low Maintenance, Color and brilliance of masonry withstands outdoor elements. • Strength can be specified as per the requirement. •Reduce in total cost of project by being less in dead load of walls.	•Size: 9.5" ×4.5" ×8" •Sylhet Sand having F.M 2.2- 2.8 is used as fine aggregate.	•Cost per unit= 60 Tk/sft	
10.	Poly block with EPS Bubble	• Made from sand, cement, EPS bubble and foaming agent. •Reduce in total cost of project: - Being less dead load of walls. •Reduce in total cost of project: - Being less dead load of walls.	•Size: 9.5" ×4.5" ×3" •The residue of expanded polystyrene is used as poly bubble.	•Cost per unit= 60 Tk/sft	

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SL	Material	Description	Specifications	Cost	Image
11.	Interlocking Block	Interlocking blocks are like 2 adjoining pieces of a jigsaw puzzle. Each block has a projection at one end and a depression at the other. The projection of one block fits in to the depression of the next so that they always align perfectly.	•Size: 9.5" ×4.5" ×3" •Mix Proportion:10% cement and 90% dredged soil.	Cost per unit=30.00 Tk/sft	
12.	Aerated Concrete Block	•Autoclaved cellular concrete (ACC) is made with fine aggregate, cement, and an expansion agent that causes the fresh mixture to rise like bread dough. •ACC materials use thin bed mortar in thicknesses around ⅛ inch, depending on the national building codes. •Lighter in weight than normal brick.	•Size: 9.5" ×4.5" ×5.5"	Cost per unit=25 Tk/sft	

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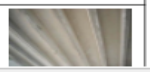
Roofing Elements

SL	Material	Details	Specifications	Cost	Image
1	Ferrocement Folded Plate	Folded plates with a trapezoidal cross-section either in the form of a 'hat' or in the form of a trough section give rigidity, ensure safety while handling to a large depth , and an inclined web with a large tension flange to accommodate reinforcements, lending for suitably pre casting (prefabricating.	•Size: Flange width=5" Thickness=3/4" Maximum Depth=8" Length= Usually 10'6"(Can be changed as per requirement)	Cost per unit= 175.00 Tk/sft	
2	Ferrocement Corrugated Sheet	•Ferrocement corrugated sheets can be used as mono pitched, gable or hipped roofing element. •It is suitable for coastal areas due to its non corrosive property. •Its thicker section, compared to conventional CI sheet, helps to withstand high wind pressure in coastal areas	•Size: Thickness=3/4" Length= 12'6"(Can be customized as per design requirements)	Cost per unit= 171.00 Tk/sft	
3	Cast in-situ Ferrocement Roof	•Ferrocement roof shell transfer much less heat as compared to cement sheet/ CGI sheet roof. •It can be fully insulated against heat transfer. •Joint less ferrocement roof prevent humidity transfer inside.	•Size and Length can be changed as per requirements.	Cost per unit= 135.00 Tk/sft	
4	Ferrocement L-Panel	•The cast ferrocement L panel is a prefabricated L-shaped roofing element consists of full span RC ribs with wider legs as flanges, which is made of ferrocement.	•Size: Rib Depth= 5" Rib width= 2" Flange width=21" Flange Thickness=3/4" Provision of ½ -1 in groove in the flange/top of the rib along the length is made for laps over the adjacent units.	Cost per unit= 188.00 Tk/sft	
5.	Ferrocement Precast Channel	•A pre cast ferrocement channel roofing element is a trough-shaped element flange, which is made of ferrocement and ribs are of reinforced concrete.	•Size: Width= 2ft(including rib portions), Length=Usually 12'6"(Can be changed as per requirement) • Thickness:	Cost per unit= 254.00 Tk/sft	

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