Reviving people's trust in Bamboo technology
A case-study of Orlaha settlement reconstruction in Bihar after the 2008 Kosi floods

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Abstract:

There is a growing body of literature suggesting significance of technical and social guidance during post-disaster housing reconstruction projects. Social process during reconstruction includes considerations of community participation or owner-driven approaches. Technical process includes considerations for achieving a balance between the world-views of beneficiaries and facilitators in terms of multi-hazard safe house form, material, technology, and its cultural, environmental and financial appropriateness. Research suggests that it is the approaches/ process to reconstruction implementation, on which, relies the long-term effectiveness of housing reconstruction projects at imparting disaster-resilience to at-risk communities (Barenstein & Iyengar 2010; Jha et al. January 2010; Lizarralde et al. 2010; Lyons, Schilderman & Boano 2010; Schilderman & Lyons 2011). However, empirical evidence suggests that despite the benefits of and socio-technical support by civil society agencies for re-adoption of traditional materials and technologies for multi-hazard safe housing reconstruction, it often proves challenging.

This paper focuses on the technological and social process of reconstruction in the settlement of Orlaha in Triveniganj block in Supaul district of the Indian state of Bihar, post 2008 Kosi floods. The paper presents preliminary observations from two field-works that were conducted during November-December months in 2012 (Stage-1) and 2014 (Stage-2). The paper examines whether the process of housing reconstruction enabled reviving household's faith in bamboo – a local traditional material for achieving multi-hazard resistance as well as met their aspirations? The research asks questions such as; what is the condition of housing, 5 years since completion of reconstruction? How satisfied are households with their housing? What are the reasons for successful uptake or failure? The paper examines whether and how a convergence can be achieved between technology and social perception.

To this end, the paper's findings indicate that post-disaster context offers a small window of opportunity during which local households are open for changing their perceptions for achieving multi-hazard resistant housing, provided the technical assistance is accompanied with social assistance.

1. Background:

1.1 Owner-driven reconstruction:

In an Owner-Driven Reconstruction (ODR) approach, the survivors are enabled and informed (through social-facilitation) to be in-charge of decision-making for the reconstruction of their own house through all stages (Barakat 2003; Schilderman & Lyons 2011). This approach to reconstruction is not entirely new, as for the poor and the marginalized people, "it is the fall-back mode when people do not receive external assistance" (Schilderman & Lyons 2011, p. 223). The positives of the ODR approach are that participants have a stronger sense of ownership, satisfaction and are able to sustain the disaster-resilience of their housing over long-term due to their engagement and awareness (Barenstein 2010; Ganapati & Ganapati 2009; Hunnarshala 2007a; Lyons 2010). The approach turns out to be quicker, cheaper, has potential to strengthen the social capital and also incorporate livelihood (Davis 1978a; Jha et al. January 2010; Schilderman & Lyons 2011).

ODR approach, however, has been found to be understood and implemented differently by various implementing agencies around the world. For instance, anthropologist Barenstein's (2010) research in the three Indian states - Maharashtra-post 1993 earthquake, the Gujarat-post 2001 earthquake and Tamil Nadu-post 2004 tsunami, found the following three variations to ODR a) owner-driven without NGO; b) owner-driven with NGO top-up, c) participatory (Barenstein 2010; Barenstein & Iyengar 2010). Barenstein's investigation suggests that household's satisfaction was highest in approaches c) and b), as it allowed them greater participation with NGO support.

1.2 Mithilanchal region

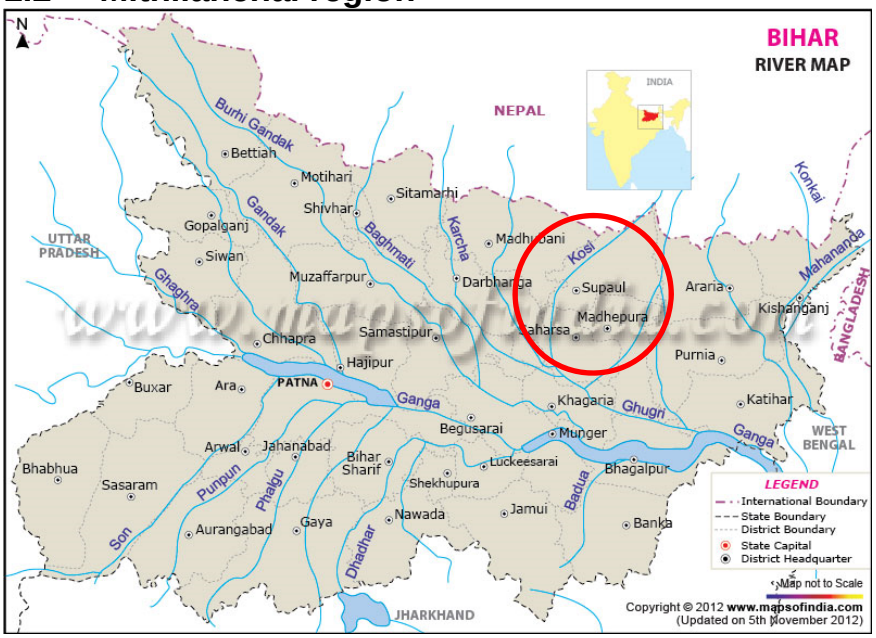

Figure 1: Map of Bihar's river basin

The Indian state of Bihar, located to its north. Bihar is divided in two parts by river Ganges which flows from west to east. Part of the region north of river Ganges is termed as Mithilanchal. River Kosi is one of seven rivers that flow through the plains of Mithilanchal, from north to south, from Himalayan into river Ganges (UNCRD 2003). Apart from these rivers, Bihar is endowed with heavy monsoonal rainfall, as it is located in a tropical to sub-tropical climatic zone. Each year, with monsoonal rains, these rivers help rejuvenate the soil with rich alluvial deposits, on which local agriculture and livelihood revolves. Hence, the local culture is significantly influenced by the climate, hydrology and landform.

Local livelihood is mainly dependent on agriculture and mining. Due to abundant water and fertile land, the region enjoys three harvest seasons in a year – wheat, rice and *mung daal*. Bihar is India's major production centre for key cereal crops such as Wheat and Rice. Presence of rich soil has also led to brick production. Despite such rich natural resources, Bihar faces immense development challenges such a poverty, flood vulnerability, health and education (UNDP 2014), as below:

- Poverty= Nearly 54.4 percent of population lives below poverty line
- Average size of land-holdings = 0.58%
- Income = Rs. 778 (equivalent to $12.67/ person per month), as per the estimates of 2011-2012 (Government of India & Commission 2013; UNDP 2014).
- Literacy rate: 63.82 percent
- Body Mass Index of women < 18.5 = 45.1 percent
- Child <5yrs mortality rate = 84.8 percent
- Rural household's access to three basic amenities - water, toilets and electricity = 10%
- Flood vulnerability = 73 percent of geographical area
- Earthquake vulnerability = 28 out of 38 districts in earthquake zone five and four.

This suggests that poverty and lack of adequate housing, makes local house-holds vulnerable to multiple hazards such as floods, earthquakes and storm surges. "Poverty in Bihar is a function of low per capita land holding, very low industrialization base and limited opportunities in the service sector. Low human endowment and poor infrastructure compound the problem" (UNDP 2014, p. 3). Despite such fertile land with three yields per year, lack of adequate housing, lack of opportunity for economic advancement to maintain housing quality and regular exposure to multiple hazards, pushes the local households further down the vicious spiral of poverty and vulnerability.

1.3 The case of Orlaha settlement, post 2008 Kosi floods:

In August 2008, Kosi River breached its embankment at the Nepal-India border. Thought Bihar is vulnerable to multiple hazards – floods, earthquake and high wind velocity, this disaster was unprecedented (Figure 2). It had devastating effect as the Kosi River burst its embankments, changed its natural river course, inundating the so called "protected area" in Bihar that had not experienced flooding for several decades (GoB 2010; UNDP 2009). Madhubani and Darbhanga districts which are hit by floods more often have evolved means of coping with floods (GoB & ODRC 2008); however, the districts of Supaul, Madhepura, Saharsa, Purnia, Araria and Katihar in northern Bihar had been relatively flood protected with no experience in dealing with floods (FMIS & GoB 2009). About 1,000 villages of 35 blocks in these five districts were severely impacted (GoB 2010). Out of three million people that lived in this region, over 1 million people were displaced; over 3 million people were affected (PiC 2010; UNDP 2009), more than 200,000 homes were damaged and a significantly damage was brought to cattle and crops due to protracted inundations (GoB 2010). This flood was no slow-onset disaster; it was a rapid onset disaster.

Figure 2: Flood devastation in Bihar

2. Research Design:

This research is concerned with the long-term effectiveness of social and technical process during housing reconstruction project in Bihar at reviving people's faith in traditional technology. Hence a mixed-methodological approach is used to inform the design of a detailed research approach. Though the investigation is predominantly qualitative, some features of quantitative methodology, which complement qualitative evidence, are adopted for this investigation.

A 'case-study' research method is adopted because the intent of this work is to study good practice post-disaster housing reconstruction projects to arrive at general conclusions (Robson 1993). A case study is defined as an empirical inquiry that "investigates a contemporary phenomenon in depth and within its real-life context, especially when, the boundaries between phenomenon and context are not clearly evident" (Schramm 1971 inYin 2003, p. 13). The case-study method in this study is modified so that it is multidisciplinary, which bridges the gap between the disciplines of sociology and architecture, due to its concerns with housing as a social artefact (Ahmed 1998) and ways in which housing and social context give meaning to each other during post-disaster reconstruction projects. The criteria for the selection of this case-study project in India are three key components (i) disaster-resilience incorporated in housing design and construction; (ii) an owner driven reconstruction (ODR) approach and (iii) an upfront consideration for capacity building. Variation was sought in terms of the scope of hazard exposure, local housing typology, building practices, socio-economic structure, years since the completion of the project and the duration of agency's involvement.

The method of sampling was based on 'purposing sampling' (Robson 1993). A small sample of about 8-12 households/ beneficiaries, about 3-5 non-beneficiaries and 5-7 agency members was identified as sufficient to give an understanding of the entire project. Information was sought from these three groups of people, for the purpose of triangulation – to enhance the quality of data on the project process and its outcomes, and to corroborate it against each other (Mason 2002). Households were identified from Orlaha settlement based on their caste, their livelihood activity, literacy, financial situation and variation in their house extensions/ modifications. The paper draws upon preliminary analysis of field-study. The outcomes should be viewed in reference to the sample size.

For data collection, qualitative techniques such as face to face semi-structured interviews and focus group discussions with the samples comprised a main aspect of this empirical investigation (Mason 2002; Robson 1993). In addition to the semi-structured interviews, focus group discussions and small surveys, some 'unobtrusive measures' such as documentation/ publications of the project by agencies were also used (Robson 1993, p. 269). Other architecture discipline specific visual techniques such as photographs, sketches of houses and settlement (immediately after reconstruction and present day) and were also adopted where found necessary.
A three step process was followed to analyse the data to overcome the weaknesses of case-study research (Yin 2003). First, themes were derived from literature review; second, analysis of field-study based on a mixed method research approach (inductive + deductive) was carried out and third, the theoretical framework was refined. Before the stage-2 field-trip, the three focus areas in the field of ODR, based on literature review include:

1. Capacity building
2. Spatial design and construction
3. Funding mechanisms

However, these focus areas were amended, as shown in table-2 below due to site-specific circumstances in the settlement areas under investigation. Thematic analysis was used to group the outcomes in key-themes, after the stage-2 field-trip of 2014. These key themes are discussed in the following section.

3. Housing and Settlement Reconstruction in Orlaha settlement

An unparalleled effort followed an unprecedented disaster of 2008, not only to reconstruct houses and settlements, but to also mitigate future disaster impacts on at-risk communities of Bihar. An

Owner Driven Reconstruction initiative was adopted by the Government of Bihar (GoB) in partnership with UNDP and was implemented at pilot stage by a technical committee termed as ODR Collaborative (ODRC). ODRC was composed to technical, scientific, academics and social workers, who were well-equipped with knowledge and experience to be able to devise a fine reconstruction strategy. ODRC was in-charge of developing and demonstrating through a pilot project - the rehabilitation process and hence the policy. Orlaha settlement (Tribeniganj Block) was one of the two places where ODRC piloted the rehabilitation process (GSDMA & UNDP 2005). Since the completion of model settlements and fine-tuning of the ODR policy, GoB has taken up the task of up-scaling reconstruction program and building 100,000 houses in the worst flood affected districts of Madhepura, Saharsa and Supaul – in Mithilanchal region. This paper mainly focuses on the process of reconstruction followed in Orlaha village during the pilot phase.

A three-fold strategy was advocated by ODRC for reconstruction during model settlements:

i. Technical- provide technical guidelines for multi-hazard safety of houses and so that the reconstruction process is not unregulated;
ii. Social - to bring faith back in people that they can built own multi-hazard safe houses;
iii. Financial – provide financial and livelihood support during the reconstruction process, to provide locals with an opportunity to come out of poverty (NIDM 2011).

4. Key themes discussion:

Based on the analysis of the interviews, focus groups, observations of the housing in the settlement and overview of secondary documents, four themes have emerged as shown in Table-1. Theme-1, for example, was identified as capacity building during the literature review, but was modified to 'Social mobilisation and facilitation for maintaining effective engagement' after the field-study. An unexpected discovery was made during the field-study noted as theme-4 - 'participatory governance', which played a significant role in ODR process's long-term effectiveness. To stay within the paper length requirements, this paper discusses one sub-theme of themes 1 and theme 2 in context of Orlaha, Bihar, as shown below.

Table1: Key themes from ODRC case-studies

Theme-1	**Social mobilisation and facilitation for maintaining effective engagement**
a)	Social facilitation process leading to formation of the "*Kosi* setu kendras" (KSKs)
b)	Beneficiary selection
Theme-2	**Technical: Disaster resilient house design and construction:**
c)	Legalising traditional construction technology
	Model house for spatial understanding
	Is owner-driven equal to owner-build?
	Incentive based timely completion
	Access to basic amenities – drinking water, sanitation and power
Theme-3	Modes of financial assistance and livelihood incorporation during ODR process
	Land titles resolution
	Financial assistance – in household's control (male and female)
	Livelihood incorporation/ diversification
Theme-4	Participatory governance
	Participatory governance great as a concept – but does it really work?
	Transition from civil society to local government

4.1 Theme-1: Social process for maintaining effective engagement:

A very strong social process accompanied the technical component. The aim was to enable people to gain faith in rebuilding a multi-hazard safe housing themselves, for them to own the process hence to

retain their dignity and to reinstate people's lost trust in potentials of bamboo and to remove the stigma of it being a 'poor man's timber'. Hence an owner-driven approach was adopted.

Figure 3: My focus group with locals in Orlaha settlement

Sub-theme a: Social facilitation process leading to formation of the "Kosi Setu Kendra" (KSKs)

Within the theme of community mobilisation and facilitation, the sub-theme is about setting up of a team for managing a social-hub (which were termed as 'Kosi Setu Kendra' (KSKs), at later stage during the scaling-up of the pilot project by GoB). Kosi is the region, "Setu" meant bridge and "kendra" meant centre/ hub. In essence, KSKs were meant to provide a bridge between the community and the government. For every cluster of two or three 'panchayats' or for every 2000-3000 houses, one KSK was provided (Acharya 2014; Rawal & Virmani 2012, p. personal interview).

During pilot stage, a group comprising of 1 engineer, 2 social workers, 2 master masons and 1 manager was formed as a 'social-hub'. This group was in-charge of community mobilising and facilitating the reconstruction process. This social-hub played a significant role in enabling community engagement thought out the ODR process.

During preliminary stage of reconstruction, the very first task of social workers (SWs) was to gain local community's trust. ODRC had teamed up with a local NGO called Meghpain Abhiyaan and others, to identify and involve social workers and masons who are local - familiar with the local culture, technology and language. The social workers provided support with the task of social mobilisation – going from one house to the other, explaining households as to why it was important for the community members to build disaster-safe housing (Yadav 2014). Once the trust was established, all the legal and financial issues were resolved through facilitation process. For example, getting local house-holds to open a bank account, where majority of people in this region of Bihar had never had a bank account and were illiterate; and to get legal papers of land-titles for the agencies to be able to help households built a permanent house (Acharya 2014).

During pre-construction and construction phase, after few different model-houses were built for showcasing choices to locals in terms of spatial design, financial package and technological choices, ODRC's team worked closely with the households and local masons. The team of SWs brought awareness to households and provided hand-holding support for purchasing materials, bamboo treatment, monitoring the construction quality and timely access to financial assistance at key

construction completion stages. The ODRC team ensured that households were aware about procuring a mature age (>3yrs old) bamboo, about significance of treating bamboo with chemicals such as boric acid, borax and copper sulphate, sun-drying of bamboo etc.. The SWs were backed up by monitoring done by ODRC's technical team to ensure quality in construction. Hence, the uptake of technical guidelines around bamboo construction can be credited to the social process or social support system established through Setu Kendras, which acted as an information channel between the local households, ODRC and the government.

4.2 Theme-2: Technical: Disaster resilient house design and construction:

Disaster- specific risk reduction technologies in housing were of utmost importance for providing future disaster-resilience to at-risk communities in Orlaha, Bihar. Hence, vulnerability and capability assessment was undertaken by ODRC to understand local material availability, its cost, construction practices (foundations, walls, roofs and connectivity), labour skills and quality of construction.

After considerable assessments, ODRC recommended two options for construction materials, based on i) brick work and ii) bamboo (GoB 2010). Two technical guidelines were proposed as follows:

- Part-I Reconstruction of Multi Hazard Resistant Houses: Brick Construction
- Part-II Reconstruction of Multi Hazard Resistant Houses: Bamboo Based Construction

Bamboo was advocated for in the Mithilanchal region as it was indigenous to the region, good quality bamboo was in ample supply along with ample artisan skills for house construction, whereas brick was expensive and brick may not be available in adequate quantities required during reconstruction (GoB & ODRC 2008). In Orlaha, out of 41 houses, all the houses with an exception of two houses were made out of bamboo.

Figure 4: Abundance of bamboo

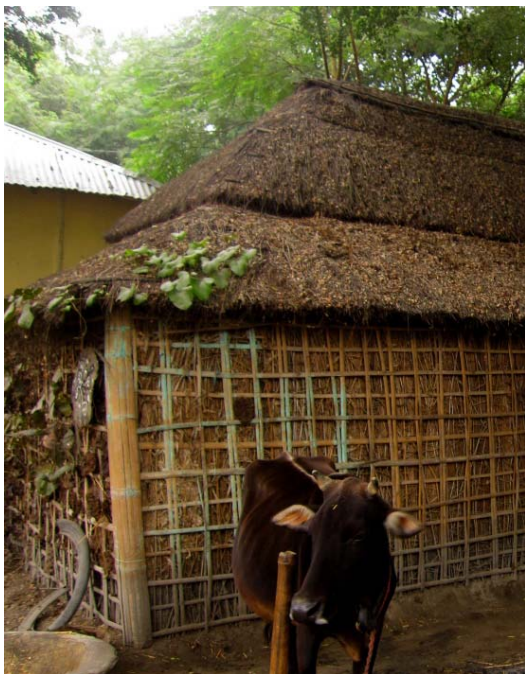

Figure 5: Traditional bamboo housing typology

Sub-theme c: Legalising traditional construction technology: Bamboo

Bamboo is central to the life of people in Mithilanchal. People there say "from birth to death' every step in their lives is supported by the bamboo" (Rawal & Virmani 2012, p. 50). In the Kosi region,

traditionally, most families grow their own bamboo groves (Figure 3). Out of many species of bamboo found in the Kosi region, three varieties of bamboo are mainly used for housing construction. Harot (Bambusa Balcoa), thick walled, structural species is used for main structural frame of the house, the long straight Chab (Bambusa Tulda) is used for roof rafters and Makhaur (Bambusa Nutans) along with other bamboos is used for making the woven bamboo panels for wattle and daub walls (GoB 2010). Hence various refined techniques were evident in traditional housing (Figure 4) such as, flattened bamboo, woven bamboo matts, lashing joinery systems and thatch roofs (Acharya 2014). Bamboo houses were pre-fabricated either by a Dabia mistry (bamboo artisan) or by the households themselves (Figure 5). Once all panels were ready, community members helped each other in assembling them. The roofs were typically made from thatch.

Despite its potential, ample availability of bamboo and artisan construction skills since time memorable, bamboo lacked people's trust in the material. ODRC identified that bamboo technology need not remain an un-engineered, un-scrutinised technology; given its potentials, it needed to be upgraded for its sustainability over 40-50 years and for it to be considered as pucca (permanent) rather than kuchchha (transient) (Rawal 2012). To legitimise bamboo construction technology, following issues were mandated in the guidelines:

i. Harvesting and treatment of bamboo
ii. Multi-hazard resistant design
iii. Bamboo connection details

Furthermore, technical innovations had to be made to accommodate context-specific issues such as:

- Lack of electricity (no power tools for bamboo connection or for pile foundation or for bamboo treatment)
- Cost constraints (limited access to expensive metal bolts or connections or cement or steel)
- High water-table of 5feet, causing issues with deep RCC pile foundation.

Figure 6: Bamboo artisan

Figure 7: Bamboo treatment in a soak pond

i. Harvesting and treating bamboo:

In the technical guidelines, the timing of harvesting during dry seasons is recommended when the starch content is low in bamboo, as starch attracts borers and fungi (Vegesack et al. 2000). Furthermore, for structural purposes, a mature age bamboo, at least more than 3 years old bamboo pole is recommended. However, during field-study it was identified that structural bamboo members in some houses were crushing. That was typically due to immature age of bamboo. The households did not accept that they used immature aged bamboo, but they did agree that there was shortage of

bamboo, prices had hiked and hence they had to buy whatever was available to complete their house construction in time.

Apart from harvesting issue, treatment of bamboo plays a major role in its durability of bamboo. For instance, it is expected that an treated bamboo has a life expectancy of over 40-50 years as compared to an untreated one, which is only 4-5 years (Acharya 2014). There are various methods of treating bamboo – such as lime wash, smoke treatment, chemical treatment etc. Chemical treatment is found to last longest and hence was recommended in Orlaha. The idea was to replace the starch and carbohydrate content with chemicals. Since bamboo has linear tube like fibres, movement of preservative is relatively easy. In Orlaha, an aqueous solution of boric acid, Borax and copper sulphate was recommended (GoB 2010). The treatment was done in a temporary soaking pond, dug in agricultural fields and lined with plastic (Figure 8).

ii. Multi-hazard resistance of bamboo housing:

Bihar is highly vulnerable to floods, earthquake and wind storms. The region of Mithilanchal had no experience or coping mechanisms against floods due to its low exposure. Hence, the coping mechanisms from neighbouring regions of Madhubani were studied by ODRC, as that region was more flood-prone and had coping mechanism (Acharya 2014).

For flood protection, three key features were introduced in Orlaha based on learnings from Madhubani region. First, an attic space to serve as a refuge for human lives in case of floods; second, a strong and deep foundation with high plinth beams on which the house would sit and third, cement stabilised mud plaster for bamboo-matt-woven walls, for plaster to give way to the pressure of water rather than compromising on structure (Figure 7). A basic mechanism such as highest flood level in extreme situation of 2008 floods was used to determine the height of house plinth level in Orlaha. Moreover, due to time constraints and absence of flood-mapping information, ODRC recommended in-situ reconstruction.

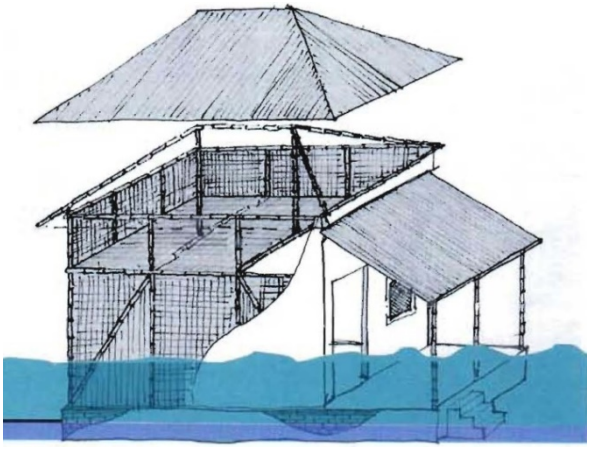

Figure 8: Flood resistant features

Figure 9: Attic space

An attic space (7-8 feet above Ground Level) was mandated for each house to seek refuge and save belongings in flooding (Rawal & Virmani 2012) (Figure 8). Digging deep foundation proved challenging in soils which could easily liquidate during floods and where ground water level was as high as 5 feet. Working collaboratively, ODRC and the local *mistries*, came up with innovative solution for foundation, whereby RCC pile foundation was pre-cast and the hole in ground was dug from within a drum, so as to keep the ground-water away (Figure 9, 10) (Satyanarayanji 2014). These multi-hazard safety features of an attic, higher plinth and give-way wattle-daub walls were new features for households in Orlaha.

In Madhubani region, bamboo architecture is almost as transient as their surrounding land and water form. Every year, mud plaster would wash away from wattle and daub walls leaving the bamboo woven wall-panels exposed, which being lightweight and easy to dismantle were removed, carried on

boats by homeowners for relocation on higher grounds. People identify their way of living with the bamboo plant – being flexible from exterior to change with the changing circumstance but very strong from its roots or in personal values (knowledge based on various discussions with locals in Orlaha). Hence, the reasons for such transient bamboo architecture were deeply rooted in the ever-changing land-form.

Figure 10: Pre-cast pile foundations

Figure 11: Hole dug in soil from drum

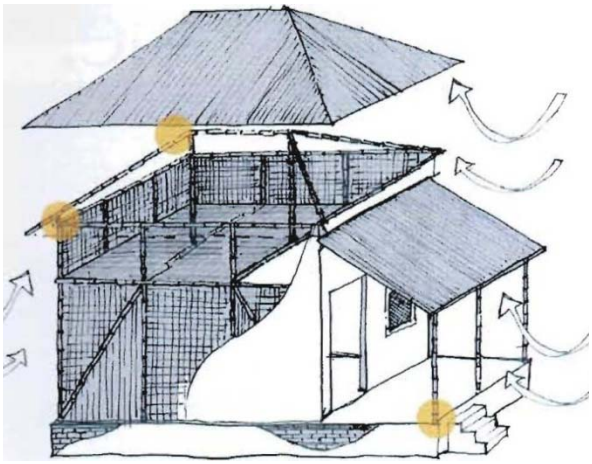

Figure 12: High-wind velocity safety features

Figure 13: Diagonal braces for earthquake safety

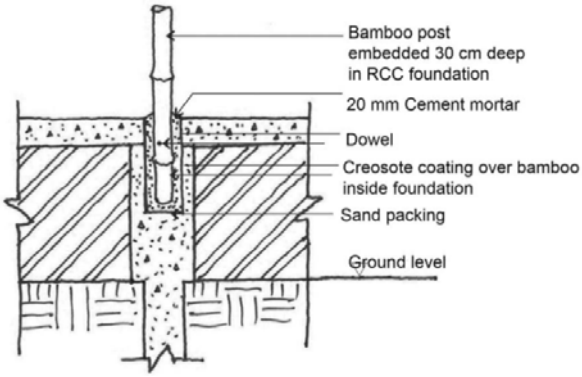

Figure 14: Bamboo foundation

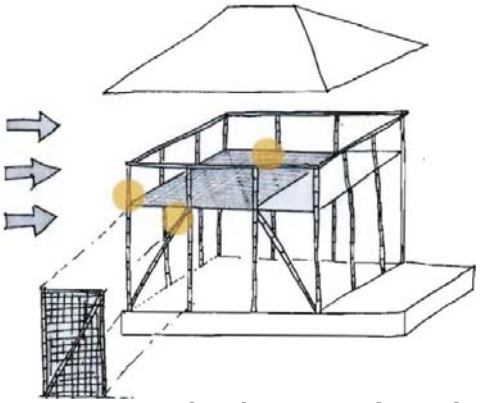

Figure 15: Earthquake resistant diagonal ties

For earthquake resistance, the flexibility, lightness and high tensile strength of bamboo found advantageous. Diagonal bracing members were mandated between posts in all corners from plinth

level to attic level (Figure 11, 12). The distance between two posts was mandated to be equal to or not be more than 1.2m centre to centre (c/c) (GoB 2010). These diagonal braces provided strength to the structure to withstand lateral thrust. This structure when combined with lightweight walls and lightweight roofing system, provided earthquake safety. For safety against high-velocity winds, the connection of bamboo post with plinth beam and the walls to roof were modified to avoid uplifting (Figure 13, 14). During field-visit, these diagonal bracings were found in every house made out of bamboo.

Figure 16: Bamboo connection details: J-bolt detail in roof for wind-safety (source: GoB 2010) (top left); J-bolt connections (top right, bottom left); lashing between column and beam (middle right); bamboo stair connection detail (bottom right)

ii. Bamboo connections:

The local bamboo artisans in Mithilanchal region, known as Dabia mistry are skilled in bamboo construction. Their name is based on the knife - termed as Dabia, which is their main tool for working with bamboo (Figure 5). Lashing and bamboo pins were used as the two main bamboo

connection methods due to existing skill base as well lack of electricity. Moreover, local knowledge, in fact, local innovation in use of Phita (synthetic zipper fabric) for tying instead of natural rope, to reduce maintenance, was incorporated in bamboo construction technology. Hence, ODRC resolved the connection details to fit in the existing skills pool rather than having to train all mistrys. However, minor up-gradations or new features had to be added for multi-hazard safety. For instance, features such as tying column with roof beam through a hole in bamboo to avoid uplift, using J-bolt in roofing members and keeping bamboo columns higher on plinths to avoid moisture penetration, were introduced (Figure 15).

5. Discussion: Orlaha settlement, 6 years after the floods:

An owner-driven process, with financial and socio-technical support meant that people could make decisions on their house design, the size, orientation, materials and construction technology. The financial assistance provided to the households was same for all beneficiaries; hence, if they decided to build a bigger house, they just had to add their own money. Most people chose to build slightly bigger size of house than the model house without much structural modification. Hence, all reconstructed houses appear similar in their form. Some variations do exist, such as exterior paint colours - pinks, greens, whites or decorations or quality of house based on maintenance. Majority of households have made minor extensions and alterations to the funded core-house, which gives each house its own distinct identity. For example, each household has built an external kitchen as they are used open fire cooking, built a *puja* room for their gods and goddess as well as built a shed for their cattle.

Satisfaction with consultation and social process:

Based on the analysis of the small sample, it was evident that majority of beneficiaries were satisfied with the social facilitation and consultation process during reconstruction. High satisfaction rate was found amongst men and women, amongst people from low and high socio-economic background. Most of the households added that regular meetings, discussions and facilitation support that acknowledged locals' capacities, had made them aware of their disaster-safe housing technology and their own coping mechanisms. To some extent, this facilitation process allowed disaster-resilience to become part of their collective memory. Overall, the satisfaction with the social process was high.

In the longer term, the social process was meant to enable households with awareness about designing, choosing materials and building/ monitoring the construction of a disaster-safe house for themselves. It was observed that most of the men showed awareness about disaster-safety features in their house, whereas most women were unaware of the same (if they were not involved during reconstruction). However, almost all women were pleased with the security and safety the reconstructed house had provided their family from future disasters.

Satisfaction with technical support and bamboo technology:

At the time of reconstruction, out of 41 houses that were built in Orlaha settlement, 39 were built using bamboo technology. The reasons why households selected bamboo over brick at that time was, one, they believed in ODRC's claims that bamboo would last over 40 years if the technical guidelines were followed and two, within the given financial assistance, households could built a two room house if used bamboo technology, whereas, they could built only one room house, if used brick technology.

5 years after the completion of reconstruction, satisfaction with bamboo technology was about 50%. Despite the treatment of bamboo, despite innovations in construction technology and technical support, majority of houses had observed infestation in their structural members by *gundh* (borers). In two instances, bamboo beams were crushed. The reason for these issues can be either selection of immature bamboo pole and/or improper bamboo treatment, both of which were responsibility of the households. Upon discussion with local social worker, it emerged that despite awareness raising and technical team monitoring the process, few households bypassed the process of treatment by soaking bamboo in plain water (without any chemicals to remove starch/ sugars from bamboo) (Yadav

2014). It was clear that those who didn't understand the significance of treating bamboo or adhering to the technical guidelines were facing major issues with bamboo's sustainability.

In terms of hazard safety, almost all beneficiaries (over 90%) were confident that their reconstructed house was safe and would provide hazard safety against future disasters. Remaining few households doubted bamboo's ability to last 40-50 years, and hence had their doubts about the safety of house. There was a mixed feeling amongst households - some were not too worried about borers in bamboo poles, whereas, others seemed too dissatisfied. Despite such difference in feeling amongst households, absolutely no households had new extensions made out of bamboo. Almost all of those who were extending their houses or building new ones were using brick and Reinforced Cement Concrete (RCC) technology. Sadly enough, neither Dabia mistry (bamboo artisan) nor any households knew what chemicals were used for treatment of bamboo, during reconstruction or where to procure these chemicals from. This suggested that no households aspired for a bamboo house. This raises questions about the success of this reconstruction project at reviving people's faith in bamboo.

6. Conclusion:

This paper focused on the technological and social process during reconstruction in Orlaha settlement after 2008 Kosi floods and investigated whether it succeeded at reviving people's faith in bamboo technology. Based on the field-study done, 5 years since the completion of reconstruction, this paper investigated housing condition and household's satisfaction with their bamboo house's multi-hazard safety and with the social process. The purpose of this paper was to present preliminary analysis from field-study on the question of whether an owner-driven reconstruction process in Orlaha managed to achieve convergence between technology and social perception/ aspiration.

Preliminary findings indicate that post-disaster context does offer a small window of opportunity immediately after a disaster, during which survivors/ households are open to changing their perceptions for achieving multi-hazard resistant housing. That was the case in Orlaha settlement of Bihar, where flood-survivors had set aside their stigma for bamboo and had given treated bamboo technology another chance to prove itself by following the technical guidelines developed by ODRC. Despite tremendous social awareness-raising accompanied with technical support, local household's faith in bamboo technology is dropping in Orlaha, merely 5 years since reconstruction completion.

It is questionable whether it is people's growing aspiration which is causing dis-satisfaction with bamboo technology or is it to do with the ODR process? On one hand, it is known that once a certain standard of living is achieved, it is but human to desire for even better standard of living, also known as aspiration. This was observed during the field-visit, as majority of households expressed interest in further improvement in their housing standard and were making brick and RCC terraced houses progressively. On the other hand, a completely owner-driven approach is questionable – as it required every household to harvest, treat and dry the bamboo for building their own house. There was no option for households with no understanding of bamboo, to purchase readily treated bamboo poles. This was the case as treated bamboo was not available in market and if available, they won't be affordable for households to buy. I question whether it was best idea to leave bamboo sourcing and treatment in hands of households, not all of whom were expert at identifying bamboo's age, managing treatment and drying process, given that treatment of bamboo was a crucial element in the success or failure of reviving people's faith in bamboo technology?

Thus far, it is understood that despite ODRC's efforts with technical guidance for multi-hazard safety, scientific backup, owner-driven approach and social awareness process, the ODR process has barely managed to change the social perception associated with bamboo in Orlaha. In other words, revival of people's faith in using bamboo-based traditional construction technology has remained low.

List of figure captions:

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