

Self-built housing as an alternative for post-disaster recovery

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ABSTRACT

Purpose: This study evaluates cases where self-built housing is applied by NGO's as a strategy for post-disaster recovery of low-income groups and indicates opportunities for further research.

Methodology: Three post-disaster recovery case studies; (1) Sri Lanka tsunami 2004, (2) Pakistan floods 2010, (3) Philippines typhoon 2013, are examined from three points of view, namely cost and time reduction, maintenance of local tradition and increased hazard resistance, and concentrate on expected long-term effects the approach can have on community resilience.

Findings: The research reveals that self-built as a strategy for post-disaster recovery, could enable cost and time reduction and maintenance of local traditions. Community resilience is achieved by creating a greater understanding of hazard resistant construction principles which decreases the vulnerability of those hit by a disaster. However, tools are lacking to exchange building related knowledge so that it lasts.

Research limitations: Due to a lack of examples, the case-studies available are not so suitable for a detailed comparison, but can nevertheless be used to give an initial evaluation to the application of self-built housing.

Originality value: Better insight is provided into community resilience, with a focus on self-built housing as an approach for post-disaster recovery, giving direction for future research into knowledge exchange tools which could support NGO's in applying them.

KEYWORDS

community resilience, post-disaster recovery, disaster risk reduction, self-built housing

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Eefje Hendriks is a doctoral researcher and lecturer at the University of Technology in Eindhoven and the Avans University of Applied Science, focussing on post-disaster sheltering and community resilience. She investigates tools to exchange knowledge about hazard resistant construction with self-builders. The tools are to be applied by NGO's to guide basically educated low-income groups of disaster survivors in their recovery process. For this paper she collaborates with a group of four master students.

1 Introduction

Worldwide, almost 60 million people are currently displaced by conflict, climate change, disasters and development, having lost their shelter and settlements (Stephanie Nebehay 2015; Gaynor 2015; Section 2015). From these displaced people 30% are sheltered by humanitarian aid organisations, in planned and managed areas, leaving the remaining to improvise their own shelters (Saunders 2016). From last year's estimated shelter demand of 1.8 billion dollars, only a quarter was covered (Initiatives 2015).

Currently, most NGO's provide temporary readymade shelters which do not catalyse the self-recovery process, creating instead an undesirable dependence on external aid (Shelter Centre 2010; SPHERE Project 2011; Baquero 2013). Over time, camps transform into permanent settlements on illegal land, informal cities, when affordable alternatives are lacking and NGO's, governments and landowners miss a long-term vision involving low-income survivors' active participation (Setchell 2006; Brickman Raredon 2016). UN-Habitat emphasizes the need to generate knowledge which gives answers to problems of informality, and indicate what works and what does not (Acioly 2016). In order to innovate the aid process, decision makers need to see practical examples of the positive impact of alternative approaches, such as self-built housing (Hayles 2010; Thrippugazh 2014; Saunders 2016).

While there is substantial literature on post-disaster reconstruction, there is, by comparison, insufficient on self-built reconstruction. It is remarkable that participation is a standard for urban development, as also presented on the No-cost housing conference, but not yet for post-disaster recovery. The cases of the tsunami in Sri Lanka(2004), the floods in Pakistan(2010) and the typhoon in the Philippines(2013), found in literature, exemplify different disaster situations where self-built housing is applied as approach for post-disaster recovery of low-income groups. The goal is to evaluate the potential of these approaches and stimulate a wider application, basing conclusions on successes and shortcomings and giving recommendations for further research.

<i>Disaster</i>	<i>Area</i>	<i>Realization</i>	<i>Project name</i>
2004 Tsunami, Sri Lanka	Jaffna district	Government, UN-Habitat	India Housing project
2010 Flood, Pakistan	Swat region	Heritage Foundation, Glasgow University	Green KaravanGhar
2013 Typhoon, Philippines	East-Samar province	Cordaid, Build Change, CAFOD	Resilient communities

Figure 1. Key aspects of the case studies

2 Self-built housing strategy

This paper evaluates qualities of the approaches that positively influence long-term community resilience. This can be defined as *“the capacity of a community... potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure”* (UN-ISDR 2004). Community resilience is indispensable to enable independence from external aid. Here, only qualities related to the approach of self-built housing which support community resilience are evaluated (IFRC 2014).

First of all, self-built housing has the potential for cost and time reduction. Users provide the needed labour and through participation, future adaptation costs are prevented since the houses directly comply with the user’s needs and principles of hazard resistance. Saving costs and time accelerates the community to create economy opportunities and take care of their own needs (IFRC 2014). Through the use of local materials, incremental processes, self-built, and informal, affordability is gained for low-income groups (Majale, Tipple, and French 2004).

In case of recurring disasters, basic understanding of hazard resistant construction principles can empower a local community reduce their vulnerability, meet their own needs and thus contribute to long-term improved resilience (Berke, Kartez, and Wenger 1993; de Haas, Cox, and Gijsbers 2013; Shaw 2014; Renaud, Sudmeier-Rieux, and Estrella 2013; IFRC 2014; Jennifer Dwyne Barenstein 2006).

Besides that, the autonomy of the end-user in the design and building process leads to liberty of expression of local identity and an important preservation of local traditions (Alexander 1989; Harris 2003). In general, an owner-driven design and construction process, enables the maintenance of the local architecture and cultural identity (Alexander 1989). The commonly used imported emergency shelters lack uniqueness, which impedes owners to recognize their home. Feeling at home and having a future perspective are both crucial for mental recovery after a disaster (Leon et al. 2009; Kennedy et al. 2008). Therefore, an acceptable maintenance of local structures is important for community resilience (IFRC 2014). In addition, community-based construction activities contribute to the psychological recovery of disaster survivors and, if organised well, the sense of community (Leon et al. 2009; Kennedy et al. 2008).

These qualities present the importance of involving the affected population in reconstruction. In this article, for all cases, these three qualities are evaluated: (1) cost and time reduction, (2) increased hazard resistance, (3) maintenance of local identity.

3 Case study evaluation

3.1 Cost and time reduction

In Sri Lanka, due to the uniqueness of the phenomenon and overwhelming media attention, the funding received was exceptional, even more than the loss to be covered. Therefore, disaster survivors with completely destroyed houses were granted relatively large funds, Rs. 550.000, at that time equal to 4300 USD, for each house (UN-Habitat 2012). However, the initial lack of coordination between stakeholders and the misevaluation of risks led to an extended recovery period (Ingram et al. 2006). The exact extension is hard to measure due to the incomparability of each disaster situation. However, time and money were saved because locals were trained to build their own houses.

The situation in Pakistan, started with poor policymaking, leaving a lot of freedom to the various organisations involved (Ward 2012). The close collaboration with the community is characterized by free labour and the extensive use of low carbon footprint local materials, such as bamboo, mud and lime, and vernacular building techniques (Heritage Foundation of Pakistan 2011b). This resulted in 266 decent and remarkably low-cost houses in Islamabad for approximately Rs. 50.000 per dwelling, around 500 USD (Heritage Foundation of Pakistan 2011b).

In the Philippines, the government and NGO's had a relatively good collaboration due to recurring disasters in the area, which enable the implementation of participatory approaches and speeded up recovery. Remarkable is the complete authority given to the community to define and prioritize their objectives and manage a large part of the available budget (Cordaid 2015). In total 537.127 Euro, 668.562 USD at the time, was available for the recovery of one local community with around 200 families (Cordaid 2014). Although the investment is not as low as for example in Pakistan, on the long-term the impact might be bigger since it responds to local needs of recovery. Participants could purchase building materials and hire local construction workers, providing a local cash flow and enabling local businesses to recover faster. The NGO only guided and trained the inhabitants, enabling for example a sensitive cost reduction by supporting community labour, which increased the project's impact (Cordaid 2014).

3.2 Increased hazard resistance

In their first response, the unprepared government of Sri Lanka overestimated the likeliness of a repetition of such an event when defining a no-construction buffer zone. This resulted in relocation of communities to the inland, destroying their livelihood and part of the social structure. However, hazard resistant buildings were ensured and the needed knowledge and skills were shared. The high multi-hazard risk associated with major floods in the monsoon season required safe construction sites with adequate drainage and safety for floods (Zubair et al. 2006; Disaster Management Centre 2005; UN-Habitat 2012).

In Pakistan, all community actors were trained in disaster preparedness, which included construction skills and knowledge about flood resistant typologies (Lari 2011; Malik and Rasul 2011). Especially women were empowered (Malik and Rasul 2011). The introduction of early warning systems enabled faster responses in the future (Heritage Foundation of Pakistan 2013). Besides that, all designs were tested for durability and hazard resistance before being introduced to communities (Heritage Foundation of Pakistan 2011b).

In the Philippines, the repetitive nature of typhoons had enabled the Government to consolidate relationships with NGO's. Through collaboration between the government, the NGO's and the communities future risks were diagnosed, gaps in resilience were identified and disaster preparedness and risk reduction plans were successfully implemented (Janse and Van Der Flier 2014). The NGO aimed to reduce structural risks by stressing principles and details to cope with high wind loads, presented in Figure 2 (Shelter Cluster Philippines 2014b). During typhoons inhabitants had cleverly sought shelter in their rigid outside toilet. This principle was

reused in the program for immediate sheltering, since reinforcing houses to withstand strong typhoons is extremely costly compared to the risk and rebuilding costs (Cordaid 2015). Through participation it is expected that future hazards will have less impact on the community and that they will be able to take measurements more independently.

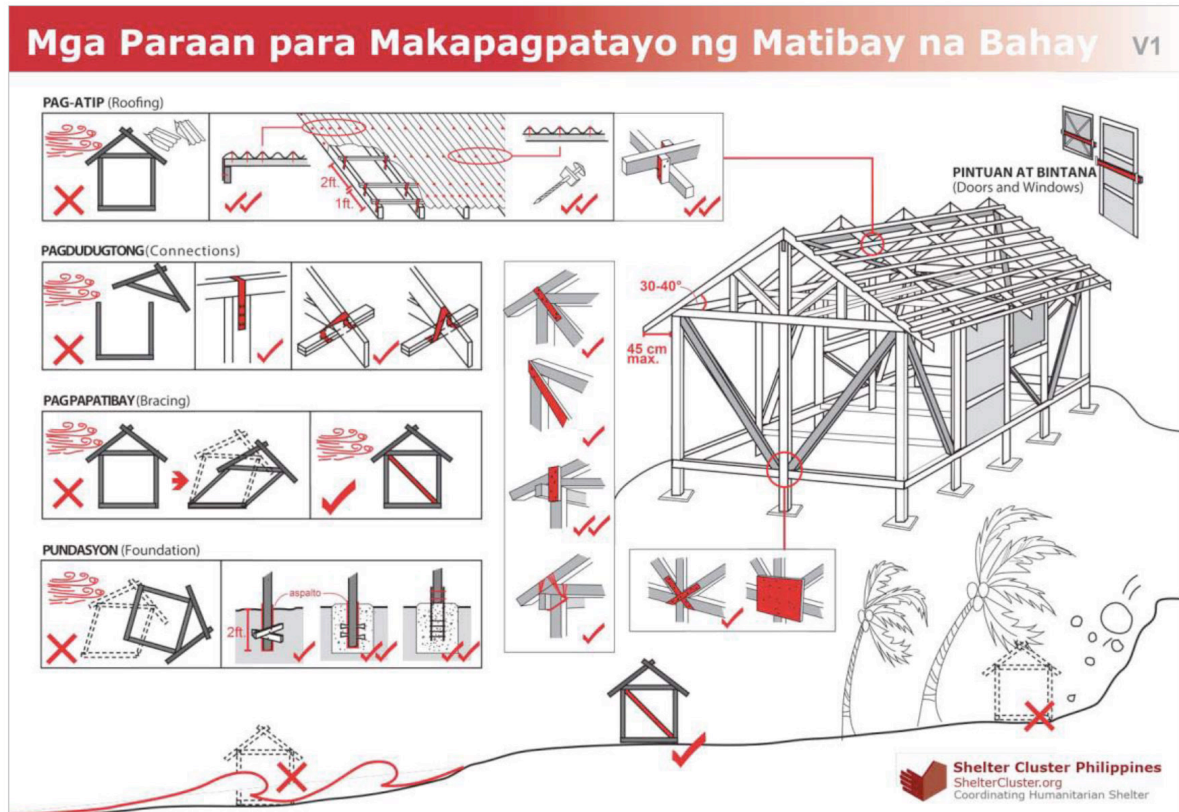


Figure 2. Joints for self-built houses in the Philippines (Shelter Cluster Philippines 2014a).

3.3 Maintenance of local traditions

In Sri Lanka, through collaboration with inhabitants, five building typologies were developed (UN-Habitat 2010). Although traditional in form, they were strongly influenced by international housing typologies with little variations and lacking reference to cultural heritage (UN-Habitat 2012). As presented in Figure 3, they only differed in the chimney position and the presence or absence of a veranda and only gable vents were recognized from traditional constructions. However, the use of cost effective green building materials and methods was encouraged: enabling the communities to execute the work themselves and manage their own natural assets (UN-Habitat 2009). Local clay, earth and sand were mixed with cement to consolidate the structure.

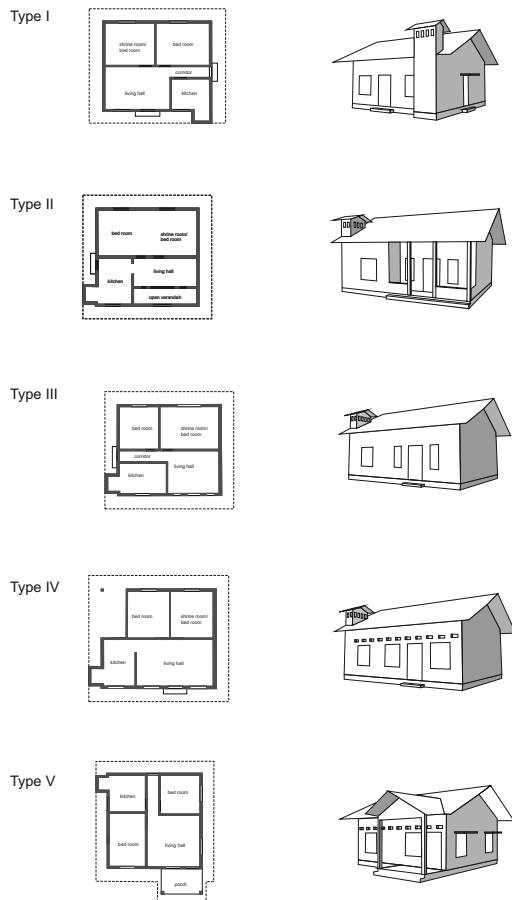


Figure 3. Housing models for Sri Lanka, drawings by Hanna Jurkowska based on (UN-Habitat 2012).

In Pakistan, the use of local building traditions and indigenous materials simplified the participation of the community and made new housing blend with older ones (Heritage Foundation of Pakistan 2011b). Bamboo structures accelerated the construction and the walls of mats resulted in a comfortable indoor climate (Lari 2011; Heritage Foundation of Pakistan 2011b). This prevented environmental degradation and supported the regional economy. With improved construction techniques, confidence was restored in local methods which corresponded to lifestyle, income and personal needs (Heritage Foundation of Pakistan 2011b). Although the designs of the houses were based on local needs, to maximize participation and reinforce the sense of ownership, only 8 designs were developed with small variations in roof types and base plinths, presented in Figure 4 (Heritage Foundation of Pakistan 2011b).

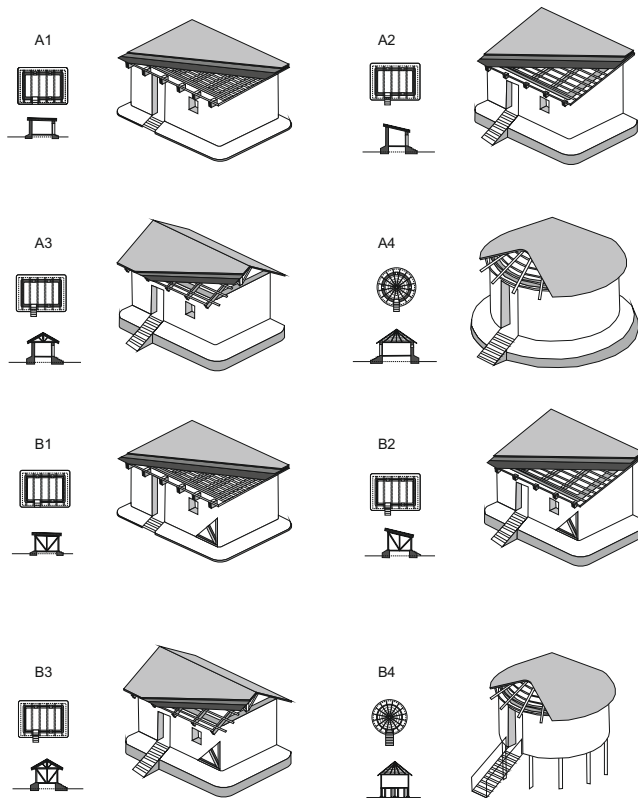


Figure 4. Housing designs for Pakistan, drawings by Hanna Jurkowska based on (Heritage Foundation of Pakistan 2016).

In the Philippines, the community participation led to maintenance of local building traditions since all houses were designed by the owners themselves and corresponded to the surroundings. The use of locally available materials such as timber, coconut lumber, bamboo and organic mats was stimulated (Howe, Chris; Himberg 2014; Shelter Cluster Philippines 2014b). Especially remarkable is the reuse of waste materials in the environment such as the large amount of young coconut trees that were destroyed by the typhoon.

4 Conclusions

Self-built housing has been applied by NGO's in several post-disaster situations as an alternative to readymade or predesigned solutions. From these case studies can be concluded that, if applied well, self-build housing can have a positive impact on community resilience, which could support NGO's and governments to consider an alternative approach. Currently, long-term measurements are lacking to support this statement. This paper highlights cost and time reduction, hazard resistance and the maintenance of local traditions. For a better understanding of the impact of self-built housing on community resilience, more cases, and more qualities and shortcomings need to be evaluated and related.

The case in Pakistan reveals the most remarkable cost-reduction, where the permanent houses had a price competitive with ready-made temporary family tents. If self-built housing would be more accepted as a recovery approach, it would provide an affordable and therefore more realistic answer to the shortage in shelter relief. Key to the low-costs in Pakistan was the strong community involvement and the collaboration with local NGO's, enabled by lacking influence of the government. The strong government involvement in Sri Lanka slowed down recovery by initiating an unnecessary buffer zone. In the Philippines, the government was experienced in disaster recovery and this supported a successful implementation of fast participatory processes. In all three cases the role of the government has influence on the speed of recovery. Based on

these cases can be concluded that recovery is best guided by those with experience in recovery based in the area, such as local NGO's or experienced local governments. In further research the exact influence of decision makers and local NGO's could be measured.

All three cases reveal that empowerment was targeted to reduce disaster risks with trainings and guidance. It would be interesting to measure long-term effects when a disaster recurs and compare the recovery of these communities with communities that had a less participatory recovery program. Besides that, it would be relevant to compare the way knowledge is exchanged in these cases and measure if they have a lasting impact. NGO's need better applied tools to support self-built initiatives.

All discussed approaches intend to respect local traditions. A remarkable maintenance of local traditions is found in the most recent case in the Philippines. No readymade or predesigned solutions were given. The participatory approach in the Philippines can be seen as a best-practice to exchange labour, materials, knowledge and funding. In Sri Lanka, large funding organisations were involved in the recovery, and their influence on the construction process and housing typologies was larger, which might indirectly have caused a greater loss of local traditions. Further research is needed to define how funds influence the loss of local traditions.

Although, few NGO's use self-built housing as a strategy for resilient recovery, in the future hopefully more will recognize its benefits. More detailed case studies, which evaluate self-built housing are needed to support acceptance by governments and NGO's.

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References

- Acioly, Claudio. 2016. "Presentation No-Cost Housing Conference."
- Alexander, D. 1989. "Preserving the Identity of Small Settlements during Post-Disaster Reconstruction in Italy(1)." *Disasters* 13 (3): 228–36. doi:10.1111/j.1467-7717.1989.tb00712.x.
- Baquero, Ivette Arroyo. 2013. "Organized Self-Help Housing as an Enabling Shelter Development Strategy." Lund University. http://www.hdm.lth.se/fileadmin/hdm/Publications/9_Organized_self-help_housing_as_an_enabling_shelter_development_strategy.pdf.
- Berke, P R, J Kartez, and D Wenger. 1993. "Recovery after Disaster: Achieving Sustainable Development, Mitigation and Equity." *Disasters* 17 (2): 93–109. doi:10.1111/j.1467-7717.1993.tb01137.x.
- Brickman Raredon, Anya. 2016. "Instant City: Humanitarian Settlement as a New Urban Form." In *No-Cost Housing*, 7. Zurich: ETH. http://affordablehousinginstitute.org/storage/pdf/Instant-City-Humanitarian-Settlement-as-a-New-Urban-Form_ARaredon.pdf.
- Cordaid. 2015. "Resilient Communities in Guian: Haiyan Recovery and Resilience in Guaiuan." : <http://cordaid.akvoapp.org/en/project/2002/>.
- de Haas, T.C.A., M.G.D.M. Cox, and R. Gijsbers. 2013. "Why (Shelter) Innovation in the Humanitarian Sector Is Scarce : Integrate Building Resilience in the Emergency and Recovery Response." University of Salford. <http://www.narcis.nl/publication/RecordID/oai:library.tue.nl:760614/Language/nl>.
- Disaster Management Centre. 2005. "Towards a Safer Sri Lanka—Road Map for Disaster Risk Management." https://scholar.google.nl/scholar?q=Towards+a+Safer+Sri+Lanka%3A+Road+Map+for+Disaster+Risk+Management&btnG=&hl=en&as_sdt=0%2C5#0.
- Gaynor, Tim. 2015. "UNHCR - 2015 Likely to Break Records for Forced Displacement - Study." *UNHCR*, December 18. <http://www.unhcr.org/news/latest/2015/12/5672c2576/2015-likely-break-records-forced-displacement-study.html>.
- Harris, Richard. 2003. "A Double Irony: The Originality and Influence of John F.C. Turner." *Habitat International* 27 (2): 245–69. doi:10.1016/S0197-3975(02)00048-6.
- Hayles, Carolyn S. 2010. "An Examination of Decision Making in Post Disaster Housing Reconstruction."

- International Journal of Disaster Resilience in the Built Environment* 1 (1): 103–22.
doi:10.1108/17595901011026508.
- Heritage Foundation of Pakistan. 2016. "Build Back Safer with Vernacular Methodologies." Accessed April 23.
<http://www.heritagefoundationpak.org/Page/2011/Build-Back-Safer-with-Vernacular-Methodologies>.
- . 2011a. "Green KaravanGhar and Beyond for Disaster Risk Reduction."
[http://www.indusvalley.edu.pk/library1/Arch/Heritage Foundation Database/Green Karavan Ghar DRR.pdf](http://www.indusvalley.edu.pk/library1/Arch/Heritage%20Foundation%20Database/Green%20Karavan%20Ghar%20DRR.pdf).
- . 2011b. "Green karavanGhar. The Low-Carbon Footprint, Low-Cost Nucleus House." Karachi.
- Howe, Chris; Himberg, Salla. 2014. "Typhoon Haiyan 2013." *Global Shelter Cluster*.
<https://www.sheltercluster.org/response/typhoon-haiyan-2013>.
- IFRC. 2014. "Framework for Community Resilience." Geneva.
[http://www.ifrc.org/Global/Documents/Secretariat/201501/1284000-Framework for Community Resilience-EN-LR.pdf](http://www.ifrc.org/Global/Documents/Secretariat/201501/1284000-Framework%20for%20Community%20Resilience-EN-LR.pdf).
- Ingram, Jane C., Guillermo Franco, Cristina Rumbaitis-del Rio, and Bjian Khazai. 2006. "Post-Disaster Recovery Dilemmas: Challenges in Balancing Short-Term and Long-Term Needs for Vulnerability Reduction." *Environmental Science & Policy* 9 (7-8 November December): 606–13. http://ac.els-cdn.com/S1462901106001067/1-s2.0-S1462901106001067-main.pdf?_tid=50ccfe68-0873-11e5-b9d9-00000aacb360&acdnat=1433172888_ba598bb8039fcb78262b967799a15db8.
- Initiatives, Development. 2015. "Global Humanitarian Assistance Report 2015."
[http://www.globalhumanitarianassistance.org/wp-content/uploads/2015/06/GHA-Report-2015_ - Interactive_Online.pdf](http://www.globalhumanitarianassistance.org/wp-content/uploads/2015/06/GHA-Report-2015_-_Interactive_Online.pdf).
- Janse, Harmen, and Kees Van Der Flier. 2014. "Cordaid's Post-Disaster Shelter Strategy in Haiti: Linking Relief and Development." *Open House International* 39 (3). Open House International Association: 77–85.
<http://www.scopus.com/inward/record.url?eid=2-s2.0-84929151748&partnerID=tZOtx3y1>.
- Jennifer Duyn Barenstein. 2006. *Housing Reconstruction in Post-Earthquake Gujarat*. London: Humanitarian Practice Network.
- Kennedy, Jim, Joseph Ashmore, Elizabeth Babister, and Ilan Kelman. 2008. "The Meaning of 'Build Back Better': Evidence From Post-Tsunami Aceh and Sri Lanka." *Journal of Contingencies and Crisis Management* 16 (1): 24–36. doi:10.1111/j.1468-5973.2008.00529.x.
- Lari, Yasmeen. 2011. "Build Back Safer with Vernacular Methodologies - DRR-Driven Post-Flood Rehabilitation in Sindh." Karachi.
https://www.academia.edu/3618923/Build_Back_Safer_with_Vernacular_Methodologies.
- Leon, Esteban, Ilan Kelman, James Kennedy, and Joseph Ashmore. 2009. "Capacity Building Lessons from a Decade of Transitional Settlement and Shelter." *International Journal of Strategic Property Management* 13 (3): 247–65. doi:10.3846/1648-715X.2009.13.247-265.
- Majale, Micheal, Graham Tipple, and Matthew French. 2004. *Affordable Land and Housing in Africa*. Kenya: UN-Habitat. http://www.iut.nu/Literature/UnHabitat/Africa_AffordableHousing_2012.pdf.
- Malik, Javeria Ayaz, and Tasadduq Rasul. 2011. "Rebuilding Lives Post 2010 Floods." *Actionaid Pakistan*.
http://www.actionaid.org/sites/files/actionaid/rebuilding_lives-publication_3.pdf.
- Renaud, Fabrice G., Karen Sudmeier-Rieux, and Marisol Estrella. 2013. *The Role of Ecosystems in Disaster Risk Reduction*. Tokyo: UNU Press. <https://collections.unu.edu/view/UNU:1995>.
- Saunders, Graham. 2016. "Need for Innovation in Sheltering." Berlin: IFRC SRU.
<https://issuu.com/shelterresearchunit>.
- Section, United Nations News Service. 2015. "UN News - Global Forced Displacement for 2015 on Track to Break All Records, Topping 60 Million – UN," December. United Nations-DPI/NMD - UN News Service Section. <http://www.un.org/apps/news/story.asp?NewsID=52859#.V0Qua2Z2ORs>.
- Setchell, Charles. 2006. "Post-Crisis, Long-Term Shelter Response Is Vital | Shelter Centre." In . United Nations Human Settlement Program. <http://www.sheltercentre.org/node/3049>.
- Shaw, Rajib. 2014. *Disaster Recovery : Used or Misused Development Opportunity*. Tokyo: Springer Japan.
<http://library.wur.nl/WebQuery/clc/2042593>.
- Shelter Centre. 2010. "Shelter after Disaster: Strategies for Transitional Settlement and Reconstruction."
<http://sheltercentre.org/node/12873>.
- Shelter Cluster Philippines. 2014a. "Typhoon Haiyan - Shelter Cluster Technical Guidelines." Shelter Cluster

- Philippines.
https://www.sheltercluster.org/sites/default/files/docs/sheltercluster_technicalguidelines_140216.pdf.
 ——. 2014b. "Typhoon Haiyan 2013." <https://www.sheltercluster.org/response/typhoon-haiyan-2013>.
 SPHERE Project. 2011. "Humanitarian Charter and Minimum Standards in Disaster Response."
<http://www.ifrc.org/PageFiles/95530/The-Sphere-Project-Handbook-20111.pdf>.
 Stephanie Nebehay. 2015. "World's Refugees and Displaced Exceed Record 60 Million: U.N." *Reuters*.
<http://www.reuters.com/article/us-un-refugees-idUSKBN0U10CV20151218>.
 Thrippugazh, V. 2014. "Post-Disaster Reconstruction and Institutional Mechanisms for Risk Reduction: A Comparative Study of Three Disasters in India." In *Disaster Risk Reduction*, edited by Rajib Shaw, 17–39. Disaster Risk Reduction. Tokyo: Springer Japan. doi:10.1007/978-4-431-54255-1.
 UN-Habitat. 2009. "Rebuilding Community Infrastructure and Shelter in Tsunami-Affected Areas." *Regional Office for Asia and the Pacific - Fukuoka*.
http://www.fukuoka.unhabitat.org/projects/sri_lanka/detail10_en.html.
 ——. 2012. "Indian Housing Project: Construction Guide 01."
<http://www.unhabitat.lk/downloads/IND/constguide.pdf>.
 UN-ISDR. 2004. "On-Line Conference: Priority Areas to Implement Disaster Risk Reduction."
<http://www.unisdr.org/2004/wcdr-dialogue/terminology.htm>.
 Ward, Olivia. 2012. "Outrage at Absent Leader Swells amid Pakistan Flood Disaster." *Toronto Star*.
https://www.thestar.com/news/world/2010/08/10/outrage_at_absent_leader_swells_amid_pakistan_flood_disaster.html.
 Zubair, L, V Ralapanawe, Upamala Tennakoon, Zeenas Yahiya, and Ruvini Perera. 2006. "Natural Disaster Risks in Sri Lanka: Mapping Hazards and Risk Hotspots." In *Natural Disaster Hotspots: Case Studies*, 109–36. Washington D.C.: World Bank: Hazard Management Unit.
https://books.google.nl/books?hl=en&lr=&id=Y4gIE0bv2u0C&oi=fnd&pg=PA109&dq=Natural+Disaster+Risks+in+Sri+Lanka:+Mapping+Hazards+and+Risk+Hotspots.&ots=2Tv-5RNdLg&sig=vUrw9kXcN82iG_RjIVU8oTQDLM.