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Liam McCarton

Project Management lessons from Tsunami Reconstruction Program in Sri Lanka.

Liam McCarton, worked in Sri Lanka from 2005 to 2007 as Project Manager for post tsunami reconstruction programs. In this article he discusses some of the technical and humanitarian challenges involved in managing a reconstruction program in a developing country and presents some of the lessons learnt.

Introduction

The Earthquake

On 26th December 2004 a magnitude 9 earthquake occurred off the west coast of northern Sumatra, Indonesia. The sudden and violent vertical displacement of the sea floor caused a disturbance to the overlying water column, which generated waves (tsunami) that propagated rapidly across the whole of the Indian Ocean. Typically, in open ocean waters, these waves have long wavelengths of the order of 200km and low trough to crest amplitudes. These properties allow them to conserve energy as they propagate over large distances. As the waves enter the shallower waters of coastal areas, their amplitude increases dramatically and their velocity reduces, resulting in violent wave impacts and extensive flood inundation inland. Unprepared for such a natural disaster and with no warning systems in place, more than 225,000 people died in South and Southeast Asia, and several million were left homeless.

Sri Lanka

In Sri Lanka, the waves which ravaged a comparably narrow flat coastal strip caused an unprecedented loss of life and property. The effects were increased due to the high density of population distribution within the coastal regions of Sri Lanka. The immediate effect was the deaths of 31,000 people. According to government statistics 92,000 homes were destroyed or damaged causing over 400,000 people to be displaced. Roads, electricity, communication, water supply and other community services were effectively destroyed or rendered unusable. Seawater flooding further disrupted agriculture, fauna, flora and sources of drinking water. The fishing industry was severely affected whilst others such as small scale farmers, craftsmen, shopkeepers, etc suffered losses to crops, tools, premises and stock. Women active in fish processing, small scale vegetable production, food preparation & sale were bereaved of their income. Adding to their plight was the loss of important documents including title deeds, and national identity cards.

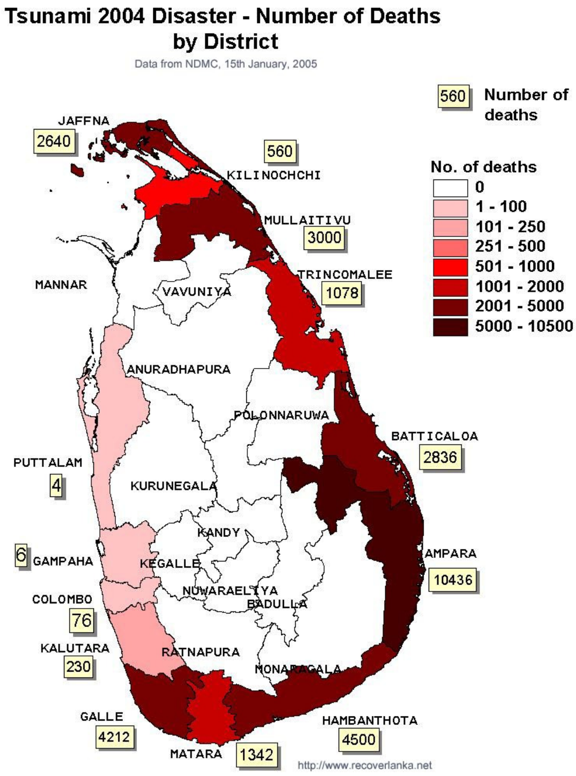

Fig 1 Tsunami Impact in Sri Lanka

Humanitarian Response

The tsunami post disaster program was implemented in three phases:

Phase 1 : Rescue and Relief

- Initial stage after tsunami
- Providing medical treatment to survivors
- Providing food to the displaced
- Providing temporary shelter in the form of tents or in school buildings, temples, churches.
- Providing water and sanitation

Phase 2 : Transitional

- Over 65,000 temporary shelters were constructed comprising two or three rooms, with 3 foot high walls completed to roof level with timber planks and roofed with corrugated sheets.
- Potable water was provided in accordance with sphere standards at a number of central taps, supplied by water tankers.
- Wastewater treatment typically consisted of squat toilets with pit latrines.
- Temporary shelters were planned as a short to medium term measure with the intention of rehousing people in permanent houses as soon as possible.
- Restoration of transport, water, & communication Infrastructure
- Debris clearance

Phase 1 and 2 were carried out in the first six months after tsunami. It is generally agreed that the rescue and relief phase was completed with no deaths due to starvation or lack of medical care, no observation of malnutrition and no outbreak of diseases.

Fig 2 Families displaced by tsunami living in shelters

Phase 3 : Reconstruction & Rehabilitation

The program was in transition from Phase 2 to Phase 3 when I arrived in Sri Lanka in August 2005. The immediate scale of the reconstruction challenges became apparent on the 1 hour drive from the capital city Colombo, on the west coast to the seaside town of Kalutara, 35km south. This densely populated coastal strip had been almost totally destroyed, with no structures intact within a 500m strip from hide tide. This devastation continued down the entire coastal journey to the Southern City of Galle and up the east coast to the northern city of Jaffna. Consider in the Irish context, an area from Dublin south to Waterford and around the west coast to Donegal with all buildings within a 500 – 1000m coastal strip either totally or partially damaged, this is comparable to the situation facing the reconstruction teams in Sri Lanka.

Fig 3 Total structural failure of blockwork homes within coastal zone

Structural Damage

An assessment of the structures affected by the tsunami waves indicates that the most severely damaged structures were those constructed close to the sea. Although the degree of damage correlates to the magnitude of wave pressure, factors such as structural form, shape of buildings and orientation in relation to the wave direction also had significant bearing on the extent of damage. Building with load-bearing walls, especially those that were perpendicular to the direction of the waves had shown less resistance to the ocean waves and had been completely destroyed, whereas framed structures with reinforced concrete columns and beams as well as load bearing walls that are parallel to the direction of the waves have shown a higher degree of resistance. This review was compiled by a team of local and international engineers and was used to prepare a design manual to assist designers to plan developments to minimise the risk of structural failure in future natural disasters.

Reconstruction Program : Construction Issues & Constraints

Post tsunami housing construction programs were completed throughout Sri Lanka, either as Donor Driven programs, where contractors were employed directly by national and international donors to construct houses, or Owner Driven programs, with grants provided to the family to manage their own rebuild. Pre-tsunami annual housing construction in Sri lanka averaged 5000-6000 units. The post tsunami demand or 92,000 houses placed demands for construction services and materials which far exceeded the capacity within the existing industry. Some of the main issues experienced by those managing the reconstruction process were as follows;

Construction Institutional Capacity

The national construction industry lacked capacity in terms of numbers of contractors, equipment, size and skills of the labor force, management practices and access to finance. Architects often lacked resources to supervise and manage contracts effectively.

Land identification and acquisition

Initially after the tsunami the Sri Lankan government declared a “setback zone” within which no building could be reconstructed. This was 100m in the South and 200m from high water mark in the North & East,. A program of relocation of tsunami affected families from coastal areas to inland sites was initiated by the government. The high population density within the coastal zone and scarcity of available land resulted in significant problems in identifying appropriate relocation sites. In many cases this land was several kilometers from the sea and the families did not wish to relocate away from the source of their livelihood. The result of these land issues was a delay in the planning and construction phase of projects. The government subsequently revised its initial buffer zone to 45m. This has had the effect of allowing donors to assist families to start a reconstruction program on the sites of their former homes.

Skills Shortage

Tsunami reconstruction exacerbated the existing skills shortage within the construction industry. Contractors use of non skilled labour in some cases resulted in poor construction. This was evident in particular where donors awarded construction contracts with no provision for professional independent supervision of the works. In some cases this resulted in buildings unfit for habitation.

Access to Materials

There was a shortage of construction materials in Sri Lanka post tsunami. While many materials can be readily imported the procurement procedures for such purchases excluded many small and medium contractors. It was very expensive to import bulk materials such as building sand and quarry products. The contractors approach to securing sand was to send a team to manually dive to river beds with a bucket and extract sufficient quantities to build. The potential environment damage caused by the continued extraction of pit sand and river sand has not been quantified. Large scale quarrying and crushed aggregate production does not exist in Sri Lanka. All concrete (with the exception of slab pours) was batched on site. Use of traditional coconut timber in construction was banned after a significant percentage of the islands coconut timber resources were used in the building of transitional shelters. All timber had to be sourced abroad, typically from Malaysia.

Inflation

Construction costs in Sri Lanka inflated by between 30% - 50% post tsunami. Indications are that the combination of contractor capacity shortages, scarcity of materials, technical skills, construction machinery, and the reluctance of companies and individuals to work in the north east had a significant impact on costs.

Provision of Utilities

Provision of water, energy and appropriate sanitation solutions to unserviced lands in remote locations posed both engineering and social challenges. Many of the families had no previous experience of utility bills and the tradition was for communal bathing practices not household connections. In many sites the developments were completed in advance of provision of these basic needs.

Landmines

The conflict within the North and East of the country has left large areas of the land mined with explosives. Prior to any construction activity taking place this land had to be assessed and declared free of landmines by a special taskforce.

MEETING CHALLENGES THROUGH INNOVATIVE TECHNOLOGY

In order to meet the increased post tsunami construction demand innovative solutions were required. Several key objectives were identified ;

- Minimising usage of scarce resources such as sand & timber.
- Minimizing skilled labour requirement by newer construction methods.
- Reduction of on site wastage & achieve better build quality.
- Minimise construction program time and cost.

The Sri Lankan body for conducting research for the construction industry, National Engineering Research Development Centre (NERDC), had conducted research into using pre-cast standardized building components within the Sri Lankan industry. They had carried out pilot projects pre-tsunami and the results of their studies showed that by mass producing building components in a controlled environment using new and cheaper raw materials and adopting size reduction of components by optimising structural design, significant savings in terms of resources and cost could be achieved.

Case Study

Thimbilli tsunami development in the western coastal town of Panadura is an example of how designers and contractors incorporated new technology (in Sri Lanka) in the tsunami reconstruction program. This development consisted of 120 three storey apartment units in blocks of 6. The traditional Sri Lankan design and construction method for a development of this type would consist of random rubble foundations with insitu columns and beams, insitu rc slabs and blockwork walls.

This development was designed to minimize the use of scarce resources and skilled labour. The design incorporated plinth beam foundations to minimize excavation by hand and use of stone. Ground floor columns comprised precast prestressed columns on precast pocket foundations. This allowed mass production of the components on site using less skilled labour, less material and by eliminating formwork, the erection program was quicker. The traditional blockwork walls were replaced by slip form walls. These type of walls comprised 1:12 cement and quarry dust / sand mix with 2% coconut coir fibres included in the mix. The walls were constructed using steel shutters in lifts of 3 feet. The high quality finish eliminated the requirements for plastering. All windows and door frames consisted of pre cast concrete frames manufactured by a local NGO. This resulted in a cost saving over imported timber of 70% and eliminated the need for lintels.

Fig 4 Shows Slip Form wall construction with team of three unskilled labourers

The floor slabs comprised 2” thick composite slabs with pre-stressed beams. This eliminated the need for formwork and insitu steel and concrete pours. Significant savings on labour and time were effected. The roof comprised a tile roof on precast concrete rafters.

Fig 5 Finished apartments, Panadura.

The contract was awarded to one main contractor with ten nominated subcontractors. Each sub contractor was trained in the proposed construction methods using teams of one skilled mason to 9 unskilled labourers. Overall sand savings in the project were from 40% - 70%. Overall resource savings were 40%. Overall cost saving over traditional in-situ apartment projects were up to 40%.

Fig 6 showing beneficiary of tsunami apartment

Conclusion

“Tsunami” now a terrifying household word that destroyed thousands of lives, caused extensive destruction of property and traumatized many more thousands, still haunts this beautiful island paradise of Sri Lanka. As a developing country, Sri Lanka was initially paralyzed by the extent of the damage. Due to a weak economy and lack of technical resources, the Sri Lankan state requested assistance. Unprecedented donations of aid from the Irish people, enabled INGO’s to mobilize technical teams quickly and by working with local engineers and architects, to make a significant contribution to the rebuilding of the devastated coastal regions.

The Author:

Liam McCarton is currently on leave of absence from the Department of Civil & Structural Engineering, DIT. He has recently worked as project engineer for in Niger, West Africa and is currently based in Sierra Leone. His areas of expertise include Project Management, Water, Wastewater and Environmental Engineering.

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