A Study on Transformation of Living Environment and Domestic Spatial Arrangements: Focused on a Western Coastal Housing Settlement of Sri Lanka after Sumatra Earthquake and Tsunami 2004

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Abstract
The objective of this study was to observe the arrangements of coastal housing settlements, their domestic spatial arrangements, and the transformations that occurred after the Sumatra earthquake and tsunami of 2004. The study focused on recovery-related resettlement and relocation programs, as well as the problems that arose during the reconstruction processes. The implications of resettlement and relocation on changes to domestic spatial arrangements and availability, in addition to community adaptations to the changing living environment were also investigated. Furthermore, the factors that need to be considered to ensure the effectiveness of future reconstruction efforts following disasters were analyzed. We also determined that housing structural quality, local living environment organizations and coastline regulations were the primary factors that mitigated the effects of the tsunami along the Sri Lankan coastline.

Keywords: transformation of living environments; domestic spatial arrangements; relocation and resettlement programs; coastal housing settlements; Sumatra earthquake tsunami 2004

1. Introduction and Objectives

Coastal housing in Sri Lanka currently faces a variety of problems related to living environment, including quality and quantity habitability issues and administrative problems in the form of vague government regulations regarding housing construction on the nation's coastline. These problems vary according to the urban or rural areas of the country. Most low income communities are located along the coastline due to the livelihood opportunities associated with such areas and the relative ease with which they can sustain themselves using the available resources such as fisheries, tourism and opportunities related to the provision of service labor, etc. About 70% of all such coastal housing is structurally unsound and susceptible to collapse during disasters. Even though government authorities have historically ignored these factors during housing planning, proper consideration is essential for developing reliable housing designs and proper living environments.

Two thirds of the entire Sri Lankan coastal population was affected by the Sumatra tsunami disaster in 2004. This paper focuses on the totally and partially damaged housing that necessitated relocation or rebuilding along the western coastline of Sri Lanka. Members of these communities have been confused by the sudden changes to their living environments, domestic spatial arrangements and availability, living patterns as well as livelihood and neighborhood environments. Furthermore, the revival of the buffer zone (set-back zone)\(^2\) policy and its accompanying regulations from the Coastal Conservation Department (CCD) has seriously disrupted the reconstruction processes and the reestablishment of new community settlements. The buffer-zone regulation directly impacts the two types of permanent housing programs dedicated to repairing or rebuilding damaged houses. These are the homeowner-driven housing reconstruction programs\(^3\) and the donor-built housing relocation programs\(^4\). For people living outside the buffer-zone, full or partial financial support is provided based on the extent of damage their houses sustained under the homeowner-driven housing reconstruction program. In this study, we describe the resettlement program for homeowner-driven housing reconstruction. For people who were previously living within the buffer-zone, the donor-built housing program, which provides full funding, is underway and is referred to here as a relocation program.

We attempted to clarify the pre-disaster and post-disaster local living environment organizations and
domestic spatial arrangements and availability. The implications of resettlement and relocation on changes to domestic spatial arrangements and availability as well as community adaptations to the changing living environment were also investigated. After observing several affected housing settlements, we determined that restoration results varied widely depending on whether it was an urban or suburban area. For this research, we focused on coastal urban areas.

It is our belief that this study could be useful for proposing appropriate planning methodology for both future post-disaster living environments and domestic housing planning initiatives, as well as for providing valuable information for other house building programs directed at alleviating the housing shortage along the coastline of the country.

2. Method

One of the six fieldwork surveys conducted in the tsunami-affected areas of Sri Lanka was used for this study during our observations of the reconstruction and transformation of the living environment in these areas.

We focused on areas within the Egodauyana GN Division of the Moratuwa DS Division of the Colombo District in the Western Province, which have undergone marked changes to their living environment, domestic spatial arrangements, and availability since the tsunami disaster, as well as on the initiation of the subsequent resettlement and relocation programs. We conducted observations during the periods of 10/02/2007-12/03/2007 and 10/07/2007-25/07/2007 in the western and southwestern coastal areas of the country.

Data was gathered through multiple collection methods including literature surveys of local statistics, international statistics, a field survey of onsite observations, questionnaire surveys, municipal drawings and informal interviews.

In the Egodauyana area, we conducted a layout survey of 350 houses. In order to create a more detailed survey, we then selected 23 families that had been relocated. During our spatial survey and analysis, we analyzed data from two viewpoints: 1) local living environment organizations, and 2) domestic spatial arrangements and availability, over three different stages. These stages were categorized as, a) pre-tsunami layout b) post-tsunami layout (shortly after the disaster) c) post-tsunami layout (2.5 years after the disaster).

Initially, we studied the local living environment organizations in an area covering 0.5 km² and prepared three-stage maps to compare the changes at each stage, and to identify the amount of damage sustained by each housing type for each of the 350 cases examined. We then conducted a detailed study of the 23 selected cases, categorizing them into two different housing types: 1) semi-permanent housing and, 2) permanent housing, in order to ascertain the changes in domestic spatial arrangements and availability associated with the reconstruction processes.

3. Local Living Environment Organizations

3.1 Location and Previous Situations of Coastline Housing Settlements

The Egodauyana GN Division is located along the western coastline of the island, 20 km from the capital city of Colombo. This is a sprawling area of congested, structurally unsound, unhygienic and poorly serviced illegal housing that extends outward from Colombo City along the coast. The high population density of the area is due to the availability of employment, transportation as well as the proximity to commercial, social and educational facilities, all of which are facilitated by the close proximity to Colombo. We identified two main housing types based on structural conditions (Table 1.).

![Fig.1. Location of Egodauyana-GN Division](image_url)

Table 1. Housing Types in Egodauyana Based on Structural Conditions (Weerasinghe W. K.)

| Housing Type | Category                | Description                                                                 |
|--------------|-------------------------|-----------------------------------------------------------------------------|
| Type 1       | Semi-permanent house (SPH) - 60% | Low quality construction material used. (Waste wood or low quality bricks and mixed cement used in construction.) Unstable structures without proper foundations. |
| Type 2       | Permanent house (PH) - 40%   | Long-term construction materials (bricks, cement and permanent roofing materials) used in construction. Stable structures with proper foundations. |
The majority of the people in this community work in the fishing industry, with the remainder being either self-employed or involved in the temporary labor sector. The Coastal Conservation Department (CCD) previously proposed relocating these communities to other areas in order to enhance the conservation status of areas along the coastline. However, due to resident objections, national political issues, and the rising prices of land in the western province, those proposals were not implemented.

We selected a line 100 m parallel to the coastline as the boundary for the study area based on the original (previous) buffer zone regulations. The study area could be divided into two major sections based on the two sets of buffer zone regulations.

Area 1 - 0 – 45 m (new buffer zone limitation)
Area 2 – 45 – 100 m (area belonging to previous buffer zone limitation only)

3.2 Affects and Transformation of the Living Environment

The level of damage to houses observed shortly after the disaster is shown in Table 2. and Fig.2.

We observed 350 semi-permanent and permanent houses in a 0.5 km² area and performed a detailed investigation, including submitting questionnaires to the residents of 23 houses. The houses of 12 of these families were located inside the new buffer zone, while the remaining 11 were outside the new buffer zone. Our observations showed that 60% of the existing houses within the 100 m study area (Table 1. and Fig.2.) were type 1 (semi-permanent houses) while 40% were type 2 (permanent houses).

After the Tsunami disaster, 33% of the community had relocated and 67% remained in Areas 1 and 2 (0 – 100 m). Our investigation showed that most of the residents that moved were employed in sectors other than fishing, while the residents that remained were involved in the fishing industry. We also found that community groups that should have relocated to new areas had built temporary houses on their original properties. The reasons for their reluctance to move included cases where the government...
1. Relocation Process

Original House - Inside the Buffer-Zone, (Permanent/Semi-permanent) → Temporary residence - in public building (temple/community hall/etc.) → Transitional Housing → Grant for a new land and permanent housing - Fully funded

2. Resettlement Process

Original House - Outside the Buffer-zone, (Permanent/Semi-permanent) → Temporary residence - in public building (temple/community hall/etc.) → Transitional Housing (based on victim’s choice) → Grant to repair or re-build the original housing according to the damage level - Fully/Partially funded

Fig. 4. Coastal Housing Arrangements in Egodauyana 2.5 Years after the Tsunami Disaster

Fig. 3. Reconstruction Processes
grant for purchasing new land and building a house in urban areas was insufficient (LKR. 100,000 or 250,000), difficulties in finding another livelihood and unwillingness to settle in a completely different inland neighborhood.

About 60% or more of the homeowners inside Area 1 (0 - 45 m) inside the buffer zone had relocated to different sites, while 40% remained. This statistic highlights the largest remaining problem. Due to the shortage of urban land, the government and donor groups have been unable to find sufficient land to effectively relocate the affected community. As a result, 38% of the home owners in this community requested permission to stay on their original land or requested a grant that would be sufficient to purchase another permanent house sufficiently near the coast for them to continue their livelihood. Another 2% asked for extra grants that would compensate them for the actual value of the property they were being asked to vacate.

Many of the homeowners living inside Area 2 (45 – 100 m), or the area within the previous buffer zone, were confused by the revision of the buffer zone and were subsequently permitted to stay in their original homes. We determined that the progress of the recovery processes in Area 2 was also low due to the inability of many homeowners to provide adequate legal documents or deeds proving previous ownership (which

![Fig.5. Housing Layout Plans in Different Stages of the Reconstruction Programs](image-url)
were required for the approval of grants), as well as the existence of confusion regarding the regulations accompanying the revision of the buffer zone.

Given the abovementioned circumstances, we were unable to fully ascertain the extent to which the current living environment (Area 1 and Area 2) has become uninhabitable and believe that appropriate planning methodologies should be implemented.

Based on our current level of research, as shown in Table 3, and Fig.2., we identified three types of housing that could be designated as either semi-permanent or permanent housing for displaced persons. We could, however, not ascertain several transition processes types, as well as the existence of confusion regarding the regulations accompanying the revision of the buffer zone.

Table 4. Profile of Pre- and Post-disaster Coastal Housing (Egodauyana by Weerasinghe W. K.)

| Pre-Settlement (PS) | Housing Type (HT) | Re-established Site (RS) | Transitional Process (TP) | FS | FA | OFA (m²) | NFA (m²) | DFA (m²) | OHHS | OHHO |
|---------------------|------------------|--------------------------|--------------------------|----|----|----------|----------|----------|------|------|
| I-1                 | PH               | OB                       | PH—TRH—LPH               | SLE | F  | 55       | 24       | -31      | 05   | 06   |
| I-2                 | PH               | OB                       | PH—TRH—LPH               | SLE | F  | 34       | 24       | -10      | 05   | 05   |
| I-3                 | PH               | IB                       | PH—Other—PH             | OS  | 65  | 65       | 00       | 05       | 05   | 13.0 |
| I-4                 | PH               | OB                       | PH—TRH—LPH               | SLE | F  | 48       | 24       | -24      | 02   | 06   |
| I-5                 | PH               | OB                       | PH—TRH                  | OS  | 32  | 24       | 04       | 04       | 04   | 04   |
| I-6                 | PH               | IB                       | PH—TRH—LPH               | SLE | F  | 32       | 24       | -04      | 04   | 04   |
| I-7                 | SPH              | IB                       | SPH—Other—TH           | OS  | 40  | 20       | -20      | 05       | 05   | 8.0  |
| I-8                 | SPH              | IB                       | SPH—Other—TH           | NGO | P   | 46       | 46       | 00       | 04   | 06   |
| I-9                 | PH               | IB                       | PH—Other—TH            | OS  | 48  | 28       | -20      | 07       | 07   | 6.8  |
| I-10                | PH               | IB                       | PH—Other—TH            | OS  | 58  | 31       | -27      | 06       | 01   | 9.6  |
| I-11                | PH               | IB                       | PH—Other—TH            | OS  | 40  | 25       | -15      | 05       | 05   | 8.0  |
| I-12                | SPH              | IB                       | SPH—TRH—LPH            | INGO | F  | 24       | 18       | -06      | 06   | 06   |

| OFA                  | Original Floor Area | OHHO | Original Household Occupancy | FS | Funding Source |
|----------------------|---------------------|------|-------------------------------|----|----------------|
| NFA                  | New Floor Area      | OHHO | New Household Occupancy       | FA | Funding Amount |
| DHA                  | Difference of Floor Area | OHHO | Difference of Household Occupancy | OA | Other Assistance |
| OHHS                 | Original Household Size | NGO | Non-Government Organization  | OS | Owner Savings |
| NHHS                 | New Household Size  | INGO | International Non-Government | F | Fully |
| IB                   | Inside Buffer zone  | SLG  | Sri Lankan Government        | P  | Partially |
| OB                   | Outside Buffer zone | XXX  | Current Residence           |    |                |

3.3 Reconstruction and Recovery Processes

Even though 2.5 years have passed since the tsunami, reconstruction and recovery processes are not yet fully in place. About 70% of the victims in Area 1 and 2 are still in transition houses or in temporary shelters that provide less floor area and low household occupancy. This indicates that the relocation and resettlement processes have implicated domestic spatial arrangements and availability. (Fig.3.)

Because relocation programs are organized based on the availability of inexpensive land in the area, and do not consider the livelihood or original communities order of the families being relocated, we found a very low rate of community integration among new members of the permanent housing environment. Because of this, some of the relocated residents continue to maintain an additional temporary house on their previous land inside the buffer zone for livelihood purposes, or otherwise spend the majority of their time within their previous neighborhoods, which passes the coastal shanty house problem on to the future.

4. Housing Relocation/Resettlement and Domestic Spatial Arrangements

We found a drastic change of housing location and domestic spatial arrangements and availability for both semi-permanent and permanent housing in Area 1. About 60% of the families had moved from their original houses inside the buffer zone and about 25% of those had already moved to relocation sites, while 75% of those (e.g. Case numbers I-2, I-12, and I-6) still lived in small transitional houses. About 40% still lived in temporary houses inside the buffer zone. (e.g. Case number I-10)

Furthermore, in the semi-permanent housing in the area of 45 m – 100 m, we found some changes in the domestic spatial arrangements and availability (e.g. Case numbers O-6 and O-1) and less changes in permanent housing. (e.g. Case Numbers O-11 and O-3).

Although only two different types of housing reconstruction programs are currently in progress, it is difficult to determine clear transition processes because each individual case is different. We could, however, ascertain several transition processes types, as well as...
problems being faced by each community group.

In case I-6 the permanent original house inside the buffer zone was totally damaged by the tsunami, and the residents were asked to move to a transition house 3 - 4 km away. Due to their low income, the family (which worked in the fishing industry) had been given a full grant for a new permanent house by the Sri Lankan government. Yet, because of the area’s high land value, the residents could buy only a land without a permanent house was about 6 km away from their original house. As a result, they continue residing in their transition house while working to handle their other livelihood problems.

In case O-1, the semi-permanent original house that was located outside the buffer zone was totally damaged by the tsunami. After residing for a short period in a transition house, the family moved back into a temporary house built on the original site. Furthermore, since they were unable to prove ownership of the property through a legal deed, they could not obtain a proper grant to allow them to build a permanent house, and thus continue residing in the temporary structure. Cases like these have resulted in an increase in temporary houses built in the area, which can be expected to extend the shanty house problem into the future.

As for domestic spatial arrangements, we found a clear change in pre- and post-disaster situations. A difference of floor area (DFA) of about 57% and a difference of household occupancy (DHHO) of about 61%, indicate negative values that imply a decrease in the infrastructure and community facilities available for use. (Table 4.)

5. Conclusions

1. One of the benefits associated with the recovery programs was that the inhabitants of shanty areas would receive guidance for building permanent housing; possibly the first such experience for many of these people. If successful, this instruction will help to mitigate the damage caused by future disasters and help alleviate problems associated with informal settlements along the coastline of the country.

2. The reestablishment of temporary structures inside the buffer zone is deferring coastal housing and living environment problems into the future.

3. The decrease in floor area and household occupancy could result in future housing quality problems.

4. Due to the buffer zone revival policy, the number of temporary structures has increased. Furthermore, the distance from the coastline affects the level of damage. These findings show the necessity for clear regulations pertaining to coastlines.

5. While the relocation and resettlement programs are effective, both need to be undertaken in a sensitive manner as community satisfaction is important. Relocation efforts will be more effective when they consider the livelihood, original community order and the previous neighborhood environment.

6. Housing measures and resettlement arrangements differ markedly between urban and suburban areas. Our observations revealed a wide gap between the quality and quantity of permanent housing and the progress of restoration efforts in urban areas compared to suburban areas. This implies that redevelopment plans should consider the differences between areas and community needs.

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Notes
1. The Sumatra earthquake, with a magnitude 9.0, occurred at 7.58 AM on December 26th 2004 under the Indian Ocean. As a result of the earthquake and tsunami, more than 220,000 people died, making it one of the greatest natural disasters recorded.
2. The buffer-zone (or set-back-zone) was divided into two parts due to the country's land value. Zone 1 – 100 m landwards from the mean high waterline in the western, southern and southwestern districts. Zone 2 – 200 m landwards from the mean high waterline in the northern and eastern districts of Sri Lanka. The buffer-zone has been a critical issue in the recovery process which has not worked equally effectively in all areas.
3. The government of Sri Lanka is providing cash grants backed by different development banks and bilateral donors to affected homeowners for the reconstruction of partly or totally destroyed houses outside the buffer zone.
4. All affected families are entitled to a house built by a donor agency in accordance with the government of Sri Lanka standards. The donor will provide each new settlement with a common internal infrastructure while the Sri Lankan government provides services up to the relocation site. The beneficiary remains the legal owner of his/her property within the buffer zone and receives full title to the property in the relocation site.
5. Grama Niladari (Village Officer) Division of Sri Lanka.
6. District Secretarial Divisions of Sri Lanka.
7. Data collected from RADA - Reconstruction And Development Agency, UDA - Urban Development Authority and other Sri Lankan authorities.
8. Data collected from websites such as http://www.earth.google.com.
9. The original (previous) buffer zone (set-back-zone) was 100 m landwards from the mean high waterline of the coastline. This was changed by the Coastal Conservation Department (CCD) after the disaster.
10. The new buffer-zone (set-back-zone) is 45 m landwards from the mean high waterline of the western coastline. This zone was established by the Coastal Conservation Department (CCD) after the disaster.