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Case studies on mitigating disasters in Asia and the Pacific

Demonstration Housing Construction for Landslide and Flood Prone Areas

A case study from Ratnapura, Sri Lanka

Introduction

The level of disaster preparedness is a major factor in mitigation of natural disasters. Mitigation of the effects of the disasters and protection against hazards require both structural and non-structural measures. Structural measures such as the construction of protective works or alterations designed to diminish the vulnerability of elements at risk and non-structural measures such as regulating land-use and building codes can all reduce the impact of disaster. Such mitigation measures should be integrated with the normal developmental activities. The floods and landslides in Ratnapura District, Sri Lanka in May 2003, again showed the high vulnerability of the community living in the area. In order to reduce the future risks, recovery programmes should integrate the risk reduction measures and construction should be carried out to a higher standard to withstand the hazard forces.

Geographic location of Ratnapura

Sabaragamuwa Province is one of the nine provinces in Sri Lanka and it comprises two districts namely, Ratnapura and Kegalle. Ratnapura District has an area of 3,275.4 km² and consists of 17 Divisional Secretary (DS) Divisions, each of which are again divided into several Grama Niladhari (GN) Divisions for administrative purposes. A GN Division is the lowest village level administrative division consisting of approximately 3,000 families.



Ratnapura is the main city in the Sabaragamuwa Province and is the only Municipal Council (MC) in the province. Ratnapura MC area covers an extent of 2,218.4 hectares. First Local Government Board for Ratnapura was established on 4th January 1922, which was promoted to the Municipal status with effect from 1st April 1968.

Ratnapura town is located in a valley, which is 70 ft. above sea level and surrounded by mountain ranges. The District consists of one Urban Council and thirteen Pradeshiya Sabhas (local government) in addition to municipality of Ratnapura.

Abstract

Relocation and resettlement of the families affected by floods and landslides that occurred during May 2003 in Ratnapura, Sri Lanka, forms the backdrop for this case study. Several public and private sector organisations including the NGOs were involved in this effort. SLUMDMP considered a "Community Based Structural Mitigation Initiative" at a relocation site. The objective of this activity was to construct demonstration housing on hazard prone land. Construction on slopes, flood-prone land and cyclone prone areas came into focus. SLUMDMP provided technical assistance. Its approach was to implement this programme through participation of the relocated community.

Mobilisation of human capital in demonstration housing was launched through the Community-based Organisation (CBO) established by the beneficiary families. Cost effective housing technologies were also introduced during the construction of the model houses. However, organisational, operational and administrative problems arose during the implementation of these activities. The case study looks at the process of implementing the project and lessons learnt.

The inside story

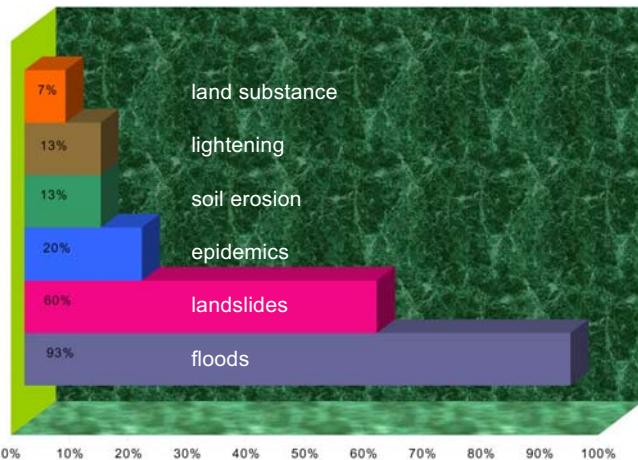
- ❑ Disaster Situation in General - Ratnapura MC area
- ❑ SLUMDMP Demonstration Activities in Housing in Relocation Areas
- ❑ Lessons Learned



Disaster Situation in General - Ratnapura MC area

Ratnapura City is prone to frequent floods and landslides. Land subsidence too is an occurrence in the area, which is mostly due to gem mining activities.

The hazard analysis carried out by the Ratnapura Disaster Management Steering Committee (RDMSC) in 1999 under the SLUMDMP identified the following hazards in the order of frequency of occurrence shown as percentage on the graph below. This data reveals that Ratnapura is vulnerable to multiple hazards.



Floods and landslides in May 2003

Ratnapura town is located at the confluence of Wey (Ganga) River with Kalu (Ganga) River. Since both catchments consist of areas with high slopes, the city gets flooded within a duration of 24 hrs. in an event of high rainfall within the upper catchment area.

On 17th May 2003, Ratnapura had extremely heavy and unusual rainfall of 347.2 mm within 24 hours. Floods that hit the city inundated the commercial area by the end of the day's downpour. This is recorded as the most severe event during the last 47 years.



"Sensing a possible crisis, we, in the Sri Lanka Red Cross Society's (SLRCS) Ratnapura District Branch Office, convened to plan for response. When we came out after the discussion, around 7.00 p.m. we realised that we were marooned by the flood. The whole area was inundated"

Prema Kalawana, Ratnapura District Chairperson of SLRCS.

The total number of deaths due to floods and landslides resulting from this deluge in Ratnapura District was reported to be around 122 of which 94 were due to landslide occurrence. 34,478 families were affected, 3,811 houses were fully damaged and 9,809 houses were partially damaged.

Many landslide occurrences have also been observed within the Ratnapura district surrounding the municipality area.



Landslide - Palawela - Elapatha

Elapatha Divisional Secretary's Division (DSD) was flooded from 16 to 18 May and the area was not accessible. Around 2.00 p.m. on 17th May, a Landslide occurred in Palawela, Elapatha. The entire "Abhepura" village was destroyed with the loss of 75 lives.

Another landslide occurred in Pallegedara in the same DSD killing 4 more persons. Two other landslides occurred in Panapola and Elukpotta in Kalawana DSD where 11 persons were killed. Another 4 persons were killed in the landslide in Devalakanda village in Nivithigala DSD.

Disaster Mitigation Initiatives in Ratnapura Prior to 2003

The Sri Lanka country project of the Asian Urban Disaster Mitigation Programme (AUDMP), Sri Lanka Urban Multi-Hazard Disaster Mitigation Project (SLUMDMP) commissioned its work in Ratnapura in October 1997 by selecting Ratnapura Municipal Council (RMC) area as the Demonstration Project site. Subsequently, project activities have been replicated in Kandy municipality, Nawalapitiya urban commercial areas and in 12 local governments in lower Kelani valley.

The project was a collaboration between Centre for Housing Building and Planning (CHPB), National Building Research Organisation (NBRO) and the Urban Development Authority (UDA).

"SLUMDMP stepped into my office of RMC at a time when I was looking for such initiatives"

Asoka Jayawardane, the then Mayor of Ratnapura, subsequently Chief Minister, Sabaragamuwa Province and later Member of Parliament, Ratnapura.

The Demonstration Phase activities started its work in Ratnapura with a hazard identification workshop. Subsequently Ratnapura Disaster Management Steering Committee (RDMSC) was established with the Chairmanship of the Mayor, Mr. Jayawardane, extending his fullest cooperation to the Demonstration Phase activities, which included the following key areas:

- a. Multi-Hazard Mapping
- b. Training and Professional Development
- c. Information and Networking
- d. Policy Development

The project replication phase ended by 31 December 2003. Demonstration housing was undertaken as a component of SLUMDMP extension phase which ended in March 2005. This activity was initiated to support recovery efforts of government of Sri Lanka after disaster events in May 2003.

Relocation of Affected Families

The Government decided to relocate and resettle most of the 34,478 families affected in May 2003 under the subsequent recovery initiative to reduce the future risks. Steps taken in the process of relocating are presented below.

- **Identification of suitable alternative lands.** The identification of suitable land raised problems due to the extent of land required. Landslides occurred in many areas such as Ratnapura, Pelmadulla, Kalawana, Nivithigala and Kahawatta. Twenty Grama Sewa Niladhari (GSN) Divisions were affected due to landslides. According to investigations carried out by NBRO there are 135 high-risk areas, 69 medium risk areas and 67 low risk areas in the whole of Ratnapura District. Identification of safe locations for resettlement took time. Two blocks of land were identified in Palawela and Ratnapura based on NBRO recommendations. The land identified in Ratnapura for relocation of families is just outside the MC limits, and is a part of Palm Garden Estate.
- **Demarcation of land.** The National Housing Development Authority (NHDA) provided the technical input required by the Divisional Secretary to block out the land for allocation.
- **Selection of families for allocation of land.** Information on the level of loss and damage to families was provided by the

Grama Seva Niladhari to the Divisional Secretariat. This information was used for allocation of blocks of land.

- **Financial Assistance to Build Houses.** Central Government funds allocated to the Social Services Department of the Ministry of Social Welfare was channeled through the Divisional Secretary as financial assistance to selected families, on the instructions of the District Secretary, Ratnapura. Rupees 100,000.00 was given to each of the selected families to build a house on the land allocated. In addition, there was also financial and other assistance given by Non Governmental Organisations (NGOs) to some of the selected families.
- **Technical assistance.** The Technical Officers and Housing Officers of the NHDA provided technical advice to the beneficiaries. No house plan was advocated thus providing flexibility for families to decide their individual house plan.
- **Labour input.** The families themselves organised labour input for construction of houses. Both voluntary and hired labour were deployed in this effort. The nature of mobilisation of labour depended on the income level of these families. The families selected for relocation had different levels of income and social status.

SLUMDMP Demonstration Activities in Housing in Relocation Areas



Initial intentions of SLUMDMP

SLUMDMP at the time of formulating the proposal for the Extension Phase, considered a possibility of initiating an activity on "Community-based Structural Mitigation" in a relocated urban community to support the government's recovery initiative. This was included in the Work Plan as a technical assistance component for construction of houses and infrastructure accommodating disaster resistant features.

The Project proposal envisaged the objectives to be achieved as follows:

- Assist a group of community members who were severely affected due to disaster events in May 2003, in reconstruction and rehabilitation efforts.
- Provide technical assistance in location selection, design and construction and replicate the process in other vulnerable communities.
- Demonstrate a cost effective methodology for reconstruction and rehabilitation efforts through community mobilisation.
- Promote community solidarity, ownership and cultural and social integrity in disaster risk reduction, decision making and implementation process.
- Training of skilled workers (masons and carpenters) in appropriate techniques for construction in hazard prone areas and introduce new sustainable livelihood options for them.

Site selection was to be based on the profile of beneficiaries at the site and considered following criteria:

- Low income level of household.
- Presence of women headed families.
- Lack of self-owned land.
- Resource limitations.

- Maximum family size.
- Partial or complete destruction of houses due to flood/landslide events in 2003 May.
- Will to provide own labour and other in-kind contributions.
- No Objection certificate or approval for construction by the local authority.
- Willingness to carry out 20% work before obtaining project assistance (land clearance, foundation leveling, excavation etc.) by beneficiaries.
- Estimation carried out by the project partners with the involvement of community.
- Willingness to obtain technical assistance from the project.
- Willingness to obtain skill training or to employ those who wish to have skill training during construction.
- No political or other interference in implementation of project activities.

Applicability of selection criteria

The selection of all the affected families for relocation was done by the government authorities and therefore SLUMDMP had no choice but to implement selection criteria such as income level of households and maximum family size etc. However, other criteria such as women headed family, resource limitations, partial or complete destruction due to flood and landslides etc. should be used for future selection.

Original plan was to construct six demonstration houses in the allocated land. It was expected to forge a partnership with the then Ministry of Housing Development to raise local funds to supplement SLUMDMP monetary contribution. This expectation did not materialise due to change of the Cabinet of Ministers after the general election held in the month of April 2004.

SLUMDMP resorted to an alternative strategy of mobilising the social (human) capital from the beneficiary families. NBRO, the SLUMDMP project partner, undertook implementation of this strategy.

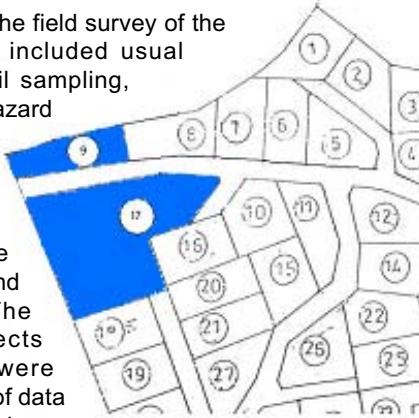
Outcomes expected from Demonstration Housing

- Model House to display how construction can be done in hill slopes
- Model house to display how to construct houses in flood prone areas.
- Construction of a common building (Community Centre), to display design and construction applications for areas prone to high winds and cyclones.
- Model structures to protect the land from earth slips and possible landslides.
- A model drainage system to provide drainage on hill slopes.
- To prevent erosion and stabilise the soil.

In most of the rural and suburban areas of Sri Lanka, the common drinking water source is the dug well. An attempt has been made to demonstrate how a well should be located in a hill slope which will also be instrumental in reducing pore-pressure that might otherwise develop within the land mass and cause slope destabilisation.

The Process

The activity began with the field survey of the land by NBRO, which included usual topographic survey, soil sampling, resistivity survey and hazard mapping. This was followed by data analysis leading to preparation of contour maps, analysis of slope stability, soil thickness and ground water level. The slope design aspects followed next which were based on the outcomes of data analysis. Design of drainage, retaining structures and stabilisation of slopes using a vegetation cover, were then conceived.



Blocking-out Plan of the site

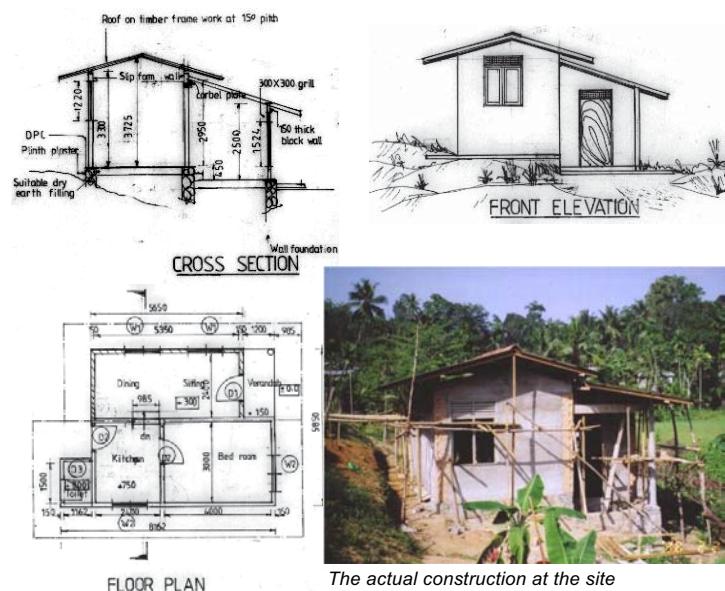
Detailed construction plans were drawn for the demonstration houses and the community centre adopting hazard resistant measures. Guidelines on Construction in Disaster Prone areas published by SLUMDMP were applied. The demonstration housing activity was applied to transform these into physical models. It was also expected to build public awareness on the technical aspects and transfer know-how to the local community. NBRO could provide technical assistance to others in the area for their construction activities.

Once construction commenced, monitoring was carried out twice a month during rainy periods and once a month during dry months.

Special features included in a Model House for flood-prone areas

Special precautionary measures:

- Raised floor level to prevent flood water entering the house.
- Constructed one section of the house at a higher level for further safety against inundation.
- Placed foundation over 600 mm. below ground level to prevent erosion and piping.



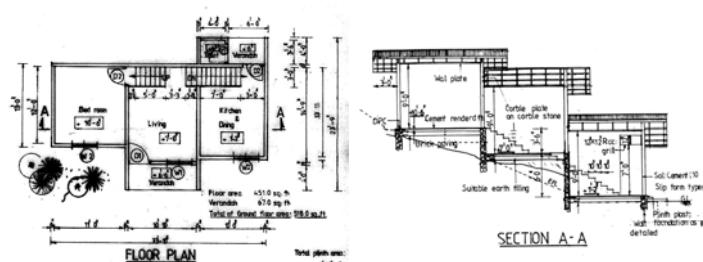
The actual construction at the site

- Constructed the entire foundation with rubble masonry (avoid brick or block masonry). In addition, used reinforced concrete (exposed to wet conditions) to the foundation.
- Plastered plinth with cement-sand (1:3) mix to prevent erosion of the foundation.
- Used clay mix (mixed cement-quarry dust (1:10), instead of the normally adopted cement in the low cost slip-form wall technology, to increase durability.
- Use concrete and cement to render the floor resistant to wet conditions.

Special features included in Model House for hill slopes to control erosion and earth slips

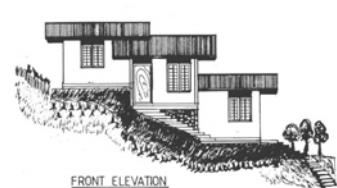
Special precautionary measures:

- Sited the roads parallel to the contour lines in the demonstration housing area.
- Carried out geotechnical investigations prior to earthworks.
- Designed the house with split levels to minimise disturbance to the hill slope, thus controlling erosion and earth slip.
- Retained natural vegetation to the maximum during site clearing.
- Minimised depths of cut and fill to the possible extent.
- Used engineered retaining walls in selected areas of the site and within the split level house.



plan of the model house on the hill slope

sectional elevation of the Model House to display how construction should be done on hill slopes



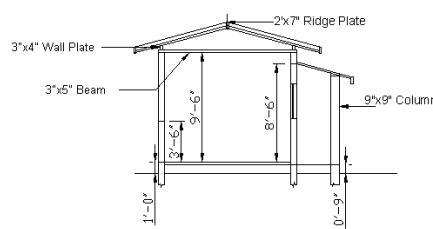
an architect's perception of the completed house on the hill slope



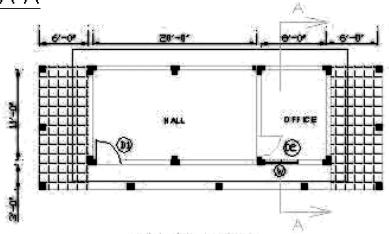
Community Centre with special features to resist high winds/ cyclones

Special precautionary measures:

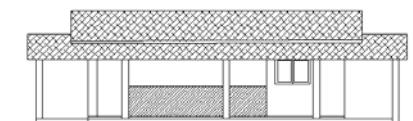
- Incorporated structural integrity in the design by providing Anchorage, Bracing and Continuity (AB&C) right through out the structure.
- Placed foundations at a sufficient depth (i.e. 750 mm) to minimise erosion and provide lateral restraint.
- Used foundations with concrete bases for the pre-cast columns and in-wall foundations to prevent erosion (avoiding brick masonry).
- Applied a damp proof course (DPC) on top of the foundation.
- Used low-cost slip form wall technology with an improved mix. For example, cement-quarry dust-soil mix (1:4:6) instead of the usual cement-soil mix. Constructed walls in between precast columns.
- Built reinforced lintel to anchor the reinforcement from the walls and provide fixing to the roof rafters. This also provided lateral restraint.
- Fixed purlins properly to the rafters not exceeding 1.0 m space between purlin.
- Properly fixed all roofing sheets to purlin with hook bolts ('J' hook bolts).



SECTION A-A

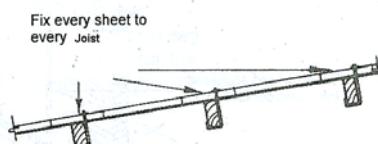
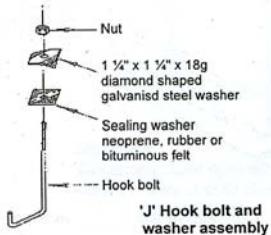


FLOOR PLAN
Total Floor Area - 622.5 sq.m



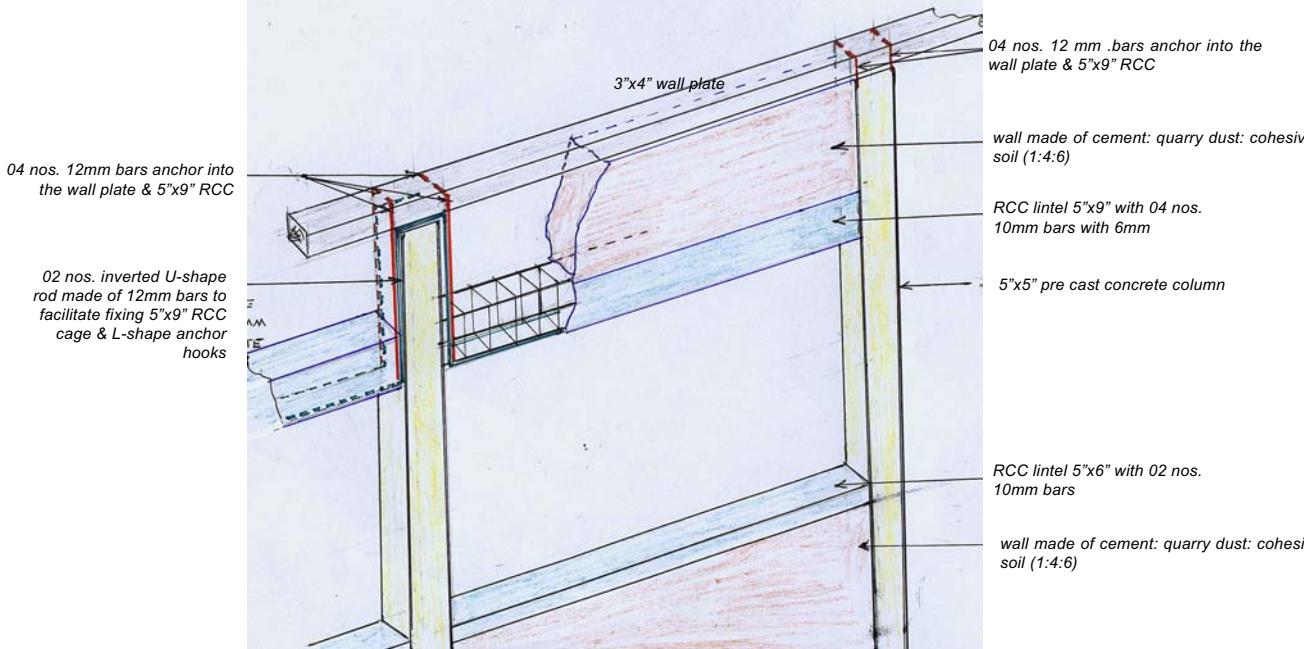
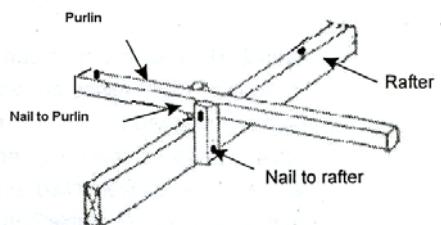
FRONT ELEVATION

Structural Arrangements to Resist Wind Forces - Community Centre



Location of hook bolts

Connection Detail of Rafter & Purlin



Community Participation

Mobilisation of Social (human) Capital in demonstration housing activities was launched through a Community-based Organisation (CBO) known as "Eksath Subhasadhaka Sangamaya" (meaning United Welfare Society), which was established by the beneficiary

families. While endorsing the concept of original intentions of SLUMDMP, the CBO made constructive suggestions to revise planned activities. These were warmly accepted and integrated as community needs were observed to be of paramount importance for the success of the venture.

"Landslides have affected me for the third time. Other families and I have been brought into this land to provide alternate accommodation. My experience tells me that I am again in danger. This is also an unsafe land. It might slip down one day in future. Everybody is now constructing on this land. Automatically, the stability of this land gets disturbed. Please do something to stabilise this land"

B.A.Manel, the chief householder of a woman headed family affected by landslides during May 2003 and relocated in Palm Garden Estate



"Without a proper drainage system in this land we will be living in unsafe conditions. The land should be stabilised even to protect your model structures"

Nishantha Disanayaka, Secretary of the CBO

Based on the feedback of the community, SLUMDMP revised its plans, establishing a good example for participatory approach in planning and deployment of social capital in projects. The community members offered to volunteer in providing labour component necessary to carry out construction.

Adopting a cost-effective construction technology

Cost of construction in Sri Lanka is rapidly increasing due to various reasons. There is a scarcity of material due to certain restrictions imposed by the government such as sand, timber, lime etc. Therefore, cost-effective technologies were applied in construction of the two model houses using mostly locally available construction materials.



Cost-effective construction activities on Relocated Land using slip-form technology and a low cost material mix of soil and cement

Partnership development

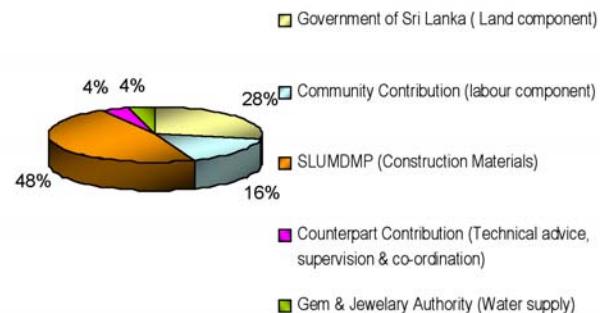
The implementation mechanism was geared through partnerships developed with other stakeholders other than the CBO. They are:

- Representative organisations of District Administration - eg. District Secretary, and Divisional Secretary, Ratnapura

- National Housing Development Authority (NHDA)
- CHPB and NBRO
- Local Authorities - RMC and Ratnapura and Kuruwita Pradeshiya Sabhas
- Other NGOs - eg. Lions Club
- SANASA Bank
- Gem and Jewellery Authority

The following chart illustrates the funds attracted from and counterpart contributions given to the project by stakeholder participating organisations, both governmental and non-governmental organisations including community-based organisation (CBO).

Funds attracted/ Counterpart Contribution



One of the request made by the CBO to SLUMDMP was to facilitate mobilisation of additional funds for the construction of houses due to the reason that funding provided by the government is not sufficient to complete the construction of houses. SLUMDMP initiated the dialogue with SANASA bank with a view to organise a micro-credit scheme for beneficiaries. The discussions so far show positive results but the success would depend on the willingness of beneficiaries to procure such funding. It was also observed that there is a positive response from the Gem and Jewellery Authority to support these activities with a possible and additional funding.

"We can support your initiative through some funds. It would be a maximum Rs. 100,000.00. Let us know what you need".

Asoka Jayawardane, Chairman, Gem and Jewellery Authority.

The organisation of Social (human) Capital, in the process of implementation, has been successfully carried out by SLUMDMP. It is premature to assess the value of social capital involved as the work in this site would continue beyond March 2005. However, prevailing situation hints that the ultimate value of social (human) capital would be within the range of 30% to 40% of the total cost involved in the demonstration housing activities.

Problems during implementation

There were several problems that came across during the implementation of these activities.

- Activities originally planned by SLUMDMP could not be carried out in time due to several reasons:
 - Delays in identification of suitable land by the government authorities (Divisional Secretary, NHDA, Ministry of Lands etc.) for relocation.
 - Delays in selection of beneficiary (affected) families.
 - Time taken for handing over/taking over of land.
 - Design of the model houses was also delayed in the process since it was to be done to fulfill the requirement of beneficiaries.

- Administrative problems created through the prioritisation of activities by other partner organisations compelled SLUMDMP to keep on revising its plan several times.
- Scaling down of originally planned activities due to changes of political environment after the General Election held in April 2004 (eg. Number of model houses were reduced to 3, from the initial expectation of 6, since the contribution expected from Ministry of Housing Development did not materialise due dissolution of the ministry under the new Cabinet).

Capacity building and training of stake holders

The project had created much interest and enthusiasm amongst the people of the area. The skilled workers hired by the project had been trained in cost-effective housing techniques as well as construction and hazard prone areas. The NBRO and CHPB together deployed trainers to the site to train interested persons. The total number of skilled workers trained was around fifteen. They are already applying this knowledge in their work outside the project, mostly in building their own homes or those of relatives and others. This fact itself affirms the credibility infused into the community. It would take some time to spiral out this paradigm and it may be necessary to reinforce this through future activities.

This project was implemented on community-based initiatives where the community is supposed to learn through participation. This is somewhat an exercise of “learning by doing and doing by learning”. Two lead trainers with the assistance of two skilled masons guided the unskilled labour contributors, who are the community members at site on methodologies and considerations to be applied in construction in landslides/flood prone lands. About 15 unskilled labourers trained in such a manner have acquired enough skills to carry out similar construction. When they go out with newly acquired skills, they can play the role of trainers and support individuals and other house builders on appropriate methods of building on land-prone to landslides and floods.

Commenting on the cost-effective housing technology adopted in the two model houses and the community centre, Mr. U.W.L.

Chandradasa, Engineer consultant/lead trainer stated as follows:

“It also needs an attitudinal change. The sustainability of this technology depends on the price of construction materials in the particular location, and the attitude of skilled workmen specially, masons towards rammed earth construction and user friendliness of the technology. Further, the technology depends on the soil bricks for the construction of columns. Availability of soil bricks and its price has a direct impact on the technology. Unless soil bricks are made available at an affordable price or an alternative to construct columns is developed an ordinary person will not be able to use this system.

The social marketing perspective

The model houses stand out magnificently at the site as a demonstration of construction in hazard prone areas. The project intends to carry out suitable landscaping to heighten the visual impact. In the time to come, they would become talking points for the surrounding communities and probably become folklore in the area of how a team of people came into the site to extend support and resources in building three model houses. The value in awareness creation is immeasurable and hopefully would make a significant contribution to a paradigm shift towards safe building in the area.

The school children who are studying the themes of disaster mitigation and related measures, which can be applied in disaster specific situations in different geographical locations, will be able to take away several messages to the elderly community as how to carry out constructions in natural disaster prone areas. Undergraduates, reading for degrees in Geography, Architecture, Town and Country Planning, Building Economics etc. will be able to carryout further research on some of the physical examples of housing construction in flood and landslide prone areas and disseminate information, which will in turn create awareness among respective communities.

Lessons Learned



- Generally, the relocation process does not take into consideration the guidance necessary for the construction of houses by individual persons. This demonstrates that integration of risk reduction is not a general practice of recovery programmes.
- The demonstration housing project should have preceded the allocation of land so that people could have benefited from the demonstration. The model houses as of now would only be useful for the future.
- The model houses have been allocated to persons nominated by the DS. Hence the community was reluctant to participate in the construction of the model houses, as they had no community affiliation. Their contribution materialised only for common utilities such as the well and the community centre. This must be a point for consideration in similar endeavours in the future.
- This demonstrates the possibility of the government institutions to mobilise community support to transfer know-how and technology applications aimed at reducing the risk and physical vulnerability.

Acknowledgment

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Accessed 26 May 2005

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SLUMDMP

The Sri Lanka Multi-hazard Disaster Mitigation Project (SLUMDMP) was launched in September 1997 under the Asian Urban Disaster Mitigation Programme (AUDMP) of the Asian Disaster Preparedness Center (ADPC). The objective is to reduce the vulnerability of Sri Lankan cities to landslides, flood and typhoons. Through activities in Ratnapura, Nawalipitiya, Kandy, Colombo and cities along the Kelani River, the SLUMDMP promoted awareness, built capacities and developed tools for incorporating risk management into urban development planning and implementation

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Safer Cities is a series of case studies that illustrate how people, communities, cities, governments and businesses have been able to make cities safer before disasters strike. The series presents strategies and approaches to urban disaster mitigation derived from analyses of real-life experiences, good practices and lessons learned in Asia and the Pacific. This user-friendly resource is designed to provide decision-makers, planners, city and community leaders and trainers with an array of proven ideas, tools, policy options and strategies for urban disaster mitigation. The key principles emphasised throughout Safer Cities are broad-based participation, partnerships, sustainability and replication of success stories.

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AUDMP

The Asian Urban Disaster Mitigation Programme (AUDMP) is the first and largest regional programme implemented by ADPC. The AUDMP started in 1995 with core funding from USAID's Office of Foreign Disaster Assistance (OFDA) until 2004. The programme was developed with the recognition of increased disaster vulnerability of urban populations, infrastructure, critical facilities and shelter in Asian cities. In an environment where good governance and decentralisation are high in most countries' political agenda, AUDMP aims to demonstrate the importance of and strategic approaches to urban disaster mitigation as part of the urban development planning process in targeted cities of Asia.

AUDMP supports this demonstration by building the capacity of local authorities, national governments, NGOs, businesses and others responsible for establishing public and private sector mechanisms for urban disaster mitigation as part of city management. AUDMP also facilitates knowledge sharing and dialogue between key stakeholders to promote replication of AUDMP approaches to other cities and countries worldwide. Currently, the AUDMP approaches have been introduced and sustained by national partner institutions in targeted cities of Bangladesh, Cambodia, India, Indonesia, Lao PDR, Nepal, Philippines, Sri Lanka, Thailand and Vietnam.

ADPC

The Asian Disaster Preparedness Center (ADPC) is a regional resource center dedicated to safer communities and sustainable development through disaster risk reduction in Asia and the Pacific. Established in 1986 in Bangkok, Thailand, ADPC is recognised as an important focal point for promoting disaster awareness and developing capabilities to foster institutionalised disaster management and mitigation policies.

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