Flood Assessment and Response Report

August 2007
Executive Summary

In late June 2007, tropical cyclone Yemyin hit the coast of southern Pakistan, resulting in extensive storm and flood damage in coastal and inland regions of the provinces of Balochistan (south-west) and Sindh (south-east).

This report includes:

- A description of the features of the flood affected areas (topology, climate, prevailing natural hazards and housing typologies). Katcha houses, made from unfired earth (mud, mudbricks) and wood/bamboo, were the most common houses in the affected areas. The common features of katcha houses are presented.

- A description of the common damage modes, including flash flood impact; standing water damage; and direct rain impact. The performance of public buildings and mosques is also discussed.

- A series of technical recommendations to mitigate the effects of flooding on common housing. These include recommendations related to site preparation and drainage; foundations; plinths; walls; roofs; and stabilisation of earth.

- A discussion of common damages and general recommendations for earthquake and cyclone resistant construction. The affected areas are at high risk of earthquakes and cyclones, and the flood reconstruction activities provide an opportunity to promote and introduce multi-hazard resistant construction policy and techniques.

- A discussion of key considerations for the development of a housing reconstruction policy is presented. This relies on community consultation and engagement, and a clear understanding of the local context. Activities include the development, demonstration, promotion and support of technical improvements for safer reconstruction.

- Maps, housing construction costs, and additional photographs are included as annexes to this document.

This report is designed to inform policy makers and partner organisation about the common flood damage modes, and general recommendations for flood-resistant, and multi-hazard resistant reconstruction.
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Annexes

This report has been prepared based on substantial field research in the affected areas by staff from UN-Habitat and CARE International (see Annex A for map).
1 Context

1.1 General

On 23rd and 24th June 2007, tropical cyclone Yemyin hit the coast of southern Pakistan (Figure 1 and Annex B). Extensive storm and flood damage was experienced in coastal and inland regions of the provinces of Balochistan (south-west) and Sindh (south-east). Affected districts include: Jhal Magsi, Bolan, Sibi, Kharan, Kech, Awaran, Gwadar, Khuzdar, Nushki, Pishin, Nasirabad, and Jaffarabad (in Balochistan), and Larkana and Dadu (in Sindh).

Figure 1. Map of flood affected regions.

1.2 Topology

Balochistan province is characterised by an arid desert plain to the west and a central mountainous ridge which drops to the Indus Valley and Sindh province, in the east. The affected areas in eastern Balochistan and the two districts of Sindh which lie in the flood plains of the Indus are low and flat and are used for intensive farming. These factors compounded the problems of
heavy rain by trapping flood water in an intricate system of breached flood defences and flooded irrigation channels. Inundation and a high water table persist in many areas, which will prolong the displacement of the population and delay reconstruction.

1.3 Climate
The eastern edge of the affected area is arid and has been suffering a prolonged drought. It experiences extremes of temperature, ranging between -14°C and +40°C, with an average of around +24°C. Average annual rainfall is less than 100mm.

The coastal region experiences high summer temperatures (up to +50°C), but falls below 0°C in winter. Average annual temperature is around 25°C. Average annual rainfall varies from 220mm in the south-eastern district of Badin in Sindh, to just 108mm in Gawadar, close to the Iranian border. Inland, temperatures range between over +50°C to be low freezing, with average annual temperature around +26°C. Average annual rainfall in this region varies between 100mm in northern Sindh, to 150mm in Sibi, Balochistan (in the north of the affected area).

The affected area has been subjected to severe flood and cyclone damage on a repetitive basis, most recently in 2005, 2004, 1986 and 1976.

1.4 Natural hazards
The provinces of Balochistan and Sindh are prone to a multitude of natural hazards, including cyclones, severe storms, flooding, extreme heat and earthquakes. In some areas, these hazards are classed as high to very very high (see Annex C for earthquake and tropical storm hazards).

The housing reconstruction policy should support and promote multi-hazard resistant construction, the needs of which will vary across the affected area. Later sections of this report provide technical recommendations for improving flood resistance (Section 4) and earthquake and cyclone resistance (Section 5). Awareness raising and promotion of safer construction techniques are necessary to achieve any substantial reduction of risk.
2 Housing typologies

2.1 Statistics

Table 1 shows the distribution of wall material used in Balochistan and Sindh according to the 1998 Pakistan census. The statistics reveal that the most common houses are *katcha* type houses [made from unfired earth (mud, mudbricks) and wood/bamboo]. This is especially common in rural areas. In some districts (e.g. Jhal Magsi and Kalat, Balochistan) more than 90% of the houses are made from unfired earth. *Pucca* houses (made from fired brick, concrete blocks and stone) make up a lower proportion of the houses in the affected areas. Approximate costs of typical *katcha* and *pucca* houses are included in Appendix D.

<table>
<thead>
<tr>
<th>Material used in outer walls – Balochistan and Sindh (1998)¹</th>
<th>Total Housing Units</th>
<th>Baked Bricks/ Blocks/Stone</th>
<th>Un-Baked Bricks/ Earth Bound</th>
<th>Wood/ Bamboo</th>
<th>Others</th>
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<td>Balochistan</td>
<td>971,116</td>
<td>143,725</td>
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<td>14.8</td>
<td>67.9</td>
<td>12.2</td>
<td>5.1</td>
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<td>Rural</td>
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<td>69,681</td>
<td>556,437</td>
<td>102,892</td>
<td>46,868</td>
</tr>
<tr>
<td>%</td>
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<td>9.0</td>
<td>71.7</td>
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</tr>
<tr>
<td>Urban</td>
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<td>73,986</td>
<td>102,967</td>
<td>15,398</td>
<td>2,810</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>37.9</td>
<td>52.8</td>
<td>7.9</td>
<td>1.4</td>
</tr>
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<td>Sindh</td>
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<td>1,733,730</td>
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<tr>
<td>%</td>
<td></td>
<td>47.7</td>
<td>34.5</td>
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<tr>
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<td>25.7</td>
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<td>86.0</td>
<td>10.9</td>
<td>2.6</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 2 shows the distribution of roofing material used in Balochistan and Sindh according to the 1998 Pakistan census. The statistics reveal that the most common roofing material is bamboo and wood, which is generally covered with mud. This is even more common in rural areas. The roofs are generally flat except in regions with higher annual rainfall, where pitched roofs are used (e.g. Kharan and some areas of Khuzdar).

¹ 1998 Pakistan Census <www.census.gov.pk>
Table 2. Material used in roofs – Balochistan and Sindh (1998)²

<table>
<thead>
<tr>
<th></th>
<th>Total Housing Units</th>
<th>RCC/RBC</th>
<th>Cement/ Iron Sheet</th>
<th>Wood/ Bamboo</th>
<th>Others</th>
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<td>782,525</td>
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<td>Rural</td>
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<tr>
<td>%</td>
<td>20.19</td>
<td>17.98</td>
<td>58.17</td>
<td>3.66</td>
<td></td>
</tr>
<tr>
<td>Sindh</td>
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<td>1,047,671</td>
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<td>236,052</td>
</tr>
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<td>347,250</td>
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<td>184,174</td>
</tr>
<tr>
<td>%</td>
<td>25.53</td>
<td>20.86</td>
<td>48.91</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
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<td>1,098,730</td>
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<td>320,716</td>
<td>51,679</td>
</tr>
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<td>50.60</td>
<td>32.25</td>
<td>14.77</td>
<td>2.38</td>
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</tr>
</tbody>
</table>

2.2 **Katcha houses**

There are three main types of katcha houses:

- Sun-dried mudbrick (known locally as kachi khishe), bonded with mud mortar (Figure 2).
- Cob-style (locally known as khodha), which consists of a single mass of earth built by adding balls of mud directly onto the wall in courses of six to eight inches per lift (Figure 3).
- A timber or bamboo frame with kera lattice/matting, plastered with mud (locally known as junpari, Figure 4 and Figure 5).

The first two types (sun-dried mudbrick and cob) are considered to be more permanent and solid and are constructed in regions where residents have greater security of tenancy. These houses have a typical lifespan of 20-25 years under normal conditions. Houses are designed to maximise thermal comfort during the long, hot summer. Climate control features include:

- Thick walls (1.5 to 2 feet thick, which provide thermal mass);
- High walls (up to 12 feet, which maintain a cool internal environment);
- Small, low windows (often less than two feet above the ground, to generate through-ventilation for the comfort of those seated or sleeping on the floor or char pais inside).

² 1998 Pakistan Census <www.census.gov.pk>
The latter type of *katcha* house (timber/bamboo frame with mud plaster) is commonly used for animal shelters and storage, or for housing in areas where tenancy is less secure. These houses have a typical lifespan of 4-5 years under normal conditions.

The roof structure in *katcha* houses is generally made of timber, bamboo and reed mats covered with mud (around three inches thick). The roofs are relatively light-weight, and provide some thermal mass, but also cool relatively quickly at night. Steel girders to support the roof are sometimes used, and widely aspired to (although these are mostly poor quality, with poor connection to the walls). Occasionally, pre-cast concrete or fired clay tiles are used.

In the flood affected areas, the majority of houses are built by the occupants themselves, using locally available resources, and techniques (both good and bad) which have been passed on for generations. For *katcha* houses, maintenance is only usually carried out after heavy, damaging rains.

![Figure 2. Mudbrick house (with plaster on bottom half).](image-url)
Figure 3. Mud (cob) house.

Figure 4. Damaged *junpari* house (timber/bamboo frame with lattice, covered with mud).

Figure 5. *Junpari* house (timber/bamboo frame with lattice, covered with mud).
2.3 **Tenancy and housing compounds**

The type of construction (sun-dried mudbrick, cob or *junpari*) and construction technique (height and thickness of the walls) is influenced by the economic circumstances and type of tenancy of the occupants. Higher, thicker, solid walls are preferred for security and thermal comfort. In the flood affected areas, it was observed that very few houses were built from fired brick, and that both larger, richer households, and smaller, poorer households were constructed of similar materials and techniques. This would suggest that earth-based (*katcha*) houses are widely accepted as being the most appropriate form of construction for the local climate and context.

In arid areas (e.g. western and northern Balochistan) there is greater security of tenancy, so residents tend to build larger, more permanent houses (from sun-dried mudbricks or cob) in shared housing compounds (Figure 6). These housing compounds generally consist of a number of households clustered together (often familial), sharing a common earthen boundary wall. Living spaces are generally constructed independent from the boundary wall. The height of the wall is usually six feet or more, and represents a significant additional construction need, which is key to the cultural and practical functioning of the housing compound. Individual households within one compound may be identified by their separate cooking areas. Commonly, animal shelters and storage areas are shared. Access to clean water and adequate sanitation is often limited.

In canal irrigated areas (e.g. eastern Balochistan and western Sindh) where tenancy is less secure (due to pressure on available arable farming land), tenants construct small, low houses, most commonly of cob or *junpari* (timber or bamboo frame with lattice/matting, plastered with mud). These houses do not generally have a boundary wall (Figure 7). Access to clean water and adequate sanitation is often limited.
Figure 6. Typical housing compound layout in arid area
(New Rehanzai, Bhag, Bolan)

Figure 7. Typical house layout in canal irrigated area
(Haji Ali Akbar Ghot, tambo Nasirabad)
3 Flood damage modes

3.1 Introduction

There are three main damage modes in the affected areas: (i) flash flood impact; (ii) standing water damage; and (iii) direct rain impact. In many cases, these conditions co-exist (Figures 8 and 9). *Pucca* houses (fired brick, concrete blocks and stone) generally performed better than *katcha* houses (mudbricks, mud, wood, bamboo), although *pucca* houses were not ‘immune’ to damage. Recommendations and strategies for safer housing reconstruction should address these common damage patterns, as presented in Section 4.

Figure 8. Severely damaged mud house.

Figure 9. Severely damaged mud house.
3.2 Flash flood impact: foundations and walls

Flash flood impact is defined as an intense, rapid contact of flood water (and associated debris) on a structure. Mostly this is a single event of short duration (ranging from a few minutes up to several hours). Unstabilised earth buildings, in particular, have little resistance to such extreme erosion. Common damages include:

- Undermining of foundations (Figures 10, 12 and 13);
- Scouring/erosion at the base of the walls (Figures 10-13); and
- Scouring/erosion at the corners of structures (Figures 10 and 13).

These damages often lead to dislocation and separation of walls, with consequent overturning (collapse) of walls and collapse of the roof.

There is very limited scope for repairing houses which have been damaged by flash flood impact. Any undermining of foundations/walls, or deterioration at the base of walls, significantly compromises the structural integrity of the house and it is technically and practically unfeasible to repair such houses.

Some *pucca* structures (reinforced concrete and fired brick masonry) were badly damaged in the flash flood areas (but less damage was observed to these houses in the areas affected by standing water).

*Figure 10. Damaged base and corners.*
Figure 11. Damaged base of wall. (Note: adjacent wall has collapsed.)

Figure 12. Damage at base of junpari wall.
3.3 **Standing water damage: walls**

Standing water damage occurs when a structure is fully or partially submerged in water for an extended period (one day or more). The water is generally slow moving or still (Figure 14). The most common damage is weakening of the submerged portion of the wall, which often leads to overturning (collapse) of the wall panel (Figure 15), or disintegration of the wall (with the appearance of ‘melting’) [Figures 15 and 16]. Water-logged foundations and ground are subject to settlement, resulting in cracking and collapse of walls (Figures 14, 16 and 17). For unstabilised earth buildings the impact of standing water is extreme and irreversible.

There is limited scope for repairing houses with earth walls which have been partially submerged by standing water, as the lack of stability of the walls significantly compromises the structural integrity of the house. This is particularly acute for cob-type walls, which are hand moulded without solid compaction or compression, which results in low density walls which are highly susceptible to water damage.
Figure 14. Partially submerged mud house.

Figure 15. Completely destroyed mud house.

Figure 16. Completely destroyed mud house.
3.4 Direct rain impact: walls and roof

Direct rain impact occurs when the walls of a structure are exposed to direct rain. In some regions, this impact is repeated periodically (during the monsoon season), whereas in other regions annual rainfall is generally very low and houses are not built with provisions to protect from heavy and sustained rain impact. Unstabilised earth buildings generally have little resistance to erosion (Figure 18), which results in deterioration of the walls (especially the lower section). Over time, this can lead to collapse of the walls.

Prolonged and extensive rainfall often leads to water-loggning of the roof, especially when a flat, earth roof is used. The combination of this additional mass in the roof, weakening of the timber elements and connections, and weakening of the tops of the walls can lead to the collapse of the roof (Figure 19).
Few houses use drainage and guttering to divert rainwater away from the face of the walls, or use copings to protect the tops of the walls, even in areas of regular monsoon rains.

It is possible that houses which have been exposed to intensive direct rain impact only may be repaired. This will depend on the degree of damage, especially at the base of the walls. If walls have been separated and dislocated then a full reconstruction is recommended.

Figure 18. Severe erosion due to direct rain impact.

Figure 19. Collapsed earth roof.
3.5 Performance of public buildings and mosques

Public buildings constructed in accordance with the Quetta Building Code\(^3\) were largely undamaged in the flood-affected areas.

It was widely observed that mosques generally resisted flood damage better than common housing (Figures 20 and 21). This included mosques built from earth. This enhanced flood resistance may be attributed to improved quality of construction (undertaken by experienced masons) and use of improved techniques, including:

- Good site selection;
- Raised floor level;
- Deep foundations, made from compacted earth (provide greater stability to walls);
- Soil is sieved prior to use (removes large foreign matter, and large clay clumps);
- Soil/mud is soaked overnight prior to use (disperses clay particles);
- Walls are thicker, especially at the base (enhances stability of walls);
- Use of buttresses or piers at corners (reduces corner scouring);
- Use of perimeter walls (reduces direct impact of water);
- Wheat chaff or chopped jute bags are included in the mud render (reduces shrinkage cracks and increases water resistance);
- Annual maintenance is undertaken.

Such enhanced performance demonstrates that there is common awareness of elements of improved construction, but also suggests that cultural values and financial resources strongly influence the quality and form of construction.

\(^3\) Developed after the 1935 Quetta earthquake.
Figure 20. Mud mosque, relatively undamaged (Jalal).

Figure 21. Mud mosque, relatively undamaged (Kharan).
4 Flood resistant housing: technical recommendations

4.1 Introduction

Alternatives for housing reconstruction range from simple, low-cost options to complex and costly options. It should be stressed that a single technical solution does not exist. Reconstruction options should take into account the local needs (climate, cost, culture) and local impacts (environmental, socio-political). Reconstruction options tending towards practical modifications to existing construction practices are preferable to wholesale changes in construction practices (e.g. mandating the use of ‘modern’ materials such as fired brick, concrete and steel). Sustainable improvements are best achieved through a combination of awareness raising, training and support.

The technical recommendations below focus on practical options for improving the flood and storm resistance of katcha houses, and include a range of options covering different levels of cost and complexity. Recommendations related to site preparation and drainage, and foundations are also relevant to pucca houses.

Specific advice for earthquake and cyclone resistant construction are included in Section 5. Multi-hazard resistant construction should form a part of any reconstruction program.

4.2 Site preparation and drainage

- Where possible, reconstruct on a raised platform of compacted earth (Figures 20 and 21). Improved results are achieved if the outer layer of the earth platform is stabilised (discussed below).
- Provide shallow drainage channels around the house, to facilitate removal of rain water.

4.3 Foundations

- The depth and width of the foundations will be dictated by the prevailing soil conditions and the width of the wall. Softer soils require deeper and wider foundations. As a guideline, foundations
should be excavated a minimum of two feet, 1.5 times the width of the wall, and ideally be made from stone or fired brick in cement-sand mortar. Alternatively, stabilised, compacted earth can be used.

4.4 Plinth
- A raised plinth should be constructed above the foundation (Figure 22). Ideally the plinth should be made from stone or fired brick in cement-sand mortar. Alternatively, stabilised, compacted earth can be used. For consistency and stability the whole plinth should be made from the same, or similar material. The plinth should be a minimum of one foot high, although a higher plinth will afford better protection.

![Figure 22 Mud house with stone plinth (Turbat)](image)

4.5 Walls
- The earth in the walls of *katcha* houses can be stabilised to protect against water damage (see below). This is most important in the lower parts of the walls, which are subject to both impact from flash flooding and standing flood water.
- Similarly, mud plasters can also be stabilised. Stabilised plasters provide a protective barrier on the outside of the wall. They provide protection against rapid, flash flood impact, but do not protect the walls from standing flood water. The use of cement-sand plaster is not recommended for earth-based construction, because it creates a
brittle, hard coating, which is subject to cracking, which allows the penetration of water into the wall. An earth wall needs to ‘respire’, allowing an exchange of air and moisture with the surrounding atmosphere.

- An outer layer of fired bricks may be used in the wall, however care needs to be taken to ensure an adequate bond between the outer and inner layers (wythes) of the wall to ensure the walls do not separate (delaminate) during any ground settlement or movement.

- The stability of earth walls can be enhanced by the use of buttresses or piers (Figure 23). Buttresses/piers at the corners also provide protection against scouring/erosion during flash flooding.

- Stability and erosion resistance are also enhanced if the lower portion (three feet) of the walls are thicker.

Figure 23. Buttresses provide stability to the walls.

4.6 Stabilisation of earth

- In katcha houses, earth is commonly used for foundations, walls, wall plaster and roof covering. Earth can be stabilised in a number of ways, using natural additives (e.g. fibres, oils, fats, tannins, gums, saps and excrements originating from plants or animals⁴) and

synthetic additives (e.g. bitumen, lime, gypsum, soap and cement\(^5\)).
The selection and proportion of additive depends on the soil
(components of clay, silt and sand), cost and availability of additive,
mechanism for mixing, and cultural preferences. Trials of different
additives should be conducted to ensure appropriate selection.

4.7 Roof

- In regions of high rainfall, a pitched roof is preferable to a flat roof.
- If possible, some water-proof membrane should be included in the
  roof.
- Gutters should be included to facilitate removal of water from the roof
  and away from the walls. Copings should be used to protect the tops
  of walls.
- The roof structure should be securely connected and strong. It
  should be securely attached to the walls (achieved by including a
  continuous timber ring beam / wall plate on top of the walls). This is
  especially critical when heavy timber or steel roof beams or girders
  are used.

4.8 Community flood protection

Spurs, dykes and bunds can be used to protect villages from flood impacts.
These structures divert the flow of water from vulnerable areas. Community
flood protection measures range from small scale interventions which can be
undertaken by community members (e.g. construction of gabion baskets), to
large-scale projects which involve heavy machinery and engineered designs.

\(^5\) See Practical Action: ‘Additives to clay: minerals and synthetic additives’
<www.practicalaction.org>.
5 Multi-hazard resistant housing: technical recommendations

5.1 Earthquakes

Damage modes

Traditional, unreinforced earthen (katcha) houses are extremely vulnerable to damage and destruction during severe earthquakes. Earth-based construction is relatively low strength and brittle. Corners are particularly vulnerable, because adjacent walls respond differently, according to the direction of the earthquake. This difference in movement commonly leads to vertical cracking at the corners, which often results in partial or complete collapse (overturning) of the wall, and consequent collapse of the roof. This problem is exacerbated when a heavy roof is used. Other common damages include inclined and horizontal cracking in walls, and dislocation of the corners.

Recommendations for earthquake resistant construction

Despite the inherent vulnerability of earthen structures, there are a number of practical techniques and design features which improve earthquake resistance, including:

- Good site selection (ideally a flat, firm, dry site).
- Simple and symmetrical building layout (ideally restricted to one storey).
- Improved foundation (ideally reinforced and made from stone, or concrete).
- Good quality soil and adobe bricks (with minimal cracking and adequate strength to be transported and laid).
- Appropriate wall dimensions (short, thick and low walls are more stable than long, thin and high walls). Buttresses or pilasters add stability to walls.
- Reduced size and careful placement of window and door openings.
- Use of vertical and horizontal reinforcement. This may take the form of any ductile material (including bamboo, reeds, cane, rope, timber, wire, wire mesh, welded mesh, barbed wire, and steel bars). Reinforcement may be placed within the wall, or external (outside) the
wall. All reinforcement should be securely tied together and to the other structural elements (foundations, ring beam, roof).

- Use of a continuous horizontal ring/bond beam on top of the walls. The beam can be made from timber or reinforced concrete and should be well connected to the wall and roof.
- Use of a light-weight roof, which is well connected to the ring beam and walls.
- Provisions to control moisture and erosion (as outlined in flood resistant recommendation, Section 4).
- Good quality construction.
- Proper maintenance to retain structural integrity.

5.2 Cyclones / severe storms

Damage modes

In addition to the impact of water damage from extensive rainfall and flooding (as described in Section 3), the extreme winds generated by cyclones may significantly impact structures, including:

- Erosion of land around buildings, including undermining of foundations which may lead to collapse of the structure.
- Overturning of walls, due to extremely powerful lateral wind pressure. This pressure is greatest at the centre of the exposed wall.
- Erosion of foundations and walls, due to high velocity winds and violent eddies, which are often loaded with abrasive material (e.g. sand).
- Suction on walls which are not directly exposed to wind (the sides and lee of a building) due to turbulence and pressure variations. Materials and even parts of the building may then be torn away.
- Damage or complete removal of roof, due to pressure variations on the roof. This is influenced by roof pitch and overhanging eaves.

These damage mechanisms are more complicated when buildings are grouped together and the architecture is more elaborate in plan and includes bays, balconies, porches, etc.
Recommendations for cyclone resistant construction

A number of practical techniques and features are designed to improve cyclone resistance, including:

- Good site selection, with protection from prevailing winds provided by relief (landscape) or vegetation. Avoid extremely hilly terrain and gaps which can channel and accelerate wind speeds.

- Proper planning of settlements, such that structures are not built in a line, which channels winds.

- Proper planning of plots, including provision of windbreaks (e.g. masonry walls, or deep-rooted vegetation), and solid construction of ancillary structures (e.g. storage shelters) so they will not blow over and hit the house. All objects which could be easily picked up by wind should be removed from around the house.

- Construction of walls on strong foundations and including vertical reinforcement well anchored to the foundations. Short, thick and low walls are more stable than long, thin and high walls. Lightweight walls should be braced.

- Careful positioning of window and door openings. Avoid openings in the exposed wall (which may raise pressures within the house), and position openings in opposing walls to promote through airflow and reduce pressure buildup.

- Secure attachment of the roof to the walls, and avoidance of large overhanging eaves.

- Good quality construction.

- Proper maintenance to retain structural integrity.
6 Housing reconstruction: policy options

6.1 General

The approach for housing for early recovery and reconstruction needs to be people centred and training and extension based.

Potential technical improvements should be developed and discussed regionally within the early recovery time period, ideally within the weeks before Ramazan. This should include pilot demonstrations of building improvements and consultation with local communities.

Implementation options to promote and achieve building improvements should be discussed regionally by the various actors participating in support for housing reconstruction. This should include a review of local capacity, planned duration and cost of support. A single policy may not be necessary. It may be appropriate to provide additional support to higher hazard or higher vulnerability communities, or to support longer piloting of programmes in the context of a longer term risk reduction objective.

The planning, construction and maintenance of settlement flood protection defences should be considered as critical to housing vulnerability and should be reconstructed or improved to mitigate risk of failure.

All decisions about Government support for housing reconstruction should be communicated as quickly and clearly as possible to all concerned communities. This should be actively supported by all those with access to the community.

6.2 Community consultation and local conditions

Community consultation and engagement are critical to the successful implementation of the housing reconstruction process. Communities should be empowered to be a part of and enabled to take critical decisions on their housing needs including: design, distribution of material, disbursement of financial assistance, compliance, and inspection. Transparency and equity will present significant challenges.
A clear understanding of the socio-economic features, and regional differences is essential. The socio-economic conditions of Balochistan are different from other areas of the country. The strong presence of influential landlords, low education rates, tribal structures, very low income of the majority of the population (who depend mainly upon subsistence agriculture), low literacy rates, poor communication facilities, widespread affected area, and limited capacity of government institutions calls for very careful planning and appropriate strategic decisions. The aspect of tenancy and landlord arrangements (which constitute the majority of the population) will have serious implications during the implementation of any efforts of housing reconstruction. These aspects vary from region to region; in some areas wealthy landlords own vast tracts of land; in other areas the majority of the population have small land holdings. Some tenants have inherited rights to the land on which they have built houses. In many cases, this land ‘ownership’ is informal.

6.3 Considerations

The process for the development of a comprehensive housing reconstruction policy should include stakeholder engagement at all levels and consider the following factors:

- Available resources (materials, tools, skills, money, support, time);
- Socio-cultural issues (e.g. housing compounds, tribal system, etc);
- Economic factors (familial, organisational and governmental);
- Land tenure and tenancy;
- Climate;
- Multiple hazards in different regions (e.g. flooding, earthquakes, cyclones);
- Other key human development priorities (water, sanitation, food security, health services, transport, communications, etc);
- Advantages, disadvantages, assumptions, risks and opportunities of alternative policy scenarios, over the short, medium and long term.
7 Summary and conclusions

The flood impacts in southern Pakistan are comprehensive and widespread. *Katcha* houses, made from unfired earth (mud, mudbricks) and wood/bamboo, were the most common houses in the affected areas. The vulnerability of such local rural houses was clearly demonstrated. Major damage modes include: including flash flood impact; standing water damage; and direct rain impact. There are a number of practical mitigation measures to provide additional protection to traditional *katcha* houses. These relate to improvements in site preparation and drainage; foundations; plinths; walls; roofs; and stabilisation of earth.

The recommended housing reconstruction policy is based on equitable distribution of financial assistance, provision of flood protection defences, and development, demonstration, promotion and support of technical improvements for safer reconstruction. These housing reconstruction activities should be linked with livelihoods recovery, water and sanitation, and other relevant programs. Timely and appropriate decisions should be taken in consultation with all key stakeholders.

In addition to reconstruction initiatives that promote flood resistant housing, a strong opportunity exists to incorporate multi-hazard resistant construction practices in the affected areas. Traditional *katcha* houses are extremely vulnerable to damage and destruction during earthquakes, and much of the affected area is classified as having a high to very high seismic hazard. Cyclone resistant provisions in the southern part of the affected areas are also a necessary part of a broader approach to disaster risk reduction.
Annex A: Field visit map

This map shows the areas visited by UN-Habitat field teams as part of the UN-Habitat flood assessment program.
Annex B: Map of flood affected area
Annex C: Hazard map (seismic and storm)
Annex D: Unit costs for house construction

The costs below are based on field research in the affected areas, and are intended to provide an indication of the approximate normal costs of construction, prior to the flooding.

**Approximate cost of building a cob mud *katcha* house.**

[Dimensions: Plan: 12 ft x 14 ft. Height: 8 ft.]

<table>
<thead>
<tr>
<th>Description</th>
<th>Qty</th>
<th>Units</th>
<th>Unit cost (PKR)</th>
<th>Amount (PKR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour (excavation)</td>
<td>2</td>
<td>labourers</td>
<td>120</td>
<td>240</td>
</tr>
<tr>
<td>Labour (walls)</td>
<td>468</td>
<td>sft</td>
<td>13.3</td>
<td>6,240</td>
</tr>
<tr>
<td>Clay soil trolleys</td>
<td>4</td>
<td>trolleys</td>
<td>300</td>
<td>1,200</td>
</tr>
<tr>
<td>Girders (2 x 14 ft)</td>
<td>28</td>
<td>rft</td>
<td>130</td>
<td>3,640</td>
</tr>
<tr>
<td>Bamboo (@ 9&quot;c/c)</td>
<td>22</td>
<td>poles</td>
<td>120</td>
<td>2,640</td>
</tr>
<tr>
<td><em>Chattai</em> mats (8 ft x 7 ft)</td>
<td>4</td>
<td>mats</td>
<td>450</td>
<td>1,800</td>
</tr>
<tr>
<td><em>Bhosa</em> wheat husks (wall + roof plaster)</td>
<td>4</td>
<td>bags</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>Door</td>
<td>1</td>
<td>unit</td>
<td>1,800</td>
<td>1,800</td>
</tr>
<tr>
<td>Window</td>
<td>1</td>
<td>unit</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>19,160</strong></td>
</tr>
</tbody>
</table>

**Approximate cost of building a fired brick *pucca* house.**

[Dimensions: Plan: 12 ft x 14 ft. Height: 8 ft.]

<table>
<thead>
<tr>
<th>Description</th>
<th>Qty</th>
<th>Units</th>
<th>Unit cost (PKR)</th>
<th>Amount (PKR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour (excavation)</td>
<td>2</td>
<td>labourers</td>
<td>120</td>
<td>240</td>
</tr>
<tr>
<td>Labour (walls)</td>
<td>468</td>
<td>sft</td>
<td>15</td>
<td>7,020</td>
</tr>
<tr>
<td>Bricks (fired)</td>
<td>9,000</td>
<td>bricks</td>
<td>3</td>
<td>27,000</td>
</tr>
<tr>
<td>Cement</td>
<td>29</td>
<td>bags</td>
<td>260</td>
<td>7,540</td>
</tr>
<tr>
<td>Sand</td>
<td>170</td>
<td>cft</td>
<td>18</td>
<td>3,060</td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>90</td>
<td>cft</td>
<td>16</td>
<td>1,440</td>
</tr>
<tr>
<td>Girders (2 x 14 ft)</td>
<td>28</td>
<td>rft</td>
<td>130</td>
<td>3,640</td>
</tr>
<tr>
<td>Bamboo (@ 9&quot;c/c)</td>
<td>22</td>
<td>poles</td>
<td>120</td>
<td>2,640</td>
</tr>
<tr>
<td><em>Chattai</em> mats (8 ft x 7 ft)</td>
<td>4</td>
<td>mats</td>
<td>450</td>
<td>1,800</td>
</tr>
<tr>
<td><em>Bhosa</em> wheat husks (roof plaster)</td>
<td>3</td>
<td>bags</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>Door</td>
<td>1</td>
<td>unit</td>
<td>1,800</td>
<td>1,800</td>
</tr>
<tr>
<td>Window</td>
<td>1</td>
<td>unit</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>57,680</strong></td>
</tr>
</tbody>
</table>
Annex E: Photo gallery

Completely destroyed *katcha* houses.

Completely destroyed mudbrick house.  
Completely destroyed mud house.

Damaged mudbrick house (Kharan).
Damaged mud cob wall (Kharan).
Collapsed mud wall.

Completely destroyed *katcha* house.

Damage to mudbrick wall.

Damage to *pucca* wall (Bagh Bolan).

Failure of wall and scouring (Jhal Magsi).

Weak corner and settlement (Kharan).
Damaged *junpari* house.

Steel girder resting on damaged mud wall.

Total collapse of roof on girders and fired brick walls (Bolan).

Damage to sagging roof (Kharan).

Failure of corner under heavy roof elements (Bolan).

Corner failure (Khuzdar). (Note: low sill height)