Guiding Principles for Infrastructure and Services Delivery

- Infrastructure restoration and housing reconstruction rarely progress on the same schedule after a disaster. Those planning housing reconstruction must make sure there are plans in place both for infrastructure reconstruction and for interim services, if necessary.
- Successful infrastructure reconstruction requires extensive coordination on many fronts: with planners, households, and multiple agencies involved in housing reconstruction, among others.
- Project developers should build infrastructure that conforms to planning and regulatory requirements, or help bring these instruments up to date if not adequate. Minimum technical standards are needed for retrofitting and reconstruction of infrastructure that incorporate disaster risk reduction (DRR) and sustainable development objectives.
- All four types of DRR measures—policy and planning measures, physical preventative measures, physical coping and adaptive measures, and community capacity building measures—are relevant to infrastructure and should be utilized in retrofitting and reconstruction.
- Entities that will operate and maintain infrastructure facilities—which may include the community—should be directly involved in infrastructure project planning and implementation.
- Involving built environment experts, such as architects and engineers, in project development increases the chance that upgraded standards are incorporated into local infrastructure projects over the long term.

Introduction

Post-disaster infrastructure restoration happens in stages. During the disaster response, the focus is on stabilizing systems and preventing secondary damage (e.g., fires from gas leaks or contamination from sewage plants). Soon thereafter, attention shifts to repairing lifeline infrastructure and networks such as roadway connections and basic communications. During reconstruction, restoring permanent infrastructure services, including those in residential neighborhoods, is the priority. However, restoration of full services may not happen right away.

Infrastructure reconstruction requires planning and coordination on several fronts. Reading Chapter 7, Land Use and Physical Planning; Chapter 9, Environmental Planning; and Disaster Risk Management in Reconstruction in Part 4, Technical References, along with this chapter will provide a more comprehensive understanding of the issues affecting infrastructure. Depending on the severity of the disaster, infrastructure reconstruction is likely to take many years longer than the reconstruction of housing, so interim solutions and full reconstruction must both be planned. Multiple agencies are likely to be involved, and it is crucial to coordinate decisions among them.

The approach to housing reconstruction affects how infrastructure reconstruction is managed; infrastructure construction at a large-scale new housing site will be different from that in a location where owner-driven in-situ reconstruction is planned. In all cases, housing should be designed to accommodate public services, even if the services are not available at the time of housing reconstruction.

The definition of infrastructure in this chapter includes lifeline systems and related local public services. The importance to community reconstruction of the rehabilitation of public facilities such as public buildings and meeting spaces, and of educational and health facilities, is also touched on.

Key Decisions

1. The lead disaster agency should work with affected communities and local government immediately after the disaster to assess the state of infrastructure systems and the capability of local service providers to restore both lifeline services and full infrastructure services, and to identify the assistance required to do so.
2. The lead disaster agency and local government should work with communities to prioritize the public services needed to restore community life and to agree on the division of labor to restore facilities between government and the community.
3. The lead disaster agency should establish and publicize the infrastructure standards all agencies involved in reconstruction should meet.

4. The lead disaster agency should collaborate with local service providers to estimate the cost of, and raise and channel the resources needed for, the restoration of local services and facilities and for infrastructure reconstruction.

5. Agencies involved in reconstruction should decide how to ensure the provision of interim and permanent infrastructure to reconstruction sites, especially if they do not expect to provide it themselves.

6. Agencies involved in reconstruction should decide how to support local service providers to build back better and conform to standards established by national, regional, or local governments for any infrastructure they finance.

7. Local service providers should work with government and other funders to ensure they have adequate resources to build back better and restore services in an economically sustainable manner. This may entail reviewing local tariffs or service fee schemes.

8. Communities should insist that agencies involved in reconstruction provide them a lead role in planning and implementing projects related to services for which they will be responsible.

Public Policies Related to Infrastructure and Services Delivery

Countries with emergency management or DRR plans will be much better prepared to plan and implement infrastructure and service restoration, since protecting infrastructure and restoring services are generally among the chief concerns of these plans.

Post-disaster projects for reconstruction, rehabilitation, and retrofitting of infrastructure should be aligned with the country’s and the locality’s overall development vision, particularly with respect to long-term development and land use plans, the allocation of institutional roles, and the standards for infrastructure improvement. While not strictly considered “infrastructure,” various public facilities are essential for communities and should also be restored early on, and the comments in this chapter apply to these investments as well. Community facilities include schools, clinics, refuges, buildings for local government administration, and meeting spaces. Schools and clinics contribute to the resumption of normal life by providing space for social services. Local government buildings and meeting spaces allow local public services to resume and facilitate community planning and the reestablishment of local governance.

To the extent possible, reconstruction should be carried out using standard procedures and in accordance with local plans and regulatory requirements. For instance, plans should conform to local building codes, or existing intergovernmental fiscal channels may be used to transfer funds. Infrastructure investments must be guided by environmental policies as well, due to the potential for extremely negative environmental impacts from both the construction and the operation of poorly planned infrastructure systems. Where the standards or the legal and regulatory frameworks are inadequate, they may need to be updated before reconstruction begins.

Because land use and development are generally governed by local land use planning agencies, local government should be involved in decisions regarding new land uses and acquisition, and should coordinate the acquisition of rights-of-way for infrastructure, especially if eminent domain procedures are involved. Land acquisition for infrastructure can be a long and contentious process, and lack of site control poses a significant construction risk. See Chapter 7, Land Use and Physical Planning.

The agencies that should be involved in decisions regarding infrastructure redevelopment, rehabilitation, or retrofitting are a combination of the national ministries responsible for the regulation and financing of the systems being restored (e.g., ministries of water and sanitation, roads, transport, environment, and power) and—equally important—local service providers: local government and community-based entities responsibility for local infrastructure investment, maintenance, and service provision. Local service providers may include departments of water and sanitation, transportation, environment, solid waste management, environment, and community-based water service providers or other community organizations. The sustainability of service provision after a disaster depends largely on the commitment and capability of local entities responsible for service provision.
Technical Issues
Types of Damage to Infrastructure from Disasters

The magnitude of damage to infrastructure depends on the hazard type, its intensity, and the ex ante preparedness. The following graphic shows relative magnitudes of common impacts by disaster type.\(^1\)

<table>
<thead>
<tr>
<th></th>
<th>Earthquake</th>
<th>Volcano</th>
<th>Landslide</th>
<th>Hurricane</th>
<th>Flood</th>
<th>Drought</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural damage to system infrastructure</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Rupture of mains and pipes</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Obstructions in intake points, intake screens, treatment plants, and transmission pipes</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Pathogenic contamination and chemical pollution of water supply</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Water shortages</td>
<td>○</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>●</td>
</tr>
<tr>
<td>Disruption of power, communications, and road system</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Shortage of personnel</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>○</td>
</tr>
<tr>
<td>Lack of equipment, spare parts, and materials</td>
<td>●</td>
<td>○</td>
<td>●</td>
<td>●</td>
<td>○</td>
<td>○</td>
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</tbody>
</table>

Moving from Recovery to Reconstruction

Two-pronged approach. To reconcile the need to act quickly while still allowing time for design and consultation, the negative impacts of a disaster should be contained and the lifeline infrastructure should be rehabilitated during the recovery period, while the planning and design of long-term infrastructure reconstruction begins. This approach responds to critical service needs and demonstrates visible efforts, while allowing lead time for land use planning, consultations, infrastructure design, land acquisition, and procurement. Government should avoid the temptation to shortchange infrastructure planning and design to take advantage of the availability of relief funds.\(^2\) The case study on infrastructure reconstruction following the 2001 Gujarat earthquake, below, describes some of the common reasons why infrastructure projects often take longer than originally anticipated.

Long lead times for infrastructure reconstruction mean that housing reconstruction is likely to take place before infrastructure is fully restored or reconstructed; therefore, short-term interventions may need to address the availability of basic services and safety of households in communities where reconstruction is taking place. The use of transitional shelter, which allows households to resettle on their own land while rebuilding, will make this especially crucial.\(^3\) International standards, such as the Sphere Standards, can be used to define minimum standards for various basic services and shelter.\(^4\) The Inter-Agency Network for Education in Emergencies (INEE) defines minimum standards for public education.\(^5\)

3. See Chapter 1, Early Recovery: The Context for Housing and Community Reconstruction, for a discussion of transitional shelter.

# Infrastructure Interventions Relevant to Housing and Community Reconstruction

## Short-term interventions

<table>
<thead>
<tr>
<th>Electric power systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give priority to functions that support other lifelines, such as treatment and pumping of water.</td>
</tr>
<tr>
<td>Incorporate DRR mechanisms in reconstructed systems and facilities. Provide power for households and community facilities and for pumping water and running generators and tools used in reconstruction. Consider alternative energy generation options in housing and community building design and community planning. Develop a DRR plan for electric power installations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transport systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prioritize access to critical facilities, such as hospitals, emergency centers, and fire stations. Initial rehabilitation of roads should support housing reconstruction, especially transport of materials to disaster site. Consider modest early repairs and more permanent reconstruction later on.</td>
</tr>
<tr>
<td>Incorporate DRR mechanisms in reconstructed systems and facilities. Provide housing site access and egress, including access by emergency vehicles for delivery of construction materials. Retrofit and upgrade to improved codes and standards. Design roadway systems for sites to encourage walking and bicycling. Plan for public transit access. Develop a DRR plan for the transport sector.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water loss increases health and fire hazards, and causes loss of cooling systems for telecommunications and computers. Strengthen and support structures. Provide alternative domestic water supply until systems are restored. Repair, clean, and disinfect wells, boreholes, water storage tanks, and tankers. Improve leak detection. Monitor water quality. Rehabilitate water distribution and treatment works. Educate population on point-of-use treatment of drinking water.</td>
</tr>
<tr>
<td>Incorporate DRR mechanisms in reconstructed systems and facilities. Test for availability and quality of potable water before selecting relocation sites. Provide water for reconstruction purposes, such as mixing concrete. Provide water for households. Consider meter installation during rehabilitation of system. Develop a DRR plan for all water installations and facilities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sewerage system and storm-water runoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>System loss causes untreated sewage discharge into water bodies or increased environmental and health hazards. Provide emergency sanitation systems. Prevent defecation in areas likely to contaminate food chain or water supplies. Educate population on hygiene.</td>
</tr>
<tr>
<td>Incorporate DRR mechanisms in reconstructed systems and facilities. Improve shut-off and diversion systems. Segregate combined overflow systems. Consider small-scale sewage treatment options. Design site for rainwater capture for landscaping and other non-potable purposes. Use permeable paving materials to maximize infiltration of water. Consider incorporating cisterns in site designs for collection of rainwater. Develop a DRR plan for all sewerage and storm-water installations and facilities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solid waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmanaged waste can pollute and obstruct water sources and provide breeding grounds for insects and vermin. Develop systems and designate sites for domestic, industrial, construction, hospital, and hazardous waste management, including recycling of disaster debris. See Chapter 9, Environmental Planning, Annex 1, How to Do It: Developing a Disaster Debris Management Plan, for advice on debris management.</td>
</tr>
<tr>
<td>Develop integrated solid waste management plan if none exists. Maintain interim facilities until normal operations resume, and maintain debris and construction waste recycling until reconstruction tapers off. See a case study about an ambitious debris recycling program following the 1994 earthquake in Northridge, California, in Chapter 9, Environmental Planning. Reestablish normal solid water management services as soon as possible. Incorporate recycling and composting services in solid waste management plan.</td>
</tr>
</tbody>
</table>
**Short-term interventions**

Public buildings (health facilities, schools, and police and fire stations)

- Social consequences and compromised health and safety result from the lack of these facilities.
- Prioritize restoration of power supply, transportation access, and water supply.

**Medium- to long-term interventions**

- Incorporate DRR mechanisms in reconstructed buildings.
- Prioritize school reconstruction to minimize disruption to school, and therefore family, life.
- Construct community meeting spaces or incorporate community space in other early public building reconstruction projects.
- Restore public facilities to improved construction and service standards.
- Design new public buildings with energy efficiency and multiple uses in mind.
- Develop a DRR plan for all public buildings.

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**A DRR-Oriented Infrastructure Project Development Sequence**

DRR measures can be categorized as policy and planning measures, physical preventative measures, physical coping and/or adaptive measures, and community capacity building, all of which are of paramount importance during post-disaster infrastructure reconstruction. DRR is a top priority in infrastructure reconstruction. Not only should infrastructure facilities be built so that the risk of future damage from disasters is reduced, but the infrastructure itself—such as a system for stormwater runoff—can provide protection from the impacts of disasters. With respect to the phases of DRR, the most relevant to infrastructure are:

- **Mitigation**: structural (physical) or non-structural (e.g., land use planning, public education) measures undertaken to minimize the adverse impact of potential natural hazard events; and
- **Rehabilitation and reconstruction**: measures undertaken in the aftermath of a disaster to restore normal activities and restore physical infrastructure and services, respectively.

The table below provides information on the stages of infrastructure reconstruction and some key considerations to be taken into account during that reconstruction effort. Part 4, Technical References, Disaster Risk Management in Reconstruction includes a methodology for risk assessment useful in infrastructure planning and provides information on sources of hazard and vulnerability data.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Key considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage and loss assessment and project prioritization</td>
<td>Locate or conduct an inventory of infrastructure assets and remaining capacity and a preliminary assessment of reconstruction and resource requirement from the post-disaster damage and loss assessment. When prioritizing projects, inventoried assets can be categorized and tasks sequenced taking into consideration priority and effort involved. Use economic and social criteria to evaluate costs and benefits of projects. Infrastructure planning, design, and construction must be coordinated with the plan for housing reconstruction to ensure the availability of basic services and sanitary conditions in such settlements. The timing of housing reconstruction affects the prioritization process for infrastructure.</td>
</tr>
<tr>
<td>Define roles and responsibilities</td>
<td>Clearly define the roles and responsibilities of the various individuals, agencies, and organizations involved in the hazard risk assessment; the design and siting of appropriately hazard-resilient infrastructure; the enforcement of design; and the quality control of construction, operation, and maintenance, while ensuring that local service providers have a lead role. Ensure local governments are given the lead when these issues fall under their jurisdiction. Provide assistance if local capacity is a constraint. Coordinate with other development or relief organizations working in the area to avoid duplication of research on hazard-proof construction and to promote a harmonized use of hazard-proof construction standards. Set up a system of consultation and collaboration with engineers, academics, local government, and the affected community. Ensure that engineers and other infrastructure service providers participate fully in the design of projects, so that they contribute more than just building or supplying to order.</td>
</tr>
</tbody>
</table>

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**Sources:**


<table>
<thead>
<tr>
<th>Stage</th>
<th>Key considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard assessment</td>
<td>Assess the frequency and dimension of all potential sources of natural hazards (geological, meteorological, or hydrological) in the area and determine the most likely hazard scenarios for consideration in the infrastructure design. Ideally, development organizations working in the country should have already analyzed some aspects of disaster risk. Make this information public and use it in planning. Existing academic studies and hazard maps may provide information for the hazard evaluation. However, depending on the prevalent hazards and the site, it may also be necessary to conduct site-specific risk analysis or micro-zonation studies. Local secondary disaster effects (e.g., landslides from excessive rain or ground shaking) should be anticipated and considered.</td>
</tr>
</tbody>
</table>
| Review of legislation and good practice | Assess existing codes of practice for hazard resistance and determine whether they are adequate for use in infrastructure reconstruction.  
- If this review has already been conducted at the national level by a development organization or by a local research/academic body, draw on whatever information is relevant to the specific project context.  
- If there is no existing review, conduct research on existing codes of practice for hazard resistance, which might include the following.  
  - Investigate the history of the code development and level of hazard inclusion.  
  - Analyze the performance of buildings and infrastructure designed to the codes during past hazard events.  
  - Compare loading and design criteria to building codes developed for countries with similar hazards and neighboring countries with similar construction practices.  
  - Review international good practices, building codes, and design guidelines appropriate to the identified hazards, and assess their applicability. |
| Review of construction methodologies and local capacity | Identify the normal local construction practices for the relevant type of infrastructure. A rapid assessment may be made in the case of new construction. A more detailed analysis is required in a retrofitting project. Weaknesses in structures and in the vulnerability of infrastructure to the identified natural hazards must be assessed. This may include a study of the rate of degradation of the structure and its materials over time to assess resilience against projected hazards. Determine the strengths and durability of materials in existing infrastructure or proposed. Identify those who will carry out the design and construction (engineered, non-engineered, self-built, or contractor-built) and ensure their ability to comply with codes. Assess program management and administration capacity and strengthen it with training or outside expertise. Assess local construction practices, their resistance to the determined hazards, and the level of risk this poses. |
| Set hazard safety objectives          | Establish clear and measurable objectives for hazard safety, based on the level of risk that can be supported by the affected public and government agencies. Take into account development agency accountability issues. Consider different performance objectives for critical facilities and infrastructure, factoring in the potential impact on the users or clients who would be negatively affected to varying extents by loss of service. |
| Site selection                        | The site for development will typically be defined by local government based on availability, land use plans, and economic criteria. The suitability of these sites needs to be assessed. Any hazard assessments carried out in previous stages should be considered. Determine whether additional works are required to render the site viable for development or whether land use should be restricted to reduce vulnerability to natural hazards. Consider whether resiting to a location of reduced risk is an option. Topographical features and landscape can be used to reduce the impact of potential natural hazards (e.g., to minimize flood risk or modify wind speed and direction). Land swaps might be a potential solution in collaboration with local government, but make sure that environmental protection is taken into consideration. Project cost estimates should plan for possible land acquisition. |
| Technology selection                  | In evaluating infrastructure technology options, evaluate the following.  
- Consider the financial and operational capacity of the entity responsible for service provision.  
- Assess capital investment and operation and maintenance (O&M) costs over the life of the project.  
- Review the availability of parts and supplies over the life of the project.  
- Consider rebuilding zoned and decentralized infrastructure systems, which may be more resistant to system failures. |
<table>
<thead>
<tr>
<th>Stage</th>
<th>Key considerations</th>
</tr>
</thead>
</table>
| **Design and procurement** | Design a sustainable and socially acceptable strengthening or construction solution that satisfies the DRR objectives.  
Consider limitations of finance, construction skills, and material availability.  
In a rehabilitation project, take into account potential disruption to normal activity.  
Ensure that the environmental and social impacts of the proposed solution are acceptable.  
Ensure (through testing and research) that the proposed solution will in fact yield the performance objectives established for the project.  
Develop a procurement strategy that provides overall value during the entire life of the service or facility.  
Apply “build back better” principles, even if they have not been translated into specific codes or standards.  
Assess the competency of contractors and ensure adequate site supervision.  
Address training needs for the implementation of the proposed solution (e.g., on-the-job training included in the implementation stage).  
Develop building codes and guidelines that account for local hazard conditions, building material characteristics, and construction skills and quality, and ensure that:  
  - building codes cover retrofitted facilities;  
  - standards are coordinated with respective ministries and local planning departments;  
  - streamline permissions and permits;  
  - work with government to streamline repair permits and demolition procedures; and  
  - enhance technical and human capacity, if necessary, to ensure speed in reviewing and issuing construction permits. |
| **Construction**           | The quality of any post-disaster construction must not compromise the design intent. Establish procedures for multidisciplinary inspection and check against specifications of works throughout the building process in the following ways:  
  - Test materials and check adherence to design guidelines.  
  - Ensure implementation of the quality assurance systems. |
| **Operation and maintenance** | Require that guidelines for O&M be provided by the builder so that the design level of hazard resilience can be maintained.  
Institute measures to ensure adequate human capacity for O&M of constructed facilities and management of ongoing risk management activities.  
Define procedures for the approval of structural alterations carried out during the life of the facilities.  
Set up structures for funding O&M and risk management activities, including cost recovery mechanisms. |
| **Evaluation**             | Assess the adequacy of the restored infrastructure system and the success of the project as a whole. This assessment should include evaluation of:  
  - functionality, social acceptability, and sustainability;  
  - project cost with respect to potential benefits of hazard-proof design in future events, skills provided to builders, and new construction guidelines introduced; and  
  - reporting of infrastructure performance under any hazard events that have occurred.  
Lessons learned regarding strengthening hazard resilience should be summarized, shared, and drawn on for future projects. |

**Other Considerations in Infrastructure Reconstruction**

**Local institutional capacity.** Since infrastructure systems and housing are interdependent and often fall under multiple geographic and administrative jurisdictions, both public and private, coordination across sectors and among agencies in constructing and rehabilitating infrastructure is necessary. Reconstruction speed and quality depends on pre-disaster conditions, such as the state of the infrastructure, record keeping, data management, and institutional capacity. Infrastructure assessments should analyze each of these issues. The capacity of local government, communities (if their role is operational), and the consulting and construction sector is particularly relevant. The involvement of academic, professional, and licensing bodies will help ensure that architects, engineers, and builders correctly apply appropriate codes and construction techniques during reconstruction and in the future. To ensure long-term sustainability and economic development, reconstruction should emphasize the use of local resources (technical, financial, operational).

If there is a risk of reconstruction approvals for infrastructure becoming a bottleneck, consider helping local government in setting up a “single window” where environmental and engineering
studies, site plans, and building plans can be approved simultaneously, and building permits issued in a single location. Partnerships with the private sector and other nongovernmental partners may help support this aspect of implementation.

In the agencies that will take over management of new facilities, training, staffing, and other institutional strengthening needs should be identified and funded. If local communities will operate or maintain the infrastructure, they should be trained as well. Local agencies should not be strapped with new infrastructure they cannot afford to operate. Assistance with analyzing not just design and construction, but also the financial feasibility of operating new services must be provided. This may entail designing new tariffs or other cost recovery strategies. The case study on relocation after Hurricane Mitch in 1998 in Honduras, below, illustrates some of the risks of underfunding new infrastructure services.

Public notifications and consultations. Local legislation may require stakeholder participation in siting, planning, and land acquisition processes, even though the community may not be involved in operation of the services. Participation may need to be accelerated in a post-disaster environment, but this should not be done in a way that compromises the intent of these processes. Acceleration may be successfully achieved through an enhanced communications and outreach effort. See Chapter 3, Communication in Post-Disaster Reconstruction, for guidance on developing a communications plan.

Urban infrastructure development. Infrastructure reconstruction in urban areas can be more challenging due to the higher population and the built environment densities, more complex infrastructure technologies and materials, the need for temporary relocation or interruption of services, and the complexities of the social structure, including diverse income levels. When considering an infrastructure project, local service providers, as well as agencies responsible for regulation in the sector and those responsible for local urban planning, should be given the lead in identifying the best approach to rehabilitation or reconstruction. See Chapter 7, Land Use and Physical Planning, for more discussion of reconstruction issues in urban versus rural contexts. Social assessment is a tool to help identify and plan for social issues in reconstruction. For guidance on social assessment, see Chapter 4, Who Gets a House? The Social Dimension of Housing Reconstruction, Annex 2, How to Do It: Conducting a Post-Disaster Social Assessment.

Managing logistics and cost overruns. The following are some options for government and agencies involved in reconstruction to reduce bottlenecks and manage cost overruns in infrastructure reconstruction:

- In establishing equipment, material, and supply requirements, make specific plans for procuring items that require a long lead time and could create supply bottlenecks.
- Expect and budget for cost increases due to an increased demand for material and labor. Increases will be a function of the size and pace of the reconstruction relative to the national economy and the supply capacity.
- If a fast pace of reconstruction will result in unacceptable cost escalations, analyze whether losses from delays in full service provision from slower reconstruction are acceptable and identify interim service provision options. The phasing and pace of reconstruction should strike a balance between costs and benefits.
- If faster reconstruction is a priority, build price incentives into construction contracts, without sacrificing the quality of workmanship.
- Ensure timely approval of plans, issuance of permits, and inspections, so that these procedures never hold up construction.
- Use the design/build approach, but only when the expertise and capacity exist to properly oversee it.
- Facilitate material imports and clearances. See Chapter 15, Mobilizing Financial Resources and Other Reconstruction Assistance, Annex 1, Deciding Whether to Procure and Distribute Construction Material, for advice on this option.

The case study on infrastructure construction in a relocation site in Sri Lanka following the 2004 Indian Ocean tsunami, below, shows how reconstruction agencies adapted to a government policy that infrastructure would only be provided once housing construction was complete.

For access to additional resources and information on this topic, please visit the handbook Web site at www.housingreconstruction.org.
Risks and Challenges

- Failure to improve the disaster resiliency of rehabilitated and reconstructed infrastructure systems.
- Restored infrastructure systems that are later unaffordable to the users and not properly maintained.
- Setting unrealistic reconstruction time frames in response to local political and social pressures, or collapsing reconstruction schedules in an attempt to avoid having donated funds diverted elsewhere.
- Not adequately coordinating infrastructure and housing reconstruction so that residents live for years without proper services.
- Underbudgeting program management and administration costs, which, in a post-disaster environment, can cost more than twice as much as those in regular projects.1
- Time and cost overruns due to limited project management capacity and increased demand for resources in local markets.
- Environmental damage from improperly planned or engineered infrastructure projects.
- Failure to involve the local service providers in planning and executing infrastructure reconstruction programs.

Recommendations

1. Government should enforce measures to ensure that infrastructure planning and reconstruction is closely coordinated with housing reconstruction, using a broad definition of infrastructure to include community facilities.
2. From the first day, support local service providers, such as local government and the community, in the planning and implementation of infrastructure projects, or at a minimum involve them in these efforts.
3. Plan in advance for activities that require long lead times, especially land acquisition and public consultations.
4. Develop realistic reconstruction schedules and service delivery strategies that take into consideration the fact that infrastructure reconstruction can take much longer than housing reconstruction.
5. Apply the “build back better” principle to infrastructure reconstruction, both in terms of its resilience to hazards and its environmental sustainability.
6. Provide a reserve for material and labor cost increases, because these costs will grow in proportion to the speed of the reconstruction effort. A contingency of at least 20 percent is realistic.
7. Make generous provisions for project management and for construction management and quality control, recognizing that the post-disaster environment will be more complex and that there is a risk that the work will be of lower quality than in normal conditions.
8. Use local technical resources in infrastructure planning and design, risk reduction, and construction.
9. Plan and budget for the human capacity development needed for the O&M of reconstructed infrastructure facilities.

Case Studies

1998 Hurricane Mitch, Honduras

Relocation without Infrastructure

Hurricane Mitch had a major impact on the housing situation in the city of Choluteca, located along the Choluteca River in southern Honduras. More than 25 high-density neighborhoods located within the natural floodplain of the Choluteca River were completely washed away, displacing approximately 3,000 families. Although many of these houses in these neighborhoods had running water and electricity, most families did not have clear title to their land. Site selection for reconstruction was based on the availability of a large parcel of land with clear title rather than on its suitability for the creation of a sustainable community. Banco de Occidente sold land that it owned 15 kilometers from the city of Choluteca for monthly payments per lot of approximately US$100 over 10 years. The settlement, later called Nueva Choluteca or Limon de la Circa, consisted of 2,154 lots laid out with little consideration of urban design, transportation needs, or environmental impact. The layout made the provision of infrastructure—water, sewage, electricity, drains, and communications—potentially more expensive, although in fact no provision was made for any of these services at the time. Nongovernmental organizations (NGOs), including Caritas, Atlas Logistique, Iglesia de Cristo, International Organization for Migration, and CECI, participated in

the reconstruction effort. In 2001, only 42 percent of the houses were occupied by their owners. The rest were rented, transferred to non-owners (friends and family), or not occupied. One-tenth of the houses were in poor condition, and the neighborhood was considered very dangerous. Poor-quality housing, continued lack of infrastructure, increased segregation of residents, lack of employment (one study estimated the national unemployment rate at 68 percent immediately after Mitch), high rates of crime, and public health problems were all evident. This project demonstrates that relocation at this scale generates a tremendous need for public services, including electricity, water, sewage, and storm-water and solid waste management, as well as social necessities, such as employment, health centers, and schools. International agencies must ensure not only that there is local capability to build infrastructure and provide services to such settlements over the long term, but even more that these projects contribute to the longer-term development of the community where they are built.


2001 Gujarat Earthquake, India
Causes for Delays in Rebuilding Urban Infrastructure
The Gujarat Urban Development Company (GUDC) was responsible for reconstruction of urban infrastructure in 14 towns following the 2001 earthquake. Government decided to go beyond replacing lost capital stock and planned the urban reconstruction program in a holistic manner. The program included both in-situ reconstruction and relocation. Development plans were prepared for the four most severely damaged towns using a 20-year horizon. Development codes were amended to incorporate national codes for seismic and cyclone safety. GUDC eventually awarded 89 contracts worth US$80.7 million, using financing from the Asian Development Bank (ADB). The four most severely damaged towns received new infrastructure, while damaged infrastructure in 10 less-affected towns was selectively upgraded. A 3-year implementation period was originally projected for the Gujarat reconstruction, yet the scope of the effort necessitated extension of the reconstruction program to six years. The ADB’s completion report attributed the delays to common post-disaster factors, including (1) the time required for acquisition of easements and removal of encroachments; (2) delayed contract awards due to multiple agency approvals; (3) selected contractors who were not able to meet requirements; (4) fraudulent bank guarantees presented by contractors; (5) the inability of suppliers to honor supply commitments due to price increases; (6) frequent transfers of implementing agency officials; and (7) late receipt of funds by the Gujarat State Disaster Management Authority, causing delayed payments to contractors.


2004 Indian Ocean Tsunami, Mandana, Sri Lanka
Coordinating the Timing of Housing Construction with Infrastructure Provision
In September 2005, after the devastating 2004 Indian Ocean tsunami, Habitat for Humanity-Sri Lanka (HFHSL) began construction on a 196-house community on unimproved land in Mandana, five kilometers inland from Thirrakkovil, on the southeast coast of Sri Lanka. The beneficiaries were selected by government authorities from tsunami-affected families that had previously lived within the high-tide line and that were not allowed to rebuild in the coastal buffer zone. Land for relocation was provided by government. Although HFHSL had originally planned to quickly provide small, 150 sq. ft. “core houses” with at least a permanent structure at a relatively low cost, the Sri Lankan government mandated a 500 sq. ft. minimum for houses built on government-donated land, in an effort to improve the quality of life of those relocated.
The first 96 families moved into new permanent houses in February 2006. Although toilets, wiring, and plumbing were in place, there was no electric service, piped water and sewage, public transportation, or graded road. Officials had stated upfront that houses must be completed before other services would be provided, but the lack of infrastructure presented challenges to the families who moved in, as well as for the construction crews.

As an interim measure, HFHSL negotiated with other NGOs to provide wells, water tanks, and water delivery; these services were continued and expanded to meet the needs of homeowners. Generators used to run cement mixers also provided limited emergency power. As homes were completed and more families moved into the community, HFHSL and the Sri Lankan management of chemical company BASF (the corporate sponsor of the project) joined with the homeowners’ new community association to press for provision of full services. Three years later, formal electric services, piped water, and septic tanks were in place and supporting a growing community. In all, HFHSL built 2,049 housing units to support post-tsunami reconstruction in Sri Lanka.


Resources


For access to additional resources and information on this topic, please visit the handbook Web site at www.housingreconstruction.org.