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International Strategy for Disaster Reduction

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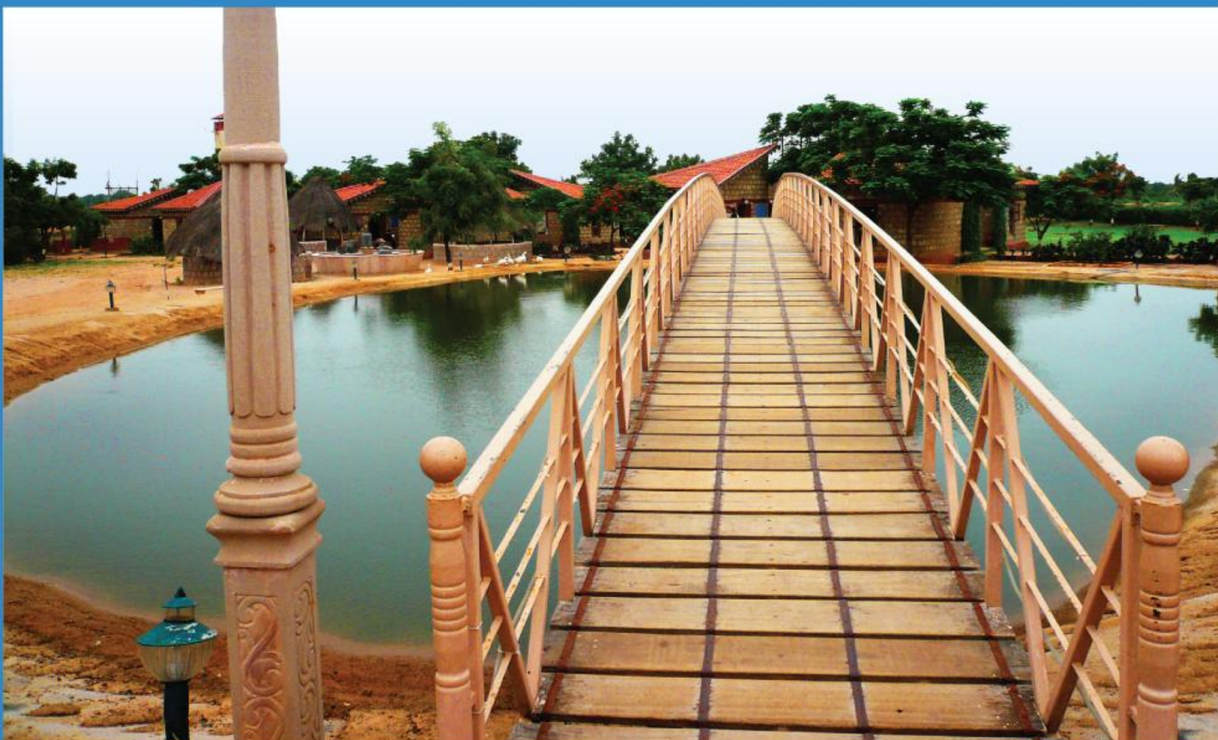
International Recovery Platform

Guidance Note on Recovery

INFRASTRUCTURE



The Guidance Notes on Recovery: Infrastructure was developed as collaboration between the International Recovery Platform (IRP) and United Nations Development Programme India (UNDP-India). IRP acknowledges the leading work of George Haddow and Damon Coppola, the consultants who facilitated the development of this Guidance Note, Sanjaya Bhatia, Knowledge Management Officer of IRP (UNISDR). In addition, many individuals and agencies contributed to the consultative process of workshops, peer reviews and the sharing of good practices and lessons learned from tools and country specific case studies. In particular, the guidance and expertise of Anand S. Arya (Former National Seismic Advisor Government of India) and Amod Mani Dixit (NSET) were instrumental. For a full list of acknowledgements please see Annex 2.

IRP was conceived at the World Conference on Disaster Reduction (WCDR) in Kobe, Hyogo, Japan in January 2005. As a thematic platform of the International Strategy for Disaster Reduction (ISDR) system, IRP is a key pillar for the implementation of the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters, a global plan for disaster risk reduction for the decade adopted by 168 governments at the WCDR. The key role of IRP is to identify gaps and constraints experienced in post disaster recovery and to serve as a catalyst for the development of tools, resources, and capacity for resilient recovery. IRP aims to be an international source of knowledge on good recovery practice. IRP promotes "Build Back Better" approaches that not only restore what existed previously but also set communities on a better and safer development path and support development of enhanced recovery capacity at regional, national, and sub-national levels with particular focus on high-risk low-capacity countries.

UNDP is the UN's global development network, advocating for change and connecting countries to knowledge, experience and resources to help people build a better life. UNDP does not represent any one approach to development; rather, its commitment is to assist partner governments in finding their own approaches, according to their own unique national circumstances. The goal of the organization is to help improve the lives of the poorest women and men, the marginalized and the disadvantaged. UNDP works in the following areas: Democratic Governance, Poverty Reduction, Crisis Prevention and Recovery, Environment and Energy, HIV and Development.

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Introduction

Purpose

There is currently an abundance of documents, plans and policies that address common issues faced in the mitigation, preparedness and relief phases of natural disaster management. Yet for disaster recovery planners and policy makers, there is no cohesive documented body of knowledge. It is conceded that preventive measures are vital to reducing the more costly efforts of responding to disasters. Nevertheless, in the post disaster situation, the availability of knowledge products reflecting past practices and lessons learned is critical for effective and sustainable recovery. Unquestionably, a wealth of experience and expertise exists within governments and organizations; however the majority of this knowledge is never documented, compiled, nor shared. Filling this knowledge gap is a key objective of the International Recovery Platform and The Guidance Note on Recovery: Infrastructure, along with its companion booklets, is an initial step in documenting, collecting and sharing disaster recovery experiences and lessons. IRP hopes that this collection of the successes and failures of past experiences in disaster recovery will serve to inform the planning and implementation of future recovery initiatives. The aim is not to recommend actions, but to place before the reader a menu of options.

Audience

The Guidance Note on Recovery: Infrastructure is primarily intended for use by policymakers, planners, and implementers of local, regional and national government bodies interested or engaged in facilitating a more responsive, sustainable, and risk-reducing recovery process. Yet, IRP recognizes that governments are not the sole actors in disaster recovery and believes that the experiences collected in this document can benefit the many other partners working together to build back better.

Content

The Guidance Note on Recovery: Infrastructure draws from documented experiences of past and present recovery efforts, collected through a desk review and consultations with relevant experts. These experiences and lessons learned are classified into four major issues:

1. Reconstruction Planning, Prioritization, and Coordination
2. Funding Infrastructure Construction
3. Upgrading of Infrastructure
4. Labor, Materials, and Technical Assistance

The materials are presented in the form of cases. The document provides analysis of many of the cases, highlighting key lessons and noting points of caution and clarification.

The case study format has been chosen in order to provide a richer description of recovery approaches, thus permitting the reader to draw other lessons or conclusions relative to a particular context.

It is recognized that, while certain activities or projects presented in this Guidance Note have met with success in a given context, there is no guarantee that the same activity will generate similar results across all contexts. Cultural norms, socioeconomic contexts, gender relations and myriad other factors will influence the process and outcome of any planned activity. Therefore, the following case studies are not intended as prescriptive solutions to be applied, but rather as experiences to inspire, to generate contextually relevant ideas, and where appropriate, to adapt and apply.

Chapter 1

Introduction to Infrastructure Recovery

Document Purpose

This guide is designed to address four interrelated needs:

To present to users a background on the root causes of infrastructure vulnerability according to which disaster-related impacts may be traced. Knowledge of vulnerabilities inherent in community and national infrastructure is key to planning for future recovery needs, mitigating consequences before a disaster happens, and addressing future vulnerability and risk in the event that disaster-related infrastructure reconstruction is required.

To summarize the impacts typically sustained by infrastructure. By understanding these impacts, it is possible to plan for their remedy prior to a disaster, and to mobilize the engines of recovery once a disaster occurs - even prior to the completion of official damage and needs assessments. In this regard, the guide helps to frame the overall scope of work that will be or is faced by housing recovery planners and decision makers.

To introduce infrastructure recovery outcomes according to which recovery in the sector may be measured. These outcomes may be thought of not so much as a roadmap for the journey but rather as the destination to which all efforts strive to achieve. It is through the identification of outcomes that the development of measurable goals and objectives becomes possible.

And finally, the primary purpose of this document is to introduce the major issues that will confront decision makers tasked with implementing recovery infrastructure, presented in the context of case-based experiences.

Document Scope (Definition of Infrastructure)

The guidance contained in this document focuses upon the post-disaster repair and reconstruction of community and national infrastructure, and the upgrading of said infrastructure for the purposes of hazard risk reduction and improvement and/or expansion of services. Because the trajectory of long-term recovery efforts in the infrastructure sector is determined chiefly by actions taken in the initial days and weeks following the onset of the disaster, short-term recovery actions are addressed as appropriate. However, actions related to the provision of emergency-phase infrastructure-related services (e.g. emergency power, alternate communications, temporary bridges), typically managed in the earliest disaster period by response agencies and organizations, is not addressed in this document.

Infrastructure can be defined as the physical and organizational structures, networks, or systems required for the successful operation of a society and its economy. Different components of a society's infrastructure may exist in either the public or the private sectors, depending on how they are owned, managed, and regulated (with shared government/private sector ownership and management occurring in some instances.) Infrastructure may be either physical or social, with the two categories defined as follows:

- Physical infrastructure constitutes public facilities that link parts of the city together and provide the basic services the city needs to function, such as a network of roads and utilities.
- Social and economic infrastructure includes facilities such as hospitals, parks and gardens, community centers, libraries, entertainment and shopping facilities, and educational buildings.

While the benefits from physical infrastructure are patently tangible, the benefits from social infrastructure are often intangible (Balachandran, n/d).

Infrastructure in the disaster management context

Government and society both depend heavily on the functioning of various infrastructure systems and components. The loss of these different infrastructure elements translates to a loss of movement and transportation, trade and commerce, communication across great distances, energy generation and transmission, organized healthcare, among others. Great investments in infrastructure have meant great improvements in development indices and quality of live. However, the damaging effects of disasters can cause major disruptions to each of these systems, can damage or destroy the facilities and equipment associated with them, can cause a loss in the information upon which they depend, and can cause injury or death to the individuals who work to make these services and components possible.

Even in the earliest phases of disaster response, there will be an effort to restore certain critical components of infrastructure even if to only partial function. The emergency services themselves depend upon this infrastructure to provide their life saving and sustaining services. For instance, this might include the use of road and air transportation systems to move equipment and emergency officials into the impacted area and to evacuate victims out of it; communication systems to coordinate and communicate with each other using telephones, internet, and radios; and energy systems to power their vehicles and equipment.

However, there are a number of mechanisms by which the services provided as a result of infrastructure may be recreated in the midst of a major disaster response, few of which are permanent solutions. For instance, generators may be utilized to replace electricity provided by damaged power plants. Trunked radio systems based on trailers may be used to replace damaged mobile cell phone towers. In the emergency phase, life saving and sustaining, not long term infrastructure sustainability, are the goal of the actions taken, and they therefore run counter to many of the actions taken in the long-term recovery phase.

Not every component of infrastructure need be maintained at levels enjoyed during non-disaster times given the special conditions that are likely to exist in a period of response. For instance, not every hospital will have the same importance or emergency capacity, nor will every disaster call upon the needs of medical services to the same degree. It is the disaster itself that dictates which infrastructure components become important in this critical emergency period of the disaster.

Infrastructure in the disaster recovery context

Infrastructure in the long-term recovery context includes the repair, replacement, and reestablishment of infrastructure components upon which society depends upon to function. Infrastructure components that might be addressed in this effort include:

- Transportation (road, air, sea, track, riverine)
- Communication (telephone, internet, radio)
- Energy (mines and extraction, refineries, generation, transportation, transmission)
- Water (treatment, distribution)
- Sanitation
- Commerce (Finance, banking, ports)
- Governance
- Education
- Health (clinics, hospitals) and public health
- Agriculture and food

This document focuses not on the specific details relevant to each of these individual components of infrastructure, but rather upon the overarching issues related to the repair, replacement, and resumption of a nation's infrastructure regardless of the type or types affected.

Document Applicability

This document, like others the series, has been developed to inform the recovery planning (pre- and post-disaster) decision-making process, not to prescribe it. It is therefore our intention that this document be viewed by the user not as a roadmap but rather a menu of options from which an appropriate response may be formulated in order to address one or more recovery-related needs. The materials contained within is driven by and presented in accordance with actual case study material collected and studied from among the many stakeholders involved in infrastructure recovery. Our approach is sensitive to the existence of the unique nature of pre- and post-disaster conditions that present in each individual event, be they hazard-related, economic, governmental, organizational, cultural, or otherwise, and as such this document applies no judgment or analysis. Our intent is merely to provide users with access to a collective record of experience from which they may draw their own selective conclusions or parallels from among these many chronicles. From these stories, best practices become lessons learned, and obstacles encountered allow future troubles to be averted. In the spirit of George Santayana, this document allows us to remember the past such that we avoid the unnecessary hardships of others[1].

Infrastructure Vulnerability Factors

Vulnerability is defined as a measure of the propensity of an object, area, individual, group, community, country, or other entity to incur the consequences of a hazard. It is important to always remember that mere exposure to a hazard need not translate to disaster – rather it is only when a vulnerability exists – either in structures or systems - that failure occurs. Infrastructure by its very nature of being dispersed throughout the geographic area of a country faces great hazard exposure. However, through the use of hazard resistant materials, more innovative design, contingency and continuity of operations planning, and a holistic approach to community hazard risk, infrastructure vulnerability can be greatly reduced. Understanding the sources of vulnerability is the key to reducing or even eliminating it, either through pre-disaster mitigation and recovery planning or through the application of risk-reduction measures during post-disaster reconstruction.

Infrastructure components have been characterized into two primary types, namely object-oriented and network oriented. Object oriented components of infrastructure tend to be individual, even if multiple units of that infrastructure exist throughout the affected area. For example, hospitals are individual 'objects' that together make up a nation's health infrastructure. Network oriented infrastructure systems are more interconnected, and often rely upon lines of transmission that traverse great geographic distances. Pipelines, communication wires, transmission lines, and roadways, for examples, are each components of network-oriented infrastructure systems (Studer, 2000). These system characteristics present the greatest influence on the vulnerability of the infrastructure component.

The following factors are the key source(s) of vulnerability in the infrastructure sector:

- **Poor land use planning.** Poor land use planning is the most likely source of vulnerability for infrastructure. Various infrastructure components are placed

[1] "Those who cannot remember the past are condemned to repeat it." George Santayana, 1905.

in high-risk zones - where residential construction has not occurred – for a range of reasons. This is due to both the proximity to resources (as in the case of water treatment and power generation facilities on the banks of rivers, for instance), because of the availability of a large swath of land, or because of the low cost of the land. In the case of network-oriented infrastructure, it can be difficult to fully avoid high-risk areas given the need to achieve continuous pipelines, roads, or transmission lines, for example. Land-use related vulnerability might also be a matter of infrastructure age. Infrastructure constructed in high-risk areas may have been built decades earlier prior to the identification and mapping of hazard risk.

- **Poor, weak or inappropriate construction materials**. All infrastructure systems and components rely fully or primarily upon physical structures and components. Network-oriented infrastructure systems that typically include a vast array of built objects, as is true with pipelines and/or transmission lines that span hundreds or thousands of miles, will crisscross the disaster-affected area. These facilities must be constructed of materials that are able to withstand the forces of anticipated hazards. There are several constraints such as a lack of access to high-quality construction materials (whether as a result of low inventory or high cost) or the unavailability of qualified human resources and/or proper quality control mechanisms, which ultimately result in vulnerability of these systems.
- **Inappropriate design of buildings and other structures.** Building design can increase resilience or vulnerability according to the hazard to which it is exposed. For instance, in seismic areas, structures with soft-storey, structures in close proximity, or structures with asymmetrical shape, are all typically more likely to fail in the event of an earthquake. In high wind zones or areas where cyclonic storms may occur, failure to incorporate wind-resistant construction (such as construction straps) can lead to roof loss or structural failure. Areas of high snow likelihood must have adequate snow load capacity built into frames and roof structures. As such, non-engineered structures present an extreme degree of vulnerability that is often avoided through the use of proper hazard-resistant construction design, principally that which is guided through legal and regulatory mechanisms like building codes and land-use zoning.
- **Insufficient building codes and Inadequate Code Enforcement.** Building construction codes are based upon known hazard risk, and are typically based upon a minimum standard of safety in recognition of the increased cost of construction with each incremental move towards stringency. Codes that do not appropriately address hazard risk lead to the incorporation of risk into building design. Codes must be regularly updated to match industry innovation, new risk information, and prevailing practice and knowledge of the construction industry. In the absence of adequate enforcement, building codes

are of little use. Because of the increased cost of construction associated with more stringent codes, they are all-too-often neglected both by contractors. Building codes are only effective when there exists a mechanisms to inspect structures as they are built and thereafter, and to impose penalties for those who do not engineer a structure correctly or build it to code.

- **Poor Maintenance.** Maintenance of infrastructure is required to ensure that it is strong enough to withstand external forces, especially the increased forces related to hazard events. However, maintenance is both costly and complicated, and is often neglected as a result. As structures and networks age, materials become weakened, broken, or brittle, and resilience levels fall below what the materials were designed to withstand.
- **Cascading failure.** Infrastructure components are all vulnerable because of the complex dependencies they have upon each other. Cascading failures occur when the loss of one aspect of infrastructure leads to the subsequent loss of others. For instance, the loss of a water treatment plant causes a power generation plant to go offline, which in turn results in a hospital losing power and becoming unable to provide services.

Infrastructure Impacts and Implications

Infrastructure facilities, services, and installations are spread throughout the community and country, and therefore face a high degree of hazard exposure and subsequent disaster impact when events manifest. Of the many components of a country's infrastructure, a select few are vital to both disaster response and to the overall safety and security of the affected population. These components are referred to as "critical infrastructure." While all infrastructure damaged or destroyed in the disaster will eventually require rebuilding or repair, critical infrastructure problems must be addressed in the short term, while the disaster response operation is ongoing. The repair and reconstruction of critical infrastructure requires not only specialized expertise but also equipment and parts that may not be easily obtained during the emergency period. However, without the benefit of certain infrastructure components, performing other response functions may be impossible.

Components typically considered most critical include:

- Transportation systems (land, sea, and air)
- Communications
- Electricity
- Gas and oil storage and transportation
- Water supply systems
- Emergency services

- Public health
- Government

Other infrastructure components, typically considered secondary in importance to those listed above, are provided in the following list for comparison. Keep in mind that, for various reasons, a jurisdiction may consider any of the following to be critical and determine any of the above to be non-critical.

- Education
- Prisons
- Industrial capacity
- Information systems
- Mail system
- Public transportation
- Banking and finance

In the longer-term recovery threshold addressed by the actions in this guide, the implications of infrastructure damage go beyond the short-term matters of loss of or reduction in infrastructure services. Infrastructure damage and destruction is more a matter of the following:

- Financial implications, typically a factor of development loans, related to the reconstruction of costly infrastructure components
- Alterations in infrastructure service patterns, resulting most prominently from population shifts, changes in recognized risk, and recovery planning priorities
- Modernization and restructuring of infrastructure components to meet modern innovations and more current population needs

Recovery Outcomes

More than any other sector, recovery of infrastructure represents a window of opportunity to update and improve what existed prior to the event. Infrastructure typically develops over time, in response to changes in settlement and population movements. It is almost impossible outside of a disaster event to fully re-evaluate the placement of infrastructure components and the actual systems and components to meet existing and evolving needs. In the aftermath of a disaster, there is often a great influx of funding to address not only the replacement of what was damaged or loss, but to address improvements and upgrades. Risk reduction options that were before an unobtainable goal may now be a contingency for funds disbursement. Areas that before saw poor or no access to infrastructure may now find that there is funding and mandate to provide a positive solution. Inefficient and environmentally-damaging infrastructure can finally be dismantled or upgraded.

Infrastructure recovery planning must assume a holistic stance considerate of the wider spectra of recovery functions, rather than considering the construction of each infrastructure component in isolation. Infrastructure recovery planning is an outgrowth of urban planning wherein the access, efficiency, and resilience of each and every component of infrastructure is maximized. All decisions should strive to meet or at least approach a core group of target outcomes, which might include any of the following:

1. **Accessibility**: Infrastructure components and services supported by the recovery effort should be accessible to all populations affected, respective to their physical location, and irrespective of their economic, ethnic, religious, or other background.
2. **Hazard Risk Resilience**: Infrastructure solutions must be constructed such that there is a significant if not full reduction in the hazard risk vulnerability factor that led to the original damages. While this is likely to increase construction costs, practice shows that every $1 spent on hazard risk reduction ultimately results in a $7 reduction in future reconstruction costs.
3. **Sustainability**: Infrastructure solutions must adequately account for the climate, geography, financial and technical capacity, and projected growth of the communities served.
4. **Scalability**: Infrastructure recovery will differ from community to community throughout the region affected by the disaster given not only the damage inflicted, but also the geographic size, urbanization, population density, and other social characteristics. Infrastructure recovery planning must be able to address the needs of each and every community irrespective of size if inappropriate solutions are to be avoided.
5. **Maintainability**: In addition to the up-front cost of construction, all infrastructure carries associated maintenance costs measured in technical and financial commitment. Communities must be spared the situation where they are equipped with systems and structures for which they have no expertise or economic capacity to maintain them.
6. **Community Input and Acceptance:** The wishes of the affected population must be heard, understood, respected, and incorporated, thereby ensuring the most appropriate solutions are delivered.
7. **Environmental Soundness**: Infrastructure solutions should have no negative effect on the natural environment, ensuring that any collateral impacts are resolved.
8. **Cost Effectiveness**: Reconstruction efforts should not put governments, communities, or individual residents in crippling financial circumstances, and must be commiserate with the overall development trajectory of the affected region.

9. **Progressiveness**: Ongoing long-term development progress must be maintained, with no sacrifice of long-term community goals for short-term individual benefits.

An overarching goal, which is generally the result of these nine ambitious outcomes, is that the infrastructure reconstruction effort provides an overall improvement with regard to reduced vulnerability (over what existed prior to the disaster). Such an ambitious goal hinges upon the ability of planners to incorporate informed urban planning methods and practices, for which related planning and forecasting has typically been established in the pre-disaster period in line with long-term development goals.

Challenges to Infrastructure Recovery

There are several factors that make recovery more challenging. By understanding these challenges and having the prescience to recognize them, planners are better able to reduce their negative impact on the ongoing repair and reconstruction efforts. Overcoming them may be difficult given the pressure placed on political and administrative leadership, by the affected population and the press, to quickly resume the provision of infrastructure-related services. However, infrastructure projects represent major national investments and can define the development trajectory of the country for decades to come. Ever disaster, and every effected population, is unique, and as such these are provided merely to provide planners with a general sense of awareness. The infrastructure-specific recovery challenges include:

- **Pressure to Quickly Reinstate Infrastructure Services and Reconstruction Infrastructure Components.** The greatest obstacle faced by those tasked with recovery in any of the infrastructure sectors is the call by the effected population to quickly resume infrastructure services and components (buildings and other structures) such that society can immediately function at levels that existed immediately prior to the onset of the disaster. Most infrastructure services are key to the functioning of society, and some, like potable water and food supply, are vital to the sustaining of life. However, it is widely accepted that simply rebuilding to conditions that existed prior to the event is not only short-sighted, but also irresponsible in that doing such ensures risk is retained. Planners will need to find a balance between the costs of using alternate methods to provide infrastructure services (while planning for repairs, reconstruction, and upgrades are made), and of reconstructing infrastructure components (hospitals, bridges, roads, dams, among many others) and the benefits of long-term development and increased quality of life gained by performing those improvements.
- **Technical Planning Expertise.** In order to reduce risk to infrastructure systems and improve access and quality of services, there is a significant amount of urban planning required. These 'big-picture' efforts require planners to work together with all government sectors to create current and forecast needs assessments, and to plan for the siting and type of infrastructure systems that

best meet those needs (within the budget that can realistically be raised to fund the planned projects). Such efforts may involve more technical knowledge than exists in government considering it is doubtful a project of such magnitude has ever been performed. In the most catastrophic events, this is akin to building a city or a region from the ground up, but on an enormous scale, and in concert with many other recovery sectors (most notably that of shelter).

- **Informal Settlements.** Informal settlements composed of illegal "squatters" can appear in almost any urban setting where available an affordable housing is scarce. Because infrastructure planning is typically dictated by official census or registration of property ownership, informal settlements must look to alternate and often illegal mechanisms for access to basic infrastructure services. In the aftermath of disasters, informal settlements typically lose access to services to a degree that equals or even exceeds that of legal settlements. However, the repair and reconstruction of infrastructure systems and mechanisms is less likely to benefit the residents in these settlements given their unofficial and often illegal status. Disaster-related humanitarian emergencies within these settlements may force governments to address the status of those living within them.
- **Inequality in Access to Repaired, Reconstructed, or Upgraded Infrastructure.** In almost all societies, irrespective of disaster events, different groups enjoy differing levels of access to infrastructure resources as a result of any number of factors, including income, social class, gender, race, legal status, culture, religion, education, and more. In the aftermath of a disaster these inequalities are greatly exacerbated. While some groups will possess the means and knowledge to be able to drive the reconstruction effort in such a way as to receive a greater benefit simply out of political connectedness or influence, technical knowledge, or financial access, others will have no ability to influence or even contribute to the planning process. Planners must be able to recognize and account for these inequalities or they are likely to perpetuate them in recovery. The following groups tend to be particularly susceptible (NHRAIC, 2001):

  a. Low-income households

  b. Single parents

  c. Medically dependent (physical and psychological) or disabled

  d. Language minority and illiterate

  e. Elderly

  f. Homeless and street children

  g. The marginally housed

h. New immigrants and Residents without Legal Status

i. Transients and newcomers

j. Isolated households

k. Racial and ethnic minorities

l. Children

- **The Availability and Cost of Building Materials and Labor.** Infrastructure reconstruction efforts place significant demands on both materials and labor. Local employment and supply markets are based on non-disaster orders, which represent a fraction of what is required post-disaster. Once reconstruction begins these thin resources may be immediately stretched to their limit, causing a recovery bottleneck that can only be relieved through external sources. Additionally, the high demand on such limited labor and materials can cause a shock to local markets, resulting in a spike in construction costs. On the other hand, a market glut caused by excessive donation of materials and labor can eliminate all demand for local products and labor and put local companies and laborers out of work.
- **The Loss of or Reclassification of Land.** Major disasters can drastically alter the landscapes they impact. Rivers can change course, coastlines can change shape, landslide-induced dams can inundate entire cities, and sea level rises and plate tectonics can cause coastal communities to sink below water. These and other processes can claim previously-developed land, destroying property upon which roads, bridges, water treatment plants, refineries, pipelines, water and sewer pipes, power lines, and other infrastructure components previously existed. Sometimes it is just the inherent risk of rebuilding on the land where infrastructure components were located that can result in the loss of that land's use. In any case where land loss occurs, new land must be located for infrastructure reconstruction, and the process by which that is successfully accomplished is a complicated one.
- **Community Dynamics.** Infrastructure exists only because there is a society for it to support. Without people and the economy they feed, there is no need for infrastructure. As societies and communities develop slowly over time, infrastructure development follows slowly behind in response to growing demand and evolving technologies. When a disaster occurs, however, there are two things that happen that drastically change this model. The first is that infrastructure must be developed quickly, oftentimes all at once, to meet an existing population. The second is that there may be uncertainty about where people will live, if they remain in the community at all, and what their post-disaster demands upon those infrastructure components may be. It is contingent upon the recovery planners tasked with infrastructure reconstruction to accurately determine both immediate and long-term

community plans such that the infrastructure components that are built are done so in a way that accurately reflects the changing and growing needs of the community that is served.

Reconstruction Planning, Prioritization, and Coordination

Chapter 2

Reconstruction cannot be performed in an ad-hoc manner. The success of national recovery efforts will ultimately become a factor of the detail and accuracy of recovery planning, the prioritization of different recovery goals and objectives, and the coordination between recovery stakeholders. These are individual yet interconnected functions of recovery.

Pre- and Post-Disaster Recovery Planning

There are two primary categories of reconstruction planning, whether for the infrastructure sector or any other concern, including: Pre-Disaster Planning and Post-Disaster Planning. Pre-disaster planning is performed in a more free-form environment that allows for the luxury of hypothetical outcomes and logical reasoning. It is relatively easy to perform, and costs very little, and can provide a tremendous benefit in the event that an actual disaster has occurred given the time-intensive legwork that will have already been completed. However, pre-disaster recovery planning is rarely performed to any significant degree, and unless planning products are regularly maintained they quickly expire and may offer little assistance in a disaster event. The unfortunate reality is that little or nothing is done to prepare and plan for post-disaster recovery until planners are faced with an actual disaster event (see Annex 1 for more information about Pre-Disaster Recovery Planning).

Post-disaster recovery planning is a function that is unavoidable to those confronted with a disaster. It is performed in a very time-constrained environment, and external pressures and influences – be they political, economic, social, or otherwise – are overbearing. The planning atmosphere is, therefore, much more challenging. On the other hand, with accurate assessments, and defined long-term development goals, post-disaster planning lends itself to a realism that simply cannot exist pre-disaster.

Disaster managers in the United States, addressing post-earthquake disaster recovery, described the differences between pre- and post-disaster recovery planning as follows:

- After a disaster, planning for rebuilding is a high-speed version of normal planning, as well as a dynamic cyclical process. Local communities faced with disaster recovery will not have the luxury of following normal procedures for development review and approval.

- After a disaster, planning for rebuilding is more sharply focused. This is not the time to begin a regional planning process.
- After a disaster, planning for rebuilding is more realistic. Planners must avoid raising false expectations by unrealistic planning schemes and, instead, strive to build public consensus behind appropriate redevelopment approaches. Comprehensive evaluation of funding sources for implementation is essential. (Spangle and Associates 1991)

What is most important when planning for recovery from a disaster is that as little construction or other action that could affect the long-term sustainability of the community is performed before being considered by the planning process. Several options can assist disaster managers with this, such as imposing a moratorium on new construction. However, the public and business owners place a lot of pressure on disaster managers and politicians to rebuild as quickly as possible. Demands increase as victims grow impatient with reduced or suspended services, and businesses begin to fail. Recovery organizations add to this stress because of their workers' needs and donors' expectations to initiate and complete their projects as soon as possible. Without rapid and proper coordination mechanisms, many projects will begin on their own, irrespective of any central plans that are being drawn to guide the recovery.

Several different activities may be initiated during the planning period. Many of these activities will already have begun due to their interconnectedness with response, such as the repair and recovery of critical infrastructure, the site selection for temporary housing, medical facilities, and hospitals, the resumption of education, and the clearance of debris. William Spangle (1991) describes two lessons that planners should consider during the planning process:

1. Planning and rebuilding can occur simultaneously; some rebuilding takes place before master plans are completed. Although building moratoria may be appropriate after a disaster, streamlined decision-making procedures for those land-use questions that can be resolved quickly might help demonstrate good faith on the part of local officials. As soon as possible, local officials need to determine areas of the community that can be rebuilt under existing plans and regulations and provide for rapid processing of permits for repairs and rebuilding in those areas. In the other, more problematic areas, clear procedures and time schedules for planning, making decisions, and getting information are needed. In this higher-speed version of normal planning, decisions might be phased so that planning and rebuilding can proceed in tandem.
2. Defining urban expansion areas helps. After a disaster, planners usually have the information needed to plan for urban expansion while avoiding clearly

unsafe ground given pre-disaster long-term urban development goals. By quickly delineating such areas following the onset of a disaster, planners can speed up the relocation of people and businesses from heavily damaged areas that may be a long time in rebuilding. Urban development zonation is not something that can typically be performed quickly in the aftermath of a disaster given the degree of geologic, hydrologic, and other studies required.

Luckily, even if most governments are facing the post-disaster recovery period without any recovery plans, there may not be a need to start from scratch. Existing plans and regulations may be acceptable for many parts of the country, especially where buildings failed because they were not designed or built to modern codes (as opposed to having failed *despite* being up to code). Additionally, despite planners' best efforts to conduct planning as quickly as possible, some construction is likely to begin immediately. Existing building and development plans, zoning regulations, and land use regulations can all help to guide the fragmented groups of players involved.

Coordination of Infrastructure Recovery

Coordination of infrastructure recovery, both within the infrastructure sector and between infrastructure and other sectors (e.g. shelter recovery) is extremely difficult to achieve, but it is vital to successful accomplishment of its goals and, more importantly, in achieving reduced risk. Though a majority of the actual recovery actions taken are likely to occur at the local level, managed by local officials, regional or national coordination mechanisms will be required to ensure proper distribution of the many resources, technical assistance, internal and external financial assistance, and other special programs that will fuel the process. Recovery of major disasters is a patchwork of local level efforts feeding from and guided by larger, centralized resources.

The success of post-disaster recovery coordination typically depends on planners' ability to achieve wide representation within the coordination structure. For the recovery plans to address the community's demographic and socio-cultural needs and preferences, all representative community groups must often be involved—including businesses, religious and civil society organizations, emergency managers, representatives from various government agencies, public advocacy groups, and the media. There may be considerable interaction between local and regional or national levels throughout the recovery process as well, so inclusion of these outside groups is vital. By involving all of these stakeholders, a highly organized recovery operation is possible that ensures lessons learned, best practices, and efficiency of labor are maximized. In the absence of full coordination and communications, recovery assistance likely will not be able to meet the needs at the local level.

If structured correctly, the resulting coordination mechanism will become a central repository of information and assistance for all groups and individuals involved. The coordination structure may be formed around an existing community group or government agency, or it may be a new representative committee. The committee may be elected, a public-private partnership, or any other appropriate format for the community or country it is serving.

Officials who may be included in the recovery coordination structure typically include:

Environmental Officers	Floodplain Managers
Building Officials	Rural / Urban Planners
Zoning Administrators	Public Works Directors / City Engineers
Parks and Recreation Directors	Storm water Managers
Economic Development Officers	Finance Officers
Transportation Officers	Housing Department Officers
Regional Planning Organizations / Officers	Local and Regional Emergency Management (Law Enforcement, Fire, EMS)
Public Information Officers	Business Community Representatives
Public and Private Utility Representatives	Neighborhood Organizations
Homeowners Associations	Religious or Charitable Organizations
Social Services Agencies	IFRC / Other NGO Recovery Officials
Environmental Organizations	Private Development and Construction Agencies

The recovery coordination group will perform many of the following functions:

1. Collate damage and needs assessment data
2. Guide and facilitate the recovery planning process
3. Establish recovery and risk-reduction goals
4. Centralize information on relief and recovery resources and services (this also includes information pertinent to the public, and as such a public information office or other similar information management structure must be established in some form accessible to those impacted by both the disaster and the recovery effort)
5. Minimize duplication, redundancy, or inefficiencies in services

6. Adjudicate complaints, grievances, and other concerns of affected individuals and groups

The disconnect that often exists in planning for and coordinating recovery often stems from inaccurate understandings of what is best for the individual communities. National officials, multilateral organization representatives, and national and international nonprofit agencies may all be working under assumptions that, albeit educated and informed, are incorrect in light of specific social and cultural conditions on the ground. Jim Rolfe of the Wellington, New Zealand Earthquake Commission and the Centre for Advanced Engineering, and Neil Britton of the Asian Development Bank, write, "The need for achieving consistency between a community's recovery and its long-term vision is perhaps one of the biggest reasons for placing management of the recovery process in the hands of local government" (Rolfe and Britton, 1995). The victims should be active participants in the recovery period, helping to define that local vision, outlining the overall recovery goals, and taking ownership of recovery projects, rather than be left on the sidelines to receive free handouts.

Development planning is a key driver behind reconstruction of national infrastructure. Because infrastructure recovery is closely tied to the movement of the populations and industry that it serves, it follows that planning for infrastructure recovery must match the identified priorities and strategies developed in those corresponding recovery planning efforts. It makes no sense, for instance, to rebuild a water treatment plant that serves a community that will likely face relocation.

Prioritization of Infrastructure Recovery

After planning and coordination, prioritization is the third component addressed in developing a broad reconstruction strategy where infrastructure is involved. It will not likely be possible to commence the reconstruction of all components of infrastructure concurrently, nor will infrastructure reconstruction mesh perfectly with efforts in other sectors, namely that of shelter. There are a number of relevant factors that shape the prioritization of infrastructure reconstruction and recovery, and include:

1. The criticality of the services provided by each infrastructure component, in relation to:
    a. Life safety
    b. National security
    c. Economic stability and commerce
    d. Quality of life and community function
2. Proposed or determined movements of populations
3. The need for additional study to determine hazard risk, hazard mitigation options, modernization options, longer-term development goals, expansion opportunities, among other alterations

4. The availability of reconstruction funding, materials, labor, and expertise
5. The settlement of legal constraints, such as land ownership and reconstruction responsibility (in the case of privately-owned infrastructure)

In the World Bank document Re-Establishment of Transportation Systems after an Earthquake and Establishment of Lifeline Systems, the authors write:

> *"Social order relies on a complex network of infrastructure lifeline systems. When disaster strikes, restoring lifeline systems is at the heart of restoring social organization. At the center of lifelines, is a multi-modal transport system. Following a seismic event, the reestablishment of critical throughways and corridors is essential to recovery efforts." (World Bank, 2008).*

This passage highlights the challenge of determining which infrastructure components play a critical role not only in the function of a society, but also in the ability of that society to facilitate recovery following a disaster event.

Recovery planners must attempt to develop and convey an ideal projected reconstruction time frame that guides the scheduling and commitment of resources, and ensures that the affected population has a realistic understanding of what lay ahead. After the occurrence of a disaster, for instance, it may take three to six months just to arrange the necessary financing and to finalize major planning decisions upon which reconstruction will be guided. This will, in turn, allow for the dedication, planning, and coordination of construction materials and skilled and unskilled labor force. This period also ensures that a more detailed damage and needs assessment is possible, which can more accurately inform the final planning products (initial assessments are based more significantly on conjecture and wide estimates due to disaster-related constraints and therefore have a lower degree of accuracy). Oftentimes recovery partners, including public officials, are not necessarily familiar with the factors that influence recovery time horizons, and may under- or overestimate scheduled based upon their non-disaster experience. It would not be inappropriate nor impractical, for instance, for recovery planners to prepare estimates of realistic reconstruction and recovery time that look three, four, or even more years into the future.

Case 1: Earthquake and Tsunami, Indonesia, 2004

Topic: Reconstruction Coordination and Planning

Recognizing that infrastructure reconstruction was being addressed by a number of different stakeholders, including international organizations, bilateral development agencies, nongovernmental organizations, private sector organizations, and others, the Government of Indonesia established policies for reconstruction that differentiated for these different players a strategy and standard for work in both 'Built Up Areas' (BUA) and at the 'plot level'. The following describes how such a policy affected several different infrastructure sectors:

Water Supply

Water supply infrastructure must cover the whole built up area (BUA), whether for a city or a village. This policy was in contrast to the previous efforts of many donors, who initially developed water supply infrastructure only for the housing clusters they provided. The Government of Indonesia supported this effort by issuing an Infrastructure Implementation Plan (IIP) that specified the extent of the supply area, water source and pipeline layout for the whole BUA. Donors that wished to include water supply as part of a housing reconstruction effort were thus required to design their water supply system according to the IIP.

Drainage

The drainage infrastructure strategy was similar to that of the water supply in that it had to cover the whole built up area, not just those areas where reconstructed housing was provided. The IIP supported these efforts by specifying the extent and layout of the BUA drainage needs. Donors were required to provide plot access over the roadside drainage channel, and if they included the drainage efforts as part of their housing proposals they were required to design their system according to the IIP.

Roads and pavements

The roadway strategy was also similar to that of water supply in that roads had to cover the whole built up area. The IIP specified the extent and layout of the BUA road layout for any involved stakeholder. These stakeholders were required to design roadway systems according to the IIP if they wished to include roads as part of their housing proposal. Moreover, it was required that constructed or reconstructed roads be assessed to determine the benefit of linking them to the country's main roadway systems (trunk roads).

Sanitation

All sanitation was assumed to be 'on-plot'. Donors were required to include with housing a septic tank or other sanitation solution, and to include access for sewage removal by a designated authority. The IIP specified for these reconstruction stakeholders the location of the sewage treatment facility.

Electricity distribution

The IIP specified the extent and layout of the BUA electricity distribution layout for donors, who were required to provide electrical coverage to the entire BUA where they operated.

The IIP was developed using 1:2000 aerial photography. This guide was intended to serve as a rapid response plan that most effectively guided efforts to meet the needs of the affected people. The original intent was for the IIP to be replaced by a Community Plan (CP) to be approved by the relevant regional planning and development body (BAPPEDA). The CP will be the basis for long-term recovery planning (five to ten year horizon).

Source: BRR. 2005. Extended Guidelines for Infrastructure Reconstruction in Tsunami Affected Areas. http://www.humanitarianinfo.org/sumatra/mediacentre/press/doc/GovInfo/PolicyIssuesforBRR_V02-150905.pdf

Lessons

- Infrastructure planning is more effective when it looks at wide (regional) areas of service rather than individual plots, small communities, or even individual settlements.
- Nongovernmental organizations involved in reconstruction of infrastructure must be closely aligned in their efforts with area-wide infrastructure reconstruction planning efforts and outcomes.

Case 2: Hurricanes Katrina and Rita, Gulf Coast, USA, 2005

Topic: Prioritization and Infrastructure Inter-Dependency

When Hurricane Katrina reached the Gulf Coast shoreline, it resulted in the devastation of much of the transportation infrastructure in the southern portion of three large US states: Mississippi, Louisiana, and Alabama. The most significant impacts were to the bay and river crossings throughout the region, which were principally affected by combined storm surge and wave action. While a number of areas experienced manageable impacts and were able to complete repairs to the point of function within days, other areas experienced closures lasting many months or more. One area in particular in Southern Louisiana saw wide swaths of ranches, bayous, and wilderness preserves entirely swept away by the catastrophic storm surge.

Electrical power failures caused the shutdown of ports, railroads, refineries, and pipeline stations that were not significantly damaged by the storms, and were cited as the number cause of delays in the restoration of transportation services in the Gulf Coast region. Highways and arterial roadways need electrical power to operate traffic lights and signs; railroads need electrical power to operate signal systems and crossing gates; ports need electrical power to operate cranes and elevators; and pipelines rely upon electrical power for the operation of the pumping stations. Modern freight transportation networks are also inextricably bound to the functioning of the power and telecommunications networks. This suggests that transportation planners and operators, as well as emergency management officials, need to pay at least as much attention to the redundancy and restoration of power and communication systems as to freight and passenger transportation systems.

Apart from the lack of electrical service, the primary factor hindering efforts to resume transportation services in many locations (particularly metropolitan New Orleans) was the lack of workers. Especially with Hurricane Katrina, truck, port, railroad and pipeline employees lost family and homes in the storm, and many evacuated the region. The city itself was closed for more than a month. In August 2006, almost a year after the storm, the population of New Orleans was estimated at 250,000, about half of the pre-Katrina total. Major transportation companies such as CSX brought in workers from throughout its system and provided them with food and accommodations for months in order to staff reconstruction projects.

Source: Grenzeback, Lance R. 2006. Case Study of the Transportation Sector's Response To and Recovery From Hurricanes Katrina and Rita. Cambridge Systematics, Inc. http://www.aiche.org/uploadedFiles/FSCarbonMgmt/Resources/Case_Study_-_Katrina.pdf

Lessons

- The criticality of infrastructure components, and likewise the prioritization of reconstruction and repair efforts, is unique to locations and driven by the economy and dynamics of each region.
- A lack of infrastructure can result in out-migration of displaced persons, which exacerbates the problem of labor force shortages given that these individuals are the primary pool of workers available to support reconstruction.

Case 3: Wenchuan Earthquake, China, 2008

Topic: Coordination and Planning

The Government of China State Council issued a detailed document "The Regulations on Post-Wenchuan Earthquake Rehabilitation and Reconstruction" on June 8, 2008, about one month following the event. These regulations were issued to provide a measured degree of coordination and standardization for the post-earthquake rehabilitation and reconstruction efforts, which consisted chiefly of housing and infrastructure reconstruction. Per the regulations, surveys were conducted to assess the damage and identify the resources required to meet assessed rehabilitation and reconstruction needs. These regulations iterated a number of guidelines that entities and organizations involved in long term recovery must follow, and included:

- Actions oriented at population dynamics that were also environmentally sound
- Planning that was based on scientific assessment and analysis
- Implementation that followed an orderly, phased approach
- A joint funding mechanism that balanced self-reliance, government subsidies, and social donation assistance

The recovery planning process was led by the National Development and Reform Committee (NDRC), which is the planning ministry of the Chinese Government focusing on large development programs of national strategic importance. In addition to the central and local government participation, best practices and commentary from the international community was solicited and incorporated. Of particular importance was a program initiated by the central Government which established an innovative assistance mechanism through which 19 provincial-level administrations were paired one-to-one with each of the 19 most significantly affected counties. Assistance pairs managed a number of reconstruction topics, including the following:

- Long-term reconstruction planning services, through the work of building design architects and advisory experts, and through various construction and supervision services
- Building and repairing public service facilities such as schools, hospitals, broadcasting and television facilities, and cultural, sports and welfare facilities
- Building and repairing various infrastructure sectors including transportation (roadways), water and gas supply, drainage, sewage, and garbage disposal
- Building and repairing agricultural infrastructure and providing agricultural technical services (food production infrastructure)
- The provision of machinery, tools, equipment, building materials and other support goods required for infrastructure recovery
- The provision of the personnel components of various infrastructure components, including teachers and medical personnel for example, and organizing the training and job placement needs of these sectors
- Encouraging investments in industrial and commercial service facilities and in commercial infrastructure development

By October 5th of 2008, the resources committed to the reconstruction efforts had 22.7 billion Yuan, meant to address the coming three years of reconstruction efforts.

Source: UNESCAP. 2009. Implementation of the Hyogo Framework for Action in Asia and the Pacific: Case Study: The National Disaster Management System of China and its Response to the Wenchuan Earthquake. http://www.unescap.org/idd/events/cdrr-2009/CDR_2E.pdf

Lessons

- Governments can issue reconstruction guidance and make regulatory actions in order to establish base standards for reconstruction efforts.
- Accurate disaster area-wide damage and needs assessments are required in order to effectively plan for recovery and the introduction of a program that tasks local governments with conducting localized assessment surveys can greatly reduce the time required for assessment and improve its geographic coverage.
- Technical and planning assistance can be compartmentalized and thus increased in efficiency and applicability by instituting a program of ‘city pairs’ wherein affected cities and region are paired with unaffected cities for the provision of financial and technical support.

Case 4: Cyclone Sidr, Bangladesh, 2007

Topic: Prioritization

On November 15, 2007, Cyclone Sidr struck the coast of Bangladesh and moved inland. Recent national investment in early warning systems helped to limit damages and led to timely evacuations, but there was a significant amount of infrastructure damaged as a result of the disaster. On December 3rd, less than three weeks following the event, the Government of Bangladesh Chief Advisor appealed to donors for assistance in developing and implementing a medium and long‑term disaster funding strategy. Members of the Local Consultative Group agreed on December 12th to conduct a Joint Damage, Loss, and Needs Assessment (JDNLA) on the cyclone's impact, with the aim of the effort to prioritize reconstruction support and recommend priority interventions for longer‑term risk reduction. The following describe the two most heavily impacted components of national infrastructure, namely roads and energy:

Roads

Cyclone Sidr's effects on the transport sector were largely confined to the road system (including bridges, culverts, and ferries) and to inland water transport. An estimated 8,075 km of roads were damaged across 11 districts, at a cost of approximately $115 million. The indirect damages resulting from increased road transport costs were estimated to be $25 million. About 25% of national inland water transport navigation was disrupted by the disaster, with economic costs estimated to be about $1 million. Damages to the road network provide an opportunity to repair them to modern standards, and at higher elevations to limit the scope of damage from future disasters, but at a higher construction cost. The assessment showed that modernization needed to include an increase in the number and capacity of the roads to be constructed, and there was a pervasive need to replace ferry crossings with bridges – seen as an unavoidable and critical requirement for development. Main roads were considered highest priority, but it was recognized that the reconstruction of secondary roads was key to the recovery success in the hardest hit communities. By increasing the capacity and number of roads, elevating them to reduce flood risk, and building new bridges, the cost estimate was increased to $145 million.

Energy

Electrical power was the only energy sector significantly affected by the event, with rural distribution mechanisms bearing the greatest impact. Damage to the power sector totaled $13.4 million, with the Rural Electrification Board (REB) receiving the greatest share of damages ($5.1 million). The cyclone's strong winds caused much of the event's damages in the energy sector, disrupting the entire nation's electricity supply for almost a full day. Damage occurred on several main transmission routes because of the sustained high winds and fallen trees. Certain substation components were also affected. The entire distribution network was impacted in the most affected areas, especially those serviced by the West Zone Power Distribution Company Limited

(WZPDCL). Fortunately, no significant damage was sustained by power plants.

Medium - to long - term reconstruction of infrastructure focused on private and public buildings, flood control mechanisms, rural roads, and economic drivers (e.g. market places), in addition to shelter. The approach taken was to provide opportunities to help affected populations regain socioeconomic stability and to introduce and mainstream new standards and upgrading that would help protect them against future disasters. The reconstruction program built upon the early recovery infrastructure activities, developing these into more sustainable investments, while creating opportunities for the private sector to strengthen its capacity. It also built on assessed earthquake risks. It was felt that the expenditure on reconstruction of damaged assets created job opportunities by utilizing local resources (both material and small and medium enterprises), built capacity among the affected populations, and improved accessibility, creating a multiplier effect on recovery in the local economy.

The medium- to long-term priorities of the reconstruction effort were as follows:

- Construction and upgrading of the transport network;
- Rehabilitation of electricity services;
- Rehabilitation of damaged or destroyed market places;
- Reconstruction of water supply services;
- Reconstruction of urban public infrastructure;
- Upgrading of health service infrastructure;
- Reconstruction of fully damaged schools to schools-cum-shelter;
- Reconstruction and upgrading of damaged embankments;
- Rehabilitation of the Sunderbans (mangrove forests key to disaster resilience).

Source: Government of Bangladesh. 2008. Cyclone Sidr in Bangladesh: Damage, Loss, and Needs Assessment for Disaster Recovery and Reconstruction.
http://gfdrr.org/docs/AssessmentReport_Cyclone%20Sidr_Bangladesh_2008.pdf

Lessons

- Collaboration should begin with the assessment phase
- When a substantial percentage of roadways require repair, there exists a unique opportunity to upgrade infrastructure and apply hazard mitigation measures
- Reconstruction and repair of secondary roads is critical to local community recovery
- Energy infrastructure upgrades can help boost private sector capacity and increase job opportunities, thereby creating a multiplier effect on the economy

Case 5: Mildwest Floods, Missouri, USA, 1993

Topic: Coordination

Following the 1993 Midwest Floods in Missouri, USA, many nongovernmental organizations were eager to assist communities in the disaster recovery effort. These organizations expressed and acted upon their willingness to perform a good measure of the reconstruction effort required, including, for example, the rebuilding of the many religious facilities that had been destroyed. Many of these efforts began prior to the establishment of any long-term recovery plans. In the meantime, the government of the State of Missouri had established an agreement with the US Federal Emergency Management Agency under which funding was provided to support the buyout of structures in the designated flood zone. This decision was made without the input of a representative community recovery planning committee, and as such the availability of the existing and ongoing alternative (nongovernmental and private) reconstruction resources were not taken into consideration.

Ultimately, it was felt by those in the local communities that the investment of time, talent, and financial assistance in this endeavor was negated since the State planned to implement the flood zone buy-out program which served to relocate disaster-prone communities away from their present locations to other areas with lower flood risk. Long-term planning with representation from the wider recovery stakeholder community would likely have prevented the confusion and waste of resources that occurred in the impacted communities. Implementation of planning and coordination in the earliest phases can help to bring all or most of the necessary perspectives and concerns together under a cooperative process that defines recovery vision, goals, and objectives. This process also helps to ensure that the needs and wants of the community are adequately considered, even if it takes someone from outside the community to provide an objective view and focus on the broader picture.

Source: COSCDA Disaster Recovery Toolkit http://www.coscda.org/disaster/

Case 6: Earthquake and Tsunami, Banda Aceh, Indonesia, 2004

Topic: Prioritization

Impacts in Banda Aceh following the 2004 earthquake and tsunami events included damages to the transportation, energy and electricity, postal and telecommunications services, drinking water and sanitation, water resources, among others. Specific damages included:

- Damage or destruction of 3,000 km of roads
- Significant damage to 14 out of 19 seaports
- Damage to 8 out of 10 airports
- Destruction of 120 arterial bridges and 1,500 minor bridges

- Damage or destruction of 3400km of electrical transmission lines (servicing over 119,000 households)
- Damage or destruction of 19 post offices
- Destruction of both cell and landline phone systems

The economy began to stall in the months following the earthquake and tsunami events due to the loss of so much transportation, communication, and energy infrastructure, leading to fear among local populations that an economic depression was underway. For many communities, these damages meant total isolation due to the loss of both transportation and communication systems.

In order to best address the long-term infrastructure recovery needs of Banda Aceh, the government of Indonesia adopted infrastructure recovery policies and strategies that prioritized the provision of infrastructure and facilities that fulfilled basic needs and which allowed for the uninterrupted operation of recovery and operational logistics. This included, for instance:

1. Giving highest priority (aside from shelter recovery) to: drinking water, sanitation and drainage infrastructure and facilities
2. Prioritizing the implementation of rehabilitation of entry point infrastructure, which included ports, harbors, and airports, as well as supporting their surface transportation access
3. Closely coordinating infrastructure recovery with the rehabilitation and reconstruction efforts being conducted to address housing *such that the shelter site selections (onsite or relocation) were not impacted*
4. Reconstructing adequate transportation and communication systems to support uninterrupted inter-regional communication within province or inter provinces and with foreign countries
5. Rehabilitating energy and electricity distribution facilities as efforts to support the resumption of social and economic activities
6. Supporting efforts to maintain food production and availability
7. Reconstruction of hazard mitigation infrastructure (e.g. drainage channels, early warning systems, evacuation routes, and dam restoration and construction)

Within five years of the earthquake and tsunami events, the government of Indonesia had accomplished the following relative to infrastructure using this strategy:

- Repair and reconstruction of 2,417 km of roads in Aceh and Nias
- Repair and reconstruction of 61 km of roads on the east coast of Aceh

- Repair and reconstruction of 581 km of roads on the west coast of Aceh
- Repair and reconstruction of 15 bus stations
- Repair of 198 bridges
- Repair and reconstruction of 15 seaports
- Repair and reconstruction of 8 ferry ports
- Repair and reconstruction of 9 airports
- Repair and reconstruction of 3 airstrips
- Repair of 1 helipad
- Construction and installation of a high speed internet infrastructure for Aceh and Nias

Source: Republic of Indonesia. 2005. Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias, Province of North Sumatra. http://www.usindo.org/publications/Blue_Plan_Aceh.pdf. Asian Development Bank. 2009. Indonesia: Aceh – Nias Rehabilitation and Reconstruction. Progress Report. http://www.adb.org/Documents/Produced-Under-TA/39127/39127-01-INO-DPTA.pdf

Lessons

- Economic impacts caused by heavy multi-sector infrastructure impacts can cause public fear and/or discontent
- Infrastructure damage can result in total isolation for remote communities
- Shelter site selection decisions should not be negatively impacted by infrastructure recovery plans
- Life sustaining infrastructure, including potable water, sanitation, and drainage, will always be a priority

Case 7: Great Hanshin Earthquake, Kobe, Japan, 1995

Topic: Planning, Prioritization, and Coordination

The Kobe earthquake caused significant damage to the infrastructure and transportation network in the affected area. Extensive rail and roadway damage included the collapse of significant portions of three major freeway routes, damage to rail systems, and the collapse of Kobe's subway stations. There was also significant damage to the water, gas, and sewer systems, with over 1 million households losing access to related services. The national government prioritized the replacement of the public infrastructure and set aside the largest portion of its financial support for its reconstruction. However, given the scope of work to be completed in such a short time, there was an acute need for technical assistance. To address a shortage of qualified technical expertise, and much needed funding, the national Ministry of Construction was tasked with assisting the city and prefecture with reconstruction. One month after the event, the national government formed a “reconstruction committee” to organize recovery efforts. This body was created through national legislation that required the participation of numerous national, prefectural, and local agencies as well as nongovernmental organizations (e.g. the Kobe Chamber of Commerce and Industry.) The Prime Minister personally managed the committee, and the Chief Cabinet Secretary and Minister of the National Land Agency served as deputy managers. The reconstruction committee also included representation from other high-ranking government officials—including cabinet ministers, the governor of Hyogo prefecture, and the mayor of the city of Kobe—as well as participants from academia. According to an official who participated in this committee, the involvement of these prominent leaders not only encouraged stakeholders involved in the reconstruction committee to collaborate in order to come to agreement on recovery goals, it brought national attention to recovery issues. Working together through this committee, these officials and stakeholders collaborated to create a national plan of action for recovery. This plan included broad proposals that provided insight for how the national government would assist in recovery. It also included more specific details to guide Hyogo prefecture and the city of Kobe’s recovery, such as promptly demolishing unsound structures and using excess concrete from the earthquake rubble for construction and repairs in the port area. In addition to providing an action plan, this committee also reviewed Hyogo Prefecture’s and the city of Kobe’s recovery plans to help localities align their recovery proposals with the funding priorities of the national government. According to an evaluation of the recovery conducted by the city as well as outside recovery experts, the specific feedback provided by the reconstruction committee, along with the recovery goals previously clarified by the national government helped local officials to come to consensus on their recovery goals. Within 6 months of the earthquake, Hyogo prefecture and the city of Kobe completed recovery plans, which included specific recovery goals for their regions. According to this evaluation, the delineation of these goals at a local level played a critical role in helping to coordinate the wide range of participants involved in implementing recovery projects. Because of the national government’s prioritization in this manner, infrastructure was restored in a relatively short time. Reconstruction of rail lines, some of which are privately owned, was completed within 7 months. Collapsed freeways, including the Hanshin Expressway, were restored within 20 months of the earthquake. Similarly, utility services were also quickly repaired. Residents regained electricity in about 6 days and were able to access gas, water, and waste system services in less than 3 months.

Source: GAO. 2009. Disaster Recovery: Experiences from Past Disasters Offer Insights for Effective Collaboration After Catastrophic Events. GAO Report 09-811. http://www.gao.gov/products/GAO-09-811

Lessons

- Heavy infrastructure damages will necessitate a high demand for a diverse range of technical specialists
- National government agencies/ministries can be a valuable source of technical

assistance with large infrastructure projects

- Large infrastructure planning efforts requiring significant national funding demand input and participation from the highest levels of government and from the affected local and regional jurisdictions
- Multi-sector participation in recovery planning committees can help to quickly achieve consensus, and to more accurately determine priorities

Case 8: Tsunami, Solomon Islands, 2004

Topic: Planning and Coordination

Damage to infrastructure in the Solomon Islands was extensive. The disaster cut off villages from the main centers on the islands. In the worst affected areas, roads and coastal areas were heavily scoured and covered with debris. Roadside drains and culverts were blocked or damaged because of seismic and tsunami action. Bridge abutments, which were not designed for seismic impacts, were completely destroyed. Even bridges that appeared in satisfactory condition were destabilized at their foundations by the seismic forces. In total, about 70 kilometers (km) of roads, 48 bridges, 0.7 km of seawalls, and 0.7 km of protection works were severely damaged or destroyed. Many other roads, bridges, and retaining walls suffered minor damages. Seismic waves also destabilized the substructures of many wharves and jetties, and the tsunami destroyed their superstructures. A total of 19 wharves, 14 jetties, and 52 causeways were damaged or destroyed. The earthquake raised parts of some islands (e.g. Ranongga) and lowered others (e.g. Simbo), which has dramatically impaired physical access and rendered some wharves unusable. Water supply and storage was also affected, with distribution main breaks in several locations. The water supply became contaminated and unsuitable for drinking as a result. Even prior to the event, the intake, distribution, and storage and water treatment systems needed to be upgraded to meet the demand from growing populations.

- **Road rehabilitation** included the repair of about 35 km of high priority unsealed roads and about 35 watercourse crossings (culverts and wet crossings), and the replacement of about 19 bridges. The bridge structures were designed and constructed in accordance with seismic standards to withstand earthquakes of a similar or larger magnitude. Designs accommodated lateral movement of the structure compatible with earthquake and tsunami forces.
- **Wharf and jetty rehabilitation** included reconstruction of about five high priority wharves and jetties. The proposed wharves and jetties were designed and constructed in accordance with seismic standards so as to withstand future earthquakes of similar or larger magnitude. Wharves and jetties were constructed and located so as to withstand tsunami or storm surge forces.

- **Water supply and sanitation rehabilitation** included: (i) repairs to the distribution main and restoration of flows to pre-disaster levels; (ii) cleaning, repair and upgrade of water intakes, reservoirs; water supply systems and investigation of more reliable sources; and (iii) installation of a new water treatment plant and the performance of repairs to the sanitation system.
- **Maintenance with community participation.** Small specialized maintenance equipment was procured for future sustainability of labor-based methods and ongoing road maintenance contracts by the community.

The total cost for infrastructure rehabilitation, reconstruction, and replacement was approximately $289.6 million. The above priority areas are being financed under the ADB's Emergency Assistance Project, in partnership with the EC, to the value of $63.9 million. SIG is also providing $5.7 million in counterpart funds. This leaves a gap of approximately $219.9 million to finance work on the airport and the balance of roads, bridges, causeways, wharves, jetties, seawalls and protection works. The balance of works will take another 5-8 years to complete following the completion of the EAP.

Source: Asian Development Bank. 2007. Solomon Islands: Strengthening Disaster Recovery Planning and Coordination. http://www.adb.org/Documents/Produced-Under-TA/41105/41105-DPTA-SOL.pdf

Lessons

- Long-term recovery plans should include accommodations for infrastructure maintenance, including necessary equipment and contract agreements
- Former water sources may no longer be viable, requiring a full investigation of alternative sources for new and upgraded infrastructure

Case 9: Earthquakes (multiple), California, USA

Topic: Prioritization

This case describes two earthquake events that occurred in a five year period in the United States, striking two major urban centers on that nation's west coast.

- The Loma Prieta earthquake occurred on October 17, 1989 in the San Francisco Bay area of California when a slip along the San Andreas Fault occurred, measuring 6.9 magnitude. The earthquake was responsible for widespread damage to transportation, utilities, and communications. Eighteen bridges were closed to traffic in what is one of the most densely populated areas of the country.
- The Northridge earthquake occurred on January 17, 1994 in the city of Los Angeles, California, measuring 6.7 magnitude. The event caused about $12.5 billion in damage including the failure of six major bridges, and damage to four others requiring replacement. Some of the busiest freeways in the country were interrupted.

Following any catastrophic hazard, the California Department of Transportation (Caltrans) prioritizes their relief efforts as follows:

- Public safety
- Protect and preserve facilities
- Reopen the transport system as quickly as possible

Within transportation, essential lifelines are prioritized to efficiently allocate resources. Following the Northridge Earthquake for example, all leadership entities including national, regional (state), local, and industry leaders took a hands-on approach in the re-establishment efforts. Personnel was organized and allocated to maximize individual strengths. In June 1994, five months after the Northridge earthquake, a task force was assembled to gather and identify crucial information about the recovery process. Consisting of expert representatives, the task force interviewed 80 people from Caltrans, Industry, and Federal Highways and sent out 140 questionnaires to contractors. From this, several recommendations were developed to guide recovery. In the case of the Loma Prieta Earthquake, disputes over the cost of repairs and the expected levels of repairs caused significant recovery delays. One example of delays included a peer review which was established by Caltrans immediately following the Loma Prieta Earthquake. The purpose of the team was to review aspects of the reconstruction; however, they did not convene until March 1990, several months after the earthquake. Following the review, many repairs that had already begun, had to be redone or abandoned, resulting in substantial delays. Considerable delays and economic waste could have been avoided if peer-review panels had been pre-selected in anticipation of a seismic event.

The re-establishment process following the Northridge Earthquake was unparalleled to previous U.S. earthquake recovery efforts with regard to its organization. All efforts focused on avoiding bureaucracy by streamlining all processes. The governor at the time exercised emergency powers to significantly reduce the time required to issue construction permits. The Director of Caltrans empowered the districts to approve emergency contracts which expedited the recovery efforts. All actions helped to empower people and local control, while management provided general overall direction and coordination. Bids were submitted only hours or days after plan, specification, and estimate (PS&E) packages were issued. Some contracts were awarded the same day as the bid opening, and were immediately provided the Notice to Proceed (NTP). Contracts were modified to establish parameters such as equipment rental rates that would typically be intended for a standard working day, not continuous construction. As the re-establishment process continued after the Northridge Earthquake, innovative financing contributed to the project's success. Contractors incurred significant expenses using double-shifts, 24/7 use of equipment, and by paying premiums for immediate deliveries of materials. To alleviate potential cash-flow issues, payments to contractors were made in two-week increments instead of one month. In other instances, often initial cost estimates were rushed and actual costs varied from estimates. Reconstruction efforts were prepared to sometimes acquire supplemental money needed for particular projects. Effective organizational and financial solutions prevented potential delays in the reconstruction. Efficient project operations prevented potential delays during the re-establishment process. After the Northridge Earthquake, disputes and decisions on project sites were settled in hours. Hotlines were established to expedite answers/responses to contractors in the field and helped to reduce paperwork.

Source: World Bank. 2008. Re-Establishment of Transportation Systems after an Earthquake And Establishment of Lifeline Systems. World Bank Good Practice Notes. July. http://siteresources.worldbank.org/CHINAEXTN/Resources/318949-1217387111415/Transport_en.pdf

Lessons

- Transportation reconstruction priorities should allow for the most efficient allocation of available resources, including technical expertise
- Input from private infrastructure and industry representatives will help guide the reconstruction and recovery planning process
- Planning should begin as soon as possible to prevent expenditures on work that began prior to the completion of planning and which is later found to be inconsistent with these plans
- Peer-review panels can help to guide work that must begin prior to the completion of long-term recovery panels (membership in these panels can be determined prior to the onset of a disaster)
- Reconstruction planning should seek to streamline processes and eliminate bureaucracy given the scope of work that will be required in such a short time
- Permit fast-tracking procedures may be developed to address work pertaining to critical infrastructure resumption work
- Contracting in recovery and reconstruction differs from typical job-specific contract needs, and should therefore be adjusted to increase efficiency given the long-term nature of equipment and supply needs

Case 10: Tsunami, Aceh, Indonesia, 2004

Topic: Developing Reconstruction Strategies

Much of the primary transportation infrastructure and transport of Aceh Province is located in the coastal areas, including the eastern and western links to North Sumatra, and is therefore at risk from storm surge and coastal erosion hazards. Tsunami damage was greatest on facilities in the western coast and northern area. Earthquake related damage was evident on port and airport structures and some roads but relatively minor in severity. However, it is likely that the impact of the tsunami impact may have been amplified on structures weakened by the earthquake, such as bridge supports. Total damages and losses for transportation were estimated to be $534 million, predominantly to roadways which accounted for 96% of the total. The remaining 4 percent included ports (almost 4%) and airports (less than 1%). Road infrastructure impacts in the affected area included:

- Approximately 316 km of national and provincial roads
- 121 bridges destroyed and 316 damaged
- Over 1,000 km of local roads

Rehabilitation Phases:

Phase I (2005–06)

- An immediate survey within the affected areas to record damages, map hazard zones and identify areas and priorities for the rehabilitation and reconstruction program within the affected areas.
- Corrective rehabilitation works to be implemented where possible using labor-intensive corrective works methods to ensure maximum engagement of local labor.
- Implementing more significant works via small to medium contracts in local areas through DPUP for speed of procurement.
- Monitoring of contracts and supervision to ensure quality of work together with appropriate fiduciary controls.
- Priority given to rehabilitation of urban roads and bus terminals.
- Priority given to rehabilitation of the Geumpang-Meulaboh road and Sp.Km 87-Lamno to provide alternative access to Meulaboh and affected areas on the west coast.
- Rehabilitation of the airports at Meulaboh (runway and airside facilities), Sinabang (runway), Banda Aceh (control tower) and Sabang (replacement of navigation equipment).
- Rehabilitation of 4 ports in Aceh and navigational aids in 9 ports in Aceh and North Sumatra.

Phase II (2007 and beyond)

- Reconstruction of the Banda Aceh – Meulaboh route along the west coast to provide access to affected areas, staged over 5-6 years beginning from north;
- Reconstruction and upgrading as necessary of the southern route from Meulaboh to North Sumatra border.
- Upgrade and betterment of unpaved portion of route through Geumpang to Meulaboh.

- Upgrading of airports at Banda Aceh and Meulaboh, depending on the strategic planning results.
- Redevelopment of Banda Aceh harbor, including provision of major coastal protection.
- Road Transport: Explore opportunities for privatizing management and development of bus terminals (institutional structure, business opportunities).
- Explore opportunities for privatizing small ports, airports, and ferry terminals.
- Identify and act on economically- and financially-sound expansions in transportation sector capacity (e.g. runway extensions or port expansions).

Source: Government of Indonesia, BAPPENAS. 2005. Indonesia: Notes on Reconstruction The December 26, 2004 Natural Disaster.
http://www.recoveryplatform.org/assets/publication/reconstruction1notes01public1.pdf

Lessons

- Infrastructure design should accommodate for the possibility of combination hazards.
- Rapid Restoration of access (e.g. to water supply, markets and social services)
- Built-in Strategic Redundancy in Systems: Strategic redundancy should be built into the transport system so as to provide for alternative means of access when disruptions occur.
- Spatial Planning: Reconstruction should include placement that is tied to the redevelopment of spatial plans and mapping of hazard zones, in order to mitigate risks and support sustainable development. This includes avoidance of conservation areas.
- Disaster Risk Mitigation: Recovery design should include hazard risk assessment and a review of structural and non-structural mitigation options.
- Construction capacity: Reconstruction planning should account for construction industry capacity and limitations. Options for expanding this capacity should be addressed. In this instance, the transport of large quantities of construction materials, notably cement, asphalt, reinforcing steel and larger bridge trusses required upgrading port facilities and rehabilitation of the arterial road access. The capacity of governmental Public Works Offices given staff losses should also be accounted for.
- Security and Cost. Risking costs, due to material price increases, security, and diminished capacities, must be accounted for.
- Guiding principles applied to reconstruction of Aceh’s transportation infrastructure included:

- Participation: Planning and implementation of programs included recognition of human and physical resources available locally, and efforts were made to utilize local resources, to recognize infrastructure as part of a comprehensive approach to improve livelihoods, and recognition of development of the local road network as a driver for socioeconomic development.
- Comprehensive strategy: The reconstruction plan was based on a strategic analysis of the transport network that includes supplementary capacity and redundancy between road, port and air. The overarching concept of the program was to bring about recovery that enhanced resilience and redundancy to minimize the impact of future events.
- Coordination of programs: The recovery of transportation infrastructure was a coordinated effort that included a range of government offices and ministries, including the Ministry of Public Works (MPW), DPUP, and The Ministry of Communications (MOC). Normal transportation infrastructure budgets were maintained over and above additional reconstruction and recovery funding provided, rather than supplanting one with the other. The emergency-related rehabilitation and reconstruction program was able therefore to focus on areas that had been severely impacted.
- Responsible Construction and Rehabilitation: The work required to ensure transportation system safety, including repairs to culverts, road furnishings, and minor maintenance to road surface, retaining walls, sea walls, protection of bridge piers and abutments, strengthening of wharf and terminal structures, resurfacing of pavements and bridge decks, was included in reconstruction projects.
- Repair and Reconstruction: The reconstruction program restored the structural integrity of heavily-damaged or destroyed roads, ports or airports. The reconstruction work included upgrading of construction standards where necessary to ensure capacity, loadings and resilience against future events.
- Capacity building: Implementation arrangements utilized and strengthened regional and local resources to the extent feasible, especially for urban and rural roads programs. Mentoring and support for surviving and new staff was provided by experienced persons on temporary transfer.
- Procurement and financial management: Special procedures were identified to assist in expediting the procurement of works and services for the first year, in the framework of fiduciary controls established for donor-supported programs.
- Funding options: Use of Special Allocation Funds as a mechanism for

channeling central government funds, including foreign grant funds, so as to promote local ownership and commitment, was utilized.

- Feasibility Studies: State-owned enterprises were required to follow sound commercial principles in planning and implementing rehabilitation and reconstruction investments and to avoid excessive standards.

Chapter 3

Funding Infrastructure Construction

Repair and reconstruction of damaged national infrastructure, whether privately or publicly held and maintained, requires extraordinary financial outlay. These costs, coupled with those tied to damaged and destroyed shelter, will constitute the vast majority of disaster-related costs, and may represent a sizeable percentage (or multiple factor) of national GDP in catastrophic events. As such, the funding of infrastructure recovery represents a challenge in terms of locating and securing financial resources to adequately plan for and sustain the work that is required. Even in instances where international (multilateral), foreign (bilateral), and NGO assistance – whether financial, technical, or human-resource based - is provided, and where international humanitarian appeals have been made, there are simply too many expenses to avoid the constraint of even the wealthiest nation's coffers.

Financial investment in infrastructure reconstruction is necessary in order to ensure and maintain ongoing recovery momentum, to rebuild a society that can function, to allow for manufacturing and trade to resume and ultimately to thrive, to allow for the repair and reconstruction of shelter, and for many other related activities. Because the notion of infrastructure is conceptually diverse, and components typically spread across and among all governmental and societal sectors, the responsibility for reconstruction costs may be divided among various societal stakeholders. Government agencies and offices are generally responsible for rebuilding public facilities and much of the infrastructure owned, operated, and/or maintained in the public domain. The private sector, including industry, individuals, and families, will lead the rebuilding of businesses, helping to restore overall economic vitality. The public and private sectors will frequently work together and share reconstruction costs. Imagine, for example, the reconstruction of a privately-owned power generation facility destroyed in a flood event. While the funding of such an endeavor might seem beyond government responsibility given the profit-making nature of the enterprise, such decisions must be weighed against the burden failure to do so will place on other infrastructure components, including water treatment plants, hospitals, schools, and others. Public and private infrastructure more commonly than not exists in a complex pattern of co-dependence. And that dependence goes both ways. Private landowners, for instance, may be unable to rebuild their homes if a government agency tasked with issuing construction permits has yet to resume their services.

How quickly the affected country can organize financial and other types of resources will determine how quickly and how effectively that nation recovers from the disaster. A nation has several options for funding infrastructure recovery, including:

1. Insurance
2. Government-based emergency relief funds
3. Donations
4. Loans (including the reprogramming of existing development loans)
5. Catastrophic bonds and weather derivatives
6. Private development funding
7. Development Incentives
8. Tax increases
9. Remittances

Case 11: Multiple Events, Canada

Topic: Disaster Financial Agreements

When response and recovery costs exceed what individual provinces or territories could reasonably be expected to bear on their own, the Disaster Financial Assistance Arrangements (DFAA) provide the Government of Canada with a fair and equitable means of assisting provincial and territorial governments. Since the inception of the program in 1970, the Government of Canada has paid out more than $1.6 billion in post-disaster assistance to help provinces and territories offset the costs of response and of returning infrastructure (and personal property) to pre-disaster condition. Examples of payments include those for the 2003 British Columbia forest fires, the 1998 ice storm in Quebec and Ontario, and the 1997 Red River flood in Manitoba.

The provincial or territorial governments design, develop and deliver disaster financial assistance, deciding the amounts and types of assistance that will be provided to those that have experienced losses. The Government of Canada places no restrictions on provincial or territorial governments in this regard—they are free to put in place the disaster financial assistance appropriate to the particular disaster and circumstances. Public Safety and Emergency Preparedness Canada (PSEPC) works closely with the province or territory to assess damage and review claims for reimbursement of eligible response and recovery costs. Other federal departments and agencies are sometimes asked to assist in determining what constitutes reasonable costs for recovery and restoration.

Through the DFAA, assistance is paid directly to the province or territory—not directly to the individuals or communities. The percentage of eligible costs reimbursed under the DFAA is determined by the cost-sharing formula outlined in the arrangements (a factor of the extent of damage and the population of the affected area). The Government of Canada may provide advance payments to provincial and territorial governments as the reconstruction of major infrastructure proceeds and funds are expended under the provincial/territorial disaster assistance program, and may include coverage of repairs and reconstruction of:

- Emergency provision of essential community services
- Repairs to public buildings and related equipment
- Repairs to public infrastructure such as roads and bridges
- Removal of damaged structures constituting a threat to public safety

These funds do carry restrictions, however, and examples of expenses that would NOT be eligible for reimbursement include:

- Repairs that are eligible for reimbursement through insurance
- Costs that are covered in whole or in part by another government program (e.g. crop insurance)
- Normal operating expenses of a government department or agency
- Assistance to large businesses and crown corporations
- Loss of income and economic recovery
- Forest fire fighting

Source: Government of Canada. http://www.publicsafety.gc.ca/prg/em/dfaa/index-eng.aspx.

Lessons

- Special national-level financial arrangements can help fill gaps in funding for local and regional governments
- The special nature of disaster-related financing requires that established mechanisms for eligibility, disbursement, and reimbursement are all established prior to the onset of an actual disaster

Case 12: Wenchuan Earthquake, China, 2008

Key Issue: Donations

On 12 May 2008, a massive earthquake struck Sichuan province, with its epicentre in Wenchuan County. The earthquake left 88,000 people dead or missing and nearly 400,000 injured. It also damaged or destroyed housing and national infrastructure in Sichuan and the adjoining provinces of Gansu, Shaanxi, Yunnan and Chongqing. UNICEF China, with support from its partners, provided about $20 million in assistance in line with the Chinese Government's three-year reconstruction plan. In August 2008, the IKEA Social Initiative joined UNICEF's relief efforts and made an in-kind donation to meet the urgent shelter needs of affected children, and to support interventions in education, water and sanitation to 39 schools affected by the quake in Xihe County, Gansu province. As a result of these joint efforts, some 10,000 students from poor rural areas have been able to return to school in the area. In Gansu, 6,000 school buildings were damaged beyond use, and there were too few resources to deal with the impact. The IKEA/Unicef partnership provided temporary classroom buildings, installed by UNICEF, that included access to water and sanitation facilities supported by the IKEA Social Initiative. The prefabricated classrooms ‑ which are equipped with quality education supplies, books and furniture ‑ were designed to be used for at least three years, until more permanent government school buildings are constructed. Children using them benefited from safe drinking water, sanitary latrines, washing facilities and waste disposal systems that they didn't have before the earthquake. In addition, teachers and principals were trained in child-friendly approaches to learning.

Source: Unicef China. 2009. IKEA and Unicef aid China Earthquake Recovery. Real Lives. July 7. http://www.unicef.org/infobycountry/china_50181.html

Lessons

- Major private sector stakeholders will often contribute to recovery in the communities where they operate, especially with in-kind assistance
- Recovery planning committees can promote public private partnerships. Or partnerships between the private sector and nongovernmental and/or international organizations, which can be mutually beneficial

Case 13: Earthquake and Tsunami, Banda Aceh, Indonesia, 2004

Topic: Loans

Of the physical destruction that occurred in Banda Aceh during the 2004 earthquake and tsunami events, it was estimated that 19% of the $4.7 billion assessed was sustained by the infrastructure sectors. The infrastructure impacts occurred in the transportation, energy and electricity, postal and telecommunications services, drinking water and sanitation, and water resources sectors, among others. In order to address the financial implications of reconstruction, the Government of Indonesia consistently applied investment principles that it was felt were based on a balanced consideration of economic, technical, environmental, social, cultural and religious factors. To do this, they used the following strategy in their funding decisions:

1. Conducted economic, technical, environmental, social, cultural and religious feasibility studies for every development activity (notably those concerned with the development of new facilities)
2. Prioritized the optimization of facilities and infrastructure constructed, before

deciding the construction of new facilities

3. Applied integration of priorities across the infrastructure and facilities sectors
4. Ensured that implementation schedule decisions were always considerate of urgency and readiness levels
5. Applied implementation and logistics principles
6. Conducted public consultation, which among others things explored and accommodated local cultural and religious preferences and values

One of the most significant sources of funding to pay for the rehabilitation and reconstruction efforts came from the reprogramming of Asian Development Bank (ADB) loans. The Government's immediate emergency and relief efforts were coordinated by the National Coordination Board for Disaster Management under the Vice President's Office and the Coordinating Ministry for People's Welfare. The National Development Planning Agency (BAPPENAS) was tasked with the formulation of a medium-term rehabilitation and reconstruction strategy for the restoration of normal life in Aceh and North Sumatra. The strategy consisted of three phases: (i) immediate emergency and relief operations that were to be completed within the first 6 months (ii) a rehabilitation phase to last up to 2 years, and (iii) reconstruction activities to be phased over a 5-year period. In the immediate aftermath of the disaster, ADB established a large multi-sector team to support the Government in damage and loss assessment (DLA) strategy formulation, and to develop the ADB emergency assistance package. Using the DLA as a starting point, extensive discussions were held on project reprogramming by the ADB team with the executing agencies (EA) and relevant sector ministries. The implementation status of each project was reviewed, loan savings were verified, and individual MOUs were concluded with each EA for reprogramming of 11 projects. On February 14th, 2005, an "umbrella" MOU on the project reprogramming was signed with the two oversight ministries, BAPPENAS and the Ministry of Finance. The combined cost for 11 projects was $1.957 billion, and the combined net loan amount after cancellations was $1.131 billion. Agreements were reached on the proposed use of loan savings totaling $64.6 million, as well as the related changes in project scope and implementation arrangements. The 11 reprogrammed projects were in the agriculture, natural resources, health, education, transport, and power sectors. Consequently, they are highly relevant to the rehabilitation needs.

Sources: Republic of Indonesia. 2005. Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias, Province of North Sumatra. http://www.usindo.org/publications/Blue_Plan_Aceh.pdf. Asian Development Bank. 2009. Indonesia: Aceh – Nias Rehabilitation and Reconstruction. Progress Report. http://www.adb.org/Documents/Produced-Under-TA/39127/39127-01-INO-DPTA.pdf
Asian Development Bank. N/d. Progress Report Indonesia: ADB's Emergency Assistance Program for Aceh and North Sumatra. http://www.adb.org/Documents/Reports/Tsunami/aceh-nsumatra.pdf

Lessons

- Each hazard will impact the infrastructure sector to a varied degree with regards to the percentage of all destruction that is represented by the sector
- Infrastructure funding decisions should be based on a balanced consideration of economic, technical, environmental, social, cultural and religious factors
- Reprogramming of development loans may not only be necessary, but also preferable, especially when the original project goals are significantly impacted by the disaster event
- Reprogramming of all loans should take place in a coordinated fashion with nationwide priorities in mind, rather than addressing each loan individually
- Infrastructure recovery planning should provide unique goals for the short, medium, and long term periods

Case 14: Loma Prieta Earthquake, California, USA, 1989

Topic: Cost Share

The Loma Prieta earthquake damaged several major transportation structures in the San Francisco Bay Area, including the Embarcadero Freeway and the Cypress Expressway. The California Department of Transportation (CalTrans) worked with the Federal Highway Administration (FHWA) to finance the replacement of the Cypress Expressway with a cost-sharing ratio of 90 percent of the funding from the federal government and 10 percent from the state. However, construction did not begin until 1994 partly because of community opposition to rebuilding the expressway in its original location, which divided a neighborhood in West Oakland. To address community concerns, CalTrans and FHWA moved the expressway so that it runs along the edge of the residential area. The space previously taken by the expressway is now occupied by new businesses, housing, and parks.

Source: GAO. 2009. Disaster Recovery: Experiences from Past Disasters Offer Insights for Effective Collaboration After Catastrophic Events. GAO Report 09-811. http://www.gao.gov/products/GAO-09-811

Lessons

- Cost-sharing can increase the amount of funding available and better focus the recovery efforts of affected local and regional governments
- Cost sharing mechanisms will require greater consensus for the affected populations which will bear some of the brunt of reconstruction costs in the form of taxes and/or changes in government services to generate those costs

Case 15: Northridge Earthquake, California, USA, 1994

Topic: Financial Incentives

The Northridge Earthquake struck Southern California in the United States in 1994, causing significant damage to infrastructure, most notably that of its vast transportation network. The earthquake resulted in 480 damage locations to federal, state, and local roads throughout the Los Angeles area and forced the closure of four major highway corridors that, together, carried over 780,000 vehicles per day before the earthquake. This caused significant disruption to commuting patterns as well as the transportation of freight.

The city placed priority status on the replacement and restoration of its highway infrastructure in order to quickly restore the freedom of movement and likewise, ensure the protection of economic operations and recovery. In the earliest phases of response and recovery, city officials established a system of alternative highway routing relying upon calculated detours. To expedite the completion of highway rebuilding projects, the California Department of Transportation (CalTrans) included financial incentives in its contracts for each major restoration or repair contract. Under this approach, bonuses were available to each contractor who completed projects early. CalTrans calculated bonuses based on an analysis of the economic cost incurred to the region as a result of the disruption to traffic and associated delays. As a result of this approach, bonuses were awarded to 9 out of the 10 eligible contractors. According to a CalTrans official, these incentives allowed the city to restore these freeways within a few months after the earthquake. The Federal Highway Administration also granted other measures of flexibility within its regulations to facilitate infrastructure recovery. For example, the agency granted exemptions from certain regulations, such as allowing the California Department of Transportation to proceed without conducting environmental impact statements as required under the National Environmental Policy Act.1

Source: GAO. 2009. Disaster Recovery: Experiences from Past Disasters Offer Insights for Effective Collaboration After Catastrophic Events. GAO Report 09-811. http://www.gao.gov/products/GAO-09-811

Lessons

- Prioritization of transportation infrastructure recovery may be required in order to restore freedom of movement and likewise, protect economic drivers
- Investment in a program that provides financial incentives for rapid completion of infrastructure reconstruction contracts can help to more quickly provide the affected population with a resumption in infrastructure services

Case 16: Flores Earthquake, Indonesia, 1992

Topic: Reconstruction Loans

The earthquake in Flores Island in eastern Indonesia was one of the most destructive disasters of the 1990's. A wide range of infrastructure and agricultural facilities were destroyed including:

- 750 kilometers (km) of roads
- Over 700 meters (m) of bridges
- 42 water resources facilities

The main damage occurred over an area of about 6,000 square kilometers, affecting the districts of Flores Timur, Sikka, Ende, and Ngada, and the towns of Maumere and Ende. One month after the disaster, the Government of Indonesia asked the Asian Development Bank (ADB) for emergency funds to reconstruct the damaged roads, bridges, and water resources facilities on a permanent basis. Along with ADB, several other donor/lending agencies (Australian Agency for International Development, Overseas Economic Cooperation Fund, World Bank, etc.) made a coordinated effort to support reconstruction. Each agency concentrated on the sectors and locations in which it had experience. For instance, the ADB focus was on roads, bridges, and water resources facilities. ADB was already supporting national and provincial road rehabilitation and improvement programs and rehabilitation and expansion of irrigation facilities. The total project cost was estimated to be $43.7 million, about 41 percent of it in foreign exchange. ADB provided $26 million, amounting to about 60 percent of the total project cost, from its Special Funds resources to be used over the next three years. The balance of funds for the Project was to be provided by the Government. The loan was to be repaid in 35 years with a 10 year grace period and a service charge of 1 percent per annum. Counterpart funding problems affected the progress of some of the construction and was one reason for extensions that were requested.

Source: ADB. 2000. Project Performance Audit Report on the Flores Emergency Reconstruction Project. http://www.oecd.org/dataoecd/14/6/35267706.pdf

Lessons

- Donors and lending institutions can focus their funds in specific sectors for which they have expertise
- Planning should account for foreseeable risks associated with cost sharing or funding otherwise providing by the affected government

Case 17: Earthquake, Haiti, 2010

Topic: Diaspora Bonds

Following the earthquake in Haiti, remittances were expected to surge 20%. Prior to the quake, remittances already constituted between 25 and 50% of national income. While a rise in remittances is common after disasters, Haiti represented the first time the restoration of remittances services was seen as a critical part of disaster relief and response. The World Bank explored the role that a wealthy national diaspora living in the United States, Canada, France and other countries continues to play in Haiti's recovery. The expected 20% increase amounts to an additional $360 million above normal levels, according to World Bank's Outlook for Remittance Flows 2010-11. The diaspora officially sent $1.4 billion in remittances to Haiti in 2008, and unofficially may have sent as much as $2 billion. Much of the 2010 increase is likely to be from 200,000 undocumented workers granted "temporary protective status" to live and work legally in the United States for 18 months. If the temporary protective status is extended another 18 months, additional flows to Haiti could exceed $1 billion over three years. In order to capitalize on this support, the World Bank proposed Haiti issue reconstruction diaspora bonds to tap the wealth of the diaspora. This group is typically more willing than other foreign investors to lend money to the affected national government at a cheap rate, thereby making socially relevant projects that offer a lower rate of return more affordable. In the past diaspora bonds have been used by Israel and India to raise over $35 billion in development financing. Several countries—including Ethiopia, Nepal, the Philippines, Rwanda, and Sri Lanka—are considering (or have issued) diaspora bonds recently to bridge financing gaps. By offering a reasonable interest rate (e.g. a 5% tax-free dollar interest rate) this option can attract a large number of investors. The bonds must, however, be implemented by a credible organization overseen by international agencies or observers. It was estimated that a diaspora bond sale could raise $200 million if 200,000 Haitians in the United States, Canada and France were to invest $1,000 each, and much higher amounts could be raised if bonds were open to friends of Haiti and guaranteed by multilateral or bilateral donors.

Source: World Bank Group. 2010. Haiti Remittances Key to Earthquake Recovery. 17 May. http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22582923~pagePK:64257043~piPK:437376~theSitePK:4607,00.html

Lessons

- Remittances can be valuable source of reconstruction funding, but standard and reliable mechanisms that allow for contributions in this manner must be established
- Diaspora bonds must be issued by a credible organization

Case 18: Paris Cholera Epidemic, 1832

Topic: Incentives

The Paris Cholera Epidemic in 1832 provided the impetus to launch the long-debated reconstruction of the city. From 1852 to 1870, under Baron Haussmann, the old Paris of dense and irregular medieval alleyways was replaced by a rational city with wide avenues and open spaces. Haussmann's projects were decided and managed by the state, carried out by private entrepreneurs, and financed with loans backed by the state. As a first step, the state expropriated those owners whose land stood in the way of the renovations. The main judicial tool was expropriation "for purposes of public interest" under which the city could acquire buildings placed along the avenues to be constructed, whereas earlier it could only acquire the buildings placed directly on the future construction site. It then demolished the buildings and built new avenues fully equipped with water, natural gas, and sewers. The state reimbursed the reconstruction loans by dividing the land into plots and selling the plots to developers who were required to build according to a set of precise rules. This system allowed the city to devote each year a budget to the renovations twice that of the municipal budget.

An innovative legal tool, the Servitude d'alignement, was also brought into use in Paris during its reconstruction. This prevented real estate owners from renovating or rebuilding beyond a certain line drawn by the administration. In this sense, it could be considered a predecessor of the urban growth boundaries that are employed for the same purpose in a number of modern cities. One of the most important innovations of the French case was the adoption of an overall objective to guide the reconstruction. This was to "let air and men circulate" based on the then-popular miasma theory of disease that associated epidemics with the circulation of foul air and odors. Even though the theory was incorrect, it enabled diverse agencies to coordinate their efforts with a single, clear objective in mind.

Source: Altaf, Mir. 2008. Land Management. In Disaster Risk Management in East Asia and the Pacific. http://siteresources.worldbank.org/EXTEAPREGTOPRISKMGMT/Resources/NOTE_10web.pdf

Lessons

- Reconstruction presents an opportunity to reverse settlement and construction on hazardous land, or in a manner that is unsustainable
- Expropriation of private property may be necessary to reconstruct and/or improve infrastructure in the aftermath of a disaster

Case 19: Wenchuan Earthquake, China, 2009

In China, a program that pairs cities of differing economic status called "twinning" has been implemented. This program has shown promise in providing badly needed financial and technical assistance to disaster-affected areas from a pre-established partner province or municipality. This mechanism pairs a more affluent province with a province of lower economic status. The agreement involves the diversion of one percent of the annual GDP and technical capacity of the wealthier province to fund recovery projects in the disaster affected province for a period of three years. Ultimately, this partnership serves a mutually beneficial purpose in that it bolsters the recovery of the disaster affected province while increasing the surplus capacity in the donor province.

Following the 2010 earthquake, Shandong Province and Shanghai Municipality were paired under the 'Twinning" program. Shanghai Municipality provided funds for the construction of schools and hospitals that incorporated hazard resilience measures and methods, and instituted a program to upgrade management and professional training for schools and hospitals in Beichuan County and Dujiangyan City. This was facilitated through the deployment of existing staff to the newly built institutes to provide on-the-job guidance or by sending teachers, doctors and managers to the donor provinces to receive training. The goal of this program was to ensure that both the structure, the staff, and the services provided were all of a higher standard than existed prior to the disaster event.

Another partnership under this program was established between Shifang City and Beijing Municipality. Thirty-five primary and middle schools from Shifang entered into individual “Twinning” agreements with 25 primary and middle schools in Beijing. This led to a Beijing – Shifang Distance Education Training Network allowing Shifang teachers to access approximately 20 courses over an E-learning system established by the Beijing Educational Science Institutes. On this network, more than one hundred education specialists provide on-line learning. In addition, Shifang students can participate in the same classes as their counterparts in the Beijing schools paired under the agreement. In a later phase of the program, outstanding teachers from Beijing will be tasked to Shifang to provide training to over 3,000 teachers and administrative staff, and 180 teachers from Shifang City will go to Beijing for training.

Source: http://www.sc.gov.cn/zt_sczt/zhcjmhxjy/cjjy/kjcj/200912/t20091217_871603.shtml
http://www.sc.gov.cn/zt_sczt/zhcjmhxjy/dkzy/sf/200912/t20091201_859811.shtml

Lessons:

- Twinning provides benefit to both recipients and donors, building capacities and government networks within the country or region.
- Twinning provides a stable source of funding for a number of years, which is pre-agreed before a disaster.
- Twinning provides a basis for longer term partnerships and risk sharing.
- Twinning can help cope with the increase demand needed for skills after a disaster as well as building these capacities. Pre-agreed before a disaster allowing for fast and predictable deployment.

Chapter 4

Upgrading of Infrastructure

The development, and likewise construction, of national infrastructure occurs over a prolonged period of time, typically in keeping with the overall expansion and social development of the people, government institutions, and economic engines for which it serves. Given the complex nature of a nation's myriad infrastructure systems, there are inevitable conflicts that arise between the physical space, the feasibility, and the technological components of these systems, and the dynamics of population expansion that limit such options from being realized. In essence, the problem lies in the fact that infrastructure systems developed for yesterday's societies provide neither the solutions nor the reach to address our contemporary needs.

There are three primary motivators for modernization of infrastructure. These include:

- **Expansion of Access**: Communities can expand faster than the infrastructure built to serve them. Expansion of infrastructure is more than just extension of transmission lines or roadways. Strategic planning for infrastructure expansion must address increased generation of utility output (as in the case of water, energy, and other supply-based systems) or expanded provision of services (as typified by hospital and educational facilities). For instance, original land transportation systems (roadways) may have been developed decades, or even centuries ago, to meet a capacity that has long since been exceeded – however, urban growth and its associated space restrictions often stand in the way of efforts to expand these systems to meet modern demand.
- **Modernization**: Technological advances can improve the efficiency and output of infrastructure in a number of ways, many of which result in prior decisions being deemed irrelevant or even a hindrance given modern needs. For instance, legacy telephone and internet systems may be incapable of meeting modern information needs, yet the existence of the old systems serves to justify resistance to development spending on modernization.
- **Risk Reduction**: Knowledge of infrastructure risk increases with scientific analysis and exploration. To meet that risk, systems are modified or replaced to minimize the chance that a disaster might disrupt services or damage and destroy facilities and equipment. In the aftermath of a disaster, there is without exception an expansion in the knowledge regarding infrastructure risk

that corrects previous assumptions regarding vulnerability and expands our understanding of what can or must be done to instill resilience into existing systems. Many old electrical transmission systems, for example, were laid as aerial lines (atop poles or stanchions). In areas where ice and/or wind storms have resulted in extensive severing of lines, which in turn leads to extensive and prolonged power failures, risk has been significantly reduced by burying transmission lines as they are repaired or replaced.

National development and hazard risk management together serve as key motivators for infrastructure expansion, modernization, and risk reduction. The recovery period and associated processes present unique opportunities for national infrastructure improvement in that there exists unprecedented access to recovery and development funding coupled with a significantly inflated concern for infrastructure protection on each of the public, policy, and media agendas. Experience, however, has shown that recovery is often accomplished through the modification of routine construction processes on an ad hoc basis in this post-disaster phase. While it is possible for such efforts to be effective in smaller-scale events, reconstruction effectiveness could be drastically improved by modifying the legislative and regulatory framework in advance of a disaster. There is a greater imperative to have appropriate systems in place in advance, to allow effective coordination and delivery of reconstruction works, even amidst the chaos following a large-scale disaster.

Case 20: Wenchuan Earthquake, China, 2008

Topic: Improved Infrastructure Access

The May 12 2008 earthquake was the worst that China had experienced in over 30 years. Given the scale of destruction sustained by national infrastructure, a massive reconstruction effort has been required. However, in rebuilding the antiquated, inadequate infrastructure systems that existed in the more rural areas of affected Sichuan province, there finally existed an opportunity to increase the access and quality of services for the population served. For generations, many villagers were required to walk two or more miles to creeks in order to fetch water – a return trip that could take over one hour to complete. Compounding this problem was the fact that they would often have to wait in long lines once there, given the incredible demand on a single source of water for a whole village. The weight of the water necessary to sustain a family for one day (approximately 125 litres) required the use of a mule or other pack animal. Caochuan village in Xihe county, which neighbours southwest China's Sichuan Province and is populated largely by the Han, Hui and Tibetan ethnic groups, was one of the areas severely affected by the event. With annual precipitation averaging a mere 500 ml, the county also suffers from chronic drought. As of last December 2008, 247 of Xihe's 384 villages lacked safe water; only 15.9% of the county's population has running water at home. As part of the strategy of 'building back better' in its extensive disaster-recovery efforts, UNICEF helped local governments build water supply systems in remote villages such as Caochuan in all the three provinces that were hit by the earthquake by providing financial and technical support. In Xihe alone, 39 such projects were initiated. The project in Caochuan brings water to each of the village's 270 households, as well as to Caochuan Primary School. Students were for the first time able to wash their hands at school.

Source: UNICEF China. 2009. UNICEF 'Builds Back Better' to improve water supply in China quake zone. Real Lives. May 12. http://www.unicef.org/china/media_10484.html

Lessons

- Infrastructure reconstruction may be planned such that the quality of life of victims and the unaffected alike is significantly improved
- Infrastructure recovery planning can allow for the decentralization of infrastructure systems such that more remote villages enjoy quality services that are no longer dependant on vast systems of transmission

Case 21: Earthquake, Marathwada, India, 1993

Topic: Infrastructure Modernization

Through funding provided by the World Bank, a massive reconstruction program was initiated in the earthquake-affected areas in India. In this effort, a number of villages required relocation, and modern design and planning technologies were used to guide the provision of housing and infrastructure. However, in the 8 years of reconstruction that followed the event, there were a great many problems encountered in the reconstruction of relocated villages, many of which were the result of relocation itself. For instance:

- The spatial plans of the relocated villages were dictated by the design of transportation infrastructure, namely the roadways. In the new villages, roadways were expanded to allow for increased flows. However, these were considered totally incompatible with 'way of life' of the villagers, wherein traditional settlements were characterized by narrow streets.
- The land use planning, and division of property among all community stakeholders (including public and private open spaces used for religious, community, and other activities), did not match what the villagers saw as meeting their traditional view of a functional community layout.
- Community plans did not account for the traditional activities of the communities, especially those of service sector employees and artisans.
- The communities were many times larger in geographic area (up to 10 times in at least one case), which translated to more expensive outlays for infrastructure. The Government of India provided the initial funding for infrastructure construction, but longer-term sustainability jeopardized by the ongoing maintenance needs of this infrastructure were not adequately

accounted for.

The primary source of contention among recipients of reconstruction assistance was in the fact that a complete 'city-like' plan, with wide streets forming grid a pattern and row housing, was provided, in the name of modernization. Reconstruction planners had made the assumption that such efforts could be effective in promoting longer-term improvement in social and economic development. These plans did little to account for the cultural and other 'human' aspects of populations, and for that they were ultimately seen as undesirable.

Source: Boen, Teddy and Rohit Jigyasu. N/d. Cultural Considerations for Post Disaster Reconstruction: Post-Tsunami Challenges.

Lessons

- Infrastructure improvement measures need to be balanced with, or at least be in line with, the social and cultural needs and preferences of beneficiaries
- Changes in community type as a result of relocation or resettlement may result in unbalanced infrastructure reconstruction requirements (in terms of cost and design)

Case 22: Tsunami, Sri Lanka, 2004

Topic: Infrastructure Modernization / Infrastructure Risk Reduction

Cost estimates of infrastructure reconstruction in Sri Lanka following the tsunami events were not based on equal replacement cost of what was damaged, but rather on the cost of upgrading infrastructure to meet modern standards and increased resilience to future hazard risk. This reconstruction effort involved the development of a scientifically defined buffer zone wide enough to ensure protection of the coastal environment and its natural resources, and the safety of people living in such areas. As such, there resulted a need for population relocation, which in turn created demand for the development and replacement of different infrastructure components to meet the new communities. One of the greatest constraints to infrastructure modernization and replacement was the availability of viable land. Several of these efforts are detailed:

- **Water Supply and Sanitation.** The primary reconstruction objective in this sector was to provide sufficient and sustainable water supply and sanitation services to the affected areas. The following three actions were implemented:
    - **Fulfillment of immediate needs:** The objective was to provide adequate water supply and sanitation facilities to meet immediate needs of affected populations. The strategy included temporary supply of safe water to transit camps, repair of damaged infrastructure and undertaking an assessment on situation of the existing water supply and sanitation situation.

- **Immediate service restoration:** This involved restoring service to similar levels seen prior to the tsunami and was achieved to through extensions of and increases to the capacity of the existing systems. Sanitation facilities in the resettle areas were improved through new installations. However the progress of the achievements will depend on availability on firm resettlement plans.
- **Immediate service expansion:** This long-term effort seeks to meet the needs of the tsunami victims across the 10-year planning horizon. The components of the strategy includes improvement of the water resources and expansion of the schemes to meet the service requirements of the population in the restored / resettled areas and construction of new schemes in the areas where there is potential for expansion. The needs assessments revealed that the areas to which supply of water be provided should include transit camps, new settlements and newly developed commercial areas. The possible sources of water supply range from pipe bone schemes to protected dug wells depending of the demand and technical viability.

- **Roads and Bridges.** The national road network in the coastal areas of the Northeast and Southern Provinces were severely damaged. In addition, extensive damage occurred to the provincial roads and to the local government and municipal roads. Bridges and culverts were displaced and embankments eroded by the advancing and retreating tsunami. The main damage occurred to roads that were already in a greatly deteriorated state due to lack of maintenance and damage during the conflict period. Further, on the east coast, flooding before and after the tsunami caused damage to coastal roads. Reconstruction plans called for temporary to permanent repairs to embankments, drainage systems (including protection measures), and bridges and bypasses. However, there was a recognized need to upgrade national roads to a maintainable and uniform standard, including widening of embankments and carriageways to 2 lanes, repairing pavement and drainage, adding flood protection measures, and rehabilitating (or replacing) culverts and bridges). To assist economic and social development, the coastal roads connecting provincial and local roads were also upgraded. The Tsunami recovery offered a unique opportunity to update the national system of roads, thereby providing access and economic opportunities to coastal communities. The total cost of rehabilitation was estimated to be $340 million, of which $318 million was donated or committed by various donors (including ADB, World Bank, JBIC, JICA, European Commission, USAID, Saudi Arabia and Spain.)
- **Railway.** Railway tracks, signaling and communication systems, and building infrastructure on coastal railway lines were severely damaged. Also some sections of railway tracks on Trincomalee and Batticaloa lines were partially

damaged. In addition engines, carriages, and Diesel Multiple Units were also destroyed. The following strategies were used for the restoration and improvement of the railway:

- The coastal railway line is one of the main corridors to the capital from the South, so resumption of train services was given high priority.
- Damaged rolling stock, communications and railway stations were rehabilitated.
- The old coastal railway line was converted to modern railway line by providing additional rail track from Kalutara to Matara, and new railway stations were created in commercial and inter-model transport centers.

ADB funds were used to restore and improve the tsunami affected areas of the Sri Lanka Railway. This covers Colombo/Matara and the Eastern and northern lines. In addition, improvement to the railway workshops occurred. The cost of rehabilitation and improvement was estimated at $185 million. Several donors have shown interest in meeting the cost. The upgrading and double tracking of the Colombo/Matara rail track significantly improved the operating speed of the railway and greatly alleviated traffic congestion, as well as improved the socioeconomic development of the areas served.

Source: Government of Sri Lanka. N/d. Post Tsunami Reconstruction and Recovery Strategy. http://www.undp.org/cpr/disred/documents/tsunami/srilanka/pt_recovery_strategy.pdf

Lessons

- Cost estimates should look not just at replacement but rather at improvement and upgrading to meet future needs, modern standards, and a reduction in risk.
- Selection of consultants and contractors has to undergo a long process that includes several stages such as, pre-qualification, calling for tenders, bidding, evaluation, obtaining donor concurrence and awarding. This process is highly time consuming and impractical for post-tsunami re-construction activities which has to be completed within a very short period. Promotion of a Turn-Key Approach provided a much faster alternative. This enabled donors to make decisions on their own with respect to purchase of equipment, selection of contractors/sub contractors and awarding of tenders. Establishment of separate Technical Evaluation Committees for each sector of the Tsunami Reconstruction Plan facilitated a reduction in implementation time lags. In addition, a special group of officers was assigned to tsunami related activities at the ministry and agency levels.
- A dearth of suitable land for reconstruction and rehabilitation activities became a major impediment in the implementation of the reconstruction plan and strategies. This occurred primarily because suitable state land was

unavailable in close proximity to the devastated areas. Acquisition of privately owned land became a difficult task owing to the fact that there is no attractive compensation package based on market value for the lands. The situation was further aggravated due to delays in clearing of land, land surveys, and lack of effective rules and regulations. Most of the projects relating to Housing, Education, Health, Industrial Estates, Townships and Tourist Community Restoration took much longer to commence because of these factors. It was suggested that the release of state lands be expedited through a coordinated approach between the national public agencies and relevant Local Authorities. State owned lands that have already been allocated for other development purposes in a close proximity to the tsunami devastated areas could be taken over and reallocated for the priority projects under the tsunami recovery plan. For private land, an attractive compensation package was developed to expedite the acquisition process. Private land owners were encouraged to donate their lands for the government or donor agencies for the purpose of implementing tsunami related projects and programs.

- It was observed that the progress of transforming pledges into real programs was slow. Some donors were involved in providing in-kind assistance or undertaking implementation of projects directly. Moreover, it was observed that some programs were not considered by donors for financing for an extended period of time (or ever). The projects and programs relating to Regional Industrial Estate Development, Townships Development, Rehabilitation of Schools and Hospitals, Improvement of Water Supply and Sanitation, Promotion of Micro Level Livelihood Programs and Tourism were adversely affected because of this.
- A dearth of skilled manpower and loss of skilled craftsmen caused by tsunami-related deaths became a major obstacle to the implementing agencies. The trainee output of an existing Vocational Training Institution program, available to local laborers, did not have enough experience to undertake the training required to support the massive construction activities required in such a short period of time. In the short-term, it was recommended that skilled personnel from non-affected areas come and work in the devastated areas through introduction of attractive incentive packages. In the long run, steps were taken to disseminate labor-saving technologies and to increase trainee intake of the Vocational Training Centers on construction related courses.
- It was observed that certain projects implemented by donors stalled due to delays in disbursement of committed funds by respective authorities. For instance, repair of about 6,500 boats did not function smoothly because of disbursement delays. To avoid such delays, the relevant government institutions can take timely actions to translate donor pledges into commitments and then disburse funds. At the same time, it is suggested that

post-tsunami reconstruction programs be initiated by providing mobilization advances using local funds.

- The shortage of construction materials (e.g. cement, sand, stone, rubble, bricks, timber) in the market became one of the constraints in the post-tsunami restoration process. This adversely affected the tsunami reconstruction process in two ways. First, increasing building materials prices limited construction affordability for the affected. Second, undue delays in construction led to socioeconomic hardship (e.g. most of the affected families had to live in temporary shelters more than 3 months without access to basic facilities).

Case 23: The Manawatu Flood, New Zealand, 2005

Topic: Infrastructure Modernization

Flooding in Manawatu was caused by heavy rain and gale force winds from the 14th to 23 of February, 2004. A Regional State of Civil Emergency was declared on 17th February. The flooding resulted in the evacuation of over 2,000 people at the height of the event. Many rivers breached their banks and considerable areas of farmland were inundated by silt and floodwaters. There was significant damage to infrastructure with damage to roads, bridges, and railways. In addition, there were telecommunication, power, gas and water supply outages to tens of thousands of people. Remarkably no lives were lost as a direct result of the event.

Recovery costs were estimated at $160-180 million for the rural sector and $120 million for roads and council infrastructure. In addition $29.5 million and $3.5 million (respectively) will be required to stop future flooding of the lower Manawatu and Rangitikei rivers.

Reconstruction following the floods

Reconstruction was carried out through collaboration between civil defense emergency management (CDEM) agencies, local authorities, utility companies and insurance companies during recovery in the two cases. For the Manawatu-Wanganui region recovery was coordinated through the regional council’s new CDEM Group arrangements under the provisions of the Civil Defence Emergency Management Act (CDEM Act) 2002. For the other territorial authorities the event was managed through their Civil Defence Act 1983 arrangements. The CDEM Act provided a structure appropriate for dealing with events such as the floods and did not introduce any structures or procedures that hindered authorities in dealing with the event. In Matata the state of emergency was extended to allow work to be completed on critical road access routes but still only lasted two weeks. The land transportation (roadway) authorities did not diverge from normal legislation and regulations and building consents were sought and granted as usual. A source of frustration for utility companies in the Manawatu flood event was the time taken to develop an understanding with the

Regional Council about emergency actions that would cover all situations under the Resource Management Act, rather than require a formal process for each activity. A particular issue arose when the Regional Council initially required that slip material should be disposed of in a designated landfill; subsequently they allowed a more pragmatic approach that meant that slip material could be moved and redeposited locally.

It was determined that the authority funding roadway reconstruction, Transfund, should ideally have become involved as early as possible following a disaster since it has direct access to government funds. However this was not the case following the Manawatu floods and it is likely that more could have been done to secure certainty over funding in the early stages of recovery, which would have helped with prioritization in the reconstruction process. Recovery at Matata relied heavily on Central Government funding since the local council had a small number of rate payers and insufficient funds to cover the recovery costs itself. Funding took some time to materialize while cost estimates were analyzed by government agencies. This frustrated the local population.

Overall there was little difference between the routine construction process and the reconstruction process, due to the fact that the disasters were of a relatively small scale. The parties normally involved during routine construction projects were also involved during the reconstruction and using existing relationships eased the process. During the initial recovery stage local contractors volunteered their time, but this required careful management. National-level contractors were a valuable resource since they were able to use their networks to mobilize resources from the whole country.

Source: Le Masurier, Jason, James O.B. Rotimi, and Suzanne Wilkinson. 2006. A Comparison Between Routine Construction and Post-Disaster Reconstruction With Case Studies From New Zealand. Paper presented at: 22nd ARCOM Conference on Current Advances in Construction Management Research. Organised by Association of Researchers in Construction Management (ARCOM), Birmingham, U.K. 4th -6th September. http://www.resorgs.org.nz/pubs/ARCOM%20Conference%20Paper,%20Birmingham.pdf

Lessons

- The time it takes for recovery and reconstruction stakeholders to develop an understanding about how reconstruction funding, planning, and operational mechanisms work can present challenges to the recovery process
- When government funding fuels recovery, funding may take time to materialize while cost estimates are analyzed by government agencies
- National-level contractors may be well-placed to mobilize large amounts of reconstruction resources (labor and materials)

Case 24: Earthquake and Tsunami, Banda Aceh, Indonesia, 2004

Topic: Prioritization

Of the physical destruction that occurred in Banda Aceh during the 2004 earthquake and tsunami events, it was estimated that 19% of the $4.7 billion assessed was sustained by the infrastructure sectors. During the reconstruction of infrastructure damaged or destroyed during these events, the Government of Indonesia made several efforts to ensure that earthquake and tsunami hazard risk was reduced in the facilities and systems that resulted from such efforts. Among the improvements that were made, the changes addressed the following:

- Increased the capacity of national ports, and the transportation access to and from the ports for commerce. This, in turn, allowed for uninterrupted and more efficient logistic distribution and, likewise, improved regional development
- Rehabilitation and upgrading of the existing telecommunication facilities and construction of new communication facilities that placed a greater emphasis on wireless technology, that together provided a vast improvement in local, regional, and international telecommunication access
- Rehabilitation and improvement of electricity distribution grids
- Increased diversification of the nation's menu of electrical energy sources, including alternative (renewable) energy sources.

Source: Republic of Indonesia. 2005. Master Plan for the Rehabilitation and Reconstruction of the Regions and Communities of the Province of Nanggroe Aceh Darussalam and the Islands of Nias, Province of North Sumatra. http://www.usindo.org/publications/Blue_Plan_Aceh.pdf. Asian Development Bank. 2009. Indonesia: Aceh – Nias Rehabilitation and Reconstruction. Progress Report. http://www.adb.org/Documents/Produced-Under-TA/39127/39127-01-INO-DPTA.pdf

Lessons

- Post-disaster improvement of port facilities can have a ripple effect in terms of benefits to long-term prospects for recovery of commerce and region-wide development
- The speed with which communication technology advances virtually mandates that technological advancements be applied in the reconstruction plans that are formulated
- Reconstruction of energy infrastructure widens the possibility of sustainable and alternative energy sources

Case 25: Flores Earthquake, Indonesia, 1992

Topic: Hazard Resistant Design and Materials

The earthquake in Flores Island in eastern Indonesia was one of the most destructive disasters of the 1990's. A wide range of infrastructure and agricultural facilities were destroyed including:

- 750 kilometers (km) of roads
- Over 700 meters (m) of bridges
- 42 water resources facilities

The main damage occurred over an area of about 6,000 square kilometers, affecting the districts of Flores Timur, Sikka, Ende, and Ngada, and the towns of Maumere and Ende.

Reconstruction following the Flores Earthquake provided an opportunity to incorporate disaster-resistant features into Indonesia's infrastructure, yet the government did little in this regard. Of particular note is that several bridges were not reconstructed using internationally recognized earthquake-resistant design standards because during implementation, the Directorate General of Highways (DGH) decided that standard designs would be used. Therefore, at present, some of the bridges do not provide for prevention of lateral sliding, and this issue still needs to be addressed in order to prevent extensive damage from any future earthquakes. An independent review found that increased earthquake loading to raise a bridge's ability to withstand an earthquake, which was recommended by the Interim Geo-technical Report, was not used because it required extremely large and costly structures. The DGWRD earthquake design standards for water resources facilities construction were, however, improved by increasing the earthquake loading Z factor (zone rating) for the eastern half of Flores Island from 1.56 to 2.11; this value was accepted by the RMT. An ADB review found that the performance of the civil works contractor was generally satisfactory, but the quality of works was poor at several bridges and irrigation headwalls probably due, in part, to poor supervision and lack of quality assurance procedures. The OEM agrees that poor construction supervision and lack of quality assurance procedures did contribute to poor quality. However, the contractor bears the responsibility for the quality of the works and is required to provide the quality specified in the contract documents. The acceptance of poor quality work by the consultants and government officials at the time of handover indicates a lack of proper accountability for government procedures or contractual requirements.

Improvements

The national road runs the full length of Flores and serves as the main means of land transport between the main urban centers of Larantuka, Maumere, Ende, and Bajawa. The provincial roads are the feeder roads that lead from the villages to the national road and serve the farm-to-market economy. Reconstruction of the national and provincial roads, as well as segments of the roads that were added for social reasons, have improved the quality of life for the beneficiaries. Given the financial crisis that is very severely impacting Indonesia, the area would be in much worse condition if the roads and bridges had not been reconstructed. The same is true for the reconstruction of the damaged water resources facilities. The rehabilitation of surface irrigation schemes and construction of underground irrigation restored irrigated farming, contributed to water supply development, improved flood protection facilities, and provided the beneficiaries with a means of livelihood. The farmers are able to harvest two or three crops per year depending upon their location. Without the irrigation infrastructure rehabilitated under the Project, the economic situation would be much worse than it is. However, production can be raised further if other inputs are provided in addition to irrigated water. To reach this potential, schemes are needed to repair the canals, which have not been properly maintained.

Source: ADB. 2000. Project Performance Audit Report on the Flores Emergency Reconstruction Project. http://www.oecd.org/dataoecd/14/6/35267706.pdf

Lessons

- The use of pre-disaster risk information and corresponding pre-disaster building codes will likely result in the construction of infrastructure that does not adequately account for future hazard risk from a similar event
- Proper construction supervision and quality assurance is key to ensuring that hazard mitigation efforts incorporated into construction plans result in actual hazard risk reduction
- Improvements in irrigation infrastructure can help agricultural communities to recovery much faster given the increase in food production that is possible, thereby accounting for losses in production that will have occurred as a result of the disaster

Case 26: Earthquakes (multiple), Turkey, 1990's

Topic: Infrastructure Modernization

In rural areas, many barns had collapsed as a result of the 1990's earthquakes. In response, the Government of Turkey and the World Bank initiated a project to fund the reconstruction of a total of 4,100 storage and cattle barns, and the distribution of 10,900 animals. This was done to restore some of the lost capital resulting from a loss in agricultural infrastructure. However the results of this project are mixed. While project beneficiaries built 2,885 barns with lump sum payments for construction materials, this total is fewer than the original estimate of 4,100, due to inaccurate damage estimates. Moreover, many barns were used for purposes other than housing livestock because the barns as designed for the project were not warm enough for the livestock, thus they had been used for other purposes. In some cases the barns were used for livestock in the summer and storage in the winter. This experience highlights that a certain degree of caution must be taken when introducing innovation when rebuilding infrastructure. Introducing new, untested infrastructure methods or designs involve careful analysis which may delay reconstruction. If this level of analysis is not completed, the reconstructed infrastructure may not meet expectations. For example, in Turkey, new earthquake resistant barns were built according to designs approved by the state. However, these barns had insufficient insulation for such a cold area and farmers left them abandoned or used them for other purposes. In reconstruction work, relying on simple, well tested and easily scalable solutions may be more efficient if an appropriate level of analysis on innovation is not available.

Source: World Bank. 2008. Re-establishment of Rural Services and Revitalization of Rural Economy. Good Practice Notes. July. http://siteresources.worldbank.org/CHINAEXTN/Resources/318949-1217387111415/Rural_Services_Economy_en.pdf

Lessons

- Inaccurate damage estimates will have profound impacts on the ability of long-term recovery and reconstruction plans to meet goals and objectives
- The introduction of innovative yet untested infrastructure can result in negative or unintended impacts on the population served
- In the absence of analysis on the expected outcome of innovative infrastructure technology applications, it may be preferable to rely on simple yet known solutions

Case 27: Earthquake, Bhuj, India, 2001

Topic: Infrastructure Modernization and Expansion of Infrastructure Access

Five districts in the State of Gujarat were severely impacted by this event, but the worst affected was Kutch, where more than 85% of the asset losses occurred. Four towns, including the district's largest – Bhuj -- and more than 400 villages were severely hit, destroying lives, infrastructure, buildings, the economy, and livelihoods. Small enterprises, schools, health clinics, rural and urban water systems, and electricity and telecommunications systems were destroyed. Bhuj was one of the worst affected towns in the district. The lack of an effective street pattern was a major obstacle to disaster management in the earthquake's aftermath.

Many historic buildings had to be demolished during the rubble removal, making retracing the original street form and architectural character difficult. Bhuj Municipality was almost paralyzed. Many municipal buildings were destroyed, and records were lost. The municipality lost several staff, and other staff members lost their families and suffered injuries. The municipality lacked the internal capacity to take the lead in relief, rehabilitation and reconstruction activities. Social assets (both public and private sector) such as schools, hospitals, community halls, town halls, markets, libraries, colleges, recreational buildings (a local gymkhana, an open-air theatre) and religious buildings were badly affected. However, the community facilities that *did* survive were quickly made available to the city by community groups. Since such places are the first refuge for people needing shelter, this demonstrates the enormous value in strategizing the future provision of social assets designed to withstand disasters and managed either by local government or local institutions themselves. Water and sewer networks in the old city were badly damaged, ironically more during the movement of heavy machinery to demolish damaged buildings and to remove debris than during the earthquake itself. Outside the old city, too, important facilities such as reservoirs, pipelines, telephone exchanges and power infrastructure were damaged. However, the trunk lines in these networks survived with minor damage, enabling the quick restoration of services. Buildings and infrastructure networks had not been designed specifically to withstand an earthquake's impact and neither had the possibility to isolate – and separately repair – badly affected components of the infrastructure system.

Infrastructure reconstruction sought to effectively reduce future risk, applying the following principles in the recovery process:

- To build the city back better, applying a policy of encouraging partial relocation and partial in situ reconstruction.
- To continue with the city's existing infrastructure, repairing and revamping it after the earthquake so that it is better managed responds better to natural disasters. This approach would save the government the considerable expenditure of building new infrastructure in the aftermath of a future disaster.
- To improve building construction quality so that it incorporates earthquake-resistant technologies and adheres to regulatory norms.
- Assist people in the reconstruction process; help them to understand statutory requirements in planning, build consensus, and frame projects that respond to people's concerns and needs.
- Make the planning process as participatory as possible, by encouraging public - private partnerships, building fora at which citizens can participate in decision making and voice their concerns; and
- Build a modicum of public trust in the process to ensure implementation.

The government established the Gujarat State Disaster Management Authority (GSDMA). The GSDMA's current role is to finance and oversee the entire post-disaster reconstruction project in the State of Gujarat. Its future role will be to guide the preparation of disaster management and mitigation plans for all cities, towns and regions in Gujarat and to finance their implementation. With the assistance of experts from the USAID-FIRE(D) project and in consultation with various local institutions and international agencies, the government created the following institutional framework for undertaking reconstruction:

- In May 2001, the government created Area Development Authorities in Bhuj, Bhachau, Anjar and Rapar under the provisions of the Gujarat Town Planning and Urban Development Act, 1976. The ADAs were made responsible for implementing town planning proposals and ensuring adherence to improved regulations.
- The government negotiated a $100 million loan from the Asian Development Bank to fund urban reconstruction.
- Since the post-earthquake urban reconstruction project demanded special attention, dedicated staff and special skills, the government designated the Gujarat Urban Development Company (GUDC) as the implementing agency for the project. The GUDC is a special purpose vehicle established by the government (before the earthquake) to conceptualize and implement urban development projects.
- In contrast to the conventional method of staffing such organizations, the Government of Gujarat chose the more progressive method of outsourcing the tasks of town planning, infrastructure planning, and scrutiny of applications for building permissions to support the ADAs and GUDC.

The urban reconstruction package announced in April 2001 favored partial reconstruction and partial relocation. It envisaged reducing the development intensity in urban areas by restricting both building height and the permissible floor space index, implying horizontal expansion of the city, during reconstruction and in the years to come.

Source: Balachandran, B.R. N/d. Case Study: Integration of Disaster Mitigation into Planning and Financing Urban Infrastructure after an Earthquake. http://www.china-up.com/international/case/case/944.pdf

Lessons

- Local municipalities that suffer a loss in technical staff, especially from within government offices, may be incapable of assuming a lead role in long-term reconstruction of damaged or destroyed infrastructure; in such cases outsourcing may be necessary
- Social infrastructure assets, such as schools, hospitals, community halls, and others, can provide immense protection in the aftermath of a disaster if they are designed to withstand hazard forces, and as such reconstructed facilities should be built with this alternative use in mind. Such infrastructure should be built to higher standards of resilience, as done in India and China
- Reconstruction work itself can have damaging effects on some infrastructure systems, mores so even than from the disaster itself
- Relocation may be necessary if risk reduction is to be achieved, but it may be possible to limit this to only certain affected areas

- Government authorities to oversee reconstruction plans can contribute to their ultimate success in achieving all stated goals, including hazard risk reduction

Case 28: Tsunami, Maldives, 2004

Topic: Hazard Risk Reduction

Telecommunications plays a vital role in linking dispersed communities and reducing the impact of the geographical isolation that exists between Maldives islands. Prior to 1995, telephone service was available on only a few islands, but by the year 2000 all inhabited islands had telephone access. The Maldives Telecommunications Policy of 2001 – 2005 was created in the year 2000 to further increase the reach of mobile and internet communication across the island chain, but in 2004, the tsunami disaster disrupted these plans considerably and changed priorities to address the gaps and lessons learned from the event's impact. The 2004 tsunami created a concerted drive for a telecommunication sector that is reliable in the event of a disaster. Prior to 2004, the Maldives had no documented record of a disaster of the magnitude sustained in the 2004 tsunami, and therefore the design of the existing telecommunication infrastructure prior to that time did not account for such great consequence risk. The tsunami event affected thousands of inhabitants and tourists, and damage to communication infrastructure components caused the failure of network nodes at Gaafaru (Kaaf), Raiymandhoo (Meemu), Meedhoo (Dhaalu), and Gadhdhoo (Gaaf Dhaalu). The failure of these nodes resulted in the failure of all public telecommunication services to 13 atolls (163 inhabited islands). The tsunami also flooded Villingili earth station, shutting down the station's regular power supply, forcing it to work on Uninterrupted Power Supply (UPS) putting international telecommunications on critical condition. The extent of damage was massive and the cost of damage was initially estimated to be $18.54 million. To address this risk, the Government of the Maldives reconstruction team tasked with telecommunications infrastructure recovery introduced a number of strategies through which communications may be better maintained in emergencies in future events. These include:

- **Increased Use of Satellite-Based Handheld Phones.** The priority is to have one satellite phone in each of the inhabited islands. Minimum requirement will be one every atoll office.
- **HF radio transceivers.** The priority is to have one HF radio transceiver at each of the inhabited islands.
- **CB radio transceivers.** The priority is to have at least one working CB radio transceiver at each of the inhabited islands.
- **VSAT.** An alternative communication routing based on satellite and VSAT provides a much-needed redundancy in terms of communication infrastructure for the Maldives. Any failure of communication in one or more islands will be local to those islands and other islands will not be affected. The cost limits a

more widespread use of VSAT terminals.

- **Optical Fiber.** Optical fiber transmission has proven to offer high capacities for delivering telecommunication services. The available bandwidth on such transmission systems bears virtually no limits as compared to the conventional microwave or satellite systems.

This project is being supported through private financing. Most Atoll Offices and Island Offices are equipped with HF and CB/VHF radio equipment. Both Dhiraagu and Wataniya use satellite telephones for emergency communication in case of a network failure at their regional operation and/or maintenance centers. VSAT terminals are present at some critical nodes in their Microwave backbone and can manually be redirected to back-up a lost link. The NSS and the Coast Guard and their vessels have effective radio communication and are considered to be one alternative communication that could support affected areas in case of emergencies.

Source: International Telecommunication Union (ITU). 2006. Rehabilitation & Reconstruction of Telecommunication Infrastructure in Earthquake/Tsunami-Hit Areas. ITU. January 31.

Lessons

- Improvements in telecommunications infrastructure can help to link previously isolated regions
- Disasters can change in-process long-term infrastructure development strategies; however former plans need not be abandoned if they are updated with new information about risk and in light of damage and needs assessments
- Vulnerable infrastructure nodes puts the entire infrastructure network at risk; as such, reconstruction efforts must place special care in ensuring that these vulnerabilities are addressed in planning
- Infrastructure planning can address the needs of emergency operations plans to ensure that critical services are available in future emergency events
- Private financing can be leveraged when new technologies are applied

Case 29: Hurricanes Katrina and Rita, Gulf Coast, USA, 2005

Topic: Risk Reduction

Hurricane Katrina had a devastating impact on much of the transportation infrastructure of extreme southern Mississippi and Louisiana and Alabama. The most significant impacts were to the numerous bay and river crossings throughout the region. The worst damage was to crossings in the area along and to the south of the I-10/I-12 corridor, including crossing on U.S. 90, LA 1, and I-110 in Mississippi and the Lake Ponchartrain Causeway. While the effects were limited in some locations and damage was repaired within days, in some coastal sections prominent elements of the transportation network remained closed many months after the storm. Almost a year later, in fact, three important spans remained impassable despite tens millions of dollars of aid invested in the reconstruction effort. By contrast, and with the exception of U.S. 90, which in many locations is a beachfront highway, damage to highway road surfaces in the region was light. The region struck hardest by Hurricane Rita was southern Cameron Parish in the southwestern corner of Louisiana. The area, a wide swath of ranches, bayous, and wilderness preserves was almost entirely swept away by the catastrophic storm surge. In Cameron, the regional headquarters, the district courthouse was one of the few structures left intact. In Holly Beach, only a water tower was left standing. Almost all of the major river and bay bridges destroyed by the hurricane surge waters were rebuilt at higher elevations, and the design of the connections between the bridge decks and the bridge piers was strengthened. The unprecedented amount of damage to the bridges triggered a discussion among bridge designers and engineers about appropriate bridge design standards. At the time, bridge design standards assumed a riverine environment and a 50-year storm event; bridges are designed for a storm surge, but not wave action. It was subsequently recommended that a 100-year storm event be considered for Interstate Highway System bridges, major structures, and critical bridges, and that design standards consider a combination of surge and wave effects. Consideration of a 500-year storm event super-flood surge and wave action was also suggested. Much of the land and sea transportation infrastructure in the area is privately owned, and efforts were made by companies to reduce risk in the systems they operate and maintain. For instance, Estimated reconstruction costs of rail bridges ranged from $250 million to $300 million, or about one-quarter of CSX's (the firm that owns much of the rail infrastructure in the area) annual operating revenues available for capital investment. CSX reported that the Bay St. Louis Bridge would reinforced as was done to the Biloxi Bay Bridge, and the timber trestle supports on the Gautier Bridge near Pascagoula, Mississippi would replaced with concrete supports. CSX was also planning to upgrade its drainage and spillway channels, and eliminate of all line-side signal and communication wires, moving them out of the way future surge waters. There was discussion of alternative routes utilizing existing rail corridors and alternative Mississippi River crossings such as those at Baton Rouge and Vicksburg. Finally, the feasibility of constructing a new rail corridor further inland was explored by CSX and Mississippi, but the costs of locating a new rail right-of-way, acquiring property rights, and financing and constructing the line made this a long-term option. The Port of New Orleans is considering relocating companies and facilities from the Mississippi River-Gulf Outlet, a deep-water channel connecting the Port of New Orleans' Inner Harbor Navigation Canal to the Gulf, to the main port area on the Mississippi riverfront. The cost of this work was estimated at more than $350 million.

Source: Grenzeback, Lance R. 2006. Case Study of the Transportation Sector's Response To and Recovery From Hurricanes Katrina and Rita. Cambridge Systematics, Inc. http://www.aiche.org/uploadedFiles/FSCarbonMgmt/Resources/Case_Study_-_Katrina.pdf

Lessons

- Main transportation infrastructure bottlenecks, such as bridges over major waterways, may be out of service for months due to the high-degree of technical planning required to make these components resilient to future events, and the general scope of work associated with their construction

- If damage assessments show that previous design standards were inadequate for the hazard forces that occurred, even those infrastructure components that survived the event may have to be retrofitted to ensure vulnerability to future events is mitigated
- Improvement of commercial infrastructure, such as sea ports and airports, can help to draw commerce to the area resulting in a net improvement in local business capacity even in spite of the disaster that occurred

Chapter 5

Labor, Materials and Technical Assistance

The demands for rapid recovery and reconstruction of infrastructure systems and components will require an immense expansion in the supply of human and material resources that address typical (non-disaster) infrastructure development activities. Moreover, these resources – which may include equipment, materials, and personnel - will be further strained by direct competition in demand that results from the repair and reconstruction of housing and private sector facilities. Reconstruction planning teams must assess, analyze, and plan their efforts according to actual human and material resource pools rather than basing any planning assumptions on the availability of such as required to meet an ideal infrastructure reconstruction and recovery pace.

Labor

Personnel are needed for design, demolition, cleanup, manufacturing of materials, structural repair, construction, supervision, inspection, ancillary support (e.g. meals and lodging support), and much more. Each of these includes a mix of skilled and unskilled laborers and/or volunteers, technical experts, and managers. Without ample personnel, a community may find itself in a situation where it has enough funding and materials to rebuild, but it lacks the personnel to support the workload.

The most important personnel source is the affected region itself. These individuals, whether they were personally affected by the disaster or not, have the most vested interest in the outcome of the recovery effort and are most in tune with the community's character. More importantly, many of these people are likely to be in need of immediate employment. As recovery efforts often require long-term commitments, locally hired workers are more likely to be able to commit to the full course of the reconstruction effort, and are less likely to suffer from recovery and reconstruction "burn-out". Using workers from the local economy also has the added benefit of ensuring that more recovery funding stays within the community, which in turn helps to spur long-term economic recovery. At the same time, wages must be set competitively but not set at a level so high as to draw workers out of other jobs, therefore destabilizing any remaining balance in the local workforce.

To address infrastructure reconstruction and recovery, there are two mechanisms by which local labor is typically compensated.

- **Food for Work:** Food for work programs provide food aid for victims in exchange for labor. The basic tenet of the program is that victims are provided with a much-needed resource (food), while at the same time the community directly benefits from the work that is conducted by the aid recipients. These programs, when successful, are effective in reducing the sentiment among victims that they are merely begging for handouts, and it helps recovery planners to increase the feeling among victims that they have an active stake in how their community recovers. Food aid programs must be designed such that they do not benefit individuals in good health and physical condition over those who are unable to work, nor should they negatively impact local markets.
- **Cash for Work:** Like food for work programs, cash for work programs provide financial assistance to survivors of disaster events. These programs help to bridge the period between the disaster and the recovery of livelihoods when victims are able to begin earning an income in their former profession.

The second largest pool of personnel is typically drawn from the governmental (affected government and bilateral assistance) and nongovernmental agencies and organizations active in disaster response and recovery. These agencies may use their own full-time personnel for this task or recruit accordingly. This is especially the true in the case of infrastructure owned, operated, and maintained by national or local government. Given ongoing needs of these agencies, reconstruction may require an increase in government employment by these agencies to address compounded reconstruction labor demands that typically last for years following the event.

Private contractors from around the country and the world may be lured with the promise of recovery dollars to work in the affected area. It is possible to support the local economy by using local construction contractors, but given that demand greatly exceeds what is normal (and therefore a driver of local supply), these local resources will quickly find themselves overbooked. Externally sourced contractors are a strong source of recovery labor given that the pool of individuals with the necessary experience is much larger, and their disassociation from disaster impacts increases the likelihood of their availability. However, external contractors are likely to bring their own support staff and teams, including laborers and artisans, thereby pulling more funding away from the affected area and competing with other non-construction jobs that exist locally. It has also been found that the machinery outside contractors bring can lead to further reductions in local employment potential (Rawal, 2006).

Of paramount concern to recovery planners is keeping recovery funding where it is needed most – in the affected community itself. Just as this was true with the purchase of materials from local markets, it is important that local labor be supported by this sudden influx at a time when expendable income will otherwise be short or nonexistent. There is, of course, no single correct way that this may be done, as the capacity of each community to meet demands differs considerably, and many local laborers will be preoccupied with the reconstruction of their homes. One of the greatest benefits of local and owner labor use is the long-term positive impacts related to skill-building and community empowerment. The livelihoods development relevant to such training can help affected individuals to better cope with traumatic stress and the loss of their regular livelihood income.

It is of dire importance to the economic balance of the community that the use of local labor is utilized in such a way as to avoid negatively impacting stable and recovering livelihoods. When local recovery labor schemes offer salaries that exceed market rates of other professions requiring equivalent skill and knowledge, workers can be drawn away from their jobs thereby causing the weakening or collapse of other markets and industries. For instance, agricultural laborers may elect to take advantage of a higher salary in the recovery construction efforts, which in turn leaves local farmers unable to manage their harvest. Cash for work programs need to strike a proper balance between accommodating an unemployed and destitute workforce and creating an adversarial competitive atmosphere among employers.

Construction Materials

Closely coupled with the importance of identifying labor pools is the selection of building materials. Differences in building materials selected can affect the pace, cost, and sustainability of the reconstruction project, and therefore must be assessed according to a range of key factors. The materials ultimately selected will affect not only the function and quality of the infrastructure facilities constructed, but also their appearance, the ease and speed with which laborers can work with it, the ability of the local workforce to participate in reconstruction efforts, and the ability of the local market to support construction efforts, among other things. There are seven principal categories through which building materials may be analyzed for suitability, including:

- **Quality**

Materials that are of poor quality may not last very long or perform well under the stresses of a future hazard event. Poor quality materials can result from contractors or owners cutting costs, from poorly-trained laborers (for instance, with the mixing of concrete or making of blocks), from profiteering on the part of suppliers, and other reasons. Materials should correspond to the hazard resilience dictated in the prevailing construction codes.

- **Cost**

Building materials must be evaluated according to a cost-benefit analysis that weighs the perceived benefit of each material against the financial impact on the overall infrastructure reconstruction program.

- **Appropriateness**

Construction materials must be appropriate for the climate where they will be used, and the hazard resistance desired. The materials must be able to best manage the climatic pressures of the affected area. Temperature, humidity, precipitation, and other factors will influence such decisions. Some materials also have inherent properties that make them more suitable for certain hazard types – such as flexibility or rigidity, impermeability, heat resistance, among others. Materials must be able to withstand insects and other vermin endemic to the affected area.

- **Local knowledge of Materials**

The technical knowledge required to work with different materials varies greatly. Unless a comprehensive training campaign is incorporated into a program that advocates or mandates the use of a new material, such provisions may lead to project delays or a retention in risk (from improper construction.) Utilizing locally available or familiar materials, on the other hand, helps to support local markets and ensure that local labor is empowered to participate in the recovery effort.

- **Local Availability**

Programs that rely upon materials that are not locally available decrease the pace of economic recovery in the affected area by limited the degree to which local suppliers benefit from recovery funding. In the future, communities may have more difficulty meeting supply needs when repairing these facilities and structures, including hospitals and government buildings, for instance. Ultimately, local markets will become marginalized in the long-term recovery effort as the community becomes more reliant on imports of materials to maintain and repair such structures.

- **Impact on Local Markets**

The selection of materials to support infrastructure reconstruction efforts almost always impacts local markets, though there are a number of factors that determine whether this impact is positive or negative. When local materials are chosen, the local economy can benefit greatly from the injection of income. However, if supply is unable to meet demand, prices will skyrocket causing what is known as a positive demand shock, and subsequently, an increase in construction costs. If foreign materials are chosen, the local markets may become marginalized and eventually see their inventory become irrelevant.

- **Environmental Impact of the Materials**

When infrastructure reconstruction needs are great following a disaster, the corresponding demand for materials is exceptionally high in comparison to normal times. This demand can lead to severe environmental impacts. The use of wood can lead to clear cutting of fragile forests. The use of bricks can result in atmospheric pollution given the wood and coal fires required to heat the ovens. Local governments and private companies that own and manage infrastructure facilities and systems can be a key resource in the determination of building materials. However, these entities may not have the ability to assess and analyze the impact of the event on the capacity to acquire those materials, or the effect of the significantly increased demand on markets or the environment. This interaction will, however, shed significant light on the ability of local construction laborers to work with different material types.

Recycling of materials found in damaged or destroyed structures, such as hospitals or schools, can present a number of benefits to a reconstruction project when appropriate. Recycled materials:

- Are immediately available
- Help to minimize the environmental impact of reconstruction
- Reduce the amount of debris that needs to be cleared to make way for construction or removed from the affected area altogether
- Reduce the cost of construction materials

There are some inherent problems associated with recycled materials, however, including:

- The quality of the materials may be what led to the structural weakness in the first place
- The recycled materials may not be appropriate for the style and/or design of the new structure
- There may actually be an increase in the cost of construction if it is more expensive to reprocess the material that to pay for its removal and purchase new materials
- Recycling rarely makes sense if the communities served must relocate away from the affected area

The decision to recycle debris must be made early in the reconstruction effort as communities will begin clearing the material as soon as they can to begin the recovery process. Recycled material typically requires a significant amount of processing, so lead-time is necessary for the construction laborers.

Technical Expertise

There is a significant degree of expertise required in any infrastructure reconstruction effort. The planning and design of schools, hospitals, roadways, ports, electrical grids, water treatment options, and much more, demands highly specialized technical knowledge that few, if any, of those in the community will possess. Appropriate technical expertise is paramount to the sustainability of infrastructure addressed by the reconstruction effort, and must therefore be present at every juncture from assessment onwards. Governments without these capabilities internal to their operations will have no alternative but to contract out such services to national and international engineering and design firms capable of handling projects of such great consequence.

Case 30: Matata Flood, New Zealand, 2005

Topic: Labor

The government of New Zealand identified in planning efforts that the process by which of building permits are issued at the early stages of reconstruction and recovery will present a bottleneck to the pace of recovery. But of particular importance in these findings was that access to required resource levels will be unlikely, meaning that there will inevitably exist shortages of qualified personnel needed to perform impact assessments and reconstruction permit processing. These assessments determined that a more flexible approach to the standard permit process would likely be required to expedite the process and help cope with the high volume of permit applications after a major disaster. In terms of the labor resources available, it was suggested that the construction industry in New Zealand could only effectively cope with a moderately-sized disaster given an average base work load, but that a large-scale disaster could require up to 180,000 additional construction industry workers (as based on an event causing $10 billion in damages in the Wellington region and with a base work load 7% higher than current levels). Another study found that a combined resource requirement for reconstruction would be about $7.73 billion. The National Civil Defence Emergency Management Plan acknowledges New Zealand may need to mobilize all nationally-available resources to address this need given that it has finite capacity and capability for recovery. On 18 May 2005 a band of very intense rain fell in the catchments behind the community of Matata, triggering landslides and several large debris flows. The destruction in Matata was caused by debris flows. Although debris flows were the primary hazard flooding also occurred. The event was calculated to be of a 500-year recurrence interval. The rainfall and landslides caused widespread infrastructure impacts, including damage to highways and roads, bridges and railway systems. In the recovery effort that followed, In response, a major infrastructure recovery operation followed, requiring a significant procurement of contract labor. Parties involved include the government, Insurance companies (AMI), Land Transport New Zealand, Hazard Task Force, Infrastructure Task Force, Rural Task Team, Task Force Green, Smithbridge Limited. Examples of the tasks managed by these parties include:

- Disaster recovery activities and coordinate hazard and risk management investigations following the debris flows, flooding and widespread damage.
- Developing plans and recovering the lifelines such as roads, electrical services, telecommunications etc.
- Performing recovery of major roadways damaged in the event
- Debris removal from rail infrastructure.

The Government was looking for an integrated recovery plan for Matata with

Whakatane District Council and other relevant agencies. To facilitate this process the Ministry of Civil Defence and Emergency Management appointed a recovery facilitator. This facilitator worked together with the Recovery manager to rehabilitate Matata and provide an interface between central Government and Whakatane District Council. The Infrastructure Task Force was responsible for clearing debris, repairing roads, and resuming delivery of water. A contract to construct a new two-way rail underpass for State Highway 2 traffic was awarded shortly before the floods struck in May, but construction was delayed by the flooding. The contractor, Smithbridge Limited, won the contract for the underpass including the construction of the new underpass and a new rail bridge, realignment of the highway on both sides of the underpass, demolition of the old underpass, removal of the traffic signals, and installation of a speed threshold. The major recovery project owners are: Ontrack, Transit, Whakatane District Council and Environment Bay of Plenty. They are owners of major infrastructural assets and therefore key parties in the recovery effort.

The recovery phase started after one week and parties came into action to clear the roads and the land from rocks, stones and debris. There was no tendering of work during this period. Parties had their own contractors and it was not necessary to involve new parties. When the reconstruction after 4-6 weeks took place, new parties were required. The tendering was fast tracked, but the parties approached were only a few parties of an existing relationship. (Brady, 2005). The work is accomplished by existing contractors and parties and the same contracts can be used during the reconstruction process. Both Ontrack and Transit own a significant part of the infrastructure in the area affected by the event. It was needed to ensure that both these organizations were working collaboratively with the Hazards and Risks Task Group to identify long-term solutions.

There was little difference between contractual arrangements of after-disaster reconstruction and normal time construction in New Zealand industry. Packages of work are tendered where needed. There may have been some expediency and short cutting, but in general terms all work is done within the existing contractual frameworks. The small differences between the normal building processes and the reconstruction process may partially be explained by the fact that the investigated disasters were of a small scale. The parties that are normally involved during the construction projects in the area are also involved during the reconstruction process, and this is certainly an advantage due to the industry familiarity and enhanced level of trust-based collaboration of existing relationships. This lends itself towards the partnering and alliancing arrangements discussed earlier. Encourage the use of relationship-focused contracts or procurement methods (e.g. partnering or traditional ones with traits of partnering) in a post-disaster reconstruction to ensure a good collaboration among involved parties and a higher level of industry familiarity.

Source: Zuo, Kevin, Suzanne Wilkinson, Jason Le Masurier, Jetske Van der Zon. 2006. Reconstruction Procurement Systems: The 2005 Matata Flood Reconstruction Experience. The University of Auckland and the University of Canterbury, New Zealand. http://www.grif.umontreal.ca/pages/ZUO_Kelvin.pdf

Lessons

- The inspections associated with permitting construction can present a bottleneck to reconstruction progress; however, a more flexible disaster-specific permitting process can alleviate much of this pressure
- A nation may need to mobilize all available construction resources to meet the construction labor requirements that exist following a major disaster
- A recovery facilitator can be used to provide an interface between the central government and the affected jurisdictions
- In small disasters, there may not be much variance between regular contracting and disaster-related contracting. However, in the event of a major disaster the processes will be highly divergent
- An advantage of including parties normally involved during the construction projects in the affected area in the reconstruction process comes in the form of familiarity with the affected area and its associated issues, and an enhanced level of trust-based collaboration of existing relationships.

Case 31: Great Hanshin Earthquake, Kobe, Japan, 1995

Topic: Technical Expertise

The Kobe earthquake caused significant damage to the infrastructure and transportation network in the affected areas. Extensive rail and roadway damage included the collapse of significant portions of three major freeway routes, damage to rail systems, and the collapse of Kobe's subway stations. There was also significant damage to the water, gas, and sewer systems, with over 1 million households losing access to related services. To address technical needs, the Japanese government created a formal organization through which human capital resources from all levels of the government were leveraged to plan for and implement recovery strategies. A committee comprised of high-ranking officials (including members of the Japanese House of Representatives and leaders of affected jurisdictions and their staff) developed intergovernmental recovery strategies. In addition to those high-ranking officials, the committee also included working-level staff from national ministries to provide expertise for developing specific details to be included in the recovery plan. For example, staff from the Ministry of Transportation brought expertise on infrastructure replacement while those from the Kobe Chamber of Commerce and Industry contributed knowledge regarding economic recovery matters. According to a Japanese official involved in the recovery, this committee combined the political know-how from the top-level officials and interdisciplinary expertise from line-level bureaucrats to propose many recovery proposals that laid a foundation for the national government's approach to recovery. The Japanese government also leveraged human capital expertise through this committee to facilitate the implementation of recovery strategies. Upon the approval of certain recovery policies, working staff associated with the committee returned to their respective organizations to guide their home departments on how best to implement the strategies. A Japanese official involved in the committee said that this collaboration helped to ensure that disparate ministries understood and properly implemented the recovery strategies they helped to develop.

Source: GAO. 2009. Disaster Recovery: Experiences from Past Disasters Offer Insights for Effective Collaboration After Catastrophic Events. GAO Report 09-811. http://www.gao.gov/products/GAO-09-811

Lessons

- A government committee comprised of both high-ranking officials and working level staff can ensure that there is technical oversight for all reconstruction plans
- All infrastructure sectors need to collaborate on a central infrastructure reconstruction plan given the cross-dependencies and effects that exist between them

Case 32: Flores Earthquake, Indonesia, 1992

Topic: Labor and Technical Expertise

The earthquake in Flores Island in eastern Indonesia was one of the most destructive disasters of the 1990’s. A wide range of infrastructure and agricultural facilities were destroyed including:

- 750 kilometers (km) of roads
- Over 700 meters (m) of bridges
- 42 water resources facilities

The main damage occurred over an area of about 6,000 square kilometers, affecting the districts of Flores Timur, Sikka, Ende, and Ngada, and the towns of Maumere and Ende. The main objective of one particular reconstruction project administered by the Asian Development Bank (ADB) was to assist the Government of Indonesia with the efficient and expeditious reconstruction of the roads, bridges, and water resources facilities damaged by the earthquake. The Project did not include a formal technical assistance component, but the international consultants provided considerable on-the-job training to their counterpart staff. Capacity building was not initially included in the design of the Project as it was already included in similar ongoing loans. However, at the request of the Government, a training program was supported during implementation. A reconstruction management team (RMT) headed by a steering committee was appointed to implement the Government reconstruction program. The Ministry of Public Works (MPW) was the Executing Agency and worked under the guidance of the steering committee. Implementing agencies were the Directorate General of Highways (DGH) and the Directorate General of Water Resources Development (DGWRD), respectively.

There were, however, delays, which were the result of the following:

- Extensive use of hand tools for excavation because blasting was not permitted
- Unanticipated construction resulting for a lack of information prior to implementation
- The use of poorly qualified subcontractors, resulting in the need to do additional works after review by international consultants

Source: ADB. 2000. Project Performance Audit Report on the Flores Emergency Reconstruction Project. http://www.oecd.org/dataoecd/14/6/35267706.pdf

Lessons

- Consultants brought in to provide technical expertise to the planning process can ensure sustainability of the new infrastructure by providing on-the-job training in line with their services
- Reliance on local methods and tools must be incorporated into planning documents or unexpected delays may occur
- Poorly qualified contractors can result in the need for additional work when their products and output does not meet design standards

Case 33: Hurricane Mitch, Honduras, 1998

Topic: Technical Assistance

The international NGO Save the Children participated in projects to repair and reconstruct transportation (mainly river crossings), water, and sanitation infrastructure following Hurricane Mitch in 1998. The hurricane resulted in a great number of mudslides, which affected water collecting systems, destroyed a number of river crossings, damaged storage tanks. The damages caused by the hurricane in both the water and sanitation sectors resulted not only in the loss of movement and of water services, but also in a reduction in water quality in those places where access still existed. Contamination ultimately affected the health of victims, especially in children. The Save the Children project resulted in the reconstruction of 84 water systems, and the addition of 7 completely new water systems, benefiting 36,125 people, with 2,438 latrines benefiting 14,947 people. To help improve transportation access in affected communities, which facilitated livelihoods, allowed access to education and health, and other benefits, damaged infrastructure was improved. A total of 19 crossings were built for a total of 243.60 linear meters and benefiting 6,046 people; and 71.1 km of rural roads were improved, benefiting a total of 15,129 people.

To address the sustainability of water and sanitation projects, Save the Children organized Water Administration Boards in recipient communities where they did not previously exist. Those communities that did have such a board were given assistance in strengthening them through training on issues that contributed to an adequate operation and maintenance of the systems. Training topics provided to 335 members of the Water Administration Boards were: water and sanitation systems structure, Water Administration Boards Regulations, systems management and calculation of fees, water quality and chlorination, sanitary education, basic plumbing and watersheds protection. Save the Children also organized Regional Water Councils in several towns. Regional Councils assembled Water Administration Boards according to their geographic location, in order to: strengthen water boards, establish relation and cooperation links between communities, especially micro watersheds that influence many systems, carry out audits, coordination of actions for procurement of chlorine, pipes and accessories in order to get better prices. Six training sessions were provided to 84 regional council members aimed at the fulfillment of their objectives and the consolidation of councils. Emphasis was made on projects management for micro watersheds protection, calculation of fees to enable sustainability, and good water quality. Four training events were provided to 67 plumbers, to give them with the necessary knowledge for the adequate operation and maintenance of the water and sanitation systems. Save the Children also held workshops to standardize and improve technical personnel actions related to community participation and training for the construction and sustainability of the water and sanitation systems.

The Asociacion de Desarrollo Perpirense (ADEPES) coordinated with the WFP the improvement of roads through the food-for-work program in the Municipality of Pespire, Choluteca. Two training sessions on Improvement and Maintenance of Rural Roads were held and 6 communities participated.

Source: Save the Children. 2001. Post-Mitch Integral Reconstruction Project.
http://pdf.usaid.gov/pdf_docs/PDABW502.pdf

Lessons

- Infrastructure impacts can affect the health of victims, especially with regards to contaminated water sources
- Nongovernmental organizations can serve as an effective source of infrastructure reconstruction expertise, funding, and labor, especially in areas that fit within their specific scope of work
- Training of local workers in the operation and maintenance of new infrastructure must be included in reconstruction planning if long-term sustainability is to be achieved
- Regional councils that oversee infrastructure reconstruction, and long-term performance, can be established at the earliest stages of reconstruction to ensure that they have adequate buy-in and/or ownership of the plans that are acted upon

Case 34: Earthquake and Tsunami, Aceh and Nias, Indonesia, 2004

Topic: Labor, Materials, and Technical Expertise

In Aceh and Nias, roads that were bad before the tsunami simply disappeared afterward. For aid to be delivered and for the economy to recover, road networks were in dire need of quick repair. Furthermore, conditions made the use of advanced technology not only costly but also generally infeasible. The ILO adopted a local resource-based approach to allow the restoration of roads for the flow of economic and humanitarian services. Simultaneously, the ILO's local resource-based infrastructure rehabilitation generated short-term jobs, immediate income, and local capacity to build good roads and create local employment far beyond the recovery phase. With a budget of $1 million from UNDP-ERTR and OCHA, the ILO restored 18 kilometers of roads, created 28,000 worker-days of employment, and generated insights for promoting medium-term development. Roads in Aceh and Nias also suffered from the lack of a cost effective road contracting system. Maintenance was not considered a design factor and pricing did not benefit from a transparent process. Road workers and small contractors did not have the necessary skills. ILO post-crisis interventions have addressed structural issues such as institutional capacity to manage roadwork and employment generation. Strategies adopted in this projects include:

Source: ILO. 2008. Lessons Learned and Good Practices From the ILO Aceh Programme. http://webdev.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta/documents/publication/wcms_117130.pdf

Lessons

- Immediate repair of transportation infrastructure, oftentimes well before long-term recovery planning has occurred, may be necessary in order to facilitate the delivery of humanitarian relief
- Infrastructure recovery projects can be used to alleviate post-disaster employment shortages and likewise, provide immediate income to the affected
- Job creation for both men and women is key to recovery; construction relies on local workers and materials. Local procurement means that jobs are created not only for the construction of the project but also in the production of supplies
- To be sustainable, the project must include a transfer of good construction and contract management techniques to Public Works officials, contractors, and workers; labor-based construction methods; transparent bidding procedures; and training for workers, contractors, and public works officials
- Strategic values must be incorporated. Infrastructure improvements provide access to crisis-affected communities, not only helping residents resume economic activities but also facilitating the delivery of further relief

- Gender sensitivity is important. Women must be encouraged to participate. This creates jobs for women and demonstrates their ability to work in areas considered out-of-bounds
- Capacity building can occur if local public works officers are trained in appropriate construction technology that can yield good roads and good jobs, now and in the future. Local contractors can be trained in contract management and technical topics
- Standardized, practical tools for skills (re)training in construction and infrastructure work enable timely crisis response. Infrastructure tends to be a typical area of work for crisis-affected areas. Though every environment is different, basic skills such as debris removal, concrete mixing, brick layering, and competence in occupational safety and health are likely to be in need in many situations
- Local resource-based approaches are applicable to infrastructure rehabilitation after a crisis. However, local officials, contractors, and workers often need to be educated on these approaches and their benefits so they can create employment with the ILO at first and, later, through infrastructure maintenance on their own. They may not favor participating in classroom-type training. Integrating training into actual work through "on-the-job training" and/or mobile training teams would be more effective. This would prevent a loss of incomes for workers and contractors
- Skills training requires special expertise. While it is not difficult to identify skilled workers in construction and road-building, identifying those who can teach others effectively is a challenge. Investment in creating a training capacity should be considered
- Community relations and inter-agency coordination in road works are necessary. In post crisis situations, high traffic volume to deliver construction and other aid materials can shorten the lifespan of newly rehabilitated roads. Furthermore, community members can become embroiled in small conflicts over road passage, access to personal property, and maintenance. Community leaders play a key role in managing community members' participation in and contribution to the maintenance of public goods
- Develop practical publications on construction issues common after crises. Topics could include skills for construction workers (such as cement mixing and bricklaying), employment services for construction trades, skills certification, quality construction and construction site supervision, and social dialogue and labour relations in the construction sector. By having practical materials on construction skills training ready in advance of any crisis, agencies can implement immediate projects to give workers the skills they need to rebuild their communities

- Break gender barriers in construction work. Encourage women to participate, including through such initiatives as women-only days on the building site, so they can earn income and play a role in the reconstruction of their communities. This also puts to rest the myth that women are not suitable for construction work
- Train all parties in a given context. For example, in its local resource-based infrastructure rehabilitation component, the ILO has trained engineers from local public works offices, contractors, supervisors, foremen, and skilled and unskilled workers. This boosts the quality of work and offers more people a better chance to find jobs into the future. It also minimizes the chance that substandard work on one part of a project will compromise the efforts of trained workers on another part

Case 35: Hurricane Ivan, Granada, 2004

Topic: Reconstruction Materials

The Caribbean Electric Utility Services Corporation (CARILEC) facilitates communication among its members and serves as a focal point for information, advocating reform in the electric utility industry throughout the Caribbean. It provides services to members including the CARILEC Hurricane Action Plan (CHAP). CARILEC created CHAP to provide for the assembly, dispatch and coordination of emergency teams of linesmen from member utilities.

Their role is to help restore electric transmission and distribution systems in a country affected by a serious hurricane. To be eligible for assistance and training under the program, each utility pays an annual fee of US$2,000 to the Hurricane Fund. After Hurricane Ivan, Grenlec requested assistance through the CHAP, which deployed 100 linesmen from the region to help repair and restoration of Grenlec’s operations. This assistance provided an important boost to recovery in the immediate aftermath of the hurricane. An often cited reason for delays in any large scale reconstruction program is difficulties encountered in sourcing materials. Reconstruction in Grenada is no different as suppliers initially had difficulties delivering materials. The main warehouses on the island, severely damaged during Ivan, created initial challenges in the distribution of materials. To overcome this obstacle, site vendors located throughout the country supplied materials before the main distribution centers came back on line. For the first four to six months post-Ivan, distributors faced significant challenges in sourcing supplies, although this ultimately improved. For the first six months, it is estimated that all suppliers combined could meet only 60 percent of Grenadian market demand. By the end of March this had risen to 80 percent. Immediately after the passage of Hurricane Emily, nearly 100 percent of demand was met.

Source: The World Bank. 2005. Grenada: A Nation Rebuilding. An Assessment of Reconstruction and Recovery One Year After Hurricane Ivan. WB Hazard Risk Management Unit.
http://siteresources.worldbank.org/INTLACREGTOPHAZMAN/Resources/grenanda_rebuilding.pdf

Lessons

- Trained infrastructure utility experts can be inventoried prior to a disaster in order to better understand quickly the resources available once an actual disaster occurs
- Site vendors located throughout the affected areas can be tapped for materials until main distribution centers are able to begin providing centralized assistance

Annex 1: Pre Disaster Recovery Planning

During the pre-disaster period, public and private owners and operators of national infrastructure may have analyzed the risks and vulnerabilities of these systems and structures, and may have even come up with a broad range of mitigation options to address them. Due to expense or feasibility problems, however, it is likely that in most cases these options were shelved for a later date. After a disaster, most of the conditions that served as obstacles no longer exist or have changed considerably. Budgets may swell with relief funding. Buildings and equipment that required very expensive retrofitting may have been destroyed, allowing for much cheaper “mitigation through design” to be performed. Systems and facilities placed in high-risk areas where they should never have been built in the first place may have subsequently been destroyed by the disaster. Unknown risks from unmapped or poorly understood hazards will now be easier to incorporate into development plans and thus avoid.

Like response, recovery is a process that is performed within a time-constrained setting and on which victims’ lives directly depend. To be performed well, recovery and response require special skills, equipment, resources, and personnel. Unlike response, however, disaster planning very rarely includes disaster recovery operations.

The recovery period follows the emergency phase of a disaster and is one in which confusion is likely to reign. There may be people displaced from their homes, business owners anxious to resume operations, and government offices that must restart service provision, among other pressures. To ensure that overall vulnerability is reduced, rebuilding without considering the disaster’s effects as well as any new hazards is unwise and irresponsible. Unfortunately, decisions are often made with little or no planning or analysis, and opportunities for improvement can be lost.

In the planning process, disaster managers identify hazards, analyze risk, and determine ways to reduce those risks. In doing so, they gain a much greater understanding about how each of those hazards would affect the community and the nation’s infrastructure (and other sectors) if they were to strike. This information can be effective if used to plan the community’s recovery from a disaster. Predisaster planning—sometimes referred to as “Pre-Event Planning for Post-Event Recovery (PEPPER)— can reduce the risk of haphazard rebuilding. Though nobody can predict exactly how a disaster will affect a community, many processes are common to all disaster types (such as hurricanes, for example), and they may be identified and studied in advance. Many decisions will have long-term repercussions and, as such, are better made in the relaxed, rational environment that only exists before the disaster occurs.

Examples of recovery decisions that may be made before a disaster include:

- The site selection for more resilient, more convenient, or more efficient infrastructure components, facilities, and systems

- The site selection for temporary infrastructure components (including temporary government, school, and hospital facilities, for instance)
- The site selection for the disposal of debris
- The identification of contractors from around the country that could be called upon to assist in infrastructure repair and reconstruction
- The development of coordination mechanisms, including leadership, membership, and information sharing, for example
- Volunteer and donations management

Mitigation measures and other hazard reduction actions that may be too expensive or unfeasible before a disaster, but that may be more opportune if existing structures and facilities were damaged or destroyed

It has been postulated that disaster recovery based upon pre-disaster planning is much more organized, is more likely to result in community and national improvement, and is more likely to result in a reduction of future disaster losses. Because nobody knows for sure exactly how and where the disaster consequences will manifest themselves, recovery plans are hypothetical, focusing more on broad goals and ideals than on specific actions and procedures. For instance, they may include "Reduce vulnerability to electrical transmission wires" or "Revise building codes to address new seismicity estimates."

During much of the actual recovery period, many decisions will require split-second action, with little or no time for analysis. A plan outlining overarching goals and objectives can help guide those decisions. Decisions made without considering these goals can drastically limit opportunities to rebuild the community to be more resilient and disaster resistant. Through the hazard identification and analysis process; communities that have performed adequate hazards risk planning will have determined what consequences they should expect to occur. Using this information, they will have created a mitigation plan outlining the possible options for disaster risk reduction. In the post-disaster recovery period, when many decisions are being made about construction and repair of structures, zoning of land, and new development, this mitigation plan can be used to ensure that proper action is taken to minimize risk. For example, if a community has determined that a water treatment plant must be moved out of the floodplain, legislation to approve the funding required to accommodate such a large project would be much more likely to pass in light of a recent disaster that affected the facility directly. Planners may find that many of the measures deemed un-fundable or impossible before the disaster are now perfectly acceptable.

Throughout the recovery process, recovery planners must be sure to align any recovery efforts with the community's needs and goals. This also is true for new opportunities. Communities may have already been planning improvements before the disaster occurred. In communities that developed with little or no planning, recovery can provide the rare opportunity to apply lessons learned on a grand scale, creating an end product that is much more conducive to the community's social and commercial activities and needs. Planners who apply the philosophy of letting community members guide themselves through recovery and reconstruction will likely find a great deal of acceptance, enthusiasm, and success.

Examples of changes to community design that can reduce hazard vulnerability and be made in the recovery period include:

- Redistribute emergency resources (fire, police, emergency medical)
- Rezone to account for new hazard information
- Adjust construction codes and ensure that all repairs and reconstruction are made to code
- Restrict building within zones of greatest risk (e.g. in the floodplain, on unstable ground, below landslide risk zones)
- Create natural fire breaks
- Design adequate evacuation routes
- Construct public buildings that can double as shelters
- Reduce population density
- Widen primary roads to alleviate pressure (for evacuation or emergency response)
- Address problems related to informal settlements in high risk zones

Case 36: Pre-Disaster Recovery Planning in the Caribbean.

Topic: Pre-disaster Planning for Post-disaster Recovery

The Organization of American States' Unit for Sustainable Development and Environment (OAS/USDE) implemented a disaster mitigation capacity building program which included the pre-disaster planning for recovery. This program recognises the pressure to quickly rebuilds that exists in the aftermath of a disaster. However, the quality of the reconstruction and rehabilitation work that takes place during this period often determines how well the same location fares in future hazard events. Time constraints and communication and transportation difficulties in the post-disaster environment can confound efforts to improve the resilience of structures that are constructed in this period. Pre-disaster planning is often necessary to ensure adequate materials are available following a disaster and to ensure that builders, homeowners and government agencies are aware of damage reduction measures and construction techniques that can reduce vulnerability to future hazard events.

Under this program, ex-ante plans and training materials were developed to assist in post-disaster reconstruction efforts to ensure that the reconstruction efforts result in a more hazard-resistant housing sector. The Housing Sector Recovery Plans for Antigua and Barbuda and St. Kitts and Nevis that were developed provide guidance and recommended action items for the respective governments, construction sectors, finance and insurance sectors, and homeowners in each nation. Reference Guides are included for use by the general population during disaster preparation and disaster reconstruction, as are Training Outlines that can be used for short courses offered on a continuous basis or immediately after a hazard event. In addition, links to hazard reconstruction manuals are provided for in-depth information on construction techniques, standards and materials.

Out of this exercise, a set of short- and medium-term recommended actions for pre-disaster planning was developed. Implementation of these actions could reduce the disaster recovery period and could significantly increase the resilience of buildings reconstructed in the post-disaster period.

Source: http://www.oas.org/pgdm/document/preplan.htm

For further information:

Los Angeles Recovery and Reconstruction Plan

http://emergency.lacity.org/pdf/epa/Recovery_and_Reconstruction_Annex.pdf

International Recovery Platform

http://www.recoveryplatform.org/resources/tools_and_guidelines

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