Post-Disaster Engineering & Construction

by Bob Prieto

As the nation faces the challenges of rebuilding in Puerto Rico after the devastation of Hurricane Maria, it is important to understand that post-disaster efforts cannot be business as usual.

The post-disaster environment changes engineering and construction requirements as well as the framework within which the rebuilding an reconstruction efforts will be undertaken. These changes drive the post-disaster program and project managers to address different considerations from those encountered on a more traditional, global scale program while simultaneously dealing with the added constraints imposed by an evolving logistical situation.

Simplified Engineering & Construction Project Model

In order to understand how the engineering and construction project model changes post-disaster, it is first necessary to construct a simplified model for the non-disaster scenario. Such a simplified model is reflected in the following figure and includes a set of project inputs that are transformed at a project site, within a well-defined framework, to deliver the desired project outputs. Framework elements in a non-disaster project model include:

- Business framework
- Project environment and setting
- Social and stakeholder framework
- Economic and political framework

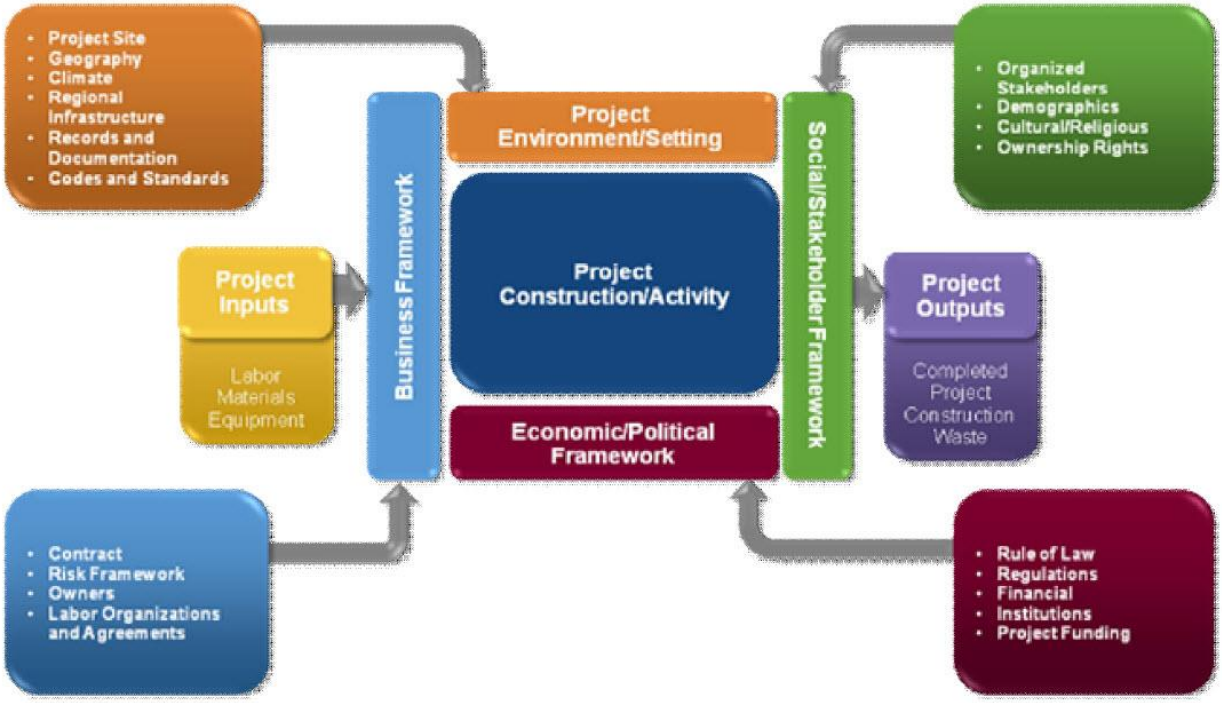
In the non-disaster scenario, project inputs simplistically include:

- Labor
- Materials
- Equipment

Outputs from the engineering and construction process include not only the completed project but also a significant amount of construction waste (25 percent of construction inputs).

Turning now to each of the framework elements in which construction typically occurs, we can define the prime components comprising each element in a “simplified” non- disaster construction setting:

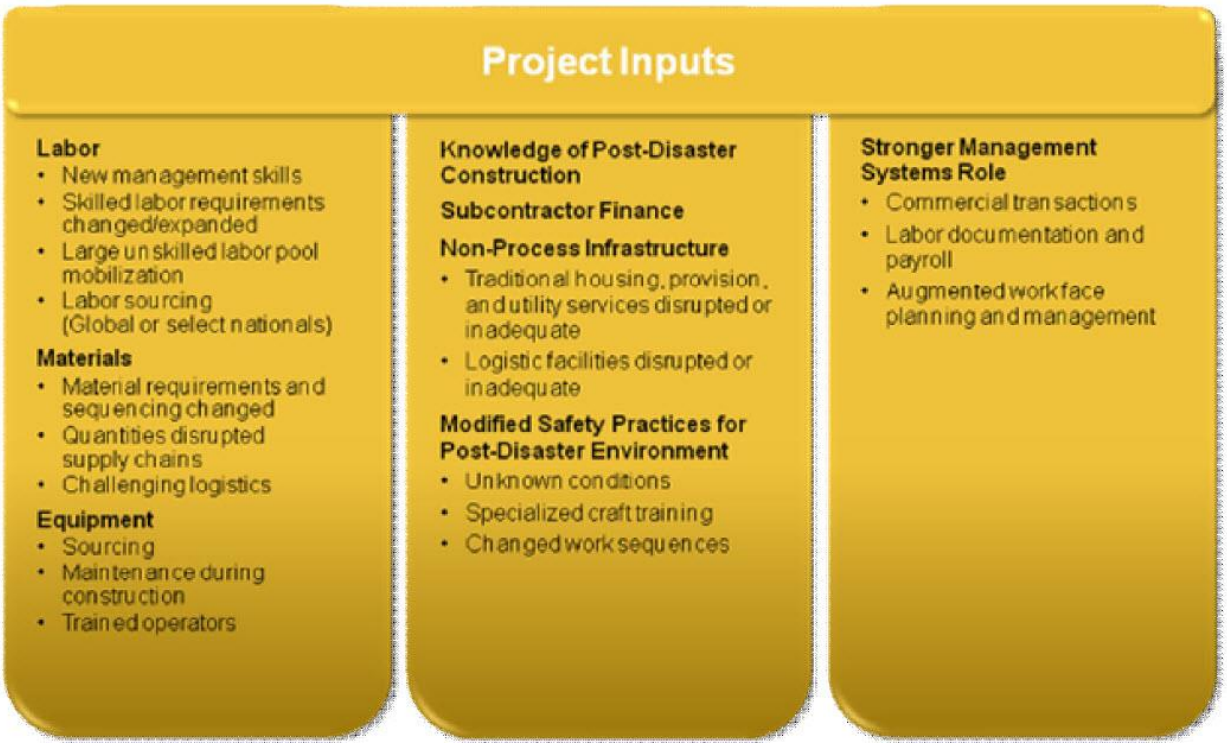
- The *business components* include the contract, the risk factors, the facility owner, and the various labor organizations and associated labor agreements that may exist.
- *Project environment and setting components* include project site factors, geography, climate, existing regional infrastructure, available records and documentation, and applicable codes and standards.
- The *social and stakeholder components* include existing organized stakeholders, local and regional demographics, a range of cultural or religious factors to be considered, and hopefully well-established ownership rights.
- Finally, the economic and political components include a well-established rule of law, clear regulations, well-defined financial institutions, other institutions taken for granted in everyday commercial activities, and a well-defined and efficiently structured approach to project funding.



Site-based factors further constrain how project inputs are transformed into the desired project outputs within this framework. The transformation process also is enabled through a set of required site services, the *esprit de corps* built among the project team, and the knowledge and experience the contractor and his/her management and technical experts bring to bear.

How the Engineering and Construction Project Model Changes Post-Disaster

Disasters change each element of this model. Also, as we will see later on, activities normally undertaken are modified by post-disaster logistics constraints as well as modify post-disaster logistics themselves. Let's look now at each element of the simplified model described above and how it is modified post-disaster, starting with project inputs themselves.



Each of the basic inputs from our simplified model (labor, materials, and equipment) is modified post-disaster, and several new input considerations become significant. These modified and new input factors include:

Labor

- New management skills
- Skilled labor requirements changed/expanded
- Large unskilled labor pool mobilization
- Labor sourcing (global or select nationals)

Materials

- Material requirements and sequencing changed
- Quantities-disrupted supply chains
- Challenging logistics

Equipment

- Sourcing
- Maintenance during construction
- Trained operators

Knowledge of Post-Disaster Construction Subcontractor Finance

Non-Process Infrastructure

- Traditional housing, provision, and utility services are disrupted or inadequate.
- Logistic facilities are disrupted or inadequate.

Modified Safety Practices for Post-Disaster Environment

- Unknown conditions
- Specialized craft training
- Changed work sequences

Stronger Management Systems Role

- Commercial transactions

- Labor documentation and payroll
- Augmented workface planning and management

Similarly, the various framework elements are subject to modified or added components, which act to shape post-disaster project management in ways not encountered in non-disaster scenarios. Let's look at each of the framework elements and how the various components are modified post-disaster.

Disaster Changes the Business Framework

Disaster changes the business framework. It introduces new factors into basic construction contract considerations, significantly altering risk frameworks that the program or project team may experience. Disaster also creates new, *de facto* owner groups that are different than those the engineering and construction team and broader community may be used to engaging. It also creates new challenges with various labor organizations.

Specific modifications to the simplified model may include the following:

Contract

- Scope includes more unknowns and potentially evolving requirements.
- Schedule now is based on potential continuing risk events, degraded labor productivity, uncertain supply chains, and evolving approval frameworks.
- Budgets now are based on uncertain labor, equipment, and material costs, accounting for competition for constrained resources.
- Quality standards must consider risks and intended usage and duration.

Risk Framework

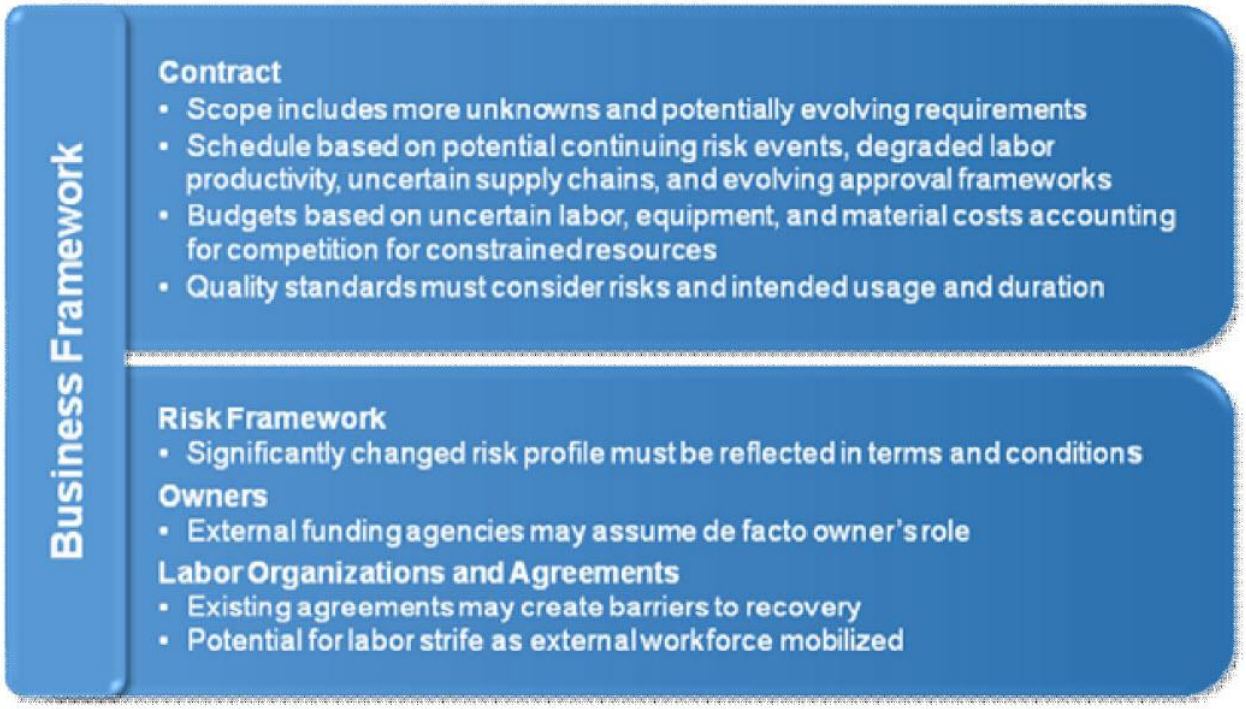
- Significantly changed risk profile must be reflected in terms and conditions.

Owners

- External funding agencies may assume *de facto* owner's role.

Labor Organizations and Agreements

- Existing agreements may create barriers to recovery.
- Potential for labor strife increases as external workforce is mobilized.



Disaster Changes Project and Environmental Setting Framework

Disasters, in particular broader scale disasters, fundamentally alter the project and environmental setting. Site access will be constrained in new and potentially evolving ways, basic site and regional geography may be fundamentally modified, and the regional infrastructure, at whatever level that projects rely on to meet many of their basic needs, may now be nonexistent. Basic assumptions under the simplified pre- disaster model are no longer valid.

Changes to the various components of this framework element include:

Project Site

- Constrained access
- Denied access
- Uncertain ownership or other property rights

Geography

- Modified topography (floods, landslides, or mudslides; earthquake displacement; lava fields; aftermath of military action)
- Terrain limits the rate of response or reconstruction.
- Accessibility constrains available options.

Climate

- Adverse climactic conditions impact response activities (continuing hurricane season, seasonal extremes of temperature or precipitation).
- Event of scale necessitates construction in nontraditional time periods (monsoon, depth of winter, peak of summer).

Regional Infrastructure

- Widespread destruction of regional infrastructures important to response and reconstruction (roads and rails washed away, bridges severely damaged or destroyed, airports rendered unusable, destroyed power generation and transmission capability, destroyed or degraded potable water treatment and distribution capability, degraded wastewater capability, constrained telecom services from facility damage)
- Regional infrastructure inadequate for level and nature of response and rebuilding activities

Social Infrastructures Disrupted or Destroyed

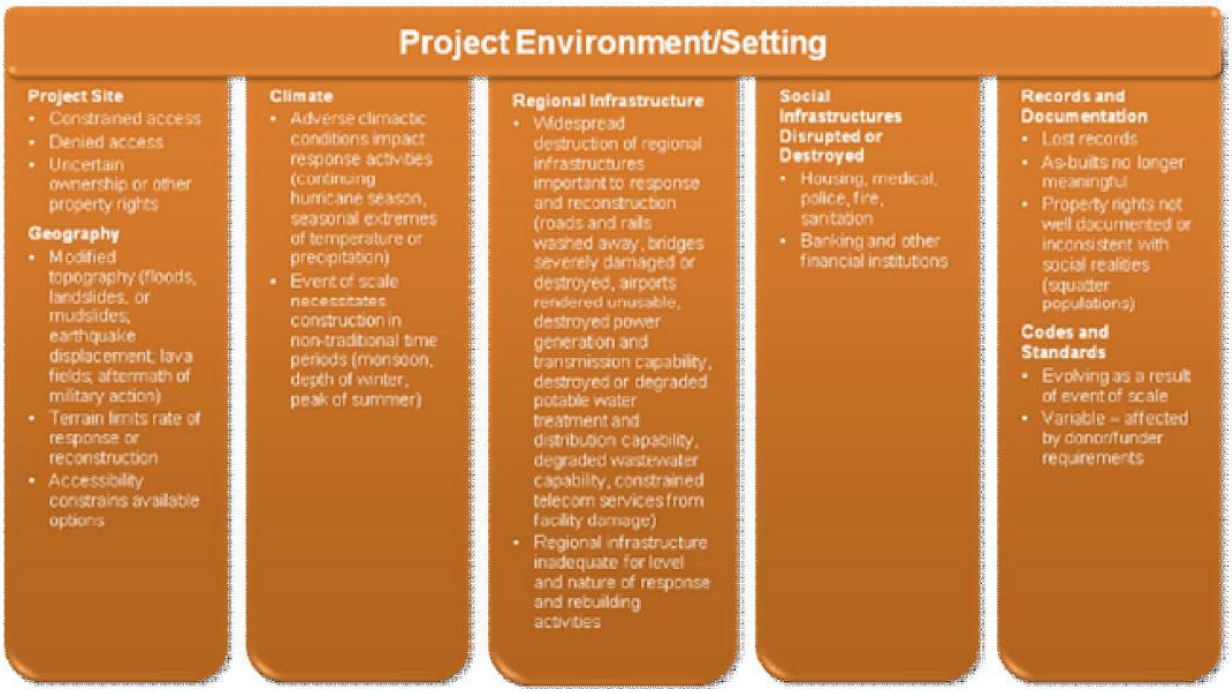
- Housing, medical, police, fire, sanitation
- Banking and other financial institutions

Records and Documentation

- Lost records
- As-builts no longer meaningful
- Property rights not well documented or inconsistent with social realities (squatter populations)

Codes and Standards

- Evolving as a result of event of scale
- Variable – affected by donor/funder requirements



Disaster Changes Social and Stakeholder Framework

Social and stakeholder frameworks undergo some of the most significant changes post-disaster, often in ways that are not readily visible. These changes impact each of the components that comprise this framework element. Traditional problem resolution mechanisms may break down, and new sources of concern or conflict may emerge. Displaced populations, transient relief and reconstruction populations, and a re-emergence or strengthening of cultural or tribal issues compound the difficulty in undertaking the engineering and construction activities needed to respond and reconstruct post- disaster. Often the debilitating and corrosive impacts of corruption are more sharply felt.

Changes to specific framework components include:

Organized Stakeholders

- Traditional stakeholder groups are dysfunctional.
- Stakeholder objectives are evolving.

- New stakeholder groups are emerging.
- National or international stakeholders gain roles to enable or Intervene.

Demographics

- Loss and displacement of populations
- Impact of relief, response, and reconstruction populations
- Constraints on construction labor

Cultural/Religious

- Transitional roles often played by cultural or religious groups
- Cultural and religious sensitivities are often elevated.
- Tribal issues and prerogatives may resurface.

Ownership Rights

- Lack of documentation and records
- Conflicting claims
- Formal vs. informal rights
- Confiscation in the absence of the rule of law
- Corruption

Disaster Changes Economic and Political Framework

The destructive impact of a disaster on economic activity that existed pre-disaster is easy to understand. Harder to come to grips with is the trajectory of economic activity post-disaster. This trajectory is often shaped by political functionality and the extension of politics into every aspect of life and every decision essential to post-disaster relief and recovery. Examples of changes in the various components of this final framework element include:

Rule of Law

- Confiscation and security risks are elevated due to lack of rule of law.

- Emergency decrees are inconsistently interpreted and applied.
- Local laws of convenience
- Corruption

Regulations

- Regulations are not relevant to situation on ground or act to impede progress.
- Traditional regulations are extended to situations for which they were not designed.

Financial Institutions

- Absent or disrupted
- Emergence of a cash economy
- Difficulty paying suppliers and labor

Project Funding

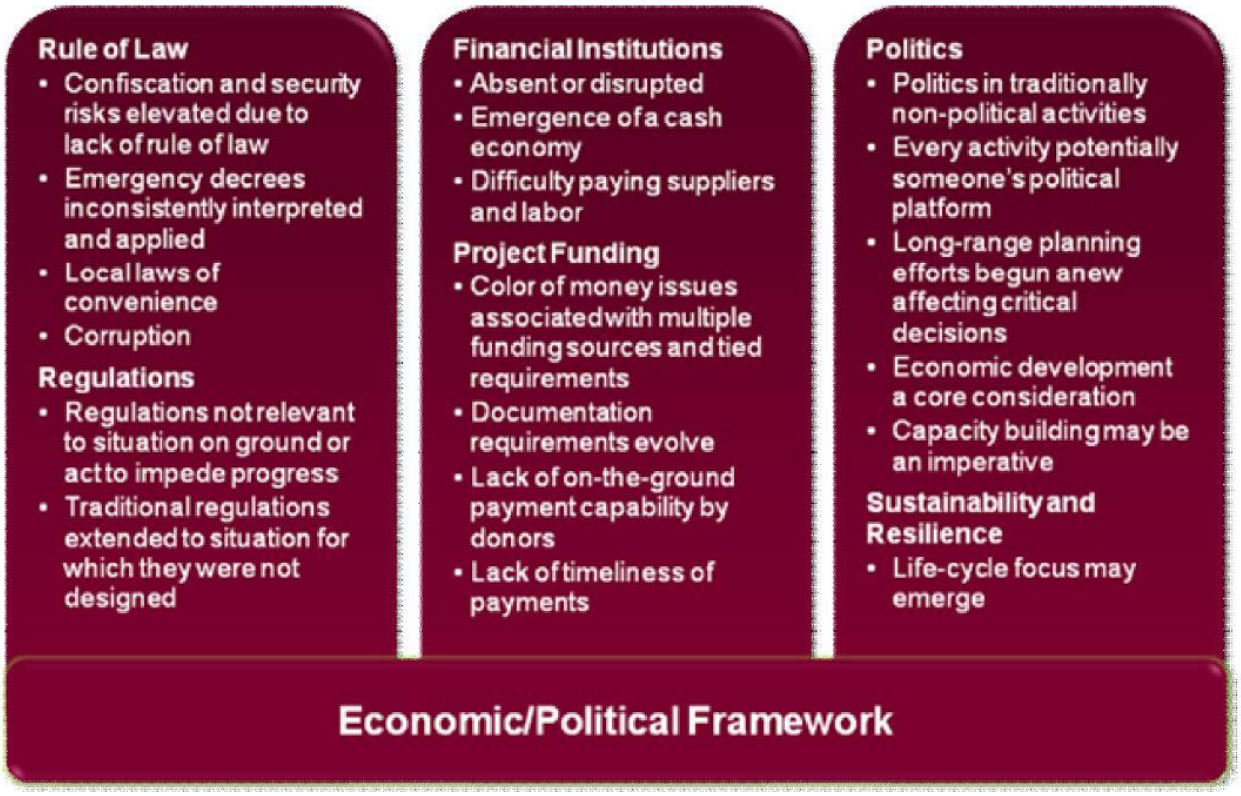
- "Color of money" issues are associated with multiple funding sources and tied requirements.
- Documentation requirements evolve.
- Lack of on-the-ground payment capability by donors
- Lack of timeliness of payments

Politics

- Politics in traditionally non-political activities
- Every activity is potentially someone's political platform.
- Long-range planning efforts are begun anew, affecting critical decisions.
- Economic development is a core consideration.
- Capacity building may be an imperative.

Sustainability and Resilience

- Life-cycle focus may emerge.



Post-Disaster Project and Construction Activity

Post-disaster project and construction activity must now occur at a site where traditional inputs and project frameworks have been modified and special challenges are present. These special challenges include:

- Debris removal and potential reuse to mitigate ever present logistical challenges.
- Changed psychology with respect to decision-making and risk-taking and to a labor force that itself may be displaced or suffering the loss of close relatives.
- Changed liability concerns, since one of the first things to grow post-disaster is uncertainty, a root cause of much liability.

We have already touched upon the corrosive effects of corruption, which may be controlled or compounded by governmental leadership and enablement. These are real issues as are those related to human and construction safety. The construction environment is inherently dangerous, and post-disaster uncertainties only exacerbate these concerns.

Finally, post-disaster construction activities face modified output requirements from more traditional, non-disaster construction.

Post-Disaster Construction Outputs

Traditional construction activities normally focus on creating new facilities, usually permanent in nature. Post-disaster projects may take on a wider range of timeframes, including temporary, transitional, and permanent dimensions.

Pressure to use disaster debris in construction may modify certain design and construction choices. Considerations related to not adding to this material problem are only heightened in post-disaster environments. Social dimensions of the "triple bottom line" of sustainability take on increased importance as part of the overall disaster recovery process.

Specific changes to post-disaster outputs include:

Completed Project

- Temporary
- Transitional
- Permanent

Construction Waste

- Linkage to debris considerations (disposal and reuse in construction)
- Recycling drivers

Sustainability

- Capacity building
- Economic development
- New industry creation
- Enhanced resiliency
- Lessons learned and best practices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Conclusion

Post-disaster engineering and construction program and project management activities are significantly modified compared to non-disaster activities. Changes to the fundamental project model employed in the management of these types of programs and projects requires a fundamental rethinking of skill sets, management processes, risks, and constraints.

In addition, these changes collectively alter the logistical characteristics of such programs significantly while at the same time modifying the broader logistical space within which the disaster has occurred. Even the most basic project activities, when occurring in the post-disaster environment, could significantly affect project and regional logistics. Even the best-intentioned relief and recovery activities have the ability to impact response and recovery in today's highly-engineered built environment.

The challenges of the post-disaster environment can be met through concerted action by the engineering, construction, government, and non-governmental sectors.