INTEGRATED NATURAL HAZARDS RISK REDUCTION - EMERGENCE OF A US APPROACH

C. Scawthorn[1)]

1) Professor of Lifeline Engineering, Department of Urban Management
Kyoto University, Kyoto 606 Japan
cscawthorn@quake.kuciv.kyoto-ac.jp

Abstract: A series of developments, some unrelated to earthquake or natural hazards risk reduction, have occurred in the US which together comprise many elements of an integrated approach to natural hazards risk reduction. These developments include the Disaster Mitigation Act of 2000, the HAZUS-MH software, the requirements of GASB 34, and passage of the Sarbanes-Oxley Act of 2002. A major gap still remaining is earthquake risk reduction for homeowners, however. Additionally, while the prospects for an integrated program of natural hazards risk reduction is promising, the need for appropriate measures of risk, and risk or performance goals, are areas for needed research.

1 INTRODUCTION

Risk identification and mitigation in the US have been significantly enhanced by several recent major "risk accounting" developments. These include the passage of the Disaster Mitigation Act of 2000 (PL 106-390) and the requirements of GASB 34, both affecting public entities, the passage of the Sarbanes-Oxley Act of 2002 (PL 107-204) affecting private entities, and the development by FEMA of the HAZUS-MH software. Together, these developments are emerging as major elements of an integrated approach for natural hazards risk reduction. This paper describes each of these developments, with the goal of both clarifying the picture in the US as well as summarizing these trends for the benefit of other countries. Lastly, several a major gap in the 'integrated program' is identified, as well as other areas for improvement and opportunities for research.

2 DISASTER MITIGATION ACT OF 2000 (PL 106-390)

The Stafford Act of 1978 (PL 93-288) formed the basis for modern disaster management in the US, allowing for Presidential Declarations of Disaster at the request of the governor of a state, and compensation to public entities for cost of repairs arising from the disaster. Additionally, the Act allowed that the "*President may contribute up to 75 percent of the cost of hazard mitigation measures which the President has determined are cost-effective and which substantially reduce the risk of future damage, hardship, loss, or suffering in any area affected by a major disaster*." As a result of a number of major disasters, including the 1989 Loma Prieta and 1994 Northridge earthquakes, it became apparent that the Act in some ways had an unintended effect, in that local governments sometimes put off major expenditures required for disaster mitigation. That is, rather than spend their own money to fix buildings and infrastructure before a disaster, local governments waited for the time if and when a disaster occurred, and then received a subsidy for the repairs or replacement of the damaged facilities, as well as a windfall in the form of Hazard Mitigation Grant Program (HMGP). Examples of cost repairs largely paid for by the federal government included the extensive and expensive repairs to the San Francisco and Oakland City Halls following the 1989 Loma Prieta earthquake, and to the Los Angeles City Hall following the 1994 Northridge earthquake.

As a result, the Stafford Act was extensively amended in 2000 as the Disaster Mitigation Act of 2000 (PL 106-390, also known as **DMA 2000**). A basic requirement of DMA 2000 is that state and local governments by late 2004 develop and implement a multi-hazard mitigation plan. This requirement is not mandatory, but only those state and local governments who have approved plans will be eligible for compensation for repairs or replacement of the damaged facilities, and the 75% HMGPs. Table 1 provides additional detail on these requirements. This 'carrot and stick' approach is quite effective, and most state and local governments are developing multi-hazard mitigation plan in compliance with DMA 2000. The multi-hazard mitigation plan has several elements (see Figure 1), including:

a) Risk Assessment, which requires identification of the hazards such as earthquake, tsunami, flood, coastal storm, tornado, landslide and wildfire; an estimate of the vulnerability to these hazards, including potential monetary losses; and a general description of local land use and development trends so that mitigation options can be considered in future land use decisions (see Figure 2, and Figure 3).

b) Mitigation Strategy, describing the goals of the strategy, and a coordinated set of feasible actions (see Figure 4)

The Federal Emergency Management Agency (FEMA) in order to support the implementation of these requirements has developed a series of reference materials that provide guidance for developing the plan, including.

- *State and Local Mitigation Planning How-to Guides* – intended to help States and communities plan and implement practical, meaningful hazard mitigation measures (FEMA 386-1 to FEMA 386-9)
- *Planning for a Sustainable Future* (FEMA 364) and Rebuilding for a More Sustainable Future (FEMA 365) – two related volumes that provide guidance for integrating sustainable practices as part of pre- and post-disaster mitigation planning efforts; and
- *FEMA Mitigation Resources for Success* (FEMA 372) – a compact disc with a compendium of FEMA resources related to mitigation practices and projects.

In addition, FEMA has prepared DMA 2000-related training and workshop materials for FEMA Regional staff, States, and local communities based on the Plan Criteria and the reference materials described above. Many communities across the US are implementing this process. Figure 5 shows an example of hazard mapping and risk identification, for tsunami hazard in Kauai County, Hawaii.

3 HAZUS-MH

HAZUS-MH was first conceived of in the early 1990's as a standardized nationally applicable natural hazards loss estimation software tool for planning and mitigation purposes. From 1994 to the late 1990's development of the earthquake module occurred, with the first release in 1997. Development of the flood and wind modules occurred from 1997 to 2003, and HAZUS-MH was released very recently (for copies see http://www.fema.gov/hazus/pdf/order_form_mh.pdf). While full details of the flood, wind or even just earthquake modules are beyond the scope of the present paper (see National Institute of Building Sciences, 1999 and Scawthorn et al, to appear, for more details), Figure 7 provides an overview of the earthquake loss estimation methodology.

HAZUS-MH is relevant to the present discussion because it is an emerging tool for the consistent estimation of losses, in support of the framework laid out in DMA 2000. Since its release in 1997, the earthquake module has seen considerable growth in its use, with 1,700 current users nationwide including federal agencies, states, localities, academic institutions, and private enterprises. In 2001 a study of estimated annualized earthquake losses for the United States was completed using HAZUS99 (FEMA 366), in order to analyze and compare seismic risk across regions of the United States, and finding that the Annualized Earthquake Loss (AEL) to the national building stock is $4.4 billion per year. Other applications of HAZUS Earthquake have been for the state of South Carolina (Bouabid et al, 2002), and San Francisco (Kornfield et al, 2002). Although HAZUS Earthquake was originally intended as a planning tool, it has increasingly been utilized for response and recovery efforts. This use is especially enhanced with the availability of ShakeMaps, developed in California by the USGS [Wald et al., 1999] or by other regional strong-motion instrumentation networks.

4 SECURITY VULNERABILITY ASSESSMENTS

DMA 2000 only addresses public entities, which leaves a large gap where privately owned utility *lifelines* are concerned, such as water, wastewater, electric power and gas. Because these are privately owned, they are responsible for their own risk management, and are not compensated by the federal government should they sustain damage due to a natural hazard. In some cases, public regulators require some risk analyses, but in general this is not the case. However, as a result of 9/11, it became apparent that these vital lifelines were very vulnerable to, and needed to be protected against, intentional acts. An example is the requirement by the US Environmental Protection Agency that water utilities in the US, public or privately owned, are required to have completed Security Vulnerability Assessments (SVAs) per the schedule shown in **Table 2**. The SVA procedure is a simplified risk assessment and mitigation methodology, Figure 6, in which a significant aspect is defining the utility's goals, and the Design Basis Threat (DBT). This differs in some ways from seismic vulnerability assessments, in that for security, in actuality, these two aspects are inter-active. That is, for earthquakes, nature provides a fixed 'spectrum' of threats, while for intentional acts, the 'threat spectrum' is defined by the goals of the utility.

SVA is relevant to the present discussion only because (a) it addresses a portion of the built environment, lifelines, often not addressed by DMA 2000, and (b) in practice, some utilities took the opportunity of performing the SVA to also address other non-Security-related hazards, such as earthquake. That is, in a number of cases, the SVA methodology was employed for both security and seismic related vulnerabilities, and an integrated mitigation program developed. For seismic, the mitigation program typically was served by the SVA process in several stages – that is:

1. the SVA served as a screening methodology for seismic vulnerabilities, identifying those parts of the lifeline system that were most critical and required vulnerability reduction,
2. for those parts of the parts of the lifeline system that the SVA identified as critical and which could be readily mitigated (eg, bracing equipment), those mitigation measures were combined with the Security-related mitigation measures (eg, installation of new Security alarms, systems, or other equipment) into a rapidly implemented program
3. for those parts of the parts of the lifeline system that the SVA identified as critical and which could NOT be readily mitigated (eg, reinforcing tanks), those mitigation measures were referred more additional analysis and design, for eventual incorporation into the Capital Improvements Program.

Table 3 shows an example drawn from the author's practice, in which Security and Natural Hazards risk results are presented, while Table 4 shows the integration of these risks into a mitigation program.

5 GASB 34

Traditionally, US governmental agencies (state and local) have accounted for infrastructure assets like roads, bridges, water and sewer facilities, dams, etc. in their annual financial report during the year in which the cost of construction was incurred – so called, cash accounting. That is, the value of all other physical assets does not appear, or is "off the books". In reality, of course, this physical infrastructure is an enormous, although depreciating, asset. A more accurate report of a government's finances would show the existing (depreciated) value of the agency's capital assets – so called "accrual accounting", in which the cost, or the loss in value, of an asset is spread across the asset's useful lifetime (eg, 20-50 years). Accrual accounting is more consistent with the reporting of other costs of doing business, and with private business practices, so that government and private business finances are more easily comparable. In order to encourage state and local governments to make the change to accrual accounting, the Governmental Accounting Standards Board (or GASB, a nonprofit entity responsible for establishing accounting standards—or generally accepted accounting practices GAAP) published GASB Statement 34, which required state and local governments to begin reporting the value of their infrastructure assets on an accrual basis, generally by 2006. The relevance of GASB 34 to the present discussion is that (a) the full economic value of local government and agency infrastructure is now valued, and (b) DMA 2000 requires its risk be accounted for. Thus, an increasing trend in US local government and agency financial accounting is the emergence of 'natural hazard risk charges' against the value of infrastructure. These risk charges are only now beginning to emerge in local government and agency accounting, but it can be anticipated that over time they will be noticed, and provide a further impetus for risk management.

6 SARBANES-OXLEY ACT OF 2002 (PL 107-204)

Just as the Loma Prieta and Northridge earthquakes led to DMA 2000, and the events of 9/11 led to Security Vulnerability Assessments, the several financial scandals of the last few years (Enron, Tyco, etc) led to the passage in 2002 of the Sarbanes-Oxley Act. Sarbanes-Oxley effectively calls for comprehensive, integrated 'enterprise-wide' risk management of publicly traded companies. That is, while the intent of Sarbanes-Oxley is largely seen as focused on corporate governance processes, disclosure practices and internal controls, compliance with Sarbanes-Oxley lays the foundation for implementing Enterprise Risk Management (ERM) capabilities that did not previously exist for many companies. Many privately-held and not-for-profit firms are also seeking to demonstrate adherence to the same standards. The result is a push by investors, policy-makers, regulators, exchanges and rating agencies towards greater transparency regarding governance, risks and internal control. The relevance of Sarbanes-Oxley to the present discussion is that a key element in ERM is the risk due to natural hazards, such as earthquakes – that is, <u>for the first time, private companies will be required to quantify their natural hazards risk</u>. While not statutorily required for private companies (as it is for the pubic sector by DMA 2000), the economically efficient management and mitigation of this risk, in concert with the comprehensive suite of risks confronting the enterprise, will be a natural outgrowth of this push for ERM.

7 CONCLUDING REMARKS

7.1 Fitting the Pieces Together

In summary, the several requirements and trends outlined above are emerging as the basis for a comprehensive program of natural hazards risk management:

- **public sector –** natural hazards identification and mitigation explicitly required by DMA 2000, as well as implicitly by GASB 34
- **utility infrastructure** – natural hazards identification and mitigation implicitly required by Sarbanes Oxley
- **private corporations** – natural hazards identification and mitigation implicitly required by Sarbanes Oxley

7.2 Areas for Research and Improvement

While the comprehensive program of natural hazards risk management, which is pictured above as emerging in the US, is promising, there are still many gaps and areas for improvement. A few of these include:

- **Personal property** – the risk to people's homes is the one major 'piece' missing from the picture outlined above. For floods, insurance has been efficiently and effectively mandated for decades via the National Flood Insurance Program (Scawthorn, 1999). Hurricane risk protection is provided at reasonable prices via the insurance industry. Earthquakes however, both in the US and Japan, are strenuously avoided by the insurance industry, so that government pools serve this need (at least in California, in the US), although not providing very good coverage or prices. Insurance is not the real answer anyway, as the 1995 Hyogo-ken earthquake demonstrated. Real risk reduction via retrofitting of buildings is required. How can this be accomplished?
- **Risk Metrics** - In all the above programs, the measure of risk is not stated, and is usually left to the entities to decide for themselves. While this has certain economic efficiencies, it also leaves each entity to 're-invent the wheel', and also results in a very heterogeneous landscape of results, which precludes aggregation. Thus, oversight agencies (regulators, rating agencies) as well as investors and, in the case of DMA 2000 the federal government, are prevented from comparing performance between entities.
- **Risk Objectives –** similarly, risk objectives or performance goals are not provided, and are left to the entities to decide for themselves. The situation is similar as that with risk metrics, with each entity floundering as to appropriate objectives, and a heterogeneous final risk landscape.
- **Explicit vs. Implicit –**except for DMA 2000, most requirements for natural hazards risk are implicit. Even DMA 2000 is mostly seen as being for local governments, so that public agencies such as water utilities are sometimes overlooked. What is needed are more explicit requirements in GASB 34, Sarbanes Oxley, as well as other mandates, for natural hazards risk accounting.

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Institute).

Table 1 DMA 2000 Mitigation Plan Requirements of DMA 2000

Requirements for Standard State Mitigation Plan (SSMP)	Additional Requirements for Enhanced State Mitigation Plan (ESMP) and Local Mitigation Plan (LMP)
a. Plan Requirement	
SSMP: Due date is November 1, 2004* Standard State Mitigation Plan (SSMP) includes the requirements of the Hazard Mitigation Grant Program (HMGP) Administrative Plan. In order for a State to be eligible for HMGP funding based on 15% of the total estimated eligible Stafford Act disaster assistance, FEMA must approve the SSMP by November 1, 2004. SSMPs must be updated every 3 years.	**ESMP:** Due date is November 1, 2004* Enhanced State Mitigation Plan (ESMP) increase eligibility for HMGP funding from 15% to 20% of available funding. ESMPs must demonstrate that the State ***(§**201.5(a)*): • Has developed a comprehensive mitigation program • Makes effective use of available mitigation funding • Is capable of managing the increased funding **LMP:** Due date is November 1, 2004* Local Mitigation Plans (LMPs) must be updated every 5 years. Multi-jurisdictional plans can be used as long as each jurisdiction participates in the process and officially adopts the plan. State- wide plans will not be accepted as multi-jurisdictional plans. Up to 7% of mitigation funding can be used to support planning, including LMP development.
b. Planning Process (Requirements Prior to Preparation of the Plan)	
SSMP: Establish coordination with other State agencies, appropriate federal agencies, interested groups, and integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.	**ESMP:** Same requirements as SSMP. **LMP:** Additional requirements includes: (1) opportunity for public to comment on the LMP during development and before approval; (2) opportunity for involvement by neighboring communities, local and regional agencies supporting hazard mitigation and development activities, and businesses, academia and other private and non-profit interests; and (3) review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.
c. Plan Content	
1. Planning Process Description SSMP: Describes the planning processes used to prepare the plan, including: • How the plan was prepared • Who was involved • How other agencies participated	**ESMP:** Additional requirements include demonstrating integration to the extent practicable with (1) other State and/or regional planning initiatives, (comprehensive growth management, economic development, capital improvement, land development, and/or emergency management plans) and (2) FEMA mitigation programs and initiatives that provide guidance to State and regional agencies. *(§201.5(b)(1))* **LM**P: Additional requirements include describing how the public was involved.

Table 1 DMA 2000 Mitigation Plan Requirements of DMA 2000 **(cont.)**

Requirements for Standard State Mitigation Plan (SSMP)	Additional Requirements for Enhanced State Mitigation Plan (ESMP) and Local Mitigation Plan (LMP)
2. Risk Assessments SSMP: Includes: A statewide risk assessment that provides a "statewide overview" characterization and analysis of potential natural hazards and associated risks. Comparison of potential losses throughout the State to determine priorities for implementing mitigation measures (item 3 below) and prioritize jurisdictions for technical and financial support in developing more detailed local risk and vulnerability assessments. The risk assessment shall include: *i.* *Overview of Hazards* Types and locations of hazards, past occurrences, and probability of future events, using maps, as appropriate. *ii.* *Overview and Analysis of Vulnerability* Overview and analysis of the State's vulnerability to the hazards based on estimates provided in local risk assessments as well as the State risk assessment. The State will describe vulnerability in terms of the jurisdictions most threatened by the identified hazards and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities in the hazard areas also will be addressed. *iii.* *Overview and Analysis of Potential Losses* Identification of vulnerable structures and estimate of potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazards areas (based on LMPs and State risk assessment).	**ESMP:** Same requirements as SSMP. **LMP:** (i) Overview of Hazards and (ii) Summary of Each Hazard and its Impacts, including: a. Types and number of existing and future buildings, infrastructure, and critical facilities in the identified hazard areas; b. Estimate of potential dollar losses and description of how estimate was prepared (similar to iii for SSMPs); c. General description of local land use and development trends so that mitigation options can be considered in future land use decisions. For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Table 1 DMA 2000 Mitigation Plan Requirements of DMA 2000 **(cont.)**

Requirements for Standard State Mitigation Plan (SSMP)	**Additional Requirements for Enhanced State Mitigation Plan (ESMP) and Local Mitigation Plan (LMP)**
3. Mitigation Strategy SSMP: Documents the follow elements of strategy: i. *State Goals* Describes the State goals to guide the selection of mitigation activities to reduce potential losses identified in Item 2 above. ii. *State Mitigation Programs* Presents the State's pre- and post-disaster hazard management policies, programs and capabilities to mitigate the hazards in the area, including: An evaluation of State laws, regulations, policies and programs related to hazard mitigation and related to development in hazard-prone areas A discussion of State funding capabilities for hazard mitigation projects A general description and analysis of the effectiveness of local mitigation policies, programs and capabilities iii. *Analysis* Identifies, evaluates, and prioritizes cost-effective, environmentally sound, and technically feasible mitigation actions and activities that the State is considering and explains how each activity contributes to the overall mitigation strategy. Also, this section should link to LMPs, where specific local actions and projects are identified. iv. *Funding* Identifies current and potential sources of Federal, State, local or private funding to implement mitigation activities.	**ESMP:** Additional requirements should address the following: Project Implementation Capability *(§201.5(b)(2)* Documents project implementation capability, identifying and demonstrating the ability to implement the plan, including: *i. Eligibility Criteria* Present established eligibility criteria for multi-hazard mitigation measures. *ii. Mitigation Actions* A system to determine the cost effectiveness of mitigation measures, consistent with OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, and to rank the measures according to the State's eligibility criteria. *iii. HMGP Management* Demonstration that the State has the capability to effectively manage the HMGP as well as other mitigation grant programs, including a record of the following: A. Meeting HMGP and other mitigation grant application timeframes submitting complete, technically feasible, and eligible project applications with appropriate supporting documentation; B. Preparing and submitting accurate environmental reviews and benefit-cost analyses; C. Submitting complete and accurate quarterly progress and *iv. Mitigation Assessment* A system and strategy by which the State will conduct an assessment of completed mitigation actions and include a record of the effectiveness (actual cost avoidance) of each mitigation action. **LMP:** Provides the blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, program and resources and local ability to expand on and improve these existing tools. Same content as SSMP, but presented as following sub-sections focusing on the local level: (i) mitigation goals, (ii) mitigation actions, and (iii) action plan. For multi-jurisdictional plans, actions must be specific to the jurisdiction requesting FEMA approval or credit of the plan. financial reports on time; and D. Completing HMGP and other mitigation grant projects within established performance periods, including financial reconciliation.

Table 1 DMA 2000 Mitigation Plan Requirements of DMA 2000 **(cont.)**

Requirements for Standard State Mitigation Plan (SSMP)	**Additional Requirements for Enhanced State Mitigation Plan (ESMP) and Local Mitigation Plan (LMP)**
4. Coordination of Local Mitigation Planning Includes: *i. Funding* Describes State process to support, through funding and technical assistance, the development of LMPs. *ii. Timeframe* Describes the State process and timeframe by which the LMPs will be reviewed, coordinated, and linked to the State Mitigation Plan. iii. *Prioritization Criteria* Criteria to be used in prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs, which should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures. Further, for non- planning grants, a principal criterion for prioritization will be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.	**ESMP:** Additional requirements to demonstrate the State's commitment to a comprehensive State mitigation program *(§201.5(b)(4))*, which can include any of the following: *i. Local Support* A commitment to support local mitigation planning by providing workshops and training, State planning grants, or coordinated capability development of local officials, including Emergency Management and Floodplain Management certifications. *ii. Statewide Support* A Statewide program of hazard mitigation through the development of legislative initiatives, mitigation councils, formation of public/private partnerships, and/or other executive actions that promote hazard mitigation. *iii. State Funding* State provision of a portion of the non-Federal match for HMGP and/or other mitigation projects. *iv. Building Code Standards* To the extent allowed by State law, the State requires or encourages local governments to use a current version of a nationally applicable model building code or standard that addresses natural hazards as a basis for design and construction of State sponsored mitigation projects. *v. Multi-year Plan* A comprehensive, multi-year plan to mitigate the risks posed to existing buildings that have been identified as necessary for post-disaster response and recovery operations. *vi. Post-disaster Recovery* A comprehensive description of how the State integrates mitigation into its post-disaster recovery operations. **LMP:** §201.6 does not require a separate section to address local coordination; however, the need for local coordination is clearly documented in the rule. The LMP should clearly document coordination processes; this could be included in section C.1 (above) or included as a separate section on coordination as for the SSMP and EMP. Multi-jurisdictional LMPs must document coordination across jurisdictions.
5. Plan Maintenance Process Purpose: This section includes: i. Method and schedule for monitoring, evaluating, and updating the plan. ii. A system for monitoring implementation of mitigation measures and project closeouts. iii. A system for reviewing progress towards goals as well as activities and projects identified in Item 3.	**ESMP:** Same requirements as SSMP. **LM**P: Describes: i. The method and schedule of monitoring, evaluating, and updating the LMP within a five-year cycle; ii. The process for incorporating the requirements of the LMP into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate; and iii. How the community will continue public participation in the LMP maintenance process. Annual reviews of the plan are recommended.

Table 1 DMA 2000 Mitigation Plan Requirements of DMA 2000 **(cont.)**

Requirements for Standard State Mitigation Plan (SSMP)	**Additional Requirements for Enhanced State Mitigation Plan (ESMP) and Local Mitigation Plan (LMP)**
6. Plan Adoption Process Documents formal adoption by the State before submittal to FEMA for final review and approval.	**ESMP:** Same as SSMP. **LMP:** Documents LMP adoption by the appropriate local government body. For multi-jurisdictional plans, each jurisdiction requesting plan approval must document adoption. LMP must identify specific projects if funding is requested.
7. Assurances Assurances for compliance with all applicable Federal statutes and regulations in effect for the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c). The SSMP will be amended whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).	**ESMP:** Should also include a demonstration that the State effectively uses existing mitigation programs to achieve its mitigation goals. (*(§201.5(b)(3))* **LMP:** While a specific section on assurances is not identified for LMPs, assurance regarding use of the LMP to achieve mitigation goals is inferred by the rule and a section should be included.
d. Review and Updates	
Plans for review and revision to reflect changes in development, progress in Statewide mitigation efforts, and changes in priorities and resubmitted for approval to the appropriate Regional Director every **three year**s. The Regional review will be completed within 45 days after receipt from the State, whenever possible. **Note:** Although not a requirement, FEMA also encourages States to review their plans in the post- disaster timeframe to reflect changing priorities.	**ESMP:** Same cycle as SSMPs. **LMP:** LMP must be submitted to the State Hazard Mitigation Officer for initial review and coordination. The State then sends LMP to the appropriate FEMA Regional Office for formal review and approval. The review process occurs as follows: The Regional review will be completed within 45 days after receipt from the State, whenever possible. Plans must be reviewed, revised if appropriate, and resubmitted for approval within **five years** in order to continue to be eligible for HMGP project grant funding. For States with managing authority, (that is, States with delegated approval authority for local mitigation plans), FEMA approval will not be required. Instead, States use the criteria in this part to review each LMP within 45 days of receipt, whenever possible, and provide a copy of the approved plans to the FEMA Regional Office .

Source: http://www.hazus.org/SEHUG/Kick_Off_Documents/Draft_Job_Aid-Mitigation_Plan_Content.pdf

Table 2 US Community drinking water systems --
Requirements Under the Public Health Security and Bioterrorism Preparedness and Response Act of 2002

Systems serving population of:	Certify and submit Vulnerability Assessment (VA) by:	Certify Emergency Response Plan:
100,000 or greater	March 31, 2003	Six months following the completion of the vulnerability assessment *
50,000 - 99,999	December 31, 2003	
3,301 - 49,999	June 30, 2004	

Source: http://www.epa.gov/safewater/security/community.html

Table 3 Example Security Vulnerability Assessment Results, combining Security and Natural Hazards

SYSTEM VULNERABILITY		SECURITY																NATURAL HAZARDS							
SYSTEM / COMPONENT	Consequence of Failure (% people without water)	Security		Floods		Land / Rock Slides / Debris Flow		Tree Fall		Winter Snow / Ice Storms		Prolonged Freezing		Volcanic Activity		Earthquake		Fire in Watershed		Urban Firestorms		Turbidity		Microbial Contamination	
Hazard Probability (% in 50 years)		50%		50%		100%		100%		100%		100%		10%		50%		10%		50%		50%		50%	
Correlation Factor (See note 1)		1		75		25		5		5		5		25		75		1		1		1		1	
North Side																									
Watershed	1%	70%	0%	7%	3%	7%	2%							7%	0%	7%	3%	70%	0%			70%	0%		
Intake Structure	1%	70%	0%	7%	3%	7%	2%									7%	3%								
Lowlift Pump Station	1%	70%	0%	70%	26%	25%	6%	25%	1%	7%	0%					25%	9%			25%	0%				
Treatment Plant	1%	70%	0%	7%	3%			7%	0%	7%	0%					50%	19%								
Disinfection System	1%	70%	0%	7%	3%			7%	0%	7%	0%					7%	3%								
Highlift/Clearwell	1%	70%	0%	7%	3%			7%	0%	7%	0%					25%	9%								

Table 4 Integration of Vulnerability Assessment Findings

Hazard	Avg. Risk	Max Risk	Risk	Mitigation	Est. Cost
Floods	4%	25%	VH	Pump station reconstruction: raise station above the 500-year flood plain.	Not estimated
Earthquake	3%	19%	VH	Add shear walls, roof anchorage and other measures.	$800,000
Security	2%	11%	VH		$200,000
Building / Facility Fire / Explosion	1%	8%	H	Develop a standard operating procedure to address storage of flammable materials. Continue annual inspection of electrical equipment to minimize the potential for electrical fires.	Negligible
Winter Snow / Ice Storms	1%	8%	H	Further develop the capability to provide emergency power for the treatment plant and remote pump stations.	Not estimated

Figure 1The Hazard Mitigation Planning Process (FEMA 386-1)

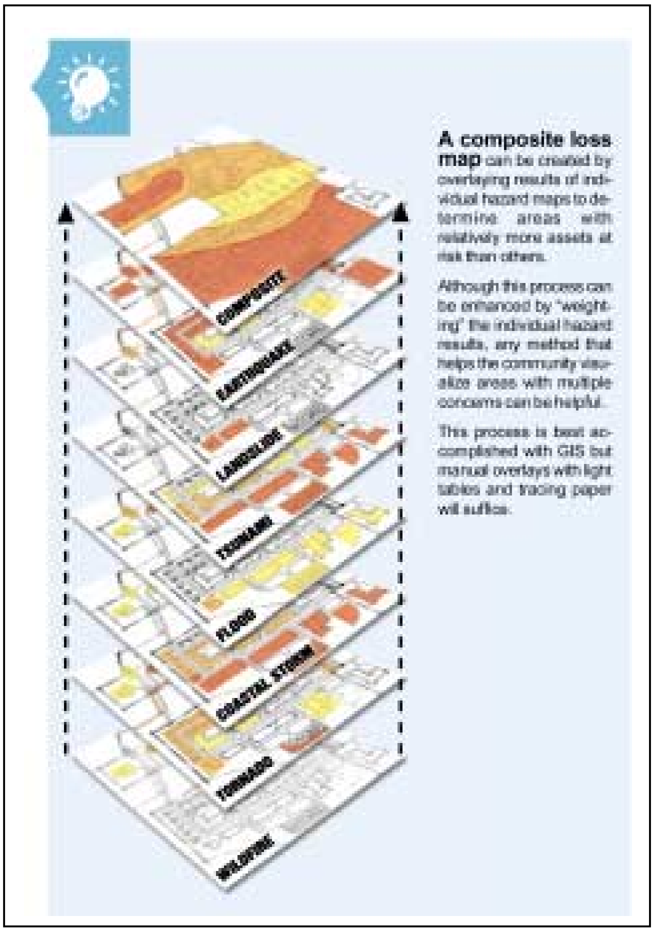


Figure 2 Composite Loss Map (FEMA 386-2)

Earthquake Professional Office Building Loss Estimation Tables

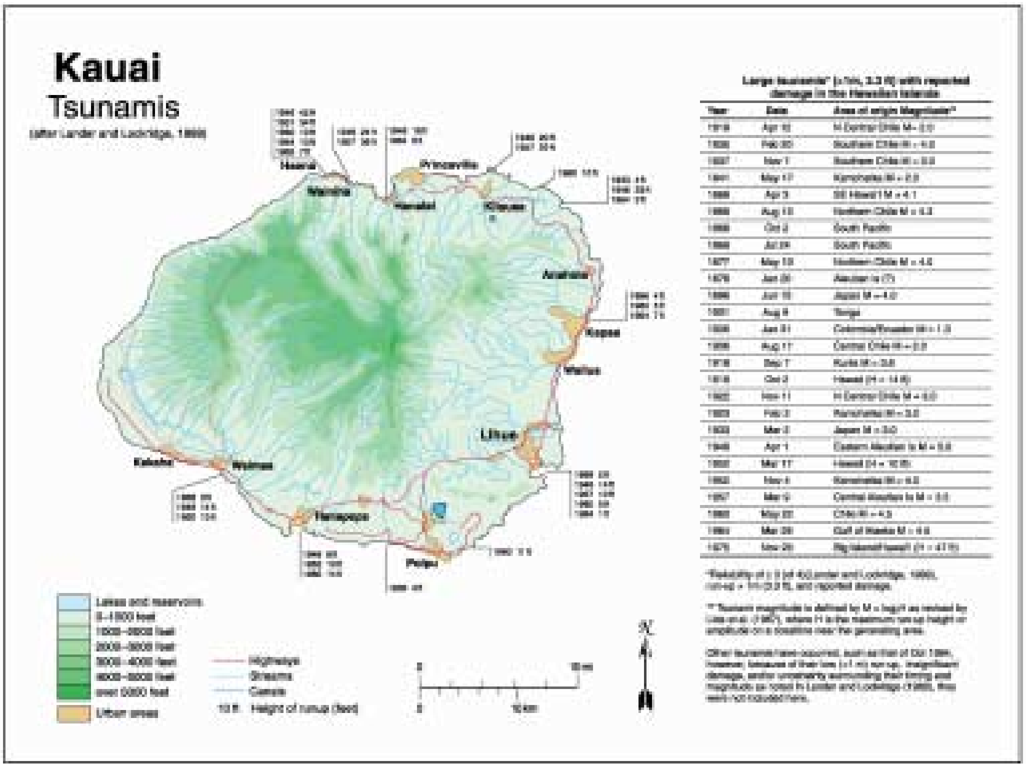
PGA (g)	Building Damage Ratio (%)**							
	Concrete Wall Construction				Steel Frame (Braced)			
	High*	Moderate*	Low*	Precode*	High*	Moderate*	Low*	Precode*
0.55	14.0	23.7	37.0	43.7	14.5	18.6	31.2	38.3
0.50	12.0	20.0	31.0	39.1	12.1	15.2	25.0	32.1
0.45	9.9	17.2	27.2	34.2	10.5	13.3	20.8	27.6
0.40	7.2	11.4	16.5	22.0	7.9	9.1	13.1	17.5
0.35	5.4	9.4	13.5	18.4	6.5	7.3	10.0	13.6
0.30	4.2	7.2	10.0	14.2	4.7	5.4	7.5	10.1
0.25	3.0	4.7	7.8	11.0	3.7	4.0	5.3	7.4
0.20	2.0	2.9	5.6	8.1	2.5	2.9	3.7	5.2
0.15	1.0	1.8	3.2	5.4	1.5	1.7	2.4	3.2
0.10	0.4	0.6	1.0	1.5	0.5	0.7	0.9	1.3
0.07	0.2	0.3	0.4	0.6	0.2	0.3	0.4	0.5
0.05	0.0	0.1	0.2	0.2	0.0	0.1	0.2	0.2
0.03	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Figure 3 Earthquake Loss Estimation Tables (FEMA 386-2)

Alternative Mitigation Actions	Prevention																
	Building codes	Coastal zone management regulations	Density controls	Design review standards	Easements	Environmental review standards	Floodplain development regulations	Floodplain zoning	Forest fire fuel reduction	Hillside development regulations	Open space preservation	Performance standards	Shoreline setback regulations	Special use permits	Stormwater management regulations	Subdivision and development regulations	Transfer of development rights
Floods	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■
Earthquakes	■		■	■	■	■				■	■	■		■		■	■
Tsunamis	■	■	■	■		■					■	■	■	■		■	■
Tornadoes	■			■		■						■				■	
Coastal Storms	■	■	■	■	■	■	■	■			■	■	■	■		■	■
Landslides	■		■	■	■	■			■	■	■	■	■	■		■	■
Wildfires	■		■	■	■	■			■	■	■	■		■		■	■

Alternative Mitigation Actions	Property Protection					Public Education & Awareness		
	Acquisition of hazard-prone structures	Construction of barriers around structures	Elevation of structures	Relocation out of hazard areas	Structural retrofits (e.g., reinforcement, flood-proofing, storm shutters, bracing, etc.)	Hazard information centers	Public education and outreach programs	Real estate disclosure
Floods	■	■	■	■	■	■	■	■
Earthquakes	■			■	■	■	■	■
Tsunamis	■	■	■	■	■	■	■	■
Tornadoes					■	■	■	■
Coastal Storms	■	■	■	■	■	■	■	■
Landslides	■			■		■	■	■
Wildfires	■			■		■	■	■

Figure 4 Alternative Mitigation Actions by Hazard (FEMA 386-3)



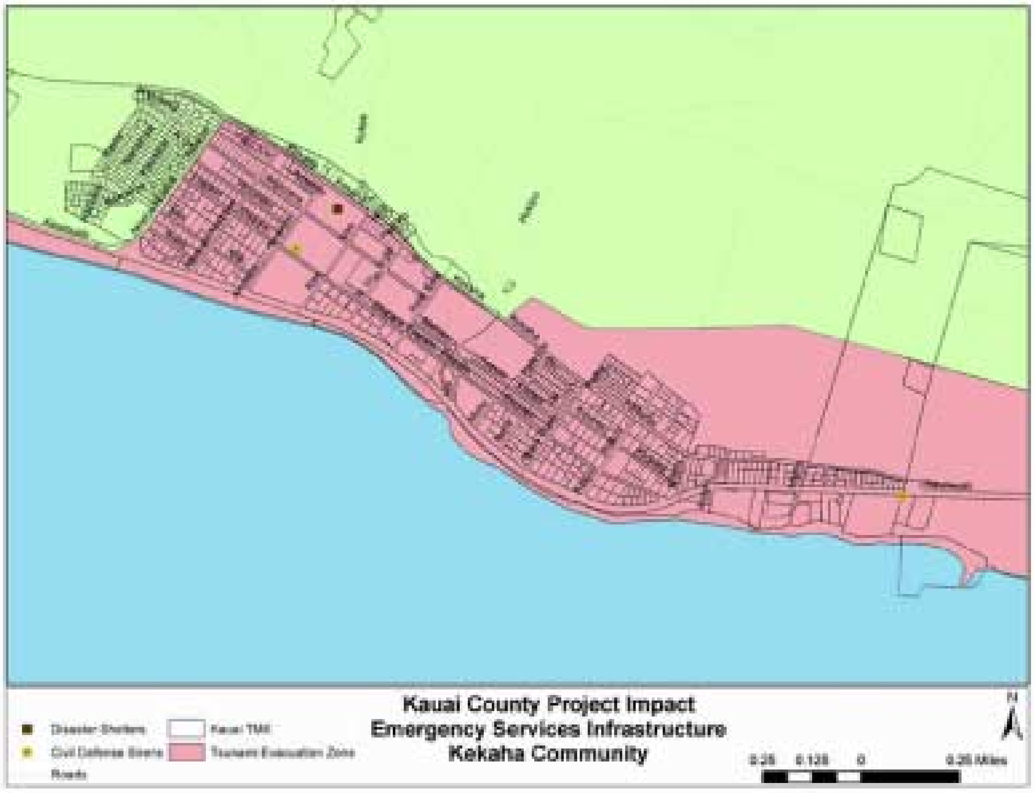


Figure 5 Kauai (Hawaii) (top) Tsunami Hazard (b) tsunami risk to emergency facilities (source: http://www.mothernature-hawaii.com/county_kauai/planning.htm)

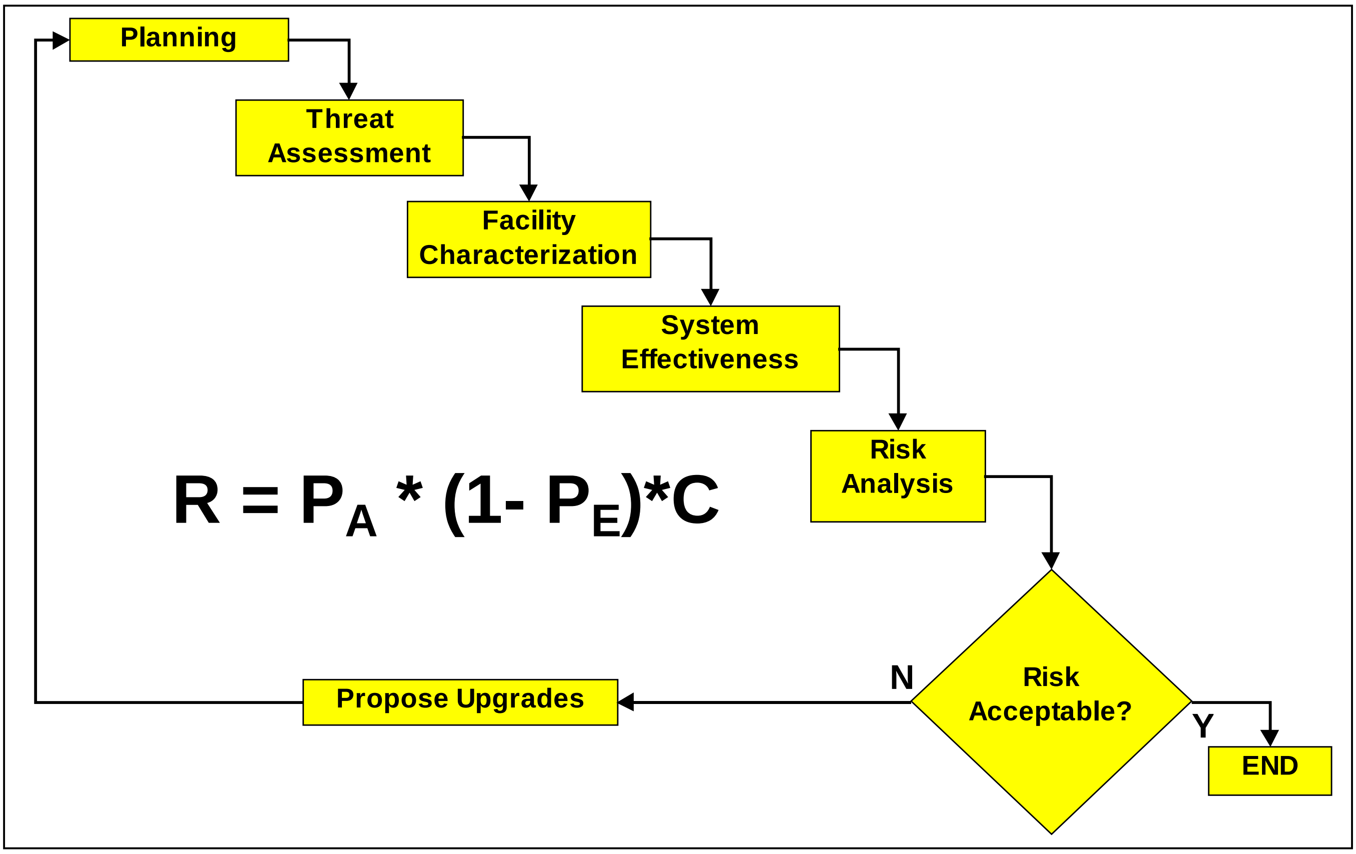


Figure 6 Security Vulnerability Assessment methodology

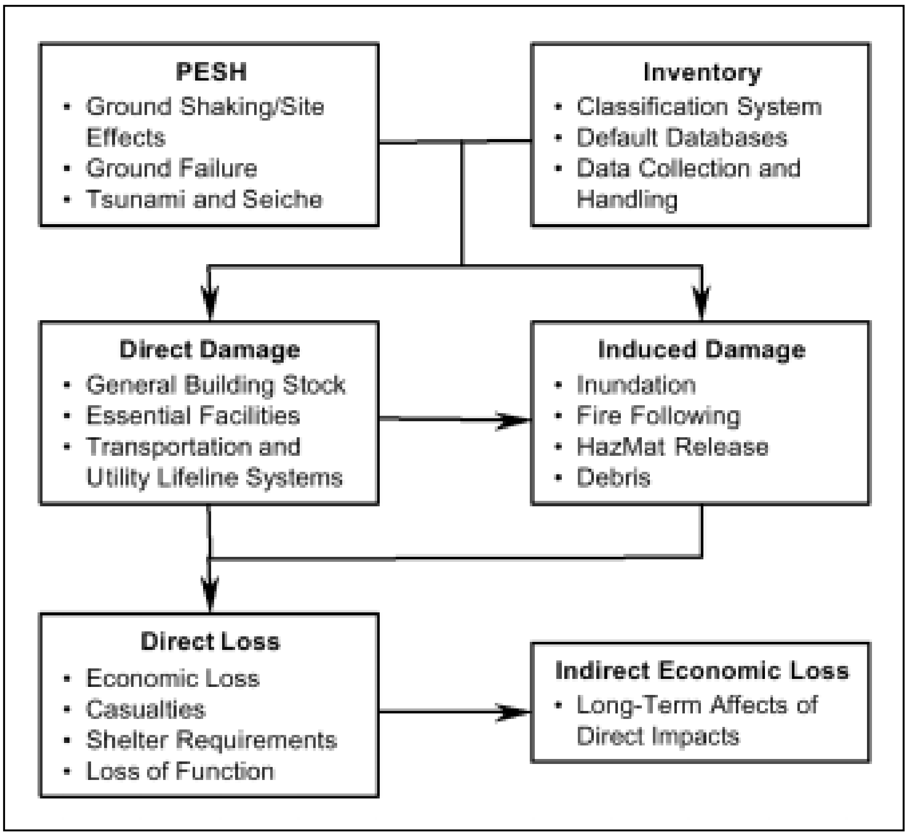


Figure 7 HAZUS Earthquake Methodology (NIBS, 1999)

Figure 8 HAZUS results, state of South Carolina (Bouabid et al, 2002)

Figure 9 HAZUS results, City of San Francisco CA (Kornfield et al, 2002)