

**Session No. 14**

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**Course Title: Earthquake Hazard and Emergency Management**

**Session Title: Earthquake Disaster Planning**

**Author: James R. Martin, II**

**Time:** 180 minutes.

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**Objectives:**

- 14.1 Identify general principles associated with earthquake disaster planning, and distinguish this type of planning from other common types of planning performed by emergency managers.
  - 14.2 Recognize the relationship between planning and other aspects of earthquake hazard management (i.e., four management phases, risk communication, nature and effects of earthquakes).
  - 14.3 Appreciate the importance of earthquake disaster planning.
  - 14.4 Identify the general principles associated with effective disaster planning.
  - 14.5 Discuss important concepts, such as sustainability, to be considered in the planning process.
  - 14.6 Describe planning tools typically used in and needed for earthquake hazard planning (GIS, HAZUS, etc.).
  - 14.7 Describe factors that influence planning and problems that impeded effective earthquake hazard planning.
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**Scope:**

The objective of this series of lectures is to introduce the student to the general principles associated with disaster planning for earthquakes. This section also provides information concerning the measures and activities typically involved with disaster planning and how such measures affect earthquake disasters. Important keys for effective disaster planning are presented.

Discussion allows the students to be exposed to various tools that can be used for planning, including Geographical Information Systems (GIS), vulnerability analysis, HAZUS, etc. Also, important considerations and issues associated with different entities such as agencies, households, and governments are discussed. The homework assignment is designed to investigate and discuss what influence good disaster planning has on mitigating earthquake disasters, etc.

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### **Readings:**

#### *Suggested student readings:*

Cowan, H., Falconer, R. Nathan. 2002. *Gaps in the Understanding and Mitigation of Earthquake.*, Lower Hutt, New Zealand: Institute of Geological & Nuclear Sciences, Feb., 2002. From: [http://www.nzplanning.co.nz/docs/cowan\\_etal\\_v3.doc](http://www.nzplanning.co.nz/docs/cowan_etal_v3.doc).

*Natural Hazards Observer, May, 1996, <http://www.colorado.edu/hazards/dr/dr193.txt>*

Quarantelli, E. L. 1985. *Research Based Criteria for Evaluating Disaster Planning and Managing.* Disaster Research Center, Newark: University of Delaware.

#### *Required instructor reading and resources:*

Quarantelli, E. L. 1985. *Organizational Behavior in Disasters and Implications for Disaster Planning.* Disaster Research Center. Newark: University of Delaware.

Quarantelli, E. L. 1985. *Research Based Criteria for Evaluating Disaster Planning and Managing.* Disaster Research Center, Newark: University of Delaware.

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#### Electronic Visuals Included:

Electronic visual 14.1 Expenditures on mitigation involves making judgments  
Electronic visual 14.2 Influence levels versus time

#### Handouts Included:

Handout 14.1 Homework Assignment 14.1

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### **General Requirements:**

The instructor should begin by thoroughly defining earthquake *disaster planning* and discussing this definition. It is important to draw a strong parallel between planning and preparedness, as

planning is obviously a major component of preparedness, as well as the other three phases of disaster management. The instructor should provide specific examples (with class feedback and discussion) to make this distinction clear and to ensure that the students can see where and how disaster planning fits into the overall disaster management picture. The instructor should refer back to Session 8 (where the four disaster phases initially are presented and discussed) during this discussion, as planning inevitably involves all four phases of disaster management. A homework assignment is included and one week should be allowed for this completion. This assignment should be distributed following the session.

Additional Requirements:

Computer and projector.

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**Objective 14.1 Identify general principles associated with earthquake disaster planning, and distinguish this type of planning from other common types of planning performed by emergency managers.**

**Requirements:**

The content should be presented as lecture.

**Remarks:**

- I. What is Earthquake Disaster Planning?**
- II. Many different types of planning for different purposes and with different foci. This discussion will focus on disaster planning, with an emphasis on earthquake disasters.**
  - A. *Disaster planning*** is essentially *the creation of plans to be implemented if and when bad things happen.*
  - B. *Earthquake Disaster Planning***, sharing many similarities other types of disasters, typically involves these primary steps:
    - 1. Organization of resources** – Identifying involved and/or interested parties, as well as the required technical expertise.
    - 2. Risk assessment and vulnerability analysis** – Assessing the *hazard* and *risk*. Identify the characteristics and potential consequences of anticipated disasters. It is key to understand the specific impacts on the entity (community, agency, etc.), especially on the vital assets.

3. **Developing the plan** – With the understanding of the impacts of the disaster, determine priorities and examine ways to avoid or minimize the undesired effects. The result is a natural hazard mitigation plan and strategy for implementation.
4. **Implementing the plan** – Entities can empower the plan in several ways, ranging from implementing specific mitigation projects (i.e., most critical) to changes in day-to-day operation. To enhance the success of an ongoing program, it is critical that the plan remains effective. Thus, it is important to conduct periodic evaluations and make revisions as need.

**Objective 14.2 Recognize the relationship between planning and other aspects of earthquake hazard management (i.e., four management phases, risk communication, nature and effects of earthquakes).**

**Requirements:**

The content should be presented as lecture.

**Remarks:**

**I. What Does Disaster Planning Involve?**

- A. Planning takes place on many levels: a household, an engineering firm, or a government bureaucracy.
- B. Is planning part of Preparedness? Mitigation? Response? Recovery?
- C. Planning involves all **four** phases or stages of disaster management, including the following as outlined by and adapted from Quarantelli (1985):
  1. **Mitigation**, which includes the policies and actions undertaken at a time distant (usually considerably before) from an actual disaster situation, and which are intended to prevent or reduce a disaster impact when it occurs. Examples would be building codes, land use regulations, educational and training information, and insurance.
  2. **Preparedness**, which has to do with the steps and measures planned for and undertaken when the probability of a disaster in a particular locality is immediate. Examples would be the issuance of warnings and the evacuation of people.
  3. **Response**, which refers to those actions taken during and immediately after impact to deal with crisis time problems. This is

illustrated by search and rescue efforts and the providing of emergency medical services.

4. **Recovery**, which has to do with activities carried out after the response during the crisis time period is over. Examples would be the rebuilding of homes and the reopening on a regular basis of businesses.

**II. Similar to the previous discussion on earthquake disaster preparedness, there is growing recognition, that *planning is not managing* (i.e., Quarantelli, 1985). More and more a distinction is being drawn between the two processes.**

- A. The former has to do with strategy, the overall approach to disaster problems.
- B. The latter, tactics, have to do with the specific contingencies that have to be dealt with in an actual disaster situation.
- C. Because there is only a partial correlation between the two processes, **it is possible to have good planning but poor managing of a disaster occasion** (Quarantelli, 1985). This difference between the processes is starting to be recognized in societies with the most advanced disaster planning.
- D. It is not an accident that the name of the major federal organization concerned with disasters in the United States went in a two-decade time period from the Office of Emergency Planning (and at one time, Emergency Preparedness) to the Federal Emergency Management Agency.

**Objective 14.3 Appreciate the importance of earthquake disaster planning.**

**Requirements:**

The content should be presented as lecture, supplement by electronic visuals.

Electronic Visuals Included: 14.1

**Remarks:**

**I. Why is Planning Important?**

- A. In many developing countries there has been a growing emphasis on disaster **mitigation** –measures and actions that will reduce the impact of disasters (Quarantelli, 1985).

- B. As discussed earlier, in *developed* countries, the recent change in focus toward mitigation (as opposed to response and recovery) has been driven by several key factors:
  - 1. The increasing economic costs of disasters and disaster relief.
  - 2. The complaints and pressure from citizens and activist groups who increasingly think that governments should try to prevent disasters in the first place rather than just reacting to their occurrence.
  - 3. A research-driven understanding that many emergency-time problems in a disaster response can only be reduced or solved by actions taken long before a crisis.
- C. In *developing* countries, the process additionally has been reinforced by a recognition that national development can be seriously set back by a major disaster.
  - 1. In some cases, the material losses can be up to five or more percent of the yearly gross national product.
  - 2. **Thus, there is considerable pressure to link disaster planning to development planning, a linkage reinforced by the position taken on this matter by the World Bank and other international lending agencies (Kreimer and Munasinghe, 1991).**

**II. This trend indicates strong *attention to mitigation as a cornerstone for managing natural hazards. An important but largely unrealized element of this approach is land-use regulation to manage development in hazard-prone areas.***

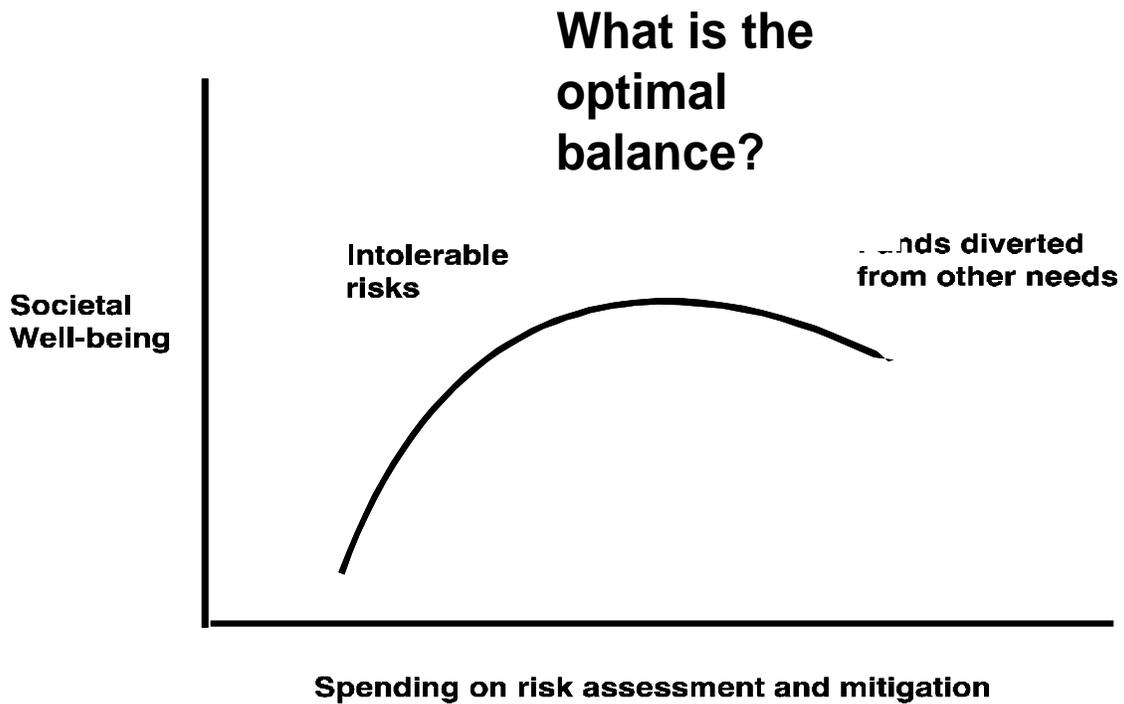
- A. ***Development planning*** is considered the process by which governments produce plans consisting of policies, projects, and supporting actions to guide economic, social, and spatial development over a period of time.
- B. The hazard management process consists of a number of activities designed to reduce loss of life and destruction of property.
- C. Natural hazard management often has been conducted independently of development planning.
- D. However, ideally these procedures should be closely integrated – such a combination of these involves the **principle of sustainability** – to be discussed later.

**III. The Mitigation Act of 2000 is the recent legislation that represents the explicit culmination of the philosophical shift in the U.S. toward the directions discussed above. This act:**

- A. Established a national program for pre-disaster mitigation, administered by states.
- B. Assigned high priority to mitigation of hazards at local level.
- C. Placed increased emphasis on:
  - 1. Assessing risk.
  - 2. Reduction of risks from natural hazards.
  - 3. Implementing loss reduction measures.
  - 4. Ensuring critical services & facilities survive a disaster.
  - 5. Form effective community-based, public/private partnerships.
  - 6. Implement effective hazard mitigation measures.
  - 7. Leverage additional non-federal resources.
  - 8. Commit to long-term hazard mitigation efforts.
- D. **In Short, the Mitigation Act of 2000 mandates disaster planning!**

**IV. Finally, we are learning that *planning is indeed a vital aspect of effective risk mitigation* (Cowan et al., 2002).**

- A. It has been suggested that the techniques now becoming available for analyzing and quantifying risk can prevent or minimize disasters, can improve safety, and can markedly reduce societal disruption following disasters (Helm 1996 in Cowan, 2002).
- B. Priorities, strategies, and standards provide the foundation for coordination of resources and regulation.
- C. Decision-making for general management of resources is about **value judgments** (see Item No. 3 in first section) based on incomplete information and imperfect predictions. Inevitably, there are tradeoffs between available resources to mitigate risk and the cultural perceptions and tolerance of those risks [*Electronic Visual 14.1*].



*Visual 14.1 – Expenditure on safety involves assumptions about hazard levels and societal perceptions of tolerable loss. Weighed against these concerns are competing priorities for overall societal well-being. An appreciation of the potential consequences (economic and social losses) associated with hazards and their probabilities should improve the quality and consistency of mitigation planning. Visual adapted from Cowan et al. (2002) from [http://www.nzplanning.co.nz/docs/cowan\\_etal\\_v3.doc](http://www.nzplanning.co.nz/docs/cowan_etal_v3.doc) .*

- E.** *Risk management* for earthquake-related hazards involves:
1. Detecting, understanding and evaluating the different hazards.
  2. Disseminating the basic and interpreted information appropriate to the needs of different users.
  3. The processes by which different users utilize information and respond according to their role or need.
- F.** Information providers, scientists, engineers, and other technical specialists are concerned primarily with the first two categories, while recognizing the important linkages and feedback required among all three categories.
- V.** **The Disaster Mitigation Act of 2000 assigns the responsibilities for hazard assessment and risk mitigation, but the lack of guidelines about acceptable standards means that local authorities have been given little practical assistance. This situation could be addressed through improved coordination and as outreach to specialists in other agencies and vice-versa. Emergency management is perceived to deal with short-term disasters and hazards, whereas urban or regional planning deals with longer-term issues.**
- A.** **Most disasters in fact, arise as a consequence of inappropriate planning decisions and inadequate preparedness.**
- B.** The **emergency preparedness community** has tended to view its role exclusively as preparing for and reacting to emergencies, and in some cases has underappreciated linking preparedness to long-term mitigation issues.
- C.** **A well-known principle of system design is that all components and linkages need to be upgraded evenly if the entire system is to perform optimally, with an equivalent improvement of outcome (Elms 1992 in Cowan et al., 2002).** The quality of information about the earthquake risk (its accuracy and timeliness) depends on the existence of monitoring and warning systems, together with the knowledge of earthquake hazards derived from local and global research. The transformation of such outputs – the better data and knowledge – to desirable social outcomes (more resilient and sustainable communities) requires considerably more effort, however, as well as sustained commitment by many agencies and professionals.
- D.** Systems such as **TriNet** (see <http://www.Trinet.org>) and early warning systems are intended to deliver timely and better information about earthquake hazards. If interagency and interdisciplinary coordination is better developed and sustainable, the Civil Defense Emergency Management (CDEM) planning process should facilitate greater understanding of hazards by local authorities and more consistent planning for the same hazards within a region.

**Objective 14.4 Identify the general principles associated with effective disaster planning.**

**Requirements:**

The content should be presented as lecture, supplemented by electronic visuals.

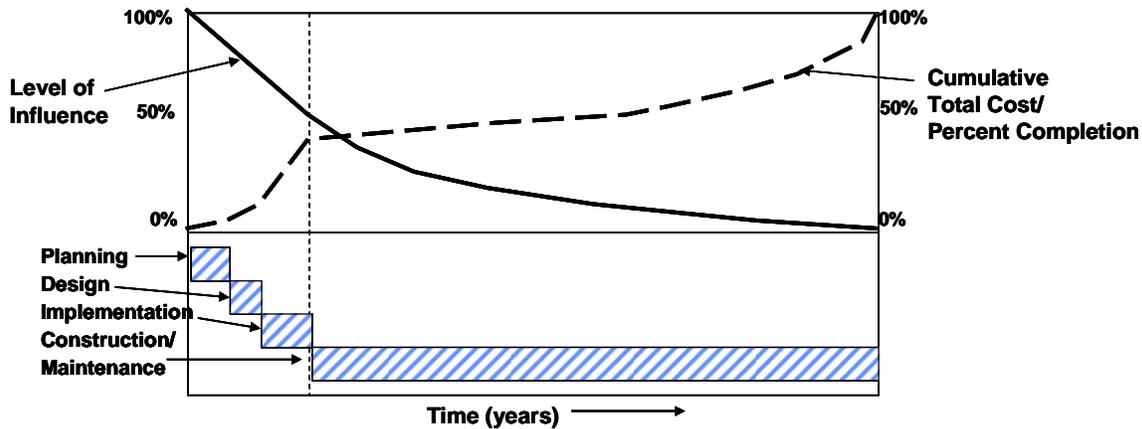
Electronic Visuals Included: Electronic Visual 14.2

**Remarks:**

**I. Principals of Effective Disaster Planning:**

- A. Planning involves a number of activities on various levels, as discussed earlier.
- B. So in general, how should we plan for natural disasters? The following is a list of crucial issues that must be considered in the planning process (as adapted from *Natural Hazards Observer*, 1996).
  - 1. Short-term decisions can have serious long-term consequences.
  - 2. Having a plan in place makes a difference.
  - 3. “Carpe diem” (Seize the day).
  - 4. Achieve multiple objectives through the recovery plan (i.e., sustainability).
  - 5. Expect a rollercoaster of economic redevelopment following the event.
  - 6. Put someone in charge.
  - 7. Become involved early-on in the process for maximum influence!!
- C. There are many systems and entities that require this type of planning process.

**II. A key principal: as shown below, most influence can be made early-on in the planning process. *Be a part of early planning efforts!* [Electronic Visual 14.2 ]**



*Visual 14.2 – Chart illustrating the relative level of influence on the final outcome of a typical process versus time. The earlier-on in the planning effort, the greater the influence on the outcome.*

**Objective 14.5 Discuss important concepts, such as sustainability, to be considered in the planning process**

**I. Sustainability.**

- A. Sustainability is development that maintains or enhances economic opportunity and community well-being while respecting, protecting, and restoring the natural environment upon which people and economies depend.**
- B. Sustainable redevelopment is simply the application of the concepts and practices of sustainable development to the disaster recovery process.**

**II. Mileti (1999) states that:**

“Disasters are more likely where unsustainable development occurs, and the converse is also true: disasters hinder movement toward sustainability because, for example, they degrade the environment and undercut the quality of life. Sustainable mitigation activities should strengthen a community's social, economic, and environmental resiliency, and vice versa.”

- A. In term of the basic principles of sustainability (Mileti, 1999), a community that wants to become more sustainable should:**
  1. Maintain and, if possible, enhance, environmental quality.
  2. Foster local economic vitality.

3. Incorporate disaster resilience and mitigation.
  4. Ensure social and intergenerational equity.
  5. Maintain and, if possible, enhance, its residents' quality of life.
  6. Use a consensus-building, participatory process when making decisions.
- B.** One of the ways that hazards management and sustainability can be closely coupled is by focusing on disaster recovery and the activities that are likely to take place – and decisions made – during that period.
- C. Sustainability ideals are beginning to be incorporated more often into hazards research and planning.** The post-disaster period remains a particularly crucial time for implementing sustainable practices because, during recovery, as there is often tremendous pressure to resume the "old ways" of building and living at risk, coupled with political, technical, and financial pressures.

**Objective 14.6 Describe planning tools typically used in and needed for earthquake hazard planning (GIS, HAZUS, etc.).**

**I. Planning Tools.**

- A. Vulnerability and network analysis theory:**
1. **A well-known principle of system design is that all components and linkages need to be upgraded evenly if the entire system is to perform optimally, with an equivalent improvement of outcome (Elms, 1992).**
  2. The quality of information about the earthquake risk (its accuracy and timeliness) depends on the existence of monitoring and warning systems, together with the knowledge of earthquake hazards derived from local and global research.
  3. The transformation of such outputs – the better data and knowledge – to desirable social outcomes (more resilient and sustainable communities) requires considerably more effort, however, as well as sustained commitment by many agencies and professionals.
- B. Geographical Information Systems (GIS) [Note: this tool also was discussed earlier in Session 13].**
1. The strength of GIS lies in the ability to represent the real world situation closely with layers of information (maps) that can be combined in a predetermined manner to identify the impacts of a natural hazard through the introduction of hazard dimension.

2. In the case of earthquakes, this information could be ground shaking intensities due to an earthquake, which again can be combined with population, housing, and infrastructure information to assess disaster impact and plan response and relief strategies.
3. GIS information, especially, can be easily combined with detailed land cover information obtainable from remote sensing, thereby updating the dynamic component of information. The most expensive part of the GIS use lies in the data preparation. It is important to note that more and more regional and global data of topography, land cover, soil characteristics, presence of faults and folds etc. are being collected.
4. The automation provided by GIS could be used directly in microzonation, because the basic information fusion process involving comparison, indices, and overlaying in microzonation is the same for basic GIS operations. Another approach is the vulnerability analysis, where the hazard potential is considered to be equally distributed regionally. This approach is adopted in earthquake microzonation where each location is subjected to the same type of ground motion, and vulnerability is assessed based on the geological structure of each location.
5. GIS is effective in carrying out such analysis as automated processes, and different outcomes resulting from changed input parameters, assumptions and scenarios can be easily compared with due consideration given to uncertainties in methodology and the input data.

**C. Microzonation (general concept).**

1. **Microzonation is the identification of separate individual areas having different potentials for hazardous earthquake effects.**
2. To reduce damage in a future earthquake, the weak points that came to light in the damage pattern of the earthquake must be avoided in future development.
3. The earthquake risk can be reduced by means of various preventative measures. The most effective measures are the reduction of the vulnerability of buildings and other structures, and the development and application of appropriate land use plans (microzonation).
4. Microzonation relates earthquake hazard to corresponding utilization and building regulations.

**D. Infrastructure and Asset Management Systems.**

1. **An inventory management** system is an operational package that enables the systematic, coordinated planning and programming of investments or expenditure, design, construction, maintenance, rehabilitation, and renovation, operation, and in-service evaluation of physical facilities.
  2. **An asset management system** refers to systematic process of maintaining, upgrading, and operating physical assets (pavements/ bridges) cost-effectively, efficiently, and comprehensively.
  3. Such systems typically are developed using computer-based databases (such as a GIS system) and are increasingly used by cities, states, transportation departments, and businesses. The main purpose of these tools is to:
    - a. Minimize costs.
    - b. Maximize benefits.
    - c. Maximize safety.
    - d. Minimize disturbance to daily life.
    - e. Minimize response time.
  4. Such systems can be used to provide answers to questions such as: Where are mitigation and response treatments most needed? What treatment is the most cost-effective? When is the best time (condition) to program a treatment?
- E. HAZUS-** (from [http://www.fema.gov/hazus/lk\\_main.shtm](http://www.fema.gov/hazus/lk_main.shtm) and [www.nibs.org/](http://www.nibs.org/))  
*[Note: this program/tool also was discussed earlier in Session 13].*
1. HAZUS is a loss estimation tool developed by FEMA and the National Institute of Building Sciences. The product features a nationally applicable earthquake-loss methodology implemented through computer-based analysis.
  2. HAZUS is currently limited to earthquake loss estimation, but is being expanded into an integrated multihazard program to include loss estimations from floods, hurricanes, tornados, coastal storm surge, and severe winter storms.
  3. Output from a HAZUS analysis includes detailed maps and analytical reports that describe building damage, casualties, economic loss due to business disruption, transportation system damage, and utilities disruption, as well as shelter requirements and cost of repairs/rebuilding.

4. HAZUS may be used at the default level (which includes standardized inventories and assumptions) to produce general loss estimates, but the system also can be used in inventory data collection to create accurate, detailed models of the user's study area.
5. TIGER files, Dun & Bradstreet data, property tax assessment data, and all types of GIS databases can be included.

**II. Emergency managers, planners, and local policymakers can then run “what if” scenarios to test mitigation strategies, as well as prepare rapid loss estimates after a natural hazard event.**

**III. Discuss important issues to be considered for specific agencies and organizations.**

**Objective 14.7 Describe factors that influence planning and problems that impede effective earthquake hazard planning.**

**Requirements:**

The content should be presented as lecture. Distribute Handout 14.1 Homework Assignment 14.1 at the end of the session and allow one week for this to be completed.

**Remarks:**

**I. Factors That Influence Planning.**

*[Note: Much of the following was adapted from Natural Hazards Observer, May, 1996, from, <http://www.colorado.edu/hazards/dr/dr193.txt>]*

- A. Planning Mandates Make a Difference.** Local governments are more likely to prepare comprehensive plans when required to do so. For states that require comprehensive plans from local governments and follow-through on those requirements, local plans have more substantial factual underpinnings, goals tend to be stated more clearly, and local policies proposed for guiding development are stronger. Furthermore, these higher-quality plans foster commitment by local officials to mitigate hazards. In states without mandates, plans, commitment, and development management programs tend to be substantially weaker.
- B. Design and Implementation Efforts Matter.** The influence of planning mandates varies considerably among states. We attribute variation to differences in the way mandates are designed and to differences in the degree of effort state agencies devote to them. The key design variables are features (such as withholding state aid) that build local commitment to follow state directives and features (such as grants-in-aid and technical assistance) that build local capacity to develop hazard mitigation plans and programs.

- C. **Mandates Affect Development Management.** By influencing the quality and character of local plans, planning mandates in turn influence the way local governments manage development in hazard-prone areas. Only those communities with strong planning commitment *and* good plans undertake balanced mitigation programs.

## II. Problems Associated with Earthquake Hazard Planning.

- A. The primary problem with planning for disasters is that they are, by their very nature, not something one can anticipate.
- B. Emergency disaster planning essentially is the creation of plans to be implemented if and when bad things happen. The timing of those bad things will almost always be inconvenient – it is an article of faith that the most serious incidents will happen at the most inopportune times.
- C. Given that earthquakes are unpredictable and will occur with no warning, the risk is somewhat nebulous. As a general rule, people are not easily excited by non-specific risks. They also are reluctant to think about the things that may kill or injure them or their loved ones.
- D. Emergency planning is very expensive, and with virtually no return on investment, it is difficult to encourage spending on disaster planning and equipment.
- E. Although the question is one of "pay now, or pay big later," it often is not seen in that light; politicians and citizens, more concerned with immediate problems, do not see the potential threat as a major concern. Essentially, beyond the fact that the risks are difficult to quantify and we don't really know what will happen, where it will occur, or when, the biggest problem is that people simply don't care.
- F. Some issues that present special challenges, many of which were discussed earlier are summarized below (NHO, 1996).
  - 1. Earthquakes occur without warning. No one is really sure **when** things are going to happen, or **what** is going to occur during or after the earthquake (Utilities may or may not work, buildings may or may not fall down, people may or may not die).
  - 2. The probability of an event occurring during nonworking hours is 2:1, which means residential structures, many with increased vulnerability, are likely to be occupied.
  - 3. Damage to communications systems will interfere with response management.

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4. Aftershocks will cause more damage and scare people.
5. Damage will be widespread, even if not severe.
6. Damage after an earthquake will be variable and can be extremely widespread, depending on size and location.
7. Planning is necessarily compared to the realities of the situation.
8. Local resources will be overwhelmed almost immediately, so surviving on your own (for a while) is important; outside assistance typically takes at least 72 hours to begin arriving in full force
9. Earthquake prevention and preparation measures are expensive, although less expensive than the alternative, and there are many other pressures besides earthquake hazards to be concerned about.
10. **Bottom line: Planning is typically difficult and earthquake planning perhaps doubly so!**

*[Distribute Handout 14.1 (Homework Assignment)]*

**References Utilized:**

- Cowan, H., Falconer, R., S. Nathan. 2002. *Gaps in the Understanding and Mitigation of Earthquake*. Lower Hutt, New Zealand: Institute of Geological & Nuclear Sciences. From [http://www.nzplanning.co.nz/docs/cowan\\_etal\\_v3.doc](http://www.nzplanning.co.nz/docs/cowan_etal_v3.doc)
- Elms, D.G. 1992. "Consistent Crudeness in System Construction," in B. Topping (ed), *Optimization and Artificial Intelligence in Civil Engineering*. Kluwer Academic Publishers, pp. 71-85.
- Meliti, D. 1999. *Disasters by Design: A Reassessment of Natural Hazards in the United States*. Joseph Henry Press.
- Helm, P. 1996. *Integrated Risk Management for Natural and Technological Disasters*. Tephra, vol. 15, No.1, p. 4-13.
- Kreimer, A. and Munasinghe, eds. 1991. *Managing Natural Disasters and the Environment*. Washington, DC: World Bank.
- Natural Hazards Observer (NHO)*., 1996. May, 1996. Data and information from: <http://www.colorado.edu/hazards/dr/dr193.txt>.
- <http://www.project-impact.org>
- <http://www.trinet.org/>
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- Quarantelli, E. L. 1985. *Research Based Criteria for Evaluating Disaster Planning and Managing*. Disaster Research Center. Newark: University of Delaware.