FRAMEWORK FOR INTEGRATING EARTHQUAKE RISK MITIGATION INTO THE COMPREHENSIVE PLANNING PROCESS

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SUMMARY

Urban planning and design hold strong potential in natural hazard risk mitigation, but unless there is considerable clarification in data gathering and policy formation methodologies, obstacles that stand in the way of implementation will render planning ineffective. Regional scale planning would be primarily concerned with the gathering of geotechnical and social data, and the definition of land uses and lifeline routing. Project scale planning would serve as intermediary between public policy and private developer, serving as the coordinator of scientific knowledge and the development of pocicy guidelines.

THE PROBLEM

On the national scale, zones have been developed to guide structural engineers, and on the building level technical knowledge provides mitigation measures for the architect and engineer. It is between these two levels of approach that planning can be focused to incorporate the knowledge developed by the physical sciences to safeguard the areas of concern to the social scientist. It is an underlying assumption of this paper that in planning there is an conspicuous gap in the range of hazard mitigation measures integrated into the comprehensive planning process. Planning for the seismic risk threat as well as for the risks of other natural hazards must become a part of the comprehensive planning efforts of a community, for there is a long over-due need to incorporate the advances of technical mitigation measures beyond the level of a single structure.

Currently, technical expertise predominates at the building scale, using seismic resistant design constraints. At the larger community or regional scale, it is primarily applied economic and social, forces that tend to influence land use patterns. The forces that shape the urban environment, and that guide the patterns and networks within that environment need to be tempered with the knowledge of physical science to bring hazard mitigation to the community level, rather than primarily at the building-specific level. A comprehensive planning framework needs to be developed that will bring scientific developments into community planning, not only as "special studies" or as outside references, but as part of the legally adopted comprehensive planning ordinance.

The field of urban planning concerns itself with the organization of uses, in addition to the planning of lifeline networks including transportation, communication, and support systems. In relation to natural hazard,

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especially the case of seismic risk, the role of urban planning, is primarily to minimize the numbers of people, and buildings that are exposed to the risk, and in so far as possible to ensure that the lifeline systems of the community have the ability to go back on line and/or continue to function effectively in the aftermath.

Seismic risk, must be analyzed from the standpoint of both social and technical implications. Comprehensive plans based on a well defined statewide data base can then be prepared. Knowledge of the hazard and the population at risk must be in a form that can be utilized in the development of the comprehensive plan. Once the means of inter-departmental coordination are clear, and the lead agency responsible for management of the data base is clearly defined, planning can become an effective tool for both scientist and policy marker. Transportation planning, utility routing, and both public and private facilities must be developed under a plan that addresses an awareness of the potential risk - at the regional, district and site specific levels.

Case Study: Anchorage

The study of the City of Anchorage, Alaska and the events of the Great Alaska Earthquake of 1964 provide a valuable illustration of the need for planning measures to better mitigate the risks of natural hazard. Study has shown that planning should deal with both the immediate recovery effort and with long term efforts to minimize potential damage, both physical and social. The Alaskan experience indicates that the answers can be developed, but that they need to be clearly stated, and translated into effective planning programs, that can work in an environment of clear communication.

The project on which this paper is based was conducted according to three primary components (Ref 1). Part I is a brief description of the 1964 Earthquake and the Immediate response period. This section also discusses the post disaster investigations which are described in the eight volume National Academy of Sciences report. Part II of the project is a parallel analysis of Alaska and earthquake hazard mitigation research today. Findings of this section describe how the majority of the recommendations in the NAS reports which pertain to the need for technical research have been undertaken. A consistent and integrated framework for utilizing and implementing the results of the technical research is, however, at best "spotty". Instead the seismic hazard is addressed on the basis of three sub-fields: emergency response, hazard mitigation, and scientific research. Accordingly Part III of the project developed a planning and public administration framework for integrating consideration of the seismic hazard into the traditional comprehensive planning framework. This planning framework is based on a number of underlying assumptions which revolved a three part planning approach:

1) Availability of common generalized data base.
2) Regional level where areas of particular susceptibility are identified either because of specific populations and/or because of the nature of the hazard.

3) Specific overlay districts with special requirements would be created within these sub-areas which address specific dimensions of a hazard.

The study of Alaska leads to the identification of two important sets of issues: first, concerns of physical responses that should be addressed in policy formation:

- o Concerns of damage prevention.
- o Retrofitting existing buildings.
- o Designing "state of the art" structures utilizing most up to date technology.
- o Building the location of new development in relation to seismic-based criteria.
- o Building intensity and density of re-development.
- o On-going maintenance - inspection functions.
- o Construction standards for new structures.

And second, the identification of those factors that were considered to be the greatest obstacles to the subsequent mitigation of the hazard:

- o Lack of communication between departments in the same agency.
- o Lack of communication between agencies, at Federal, State and local levels.
- o Lack of interdisciplinary communication.
- o Over specialization of planning practioners.
- o Inability of data users to recognize and articulate specific data needs.
- o Lack of financial support of specialized expertise.
- o Lack of comprehensive and integrated accountability (Ref. 1).

It becomes clear that an approach is needed which provides clear responsibility and support for the planning process in terms of technical information managment which is to be the key in developing a functional hazard mitigation planning model. The most valuable recommendation from the study of Alaska was the development of a prototype hazard mitigation program for implementation through planning that would use specific technical tools, such hazard mapping, and geotechnical studies, in conjunction with legal tools, such as zoning, and identification of special building codes.

PLANNING RECOMMENDATIONS

Although there are considerable obstacles to the implementation of risk mitigation measures through planning, these are not insurmountable, with the development of a planning methodology at both the regional and the project level. Policy can be developed that can bring seismic hazard based planning into play as a valuable tool in the mitigation of all natural hazards. Creating clear hierarchies of responsibility, and defining communication paths for both the development of a an area-wide data base to be used by planners concerned both with emergency response and with long term mitigation, and planning guidelines based on that data base, would allow planning to become the much needed implementation methodology for mitigation measures.

At the regional scale, the development of a data base would be a fairly elaborate task, but a task that has already been initiated in many communities. The State of Alaska, and specifically the City of Anchorage are an excellent example of the type of data-base that can be developed by combining Federal, State, and local efforts. For the Anchorage area, for example, this data-base includes the Regional Profiles, prepared by the State, an Environmental Atlas developed by the University of Alaska, and numerous publications and studies prepared by the Muncipality of Anchorage. Combined, these tools have the ability to become essential assistance to the planner and the local government as they develop a regional plan. There is a need for a clearly defined lead agency to coordinate this data, and to develop the means of disseminating it as a planning development tool, and to avoid unnecessary duplication of effort.

A regional plan would address many issues that should have a risk mitigation consideration or component. These would include detailed land use criteria, density/intensity of land use patterns and the location of life lines in relation to perceived risk areas. Such a plan could also address at the macro or regional scale elements of response planning for natural hazard, including warning systems, evacuation routes, emergency powers and responsibilities, and post-disaster relief processes. The awareness, and integration of a scientific data base would greatly strengthen this type of plan, and could help to reduce to a large degree the social shock following a major event.

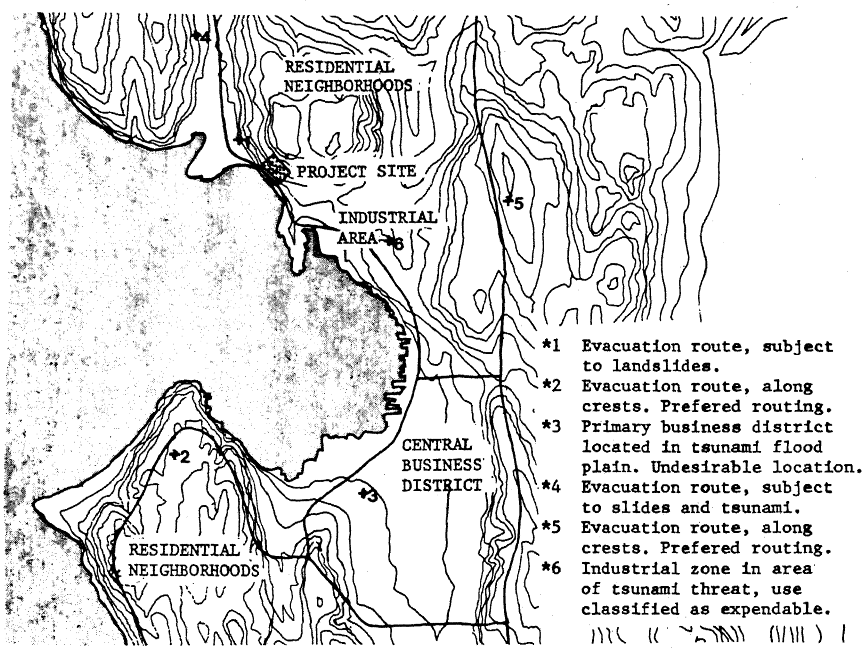

Figure 1 - Quakeopolis - A hypothetical coastal city illustrating positive and negative mitigation planning.

The regional scale data base permits creation of planning guidelines, which would allow each community and region to identify areas that need to be treated as sub-zones because they possess unique areas of concern. This approach is similar to that which is already in affect in the national coastal zone management program. The figure above of a hypothetical coastal city, Quakeopolis, illustrates some of the regional specific considerations that would confront a city. These issues would include density and intensity of land use, future development planning, the routing of transportation and communication, and considerations of life line planning to assure maximization of safety to human life, and property.

Although any one of these issues has the ability of becoming a critical problem for the community, effective management of scientific analysis, and its integration through planning and the overall decision-making framework can have an important long term mitigating effect in this community.

Project Scale Considerations

Planning which specifically addresses the dynamics of the hazard can further become an implementation tool at the site or project specific scale. Thus, special district provisions will be tailored to an individual site, e.g. susceptibility to strong ground motion, tsunami inundation, liquification, etc. It is at this scale that the greatest applications of scientific advances have been made. In the areas of structural design, building configuration, materials and construction, techniques designed to maximize seismic resistance have been an important issue. There is, however, a need to integrate the planning constraints that should be a part of the development of any site. Given the case of a regional plan that addresses the issues of planning for hazard mitigation, there should exist a flexible zoning concept for any particular site based on responses to the hazard. Planning needs to become further involved in the coordination of technology and devlopment, and in the development of sub-zones at a neighborhood or even site-specific level.

To consider the function, and obligation, of planning in hazard mitigation at the site specific or neighborhood level, let's go back to the hypothetical city, Quakeopolis, introduced earlier. Here, located on a steeply sloped ridge, lies a currently undeveloped ten acre site that the owner would like to develop. The site has been the subject of soil analysis twice in the past 20 years, revealing a mixed profile of sandy soils, silt and clay laminations. It has shown some sliding, especially on areas of 35 year old fill, has some drainage/run-off problems and about 20 percent of the site is a marshy depression just above a 10-30 percent slope. At the base of this slope is a major transportation arterial, that has twice in the last 5 years shown on-street light flooding from run-off at this site. There is a housing crisis in Quakeopolis, and the city, cannot afford to condemn marginally developable sites, especially as this one has exceptional views which makes it too expensive for acquisition. The issue is how to implement guidelines that will allow development that will be just to both developer and the community, and that will provide the greatest amount of mitigation or the earthquake hazard that Quakeopolis faces.

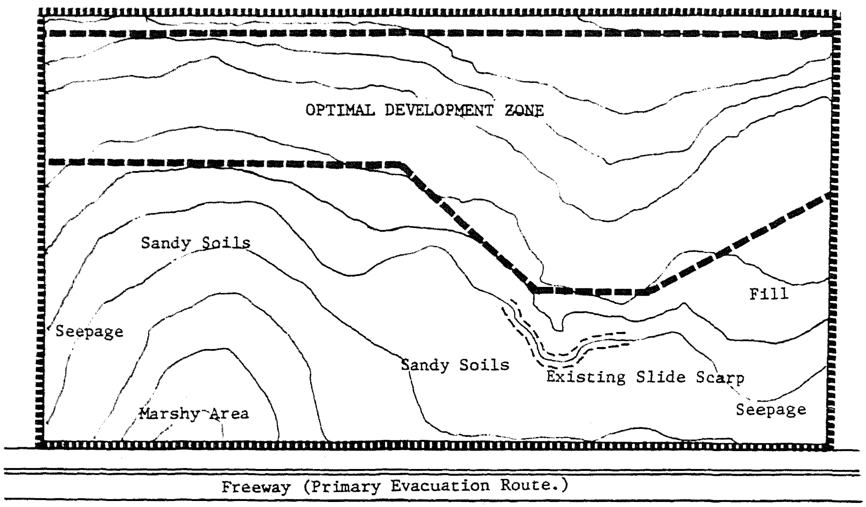

Figure 2 - Project Zoning In Response to Potential Seismic Hazards

Presently the practice is to impose general guidelines at the neighborhood level, based predominantly on economic and social factors, but the use of site specific technical knowledge when coupled with responsive planning gives us the ability to utilize sites in hazard prone areas that might otherwise be misdeveloped, or left unused due to restrictive protective policy by the local governmental body. It is at this level that the land planning issues which represent the interaction between the physical threat and the land are addressed.

The answer lies in the application of what the geosciences know about the site and its vicinity once the administrative decision is made to allow development at a clearly identified hazard site. Project scale planning would be concerned with the arrangement of uses to mitigate the special environmental problems that are evident. This could include use of architectural features to mitigate slide potential, and the siting of open spaces in areas of the greatest hazard. Circulation would be laid out so as to maximize evacuation potential, and to allow easy integration with the surrounding system. Analysis of the site as a whole reveals various options to stabilize some of the steeply sloping portions of the site. Geotechnical analysis reveals the presence of significant water levels in portions of the site. The combined conditions result in the determination that the city (or the developer) has two very different options for zoning the land. One is relatively low density which does not require elaborate and results in a minimum of excavation. The other, because of the need to spread out the costs of a relatively expensive foundation system, results in relatively high densities. The analysis clearly eliminates the middle range of development intensity.

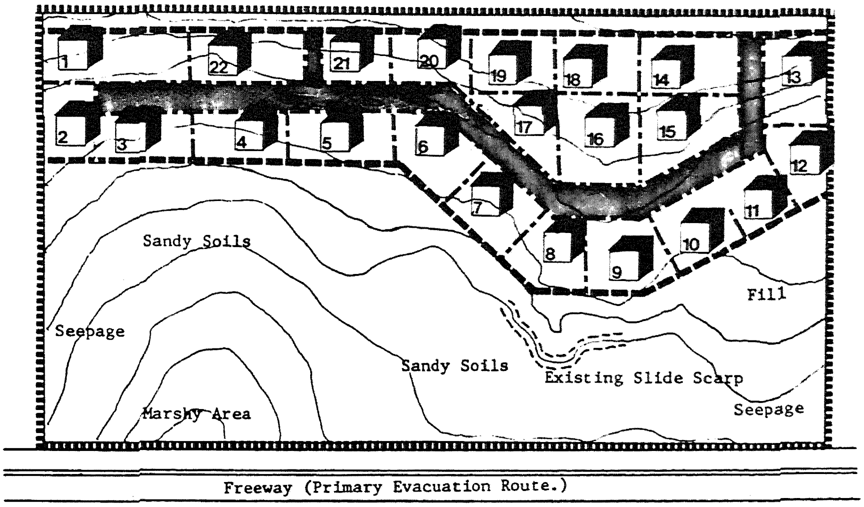

Figure 3 - Low Density Option - illustrating 22 feasible single family housng sites.

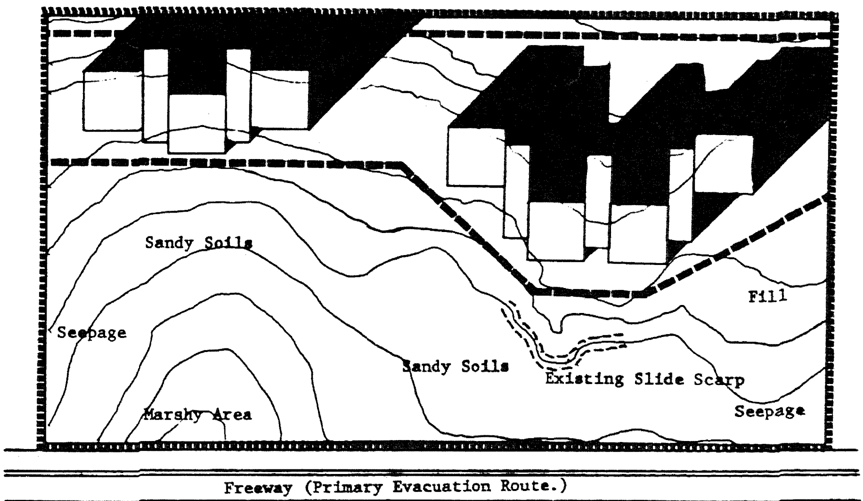

Figure 4 - High Density Option - illustrating high-rise housing typology, 150+ feasible units with underground parking.

CONCLUSIONS

Urban planning and design hold a strong potential in the realm of natural hazard risk mitigation, but unless there is considerable clarification in the data gathering and policy formation methodologies the obstacles that stand in the way of implementation will render planning ineffective. At a regional scale planning would be primarily concerned with the gathering of geotechnical and social data, and the definition of land uses and lifeline routing. On a project scale, planning would serve as the intermediary between public policy and private developer, after serving as the coordinator of scientific knowledge and the development of policy guidelines based on that knowledge. Effective implementation of a scientific planning scheme of natural hazard risk mitigation should include the following elements as a means of negating the obstacles that currently exist.

- A clear hiearchy of responsibility and managment at Federal, State and local levels of government.
- Constraints and responsibility for data base development.
- Lead Agency identification for responsibility of coordination and managment of data base.
- Define constraints of public policy development/private development responsibilities.
- Identification of sub-zones or areas where additional data is required.

Ref. 1 - Analysis of the Anchorage case study is drawn from draft chapters from The Great Alaska Earthquake Experience: Implementation of Risk Mitigation Through Comprehensive Planning, conducted by the University of Alaska in Anchorage and Urban Regional Research; Lidia Selkregg, Principal Investigator and Project Manager, University of Alaska; and Jane Preuss, Project Manager, Urban Regional Research

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