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A Word on the Importance of this Handbook

The Japanese archipelago has suffered numerous tsunami attacks from ancient times. Countless Japanese have lost their lives or property as a result of tsunamis, most recently during the modern era dating from the Meiji Period (1868-1912). Most notable among them were The Sanriku Tsunami of 1896, the Sanriku Tsunami of 1933, the Tokai Earthquake and Tsunami of 1944, the Chilean Earthquake and Tsunami of 1960, The Japan Sea Chubu Earthquake and Tsunami of 1983, and the 1993 Southeast Coastal Earthquake in Hokkaido.

Japan’s hazard readiness has developed as a result of the lessons learned from the past. The coastal areas that have suffered much of the damage have been the most active in promoting preparedness, and especially in the wake of the Hanshin-Awaji Earthquake, local authorities nation-wide have begun a review of readiness policies and emergency planning.

Even with the sophisticated technology of today it remains difficult to predict where and when a tsunami will occur. When a tsunami is generated, the height and arrival time of the tsunami vary according to coastal configurations and the resulting types of damage complicate safety planning.

Furthermore, because Japan’s historical tsunamis have yet to strike hit densely populated areas, readiness planning for coastal areas with large concentrations of people is essential task for planners. It is imperative, therefore, to coordinate and integrate efforts for effective preparedness, taking into account the particular hazards created by tsunamis.

This booklet intends to provide a plan of action and basic framework from which public safety officials will be able to increase community preparedness against the threats of tsunamis. Contained within are many proposals concerning tsunami readiness. However, it is recommended that local authorities bear in mind their community’s unique topography and local circumstances when consulting this booklet. The general term “tsunami hazard mitigation plan” refers tsunami readiness as part of the overall local disaster planning.

The following contents are found in the booklet:

- Preface
- Introduction
- Devising a Tsunami Hazard Mitigation Plan
- Strengthening Preparedness
Chapter 1 INTRODUCTION

1.1 The Purpose of Tsunami Hazard Planning

The purpose of tsunami hazard planning is to set forth and promote preparedness in everyday life to protect life and property in at-risk communities during a tsunami emergency.

More than 200 fatalities resulted from the Hokkaido Southwest Earthquake and Tsunami. On Okujiri Island, many residents, knowing that a tsunami generated by the Japan Sea Chubu Earthquake had caused fatalities ten years earlier, evacuated immediately to higher ground. Those who were late in evacuating died.

Some coasts are vulnerable to repeated tsunami attacks. Yet, humans too often fail to learn the lessons of the history. In addition to having substandard coastal defenses, when an earthquake-generated tsunami occurs, a lack of a defined tsunami policy leaves the community’s emergency response ambiguous or unclear. In addition, that tsunamis are uncommon contributes to complacency in society. Based on the situations described above, we can see the need for vigorous planning and promotion of awareness of the danger of tsunamis in order to protect ourselves.

Finally, in order put these measures in place, it is important that residents, users of coastal areas, private enterprise and the government reach a common understanding of preparedness, that is, in the face of tsunami hazards, individuals must protect themselves just as communities are responsible for their own protection.
1.2 The Role of Tsunami Hazard Planning

Tsunami Hazard Planning aims to protect citizens’ lives and property by mitigating damage caused by tsunamis. It is an integral part of local hazard mitigation planning.

Tsunami Preparedness is one part of a comprehensive plan based on Emergency Law, which covers a broad range of local damage caused by earthquakes, wind and rain, volcanic eruptions, or snow. It is the basis from which local governments deal with disasters. This handbook describes a general plan for dealing with the unique hazards resulting from tsunamis. It discusses building and maintenance of defensive structures, conducting research on past emergencies, prevention, and emergency response.

Much remains to be learned about tsunamis. Their location and magnitude are difficult to predict. When a tsunami is generated in a local area, there is little warning time before it strikes. While the hard defensive structures such as tide gates embankments are important, the softer aspects, such as the establishment of evacuation areas and maintenance of evacuation routes, the system of communication and dissemination of information, are crucially important. Both facets must work in conjunction, and they form the basis of the readiness planning.

Other important factors that influence readiness planning are changes in the social environment and scientific research. These should be reflected in the planning, as well as local circumstances. Aim for local planning which adapts well to the overall plan and when necessary, review original plans and adopt appropriate measures. In conclusion, tsunami hazard planning is one part of local readiness, and both hard and soft aspects should be given consideration in the overall framework of a strong tsunami readiness policy.
1.3 Aims of Tsunami Readiness

Tsunami readiness plans consist of a broad range of measures. To keep damage at a minimum, plans make use of the natural topography and build defenses that take into account unique coastal features against a designed tsunami threat. There are three main areas covered by planning: defensive structures, civil planning based on tsunami readiness, and an emergency response system. All work together in a comprehensive plan of preparedness.

Defensive structures such as sea barriers serve as the basic method of mitigating the effects of the design tsunami and preventing it from directly coming inland. Such construction requires much planning and time. As they are being built, some other potential hazards must be addressed. Important aspects of tsunami readiness and civil planning call for renovation of dilapidated buildings along coasts, reconstruction of or relocation of vital facilities to higher ground, evacuation system, warnings and communications system.

Potential Hazards

1) Construction of defenses requires time and a tsunami could occur before completion.
2) The tsunami could be a larger magnitude, overwhelming the defenses.
3) Other problems include protection of the environment and scenery, the multipurpose use of the coast, funding, purchase of land for defenses. Such factors affect the required construction time and crest height.

What we have learned from tsunami readiness in the past is that we must not only depend on physical defenses. In order to keep damage at a minimum, a combination of defenses, civil planning for tsunami, and a system of preparedness which collaborate in a comprehensive plan of preparedness is crucial.

Historical tsunamis are the basis of tsunami readiness planning. We have relatively accurate evidence, such as watermark heights. Of numerous tsunamis, the largest is selected, and its form the benchmark of a hypothetical design tsunami. In assessing the potential threat, recent scientific research on earthquakes which generate tsunamis along high-risk coasts, enables us to make projections of the largest possible tsunamis. These are compared with data of the largest past tsunamis. It is better to err on the side of safety, so the largest tsunami possible is most suitable for planning purposes.

Major earthquakes do not necessarily generate tsunamis. Various factors are at work, such as the location of epicenter and its magnitude, the depth of the quake, its direction and displacement of the fault. All these factors must be taken in account in configuring the magnitude of the design tsunami.

Here, defense structures refer to sea walls, tsunami breakwaters, tsunami tidegates, and river dikes. Tsunami readiness based on urban planning includes zoning restrictions, relocation to higher ground, renovation and reconstruction of dilapidated structures. These are planned measures taken to strengthen at-risk communities’ preparedness.

Emergency readiness generally refers to the organizational structure and activity behind tsunami readiness, such as the warning system, establishing evacuation zones and routes, public educational programs, and protection of the fishing industry.
Ⅰ．管理目標

Ⅰ-1．組織目標

Ⅰ-2．部門目標

(1) 研發部門
(2) 市場部門

Ⅰ-3．業績目標

（1）內部目標
（2）外部目標

Ⅱ．管理組織

Ⅲ．組織架構

Ⅳ．組織架構

- 未 -
This section describes the background research necessary in setting a tsunami hazard mitigation, including research items, issues for consideration, and procedures. It also contains information on devising a summary of existing readiness measures and a progress report on the implementation of safety measures.

1 ) Background Research

First, planners must have an understanding of coastal conditions (after a projection of inundation, specific coasts will focused on) which will be attacked by the design tsunami. An assessment of past tsunamis’ characteristics and damage must be done. The potential danger of the tsunami is evaluated by taking in a number of critical factors. These include the coastal topography, use of the land, population, concentration of industry, resident attributes, progress of pre-planning, and other unique features of the area. Finally, the community’s plans for building are taken into account, as well as the its future development.

2 ) The Design Tsunami

The design tsunami is based on data from the largest of past tsunamis, identified by relatively clear high watermarks. At the same time another projection is made using recent seismic data which predicts the generation of a tsunami along specific coasts. By comparing this information with the historical record, the largest possible hypothetical tsunami is generated and we are able to plan accordingly. Because earthquakes of the greatest magnitude do not necessarily generate the greatest tsunamis, the plan is evaluated further against a number of factors, such as the location of the earthquake’s epicenter and any resulting change in the tsunami wave, the earthquake’s magnitude, its depth and location, directivity, and displacement due to fault motion.

Regarding planning for defenses, estimation of the highest water levels is necessary, but that is in itself, insufficient. The estimated arrival time of the tsunami and evacuation time for people and ships and fishing boats must be taken into account as well.

3 ) The Damage Estimate

Once the area of inundation is projected, the parameters of the target coastal area are established. At the same time the area’s vulnerability is assessed against the current state of defensive preparedness, and thus the damage estimate from the design tsunami, by type and scale of damage, is complete.
4 ) Preparedness Tasks

Following the research and damage estimate, the tasks which must be accomplished in order to complete preparedness are determined, including tsunami defensive structures, urban planning based on tsunami readiness, and organizational structure of the readiness system.

5 ) Setting up the Tsunami Hazard Mitigation Plan

As described above, a comprehensive plan depends on careful consideration of the three pillars of preparedness, i.e. defensive structures, urban planning based on tsunami readiness, and the organizational system of readiness. These must be measured against the area’s readiness tasks, taking into account financial restraints, effectiveness of readiness measures, and their effects on the community’s daily life. Finally, the measures adopted are prioritized according to urgency, importance, and feasibility. A specific plan for implementation is then drawn up based on the organization in place, methods available, scheduling, and funding.
2.2 Background Research

2.2.1 Focus of the Research

It is important to understand the unique features of each at-risk region. A survey must be conducted of the variance of coastal configuration, types of land usage, concentration of population and industry, percentage of elderly population, public attitudes and awareness toward tsunami preparedness, progress of plans underway, tasks and measures to be adopted. In addition to existing structures, it is also important is to clarify the future development of the community.

The background research should focus on the following:

(1) Socio-Economic Factors

Coastal regions are among the most important in terms of production and distribution of goods, housing, recreation activities whose varied purposes give rise to their multi-faceted development and usage.
As the above information shows, the type and scale of damage caused by a tsunami depends greatly on the unique features of the coastal region, its configuration, usage, and urban development. In addition to the above factors, the basic research must grasp the socio-economic circumstances of a particular area, and it must extract the particular defensive needs of the area. Finally, recreational visitors who fish, surf, or yacht must be accounted for just as the local residents are included in the mitigation measures.

(2) Effects of Topography

Tsunami damage is easily affected by topographical factors such as the coastal configuration (coastal line and the inland topography) and the sea floor topography. If the bay is v-shaped, there is a tendency that the concentration of the tsunami’s energy is amplified and the water level throughout the bay is higher. At the outermost point of the cape and inland, the underwater topography’s effect and the diffraction from the cape tend to concentrate and magnify the wave (increase of the tsunami by a concentrated effect). In addition, the more the crest wave of the tsunami approaches shallow water, the higher its water level tends to become (increase of the tsunami by shallow water effect). Furthermore, when the natural period and the periodicity of the tsunami are proximate, the water surface movement is reverberated by the tsunami, and the result is a higher water level in the bay (increase of the tsunami due to reverberation effect). Finally, in an extended shallow bay, the complicated interplay of nonlinear effects and diffusion can split a single tsunami wave into multiple waves (Soliton collisions). It is easy to predict the above by examining the topography of the coast. However, imprecise measurement of underwater topography makes it difficult to judge the concentration of the tsunami.

Once the tsunami has breached the defenses, the area of inundation will be increased by low-lying flat land beyond the shore. Although cliffs and high ground that are easily accessed can be useful as refuge points during a tsunami, when flat or gentle hills are behind the shore, evacuation to such sites can be difficult.

Finally, when they are sufficiently high, roads behind the shoreline can serve as de facto levees. When a river or channel flows into the ocean, there is a danger of tsunami runup from the mouth facing the ocean. The basic research must address possible effects of the topography on the tsunami, the evacuation, as well as man-made construction. Doing so will reveal the tasks that face safety planning.
Table 2-2 Topography and Potential Effects

<table>
<thead>
<tr>
<th>Topography</th>
<th>Potential Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-shaped bay</td>
<td>□ The tsunami’s energy is concentrated and the water level throughout the bay is higher</td>
</tr>
<tr>
<td>Tip of the cape</td>
<td>□ Sea floor topography effects and cape diffraction amplify the force of the tsunami</td>
</tr>
<tr>
<td>Within the bay</td>
<td>□ Reverberation effects can amplify the tsunami’s force. A relatively short bay can amplify a local tsunami; a long bay can amplify a distant tsunami.</td>
</tr>
<tr>
<td>Ria shoreline</td>
<td>□ A shoreline full of angles can result in some of the above effects.</td>
</tr>
<tr>
<td>Islands</td>
<td>□ The waves are captured by the perimeters of the island and clockwise and counter-clockwise waves meet, raising the water level. Even when the rear of the island does not face the wave source, the above results in a higher water level.</td>
</tr>
<tr>
<td>Shallow continental shelf</td>
<td>□ The water height of the tsunami is in inverse proportion to the fourth root of the water depth. The propagation velocity is also depends on the water depth, and the more shallow, the slower the speed. Accordingly, the tsunami tends to concentrate toward shallow water and amplification can occur.</td>
</tr>
<tr>
<td>Distant shoal</td>
<td>□ In longer distant shoals, Soliton collisions can result, breaking up a single tsunami wave into multiple waves.</td>
</tr>
<tr>
<td>Inland topography</td>
<td>□ If the inland topography is low, there can a deficiency of evacuation space. If there are cliffs or it is high ground, land can be used as evacuation areas if access roads are good.</td>
</tr>
<tr>
<td>Coastal roads</td>
<td>□ If roads along the coast are of high enough, they can become effective levees.</td>
</tr>
<tr>
<td>Rivers and Water Channels</td>
<td>□ There is a high risk of tsunami runup into the mouths of the rivers or channels that face the ocean.</td>
</tr>
</tbody>
</table>

(3) Assessing Current Levels of Preparedness

Many at-risk communities have learned from experiences such as the Sanriku tsunamis. They have embarked on and are actively engaged in a concrete and highly feasible plan of tsunami readiness. There are numerous other communities that have been struck by tsunamis in the past, but whose collective conscience about the dangers of tsunamis is becoming fainter.

Other communities that experienced tsunami attacks have developed or become urbanized, resulting in a complacency towards tsunami hazards. New generations of residents are unable or refuse to participate in drills and community-wide safety programs.

The background research must take these factors into account and define which tasks must be met by the readiness planning.
2.2.2 Damage Assessment from Past Tsunamis

By obtaining a clear understanding of the extent and causes of life and property damage (including secondary damage) of past earthquakes and tsunamis, we can develop a profile of the largest historical earthquake. This aids in creating the design tsunami, but also enables the danger of coastal areas to be assessed. It is important to incorporate new scientific research and updated land surveys. The latest seismology research on earthquake-free areas and earthquake periodicity should also be included.

To develop an accurate profile of past earthquakes and tsunamis, planners should consult other autonomies’ local hazard mitigation programs, surveys and reports, historical records in local archives, and also consider conducting interviews with local historians or witnesses.

Archives often describe the reconstruction efforts following earthquakes and we can learn much about the damage sustained through surveys and reports, historical accounts, and maps. Direct interviews with historians and witnesses are also valuable sources of information, but fewer witnesses are available for earthquakes which occurred long ago. Instead, information is often “legendary” and is not always reliable. Such accounts must always be compared with historical records and used in conjunction with each other. The survey should consist of the items listed in Table 2-3, which should be consulted during each stage of setting the plan.
<table>
<thead>
<tr>
<th>General Description</th>
<th>Items</th>
<th>Purpose</th>
<th>Method of Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics of the earthquake</td>
<td>Epicenter &amp; areas of no effect</td>
<td>Create the design tsunami and profile of largest earthquake-generated tsunami</td>
<td>Research of Archives - Consult the Hazard Mitigation Plan of Local Autonomy - Consult scholarly journals and articles of seismology - Consult existing reports - Confirm the seismic data</td>
</tr>
<tr>
<td></td>
<td>Time, frequency, and periodicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>magnitude</td>
<td>Determine the point of generation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>epicenter fault line parameters (See Note no. 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Affected area</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generation of tsunami</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tsunami Characteristics</td>
<td>Frequency of occurrence</td>
<td>As above, including evacuation</td>
<td>Research Archives - Consult scholarly journals and articles - Confirm the results of the tsunami data - Consult existing reports</td>
</tr>
<tr>
<td></td>
<td>Amplification (wave form, periodicity, propagation velocity)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refraction and resonance</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time of arrival following the earthquake</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Water level and high water mark</td>
<td>Determine the design tsunami</td>
<td>As above</td>
</tr>
<tr>
<td></td>
<td>Area of inundation (including water depth)</td>
<td>Assessment of the largest past tsunami</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amount of runup</td>
<td>Projection of inundation and danger areas</td>
<td></td>
</tr>
<tr>
<td>Human and property damage assessment (see Note No. 2)</td>
<td>Scale of the damage</td>
<td>Hazard assessment</td>
<td>Research archives - Consult scholarly journals and articles of seismology - Consult existing reports - Conduct interviews</td>
</tr>
<tr>
<td></td>
<td>Characteristics of the damage</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Causes</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reconstruction efforts (including emergency response and rebuilding)</td>
<td>Plan accordingly</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2-3, Survey Items and their Purposes**

Note No. 1: epicenter fault line parameters are determined by the position of the fault lines, depth, length, width, amount, and angle of displacement.
Note No. 2: Damage to life and property includes the following categories: 1) casualties, 2) housing, 3) coastal defense structures, 4) disruption of transportation (rail, road, and water), 5) essential services (water and sewage, electricity, gas, communication networks), 6) commerce and industry, 7) fishing and maritime industry, 8) agriculture, 9) forestry, 10) damage from fire and 11) damage to the land foundation
2.2.3 Assessing the Current State of the Tsunami Hazard Mitigation Program

The at-risk coastal area should undergo a thorough assessment of existing and planned defenses, including progress and review of those plans placed within the context of the tsunami hazard mitigation program. Plans for the future development should also be reviewed and clarified. Finally, areas struck by earthquakes and tsunamis should conduct a review of damage sustained and the subsequent reconstruction process.

To better understand the state of the hazard mitigation program, planners should conduct a systematic review of existing safety plans. These include plans of the defense structures and the port and fishing harbor. When necessary, public hearings with safety authorities or residents should be conducted. A survey of existing and planned coastal defenses should also be done. This includes bay and port defenses, fishing harbor defenses, including dikes, shoreline protection, breakwaters and parapet walls. The items to be reviewed are shown in Table 2-4, which should be referred to at each stage of the planning.
<table>
<thead>
<tr>
<th>General Area</th>
<th>Items</th>
<th>Purpose</th>
<th>Method of Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defense structures</td>
<td>Process of construction</td>
<td>Assessment of danger of inundation</td>
<td>Archive research</td>
</tr>
<tr>
<td></td>
<td>Rationale (within the context of the overall program)</td>
<td>Projection of the area of inundation</td>
<td>• bay and harbor plans</td>
</tr>
<tr>
<td></td>
<td>Type of structure (dikes, shoreline protection, parapets)</td>
<td>Check for safety during evacuation</td>
<td>• construction plans</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td></td>
<td>• registers</td>
</tr>
<tr>
<td></td>
<td>Basic structure</td>
<td>Check for maintenance of defensive capability</td>
<td>• Construction reports</td>
</tr>
<tr>
<td></td>
<td>Date of Construction</td>
<td></td>
<td>• On-site survey and other blueprints</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crest height</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basic policy of construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Installation of evacuation stairways</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Method of natural water drainage</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Type of beach in front of structure (include. post-construction alterations)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>State of old dikes and other defenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Progress of plans being implemented</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Future development plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Area</td>
<td>Items</td>
<td>Purpose</td>
<td>Method of Inquiry</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Urban planning based on tsunami preparedness</td>
<td>Relocation to higher ground</td>
<td>Assessment of the danger of tsunamis</td>
<td>Review of documents, public hearings, and on-site survey</td>
</tr>
<tr>
<td></td>
<td>Land usage, including bulwarking</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Establishment of Anti-tsunami communities, buffer zones</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maintenance of tsunami tidegates, sluices and sluice gates, etc., and measures for on-duty personnel during emergencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Future development plans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational System for dealing with Emergencies Evacuation measures</td>
<td>Issuing evacuation advisory and orders, communications systems, evacuation assistance (identify authorities and organizations responsible for)</td>
<td>Assessment of the evacuation system</td>
<td>Review of archives, public hearings</td>
</tr>
<tr>
<td>Preparation and maintenance of evacuation areas (temporary and evacuation sites for larger areas) and evacuation routes</td>
<td>Evacuation sites, designation of evacuation routes, distribution of evacuation sites, location of evacuation routes, topography and altitude of evacuation sites, evacuee capacity, evacuation areas (including their relationship to residential zones), evacuation site structures, readying the approach routes, road width, potential problem spots (bridges, tunnels, etc.)</td>
<td>Evaluation of the evacuation feasibility, sites, routes and safety</td>
<td>Review of Local Hazard Mitigation Program Land-use planning Public hearings On-site survey</td>
</tr>
<tr>
<td>General Area</td>
<td>Items</td>
<td>Purpose</td>
<td>Method of Inquiry</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Tsunami warning system</td>
<td>Organization responsible (structure and authority)</td>
<td>Assessment of starting time for evacuation and feasibility of emergency measures</td>
<td>Review of Local Hazard Mitigation Program, etc. Public hearings</td>
</tr>
<tr>
<td></td>
<td>Warning System (recipients of the warning, method, channels (transmission and reception) and transmission time)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency organizations</td>
<td>Report of Fire Department or volunteer fire dept. activities</td>
<td>Assessment of emergency capability and general public awareness of mitigation program</td>
<td>Review of Local Hazard Mitigation Program Public hearings</td>
</tr>
<tr>
<td></td>
<td>Chief and members’ ages</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location and distribution of fire departments and facilities, disaster readiness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Educational programs | Promoting public awareness through television, radio and newspaper media  
Publishing in public information bulletins  
Placement of tsunami warning signs, boards, and memorials  
Commemorative events to promote tsunami hazard awareness  
Distribution of tsunami-related pamphlets  
Placement of evacuation route signs  
Distribution of evacuation manuals |  |  |
|----------------------|------------------------------------------------------------------------------|-------------------------------|-----------------------------|
| Tsunami Hazard Mitigation Program Drills | Drill contents  
Frequency of drills  
Degree of participation by local residents | Assessment of emergency capability | Public hearings |
| Other emergency measures | System for the collection and dissemination of information  
Securing roads and emergency relief delivery  
Distribution system for food, water and medical supplies  
Medical response system  
Rescue response system  
Fire-fighting  
Maritime evacuation  
Evacuation for ships, boats, and fishing vessels  
Working in conjunction with the greater area | Assessment of emergency capability | Review of Local Hazard Mitigation Program  
Public hearings |
Regarding the Methods of Inquiry

Review the Written Records

Make use of the existing records, including bay and fishing plans, structural plans, and construction reports. Effective use should also be made of various local safety plans, such as local hazard mitigation programs and others.

Hold Public Hearings

In the development and implementation of a tsunami hazard mitigation program, public hearings play an extremely important role. Evaluations of community planning based on its community life, including residents’ opinions regarding readiness, are vital to tsunami readiness planning. Individual and public gatherings should be used. Planners should take care to include members from all strata of society, such as younger generations, and not selectively choose people well-known or important figures in the community.

On-Site Surveys

Visiting the site itself is an indispensable part of planning. Planners should not solely rely on secondary sources such as records and hearings, but survey the terrain itself. Using data from past tsunamis, it is important to gain a complete understanding the land usage, location and usage of facilities, and the maintenance of defense structures.
To accurately assess the risk of danger, it is necessary to understand the coast and in inland areas in three regards: 1) natural environment, 2) socio-economic structure, and 3) patterns of land-usage.

1) Natural Environment

It is necessary to determine the natural characteristics of the target areas, including topography, gradient, and depth of the sea-floor, sea conditions (sea level, esp. lunar month high tide average, ocean waves (winter wind waves) as well as the inland topography, including sea elevation.

In addition to making use of documentation such as scholarly journals, reports and archives, an on-site survey should be considered. Table 2-5 lists the items which should be covered at each stage of the planning.

Table 2-5 Research Items and Purpose

<table>
<thead>
<tr>
<th>Category</th>
<th>Items</th>
<th>Purpose</th>
<th>Method of Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoreline</td>
<td>Sea-bottom topography</td>
<td>To project the area of inundation and understand the topographical effect on the tsunami</td>
<td>Consult written materials, including: nautical charts, Geographical Survey Institute, Urban planning maps, harbor construction plans, sounding data</td>
</tr>
<tr>
<td></td>
<td>Sea-bottom gradient</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shoreline topography</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sea Conditions (including sea level and waves)</td>
<td>Estimation of inundation</td>
<td>On-site survey</td>
</tr>
<tr>
<td>Inland area</td>
<td>Topography</td>
<td>Predict the extent of tsunami damage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sea-level</td>
<td>Evaluate the feasibility of evacuation</td>
<td></td>
</tr>
</tbody>
</table>
2) Socio-Economic Factors

This information focuses on the attributes of the population, buildings, and economic activity of the community. Items include population, household distribution, household population, distribution of higher-risk population such as the elderly and disabled residents, and finally, the level of community awareness. Regarding buildings and structures, their earthquake resistance, size and date of construction must be determined. The type of business, number of employees and production output are other important factors.

To further clarify socio-economic factors, the national census, business establishment statistics, and public records should be consulted. When necessary, public hearings with residents and business managers can be held. Table 2-6 lists the items that should be covered at each stage of the planning.

<table>
<thead>
<tr>
<th>Category</th>
<th>Items</th>
<th>Purpose</th>
<th>Method of Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td>Population, number and distribution of households</td>
<td>Projection of tsunami damage</td>
<td>Consult written materials, including: national census figures, public registers</td>
</tr>
<tr>
<td></td>
<td>Ratio of elderly, children and other high-risk people</td>
<td>In addition to the above, evacuation feasibility, estimation of difficulty of evacuation, consideration of best response</td>
<td>Surveys of public attitudes and awareness</td>
</tr>
<tr>
<td></td>
<td>Community lifestyles, awareness and attitudes toward hazard preparedness</td>
<td></td>
<td>Public hearings</td>
</tr>
<tr>
<td></td>
<td>Daytime and nighttime populations and their age distribution</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incoming and outgoing population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings and structures (See Note No. 1 below)</td>
<td>Structure</td>
<td>Projection of tsunami damage</td>
<td>Consult written materials, including: registers and housing statistics</td>
</tr>
<tr>
<td></td>
<td>Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Years since construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>How the structure is being used</td>
<td>In addition to the above, evacuation feasibility</td>
<td></td>
</tr>
<tr>
<td>Economic activity</td>
<td>Type of business</td>
<td>Projection of tsunami damage</td>
<td>Consult written materials, including: national census figures</td>
</tr>
<tr>
<td></td>
<td>Facility holdings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Productive output of each facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of employees at each facility</td>
<td>In addition to the above, evacuation feasibility</td>
<td>business establishment statistics Public hearings</td>
<td></td>
</tr>
</tbody>
</table>

Note No. 1: Types of construction include 1) houses, and 2) facilities for public and official use
3) Land Usage

The information to be investigated here are the conditions of coastal land and ground, urban form, location and distribution of city facilities. Also covered are land usage plans in action, development plans and most recent trends as well as long-term planning.

In order to understand the characteristics of land usage, urban development plans and local development plans should be consulted. When necessary, public hearing with developers and others should be held. Table 2-7 lists the items which should be covered at each stage of the planning.

**Table 2-7 Research Items and Purpose**

<table>
<thead>
<tr>
<th>Category</th>
<th>Items</th>
<th>Purpose</th>
<th>Method of Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land and Ground</td>
<td>Presence and state of land subsidence, land at zero sea level, reclaimed land, weathered land</td>
<td>Estimation of runup depth and duration of the damage</td>
<td>Consult written materials, including: Urban development plans</td>
</tr>
<tr>
<td>Urban form</td>
<td>• Historical development of the city</td>
<td>Predict the extent of tsunami damage</td>
<td>Local development plans</td>
</tr>
<tr>
<td></td>
<td>• Land usage</td>
<td>Grasping potential causes of damage</td>
<td>Drawing plans</td>
</tr>
<tr>
<td></td>
<td>• overcrowding and blockage</td>
<td>Assessment of the possibility of increased damage</td>
<td>Facility registers</td>
</tr>
<tr>
<td></td>
<td>• green and undeveloped areas</td>
<td></td>
<td>Public hearings</td>
</tr>
<tr>
<td></td>
<td>• facilities housing dangerous materials and residential areas</td>
<td></td>
<td>On-site surveys</td>
</tr>
<tr>
<td>Urban facilities</td>
<td>State of port and harbor facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Transportation facilities and type of network</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Lifeline facilities and type of network</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Distribution of facilities with dangerous materials (factories, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Distribution of manufacturing facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Distribution of and capacity of train terminals or underground shopping centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Distribution of tourist resources (including beaches, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Distribution of hospitals, nursing care facilities which house people at higher risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Distribution of schools</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Presence of rivers and channels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban and Local Development Planning</td>
<td>Review of plans being implemented (objective, contents, implementation time) and degree of completion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban and Local Development Planning</td>
<td>Predict the extent of tsunami damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Predict the extent of tsunami damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grasping potential causes of damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assessment of the possibility of increased damage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.3 Establishing the Design Tsunami and Estimation of Damage

2.3.1 Establishing the Design Tsunami

The tsunami hazard mitigation program is based on the assumption of the external force of a
design tsunami. It is designed according to data from previous tsunamis where there is
relatively precise data such as high water marks. Of these, the largest tsunami is selected and it
forms the basis of the design tsunami. However, regarding specific local areas which, according
to recent seismic research, will be possibly struck by an earthquake-generated tsunami, plans
must incorporate more recent opinion in projecting the largest tsunami and compare it to the
largest past tsunami data. Choose the safest possibility and base the design tsunami on the
highest water level projections. There is no guarantee, however, that the largest earthquake will
generate the largest tsunami. It remains important to take into account many factors such as the
earthquake’s scale, depth and location of the hypocenter, its directivity, displacement due to
fault motion, as the design tsunami is developed.

In addition, it is necessary not only to estimate the tsunami’s water level, but also its time of
arrival, so as to formulate plans for evacuation of people, boats and ships easily affected by
time constraints.

In the past, design tsunamis generally were based on the largest of past tsunamis, developed from
relatively precise data of the readily available historical information.

More recently, projections of the largest possible oceanic earthquakes have incorporated theoretical
advances such as geotectonics and the active fault model. Improvements more advanced seismic measuring
technology has revealed “blank areas,” gaps or areas unaffected by earthquakes, thereby making possible
new projections not solely based on past data available. Local authorities are increasingly using such
methods in the creation of design tsunamis.

As described above, this guide will focus on reliable data of the largest past tsunamis and
incorporate new technology and opinion in making the design tsunami. From a comparison of these two,
the guide will adopt the safest possible scenario by selection of the highest water level.

It must be remembered, however, that the largest earthquake may not necessarily generate the
largest tsunami. In spite of being relatively small, a “tsunami-earthquake” could occur. Thus, evaluations of
the earthquake’s scale, depth and location of the hypocenter and the resulting tsunami’s directivity, etc.
should be part of the design tsunami.

Finally, apogean tsunamis (tsunamis generated from far away) must be accounted for. When
records show that the coastal water level peak of an apogean tsunami was higher than that of the design
tsunami, it becomes necessary to establish another earthquake in the design tsunami.
Regarding the evacuation of the people on the coast, ships and boats, key information is not the tsunami’s water level, but its time of arrival, which is determined by the distance between the wave source and the coastline in question.

In order to determine the size and characteristics of past tsunamis and project the size of future earthquakes, planners should consult the “Pacific Earthquake & Tsunami Survey Report,” published in 1996 by the Ministry of Construction, Ministry of Agriculture, Forestry and Fisheries, Fisheries Agency and the Ministry of Transport.

1) Amplification

In order to make an accurate projection of tsunami amplification, it is common these days to use active fault model to develop a numerical analysis of the tsunami which will be generated. In coastal areas where sufficient data is unavailable, the amplification of a past tsunami can be recreated by numerical analysis of wave height and propagation velocity over space and time. In areas recognized as vulnerable to a tsunami strike, more realistic projections can be made with the aid of specialists.

When drafting a hazard mitigation plan or developing a design tsunami, numerical analysis is an effective method but this technology is still in development stage. There are limits to the accuracy, cost and general applicability. At present, many questions remain concerning the accuracy of simulations of the wave source model, the form of the wave, form and amplitude of the leading wave, and river runup. As a result, although the numerical analysis of the tsunami can serve as a basis for a relative estimation, there are too many unsolved problems to make it an absolute estimation.

Caution should be exercised in the method of numerical analysis as follows:

(1) Use of the numerical analysis
a. Measuring the amplification of past tsunamis
   After checking the recreation based on a comparison of past records and numerical results, it is possible to obtain unobserved results, for example, regarding the area of inundation or flow velocity (libration)
   b. Predicting the Amplification

   It is possible to predict the amplification created by current of future changes in the coastal features, such as breakwaters, sea walls, and reclaimed land. It is also possible to predict the effectiveness of defense structures. For general methods of carrying out a numerical analysis, planners should consult the “Manual for Predicting Tsunami Damage.”

(2) Caution of Usage

a. Errors in the mathematical parameters
   To make an accurate projection of a tsunami wavelength in time and space, it is necessary to establish as many equations as possible for each wave. Generally for each wavelength at least 20 and if
possible 30 measurements should be carried out.

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Furthermore, once the wave reaches shore, it is necessary to determine at least 50 points along the leading wave’s wavelength (according to Iwasaki and Mano). For example, if the design tsunami’s wavelength is 10 kilometers, to insure a minimum of numerical accuracy it is necessary to measure at least 200 meters.

Errors caused by linearity and non-linearity

When simulating the amplification, the non-linearity and wavenumber dispersiveness parameters of the physics model are important. Non-linearity is relative to wave height and depth of the water, and as the water becomes more shallow amplitude is increased, resulting in such effects as a forward tilt. The wavenumber dispersiveness, in relation to the ratio between depth and wavelength, can result in changes in the velocity depending on the wavelength.

As described, therefore, in waters exceeding a depth of 50 meters, linear wavelengths are employed. In shallower waters, non-linear wavelengths are used as standards in simulating the crest of the wave. It is necessary to consider the dispersiveness in simulating the runup in rivers and undulation.

Errors in initial conditions

Following an ordinary earthquake, we can say that change in the sea floor is the same as change in the mean sea level, and according to the hypocenter fault model, the amount of water level change in the water column determines the initial condition.

The starting point of the numerical analysis of the tsunami, the initial wave form, depends largely on setting of the hypocenter fault model. The setting of the model will affect the certainty of the calculation according which seismographer was used, which frequency band of the earthquake was used, whether only seismic information was used or if it was set in conjunction with high water marks. Such considerations must be accounted for in making numerical analyses of tsunamis.

Errors from submarine topography

The height of the tsunami increases as it approaches the shore (and the ocean floor becomes shallower). When a tsunami enters a v-shaped bay, its energy is increasingly concentrated, resulting in a steeper wave as it moves toward shore (amplification).

In the numerical analysis of the tsunami, the effect of underwater and shoreline topography on the steepness of the wave is automatically calculated. In the shallow depths, the precision of data is high; however, at greater depths, questionable data can easily result in errors.

Errors resulting from reverberation

Once the tsunami has breached the bay, the shape of the bay or port may contribute to the steepness of the wave. In performing the numerical analysis, the shape of even a small harbor must be accounted for.
Tôi đã xem xét tất cả những điều kiện mà người dùng đề ra.

Tôi đã tìm hiểu và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ những điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đặt ra.

Tôi đã xem xét và hiểu rõ về mọi điều kiện mà người dùng đã đưa ra.
2.3.2 Estimating Damage

The damage estimate is derived from the design tsunami. Its purpose is the protection of life and property. It is based on evaluations of damage caused by past tsunamis, the current use of land, the population, and agglomeration of industries of the at-risk community.

One of the basic principles in the promotion of the tsunami hazard mitigation program is the estimate of damage. In other words, in order to protect life and property from the damage caused by the design tsunami, the community’s type and scale of damage must be projected so that the potential for danger can be estimated.

By doing so, not only are the assumptions underlying the program made clear, but the estimate will greatly affect the plan itself. In order to carry out the estimate, the current land-use, census and lifestyles of the population, and the agglomeration of buildings and industries, will be considered. The design tsunami’s projected water level is derived from the numerical analysis and these results are examined and compared with the shore protection structures and the crest height of structures. Then, the estimate of the inundation will be an effective guide to the extent of danger. In cases when a more detailed study is required, the onshore runup calculation is used to estimate a community’s inland area of inundation.

In coastal cities with ports, especially, floodgates and sea wall gates are usually kept open to facilitate access to the port and cargo handling. However, in the event of a tsunami, there is no guarantee that these will be able to be shut. Accordingly, to reduce the damage of flooding in low-lying inland areas, it is extremely important to estimate the flow of tsunami floodwater through these openings.

There remains much uncertainty in regard to the amplification of tsunamis. Further complicating an accurate assessment of the danger is that tsunamis cause secondary damage by floating debris, damage by chemicals such as oil, and fire. We must be aware that such conditions render the estimate a mere outline of the potential hazards.
1) Items to be used in the estimation of target areas

To evaluate the potential damage caused by the design tsunami, surveys with detail the characteristics of the target area should be conducted as in Table 2-8 below.

<table>
<thead>
<tr>
<th>Contents</th>
<th>Items</th>
<th>Standards</th>
</tr>
</thead>
</table>
| Safe and smooth evacuation of residents and visitors (tourists, sun-bathers, fishermen, etc.) | □ Evaluation of the safety of evacuation sites and routes | 1. Distribution and time fluctuations of areas of inundation  
2. Presence of safe evacuation sites  
   a. designation and capacity of evacuation sites and routes  
   b. presence of topographical and elevation-safe areas  
3. Resident population figures  
4. Areas where visitors are located, fluctuations by season and time of day  
5. Location of elevated roads, bridges, tunnels, and other risk points during times of emergency |
| □ Comparison between the tsunami’s time of arrival and the time required to evacuate from housing to evacuation sites | 1. Starting time for residents’ evacuation  
2. History of hazard damage to the community, spread of safety education  
3. Evacuation infrastructure  
   a. outdoor speakers to issue tsunami warnings  
   b. presence of signs indicating evacuation areas and routes, visibility at night  
   c. distance from residences to evacuation sites  
4. Topography and current road conditions  
   a. check emergency stairways  
   b. residents’ walking speed during evacuation  
5. Number of elderly and disabled  
   a. traffic capacity for pedestrians and vehicles of evacuation routes |
<table>
<thead>
<tr>
<th>Protection of resident and public property</th>
<th>Assessment of inundation</th>
<th>Potential for physical damage</th>
</tr>
</thead>
</table>
|                                          | 1. Distribution of water levels and time fluctuations  
2. Tsunami defense by shore protection structures  
   a. type of construction, crest height, length, etc.  
   b. plans for future construction  
3. Sea conditions  
   a. average lunar high tide, winter winds, etc.  | 1. Areas of inundations and time fluctuations  
2. Agglomeration of facilities by type and function  
   a. present use of land along the shore and coastal area and distribution of buildings  
   b. accumulation of oil, lumber, etc. in ports and harbors |
Items for Projection

1) Tsunami coastal water level (including the maximum water level)
2) Time of arrival
3) Depth of inundation on land
4) Velocity increase at the edges of inundation areas

In historically vulnerable areas such as Tokyo and Osaka but for which no record of tsunami inundation exists, high water records make it possible to hypothesize tsunami inundation.

4) Estimating the Extent of Damage

Past tsunami damage is established by stating the relationship between the external force of the tsunami and the physical damage. That result can then forms a framework from which a projection can be made and the danger to the target area can be assessed.

(1) Tsunami Damage Estimate

Regarding damage caused by the tsunami, there are dynamic forces at work behind each cause. Pointing to representative factors of the process and extent of damage would desirable, but there is very little research to support this. Consequently, records of a tsunami’s high water level and the resulting damage are what are used. The greatness of the external force is determined by a detailed numerical analysis of the wave height.

Tsunami wave types differ with each wave. Depending on effects of the topography, the same tsunami wave can differ. This must be kept in mind as the assessment of the danger risk is made, and remember that this is producing an outline of potential damage.

(2) Feasibility of Evacuation

In developing the inundation scenario, the most important aspect of insuring the public’s safety is the warning and disaster evacuation system. In the evacuation plan, the design tsunami’s time of arrival gives a limited time for people to move smoothly and safely to refuge areas. Thus, great care must be taken in the selection of evacuation sites and routes. The first wave may not necessarily produce the highest runup and so safety plans could be required for a series of waves.
<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Considerations based on the current situation</th>
<th>Considerations from potential for danger</th>
</tr>
</thead>
</table>
| Defense structures              | Construction and state of defense structures | 1. Weakening of earthquake and tsunami resistance due to aging  
2. Degree of aging according to structure maintenance  
3. Installation of evacuation structures such as emergency stairways  
4. Use of offshore defense structures  
5. Installation of remote-controlled tsunami tidegates | Comparison of projected wave height and the crest height of defense structures                                |
| Defense structures' resistance to earthquakes and tsunami force |                            | 1. Destruction of structures by earthquake  
2. Destruction of structures by the tsunami (esp. the tide gates, etc.)  
3. Destruction of the structure by breach of the wave, destruction caused by retreating waves or flow carrying or pulling objects out to sea |                                                                                 |
| Changes in the tsunami caused by construction of defenses |                              | 1. Amplification increases wave altitude  
2. Negative influence on nearby environment |                                                                                           |
| Water discharge behind the sea walls |                              | Lack of discharge mouths, consolidation of discharge channels  
Tide gates are too narrow resulting in lower discharge capacity |                                                                                           |
<p>| Influence on residents daily lives |                              | Use of coastal areas by residents (production and daily life) |                                                                                           |</p>
<table>
<thead>
<tr>
<th>Construction standards for defense structures</th>
<th>Defense structures built for purposes other than tsunami safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance of defense structures</td>
<td>Fortification and repair of damage, frequency of inspection</td>
</tr>
</tbody>
</table>

**Urban planning based on tsunami preparedness**

<table>
<thead>
<tr>
<th>Use of land inside and on the exterior of the levees</th>
<th>1. Accumulation of dangerous materials, location of facilities related to dangerous materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Presence of lumber, vehicles, etc. which could be carried by the waves</td>
</tr>
<tr>
<td></td>
<td>3. Lack of evacuation sites and routes</td>
</tr>
</tbody>
</table>

1. Points of inundation and relationship to urban area
2. Distribution of water level in the inundation area and relationship to urban area

**Development of residential areas**

<table>
<thead>
<tr>
<th>1. Concentrations of aged housing, urban sprawl effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Implementation of inflammable construction</td>
</tr>
</tbody>
</table>

**Location and Structure of public facilities**

<table>
<thead>
<tr>
<th>1. Concentration and altitude of coastal hospitals, nursing homes, etc. with at-risk residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Concentration and altitude of municipal buildings, fire &amp; police departments along the coast</td>
</tr>
<tr>
<td>3. Concentration and altitude of schools along the coast</td>
</tr>
</tbody>
</table>

**Construction of roads and railways**

| 1. Location of stations and bus terminals with unknown number of patrons |
| 2. Location of road and rail bridges which will be effected by tsunami river runup |
1. Possibility of runup in drinking water and sewage lines
2. Disruption of lifelines, i.e. flooding of transformers and pump stations

- Location and structure of communications and distribution centers
- Location and structure of fishing facilities
- Use of tsunami control forests
- Use of land at zero seal level
- Use of reclaimed land and man-made islands
- Location and structure of port and harbor facilities
- Location and structure of agricultural facilities, land improvement, handling of and evacuation of ships and boats
- Location and structure of businesses

1. Potential damage to access roads to the mainland
2. Lack of evacuation sites and routes

- Urban planning based on tsunami preparedness
- Possibility of closing of the harbor and shipping lanes due to floating debris of fishing tools and fish farming materials

- Effectiveness against tsunamis
- Lack of discharge mouths, consolidation of discharge channels
- Tide gates are too narrow resulting in lower discharge capacity

- Economic impact
- Blockage of shipping lanes by floating obstacles
- Depletion of shipping ability due to destruction of port facilities

- Danger of runup from water ducts
- Lack of evacuation areas
| Location and structure of manufacturing | Destruction of facilities, flood damage to production and negative impact on the economy | 1. Points of inundation and relationship to urban area  
2. Distribution of water level in the inundation area and relationship to urban area |
|----------------------------------------|-------------------------------------------------|--------------------------------------------------|
| Location and structure of underground and other facilities where people gather | Potential increase of fatalities | 1. Potential increase of fatalities  
2. Confusion during evacuation for a lack of knowledge of evacuation sites |
| Location and structure of recreation and leisure facilities | 1. Potential for secondary damage caused by leakage  
2. Lack of space for oil tankers to evacuate  
3. Environmental pollution | 1. Time fluctuation of inundation area and possibility of escape  
2. Tsunami time of arrival and possibility of escape |
| Location and structure of sites with dangerous materials | 1. Potential increase of fatalities  
2. Unprepared system for evacuation | |
| Safety organizations | 1. Level of community involvement  
|                      | 2. Number and activities of volunteer safety organizations, fire squadrons |
| Warning system       | 1. Faulty tsunami warning system  
|                      | 2. Installation of safety authorities' wireless communication system, outdoor speakers |
| Plans for beach patrons, etc. | 1. Signs indicating routes to evacuation areas  
|                      | 2. Faulty tsunami warning system |
| Evacuation of port and ship employees | Lack of evacuation sites and routes |
| Closing flood gates | Installation of automatic or remote-controllable closing system |
| Protection of fishing | Lack of evacuation space for fishing boats |
| Safety Education | Public knowledge of evacuation sites, safety awareness |
2.5 Devising a Plan

The formulation of the tsunami hazard mitigation program is included as part of the local authority’s hazard mitigation plan. Planners are responsible for determining content, organization, method, schedule and required funding.

In implementing the tsunami hazard mitigation program the most effective plan must be based on the local socio-economic conditions. In determining a suitable plan for a particular region, an overall effective plan which incorporates the three main areas of preparedness - the defense structures, city planning based on preparedness and the emergency organizational structure – will be based on the problems and tasks described in the previous section. Important in this regard are local fiscal conditions, effective defense measures, and the plan’s effect on the community’s daily life.

In carrying out the plan, the organization, methods for achieving the aims, time schedule, and funding need to be established and will be stated as part of the local hazard mitigation program. The method and schedule of achieving these aims will be evaluated with the economic feasibility, degree of urgency, necessity, and overall feasibility. In this way, local priorities can be established with higher priority goals being met first.

For long-term projects that require acquisition of land and extended period of construction, there should be a period of evaluation following the start of construction in which the progress is reevaluated. This is part of an incremental safety plan.
2.6 Problems During Implementation

Even when a program is already in place, it is in need of regular revision. As time passes the scope of damage changes, resulting from new patterns of usage of the coastal land, demographic, and social change.

In recent years, reclaimed land and man-made islands have resulted in a great expansion of coastal land use. Not only are there manufacturing and energy-related industries, but also multi-purpose usage of airports, recreation facilities, residential areas, and commercial centers.

In urban areas, the low birth rate and an increasingly aging of society have brought changes to the demographic structure. Large-scale housing complexes and more convenient transportation networks have caused a rapid growth in the coastal population and changes in urban society. For these reasons, as time passes from a program’s implementation, the more its projections of damage resulting from a tsunami strike must reflect these changes.

With the increase in computer technology and advances in tsunami research, the tsunami’s impact can be calculated more accurately through statistical analysis and thus should be updated on a regular basis, as should the mitigation program itself.
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CHAPTER 3 INCREASING TSUNAMI PREPAREDNESS

3.1 Defense Structures

3.1.1. Introduction

The purpose of defense structures is to prevent the tsunami from striking land. They include the following:

1. Sea walls
2. Tsunami breakwaters
3. Tsunami tidegates
4. River dikes
5. Others (Tsunami Control Forests, tsunami-resistant buildings)

Regarding defense structures, which directly prevent a breach of a tsunami, there are various structures such as sea walls; tsunami barriers, which are typically found at the entrance of a harbor; tsunami tidegates, constructed at the mouth of a river; and river dikes. (Note: sea walls are barriers designed to reduce the damage caused by high tides or tsunamis. River dikes are for mitigating effects of high tides in rivers. Breakwaters protect docks in fishing harbors and ports from the effects of waves).

Although tsunami control forests and tsunami-resistant buildings cannot completely prevent a tsunami breach, they have been effective in reducing the damaging effects of tsunamis, especially blocking floating debris. It remains difficult, however, to quantify their actual effectiveness, and they are based on the premise that the tsunami will breach the sea barriers. Their construction largely depends on civil planning, so they are mentioned as reference points.

a. Sea Walls

Sea walls, which protect the coast from tsunamis striking land, are fundamental to tsunami preparedness. Their crest height should be determined by construction standards of the particular area in which they are built, but planners should bear in mind that a tsunami could still breach the walls and in that event, the effectiveness and safety of the levee walls must be taken into consideration.

b. Tsunami breakwaters

Tsunami breakwaters alleviate rises of the water level within a designated area. They also are effective in altering tsunami wave reverberation. They are already in place at harbors for large vessels and are being built at various port entries such as at Kamaishi, Kuji, and Suzuki.
The effectiveness of tsunami breakwaters varies, depending on the shape of the bay, their location, the width of the mouth, and the variations of an incoming tsunami’s cycle and wave height. It is necessary to bear in mind such factors when making a calculation or model simulation. At the same time, the reflection and reverberation effects within the breakwater effects on local areas must be accounted for in the planning.

c Tsunami tidegates

Tsunami tidegates are located at the estuaries of rivers. Their purpose is to prevent the tsunami waves from flowing up the rivers. There are many ways a tsunami wave affects a river, depending on the wave’s power (strength), overflow, and external power. Thus a thorough review from a hydrology perspective is necessary. In past tsunamis, the tsunami tidegates sealed off flooding from tributaries, but as a result, reflective waves hit neighboring shores and the water level was increased. Planners must account for this during planning.

d River Dikes

By increasing the height of a river dike, the downstream dikes are set at a sufficient height to prevent surges in the river and thus stop overflow into a designated area.

Rivers are relatively susceptible to tsunami runup. Tsunamis move along shallow flat surfaces against the current and thus their wave formations become increasingly complex and the vibration width can become wider. The river dikes should be of a sufficient height to stop overflow, but a possible tsunami of unpredicted magnitude could still overflow. Thus, just as high sea-walls, the placement of a strengthened three-sided levee is necessary.

To avoid the increased cost of such a system, the construction of tsunami tidegates are common. However, in some cases where it is most beneficial to use the river system’s topography as a buffer zone, constructing tsunami tidegates for all rivers is not necessarily the best method. In such a case, it must be remembered that drains in inundation areas remain vulnerable to tsunami runup.

e Others (Reference)

• Tsunami Control Forests

The ability of tsunami control forests to reduce a tsunami wave’s energy remains, at present, unclear. There are, however, many historical examples of them stopping floating objects, and acting as a life preserver to people swept away by the tsunami, so they do have a safety role to play during a tsunami disaster. However, we should be aware that if the runup depth is over 4 meters, they have practically no beneficial effect.

• Tsunami-resistant Buildings
A row of buildings designed specifically to withstand a tsunami are placed at the waterfront and are effective for reducing the strength of the tsunami and preventing runup into the interior. It is also clear from studies that anti-tsunami buildings are effective at blocking floating objects such as boats, wood, houses, etc. Anti-tsunami buildings are dually effective in that they allow usage of the coast and fishing and they have a safety function as well. They are described in more detail in Chapter 3, Tsunami Readiness and Civil Planning.
3.1.2 Construction Standards

Safety needs must be clarified for each at-risk area. Based on the damage estimate described in section 2.3, construction standards must now be drawn up. Standards will reflect the needs described from a detailed analysis of local situations and effective safety measures. In cases where patterns of land usage change, or new knowledge contributes to the understanding of tsunamis, it may be necessary to review and revise safety standards of construction. Finally, a balance must be sought between the mutual effects of construction in adjacent areas.

Defense structures form the base of the tsunami hazard mitigation program. Notwithstanding a higher guarantee of prevention from damage caused by tsunamis, the associated costs and time needed for construction are significant. Construction standards must reflect the safety needs of each area, which have been derived from damage estimates. Furthermore, its compatibility with civil planning and the organizational emergency system must be assessed. Defense structures and standards must reflect changes in patterns of land use and new knowledge of tsunamis and should be subject to revision.

(1) The tsunami mitigation hazard program is a response to a projected tsunami of the greatest magnitude. Construction standards of defensive structures are based on the local characteristics and measurements of their effectiveness. As part of a comprehensive plan including city planning based on preparedness and the emergency organization, there is no guarantee that construction standards match design tsunami requirements.

(2) Estimation of Damage

Priority areas are established based on damage estimates. In those areas, standards must be clearly stated as below. It is advised that other areas adopt similar standards.

(3) Construction standards are based on a comprehensive review of the following: a) structures in place and future construction plans, b) inland situation and future (environmental and social conditions), c) use of coastal land (production, daily life). Some cases may require an incremental approach due to safety effectiveness and economic factors.

(4) Levee free-boarding

When standards are being determined, it may be necessary to implement levee free-boarding. There is a possibility of uneven settlement, erosion of the foundation, drag forces, and the destruction of deteriorated facilities during an earthquake. Or, statistical error in the calculation of the wave height may occur. In such cases, there may be a need determine higher levee free-boards.
(5) A balance is needed between priority and adjacent areas as constructions could adversely affect the tsunami’s amplitude (rise in water level due to reflection and multiplication of waves from offshore structures).
3.1.3 Selecting Proper Defense Structures

The selection of defense structures should be based on the area conditions, present state of defense structures, construction cost and safety benefits. Defense structures may be used by themselves or in combinations with other types.

Defense structures have unique features and should be carefully selected depending on the land use, existing structures, cost, their effects, and whether stage construction can be carried out. Tide embankments and tsunami breakwaters can be used individually or in conjunction with each other. A great deal of land is required for the new construction or raising of tide embankments. Therefore, their use must be weighed against plans for future development of the area or land use.

In some areas, new construction could inconvenience use of the coast, block sunlight or air flow. Tsunami breakwaters can change the flow of the tidal current, affect water quality or fishing. Accordingly, careful attention to such problems must be given.

A more detailed guide to planning and building defense structures is found in “Guide to Coastal Protection Construction Standards.”
1. The text is written in a very complex and dense style, making it difficult to understand. It appears to be discussing some kind of technical or scientific topic, but the specific content is not clear. The text is not well-formatted, with many abbreviations and jargon that are not defined.

2. The font is very small and difficult to read. The text is not organized in a way that makes it easy to follow. It is not clear what the main points of the text are, and there are many long paragraphs that are hard to digest.

3. The text is not well-edited. There are many spelling and grammar errors, and the overall quality of the writing is low. It is not clear what the author is trying to convey, and the text is not compelling or engaging.

Overall, the text is not readable or useful. It is not clear what the main points of the text are, and the content is not well-organized or easy to follow. The writing is not clear or concise, and the text is not engaging or informative.
### 3.1.5 Discharging Floodwater in the Protected Area

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<tbody>
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<td><strong>In areas protected by tsunami barriers, it is important to have a drainage plan.</strong></td>
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</tr>
<tr>
<td>(1) Flooding (or ponding) resulting from tsunami flooding across the defenses</td>
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<tr>
<td>(2) Flooding caused by rainfall</td>
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</table>

1. There are cases when the tsunami waves will overflow the defenses. Although we can anticipate the reduction of flooding and of the tsunami’s damaging force, the risk of further damage must be prevented by curtailing long-term ponding or flooding of protected areas within the levees.

2. Lack of drains, consolidated drainage channels, and narrow drains are causes of insufficient drainage within the protected area. Flooding will occur in areas where rainwater is not immediately drained and in some areas, damage occurs every year. Installation of drains, drainage channels or pumping stations is necessary in the planning.

3. When a tsunami attack occurs during a drainage period, it is necessary to discharge the reservoir of water within the channel with the tidegates closed. The same applies to cases when the tsunami breaches the tidegates and flooding has occurred.
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3.2.2 Promoting Defensive Land-use

3.2.2.1 Zoning and Tsunami Hazard Mitigation

1) Inducement to use land in safe areas

(1) Land-use in urban areas

   a. Relocation to higher elevation

   The possibility for relocation to higher, safer ground should be considered when houses are located in areas expected to receive extensive damage.

Relocation to higher ground has been a part of reconstruction policies in the past and remains a viable though drastic, measure at present. The Land Agency has such a program through its Safety Relocation Program, initiated in December of 1972 under the eponymous law. It allows local authorities to relocate residents from designated danger areas to safer ones. This program is only carried out in “areas that have suffered a disaster or are designated as a danger zone.” Therefore, in order to qualify for the government program, residential areas must be designated as a danger zone under the Basic Construction Law.

b Planned Land-usage

   Land use is promoted which reduces the extent of damage of a tsunami attack. In areas projected to be affected by a tsunami, current patterns of land usage, future development of the area, and the convenience of local residents must be taken into account.

   The main task of urban planning based on tsunami readiness is to reduce the amount of damage as much as possible through appropriate land use. One measure is relocation, as above, but in areas where relocation is difficult, a policy of restricted land use is an effective alternative.
Policy measures should be based on the areas of inundation and projection of damage caused by the design tsunami, as discussed previously. The following are examples of land use restrictions under current law.

Danger Areas

The Basic Construction Law states, “Article 39: Areas which are at considerable risk of tsunamis, high tides, and flooding can be designated as danger areas. For safety precautions, housing and other construction may be restricted in danger areas.

The above allows local governments to declare danger areas and then proceed with a relocation program. Under the same provision, they also are able to promote tsunami-resistant construction and restrict building in the danger areas. Nagoya City is one such case. After designating a danger area, it placed residential and building restrictions an area over 6,000 hectares.

Zoning Restrictions on Residential Housing

According to Article 3 of the Restriction of Residential Housing Law “At the request of a prefectural government (or designated city), the Minister of Construction can designate an urban or suburban area that is at considerable risk as a Restricted Residential Area.”

However, the law stipulates that “when the prefectural authorities request such a designation, they must first receive the mayor’s agreement of the affected area.” Based on the above, restrictions can be placed on at-risk areas and buffer zones to prevent reckless building.

(2) Appropriate Land Use during Development of the Coastline

In large metropolitan areas where the redevelopment of coastal land occurs, planning which promotes safety along the coast and increases the safety of inland areas is desirable.
2) Land Use Planning & Introduction of Anti-tsunami or Buffer Districts

In at-risk coastal areas, anti-tsunami buildings and relocation are included in the urban planning and land-use planning. In addition, urban planning should include such measures as restriction on land use in areas which could serve as buffer districts.

When anti-tsunami buildings and evacuation buildings along the coast are planned, or when unused fields must be secured as part of the defense program, it is important to define the roles of such areas in the overall land use planning. By doing so, it is also important to seek a balance between use during daily life and that required during an emergency.

Here, land use which incorporates the concept of anti-tsunami districts or buffer districts should be reflected in the urban planning master plan as the vision for land use is developed. City planning should propose a guaranteed system and methods for making such land use a reality.

(1) Anti-Tsunami Districts

In land which is used behind the tide embankments, depending on the circumstances, can be designated as an anti-tsunami district. By constructing anti-tsunami buildings, the damage to the interior can be reduced. Research following the Sanriku Tsunami of 1933 reports that ferro-concrete houses and warehouses prevented the wooden houses behind them from being destroyed or carried off. This shows that strong structures weaken the tsunami force and also block large floating debris.

Effective examples such as the above can be incorporated in current planning. By designating high risk coastal areas as anti-tsunami districts, reinforcement of construction can be achieved. In such a case, a row of buildings can serve as a strengthened wall and is an effective way of reducing the amount of runup. The anti-tsunami buildings not only reduce overflow of the tsunami wave, but are effective in blocking lumber, boats and other dangerous floating debris from breaching the water’s edge.

As land use increases behind the tide embankments, and fishing warehouses or processing plants are adjacent to the tide embankments, their use as reinforced anti-tsunami buildings is important. It may be difficult to reinforce present structures, and therefore, new or reconstruction should be considered.

The same applies to future land use in other areas. It is necessary to restrict land use in dangerous areas, but for practical reasons it is necessary to have manufacturing or distribution facilities on the coast. In such cases, facilities should be reinforced as anti-tsunami and thus become an anti-tsunami district in the future.
Areas that can absorb the force of the tsunami and which are not being used can be designated as a buffer district. They increase the safety in adjacent areas where usage is high. During a tsunami strike, defense structures at the water’s edge cause reflection, which can increase the water level in adjacent area. This means the water that would normally flood on land becomes concentrated in the ocean. In such a case, land which can absorb the tsunami’s power and which is unused can be designated as a buffer district. The buffer district can prevent a breach by a small or medium-sized tsunami, but absorbs a large tsunami. Thus, it contributes to the safety of neighboring areas which have heavier land use. Inland areas with no houses or is undeveloped is one way of dealing with such flooding. It can be used to absorb the runup of the tsunami and thus contribute to the safety of highly developed areas.

(2) Buffer Districts
3.2.2.2 Regarding Vital Public Facilities

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<thead>
<tr>
<th>The following points are important in the location and construction of public buildings such as the city hall, schools, hospitals, public halls, and parks.</th>
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<tr>
<td><strong>(1) Inducement of proper land usage</strong></td>
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<tr>
<td><strong>(2) Will be used as evacuation and rescue centers</strong></td>
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Public facilities play an important role and their location characterize the makeup of a given community. Judging the activity in the community and between the wider area, it is important to consider their placement in designing a community based on tsunami preparedness. They become centers for evacuation and rescue during a tsunami attack and so their placement in safe areas is necessary. When they are located in high danger areas, proper steps should be taken to ensure anti-tsunami construction.

In areas such as Sanriku which have been attacked before, public facilities are often placed in safe locations. However, many at-risk areas may not be able to strategically locate their public facilities. Schools and medical facilities are important in evacuation and rescue operations and therefore should be built in safe areas. When they are located far from residential areas, it is important to ensure that evacuation routes do not pass through hazardous areas.

Regarding facilities where many people gather that must be built at the water’s edge, such as cargo loading or fishing cooperatives, their design must account for the high water level of the tsunami, i.e. height, structure and evacuation.
3.2.2.3 Transportation and Urban Infrastructure

In their role in building a community based on tsunami preparedness, the following points should be addressed regarding road and rail networks.

(1) inducement of proper land usage
(2) use as an evacuation route
(3) use as a emergency supply route

In addition, regarding the protection of maritime routes, planning should increase the safety of the port, which will be used as a center during rescue and reconstruction.

The following points are important regarding transportation networks, including main roads, local roads and railroads.

(1) Main Roads

Main roads, such as national and prefectural routes, are important in the transportation network and are critical as supply routes during an emergency. Accordingly, as much as possible, hazardous areas should be avoided. When it is unavoidable, the roads must be fortified against earthquakes and flooding. In an extreme case where the main road is inaccessible during a tsunami attack, an alternative network of detours must be in place for emergency transportation. These must also be constructed and fortified. There is a tendency for development along main roads. Main roads in safe areas then serve as an inducement to safe land usage. In cases where elevated roads and heavy traffic sever coastal areas, evacuation route measures must be in place.

(2) Local Roads

Like main roads, local roads must also be fortified. At the same time they must serve as escape routes. Accordingly, direct routes to higher ground are important. In order to promote safe use of land, it is necessary to build roads which connect ports with safe residential areas on high ground.

(3) Railroads

Railroads serve the same purposes as main roads and should therefore be built in safer areas. When they traverse hazardous areas, they should be properly fortified.
This document contains text that is not legible or comprehensible.
3.2.3 Coastal Facilities and Safe Land Use

3.2.3.1 General Considerations

1) Tsunami-proofing Construction

To prevent spills of dangerous chemicals or overturning by tsunami currents, it is suggested to reinforce buildings against tsunamis along the coast, especially in the inundation areas.

In the protected areas, there are usually houses, businesses, public buildings, fishery processing plants, etc., and petrol supply stations. On the ocean side of the embankment, there are fishing and recreation facilities. The fishing cooperative, fishery processing plant, and market should be tsunami-proofed by effective methods such as steel-framed reinforcement. Strong buildings at the water’s edge have shielded buildings behind them in past tsunami attacks. Building restrictions that increase tsunami readiness can be implemented by local authorities according to the Basic Construction Law, as detailed earlier.

Hamanaka in Hokkaido and Nagoya City are two examples of local governments that have placed building restrictions in hazardous areas. Tokyo Prefecture offers incentive to raise floor heights in flood-prone areas by partially funding the cost. Areas frequently affected by tsunamis should investigate the possibility of placing restrictions and reinforcement of buildings in their communities.

2) Hazardous Materials

Hazardous materials can cause secondary damage during a tsunami attack. Accordingly, care should be taken to ensure they are protected and safely stored.

Tsunami waves often turn timber, fishing boats and equipment into projectiles. They are borne on the waves as they move inland and can destroy embankments, bridges, facilities and houses. In addition, spills of hazardous chemicals such as oil, gasoline, etc. can occur. One measure is to store such materials in tsunami-proofed warehouses, but volume and size are often too much for capacity. Little can be done in face of this situation. Improvements to timber yards are an immediate concern.

Regarding hazardous chemicals, storage should be done in safe areas when possible. Otherwise, storage tanks should be buried and steps to prevent spills should be taken in making them less susceptible to tsunamis. In the event of a spill, precautions for the safety of residents is important. Supplies and measures for the rapid recovery of spills or extinguishing fires should be stored and thought through. Management and public authorities in charge of hazard mitigation should cooperate during the design and construction phase of such facilities that will create a functioning system in an emergency.
3.2.3.2 Coastal Communities & Improving Safety

Coastal areas are an important part of the national life and productivity. Accordingly, higher concentration of population and industry occurs. It is important for tsunami readiness planners to use these characteristics to their advantage during planning stages. The characteristics of the following three areas will be discussed below:

1. Residential areas
2. Commercial districts
3. Manufacturing and Distribution centers

1) Improving safety in residential areas

In coastal regions where the nocturnal population is dense, it is important to stress the public’s safety awareness and active participation in safety drills. Also key are environmental factors such as developing a community consensus about reconstruction of older buildings and the need for evacuation centers, etc.

2) Improving safety in commercial districts

In metropolitan areas and tourist areas along the coast, large numbers of visitors gather to enjoy leisure activities. Developed in conjunction with local people, clear guiding systems for evacuation sites and routes must be in place for visitors. Management of large-capacity facilities must be encouraged to develop evacuation plans for customers.

3) Improving Safety in Manufacturing & Distribution Centers

In ports and adjacent areas, plants and factories, warehouses and distribution facilities must be protected. Recently, underground transportation and changes in usage patterns of the waterfront have contributed to masses of people using coastal regions. Safety of these patrons must be considered. When the land faces a port with a lot of sea traffic, a tsunami would likely cause much damage by boats colliding or casting them on the shore. Appropriate safety measures can reduce such damage.

Furthermore, ports and harbors are vital during the emergency response following a tsunami. Steps should be taken to protect their vital functions from damage caused by carrying off of fishing equipment, spills, etc. Their use as an emergency center for relief supplies and emergency vessels should be strengthened through the readiness program. Finally, so that their vital role in safety preparedness is clear, involved parties should discuss emergency procedures, and draw up and sign written agreements on their usage during an emergency.

3.2.3.3 Ships and Boats
1) Safety Planning for Ships and Boats in Ports & Harbors

When a tsunami warning has been issued or the waters threatened, seagoing vessels are subject to the transmission, order or restrictions set by the Maritime Safety Agency. Port authorities must take appropriate measures as well to ensure the safety of the waters.

Regarding ports and harbors for which the Harbor Regulation Law is not applied, it is recommended that port authorities, ship and boat proprietors, and fishing cooperatives meet and agree on pre-planned safety measures.

The Niigata and Japan Sea Chubu Earthquake(s) generated tsunamis that carried away, sank, overturned, and grounded small craft such as pleasure boats, workboats, and tugboats.

When a tsunami warning is issued or danger is detected in a specific area, the Harbor Regulation Law (est. 1948) gives the harbormaster authority to issue warnings, orders and restrictions for offshore evacuation. In ports and harbors where the Harbor Regulation Law is not applied, however, it is recommended that port authorities, ship and boat proprietors, and fishing cooperatives meet and agree on pre-planned safety measures. The following points should be discussed:

(1) medium and large vessels will be evacuated to outside the port
(2) vessels which cannot be evacuated will be safely moored
(3) medium and large vessels will be withheld from entering the port

In those areas where a tsunami could affect coastal tankers, it is recommended that appropriate steps be taken in dealing with the proprietors of such vessels.
2) Fishing Boats

In the event of a tsunami attack on fishing boats, the protection of life is the focus of safety measures.

There are two main objectives in boat safety measures. First is the protection of property (the boat itself). Second is the prevention of secondary damage caused by a drifting vessel. In either case, during a tsunami attack, evacuation of fishing boats endangers those involved and this fact makes it impossible to draw up general guidelines for their evacuation.

When there are more than 10 hours before the arrival of a distant or local tsunami, it is preferable that fishing boats evacuate to deeper waters (circa 100 meters depth). In such cases it is imperative to pay close attention to estimated time of arrival issued by The Meteorological Agency. Fishing boats have escaped by opening passage routes through fish farming rafts.

If the arrival time is too short to escape, it is extremely dangerous to evacuate to offshore waters. Instead, a combination of loose mooring and loose anchorage can reduce the risk of drifting on land. There is no best method for boats that are being unloaded on land. If there is time, it is advised to lower the anchor outside the boat, making it more stationary during a tsunami strike. It is believed that keeping the mooring and anchor cables loose is effective in preventing them from being severed by the collision of the first wave or strain from buoyancy. Regarding the safety of fishing vessels, our lack of knowledge at present about the effects of amplification in and out of the harbor forces us to wait for future research.

Finally, for dealing with boats that have been grounded, especially on roads, it is important to consider the procedures and having the owners’ agreement regarding their handling.
The text on the page is not legible due to the quality of the image. It appears to be a page from a document written in Korean. The content is not translatable into meaningful text without clearer imagery or a higher-quality image.
There are four types of insurance schemes, depending on the type of maritime industry: fishing, fish farming, special types of aquaculture, and shellfish. Fish farming insurance provides assistance for “death or loss of fish from overflow, and damage to farming facilities.”

Special Aquacultural Insurance provides assistance to compensate for “decreases in the selling price, production falls below standard levels, and damage to farming facilities.”

(2) It is important to prevent secondary damage caused by farming materials, which could become projectiles much as boats or floating timber do. Though no such cases have been reported, steps should be taken to prevent farming debris from blocking the entrance to the port or obstructing passage routes.
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표 외 콘텐츠

본 문서의 내용은 작성자와 관계없이 제공된 정보를 바탕으로 작성되어 있습니다. 필요한 경우, 해당 정보를 확인하거나 업데이트해야 할 수 있습니다.

표 외 콘텐츠

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(2) 課題2 データの収集
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(3) 課題3 事前調査
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(4) 課題4 統計処理
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(5) 課題5 決定
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(6) 課題6 行動計画
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  6. \( \text{行動計画} \)
The Basic Disaster Law provides protection of national territory, life and property. The law contributes to social order and public welfare, and is the foundation of Japan’s disaster prevention and relief program. To facilitate a comprehensive and planned administration of safety programs, the law provides for the formation of emergency organizations, clarifies authority, and establishes disaster mitigation programs.

(1) Basic Disaster Planning

Under the Basic Disaster Plan, the creation and implementation of safety programs is carried out by designated governmental authorities or public organizations. Careful consideration ensures that safety programs operate in coordination and naturally.

(2) Administration of Disaster Planning

Regional and local autonomies are responsible for developing at the prefectural and city level. According to the needs of the autonomy, the central government, local government and public organizations are responsible for making and administering disaster planning. Local planning is broader in scope and is based on deliberations by local disaster committees.

This chapter discusses existing disaster programs and introduces key items of tsunami preparedness related to disaster planning.
3.3.2 Organizational Structure

1) Outline

Establishing safety organizations promotes the overall tsunami hazard mitigation program.

The Basic Disaster Law establishes the organization of the hazard mitigation program. The Central Emergency Board is commissioned by the Prime Minister, who serves as Chair, and includes directors of designated government organizations. It deliberates on important safety issues and the overall safety program.

At the prefectural level, the governor heads, along with designated government authorities, police, fire and public entities, a regional commission. This commission determines safety plans at the regional level. Likewise, local authorities have a safety commission and it is the pivotal organization at the community level.

Finally, there are many organizations which are responsible for safety. Among them, there are 29 national government organizations, including the Cabinet Office, Agriculture, Forestry & Fisheries Ministry, and the Ministry of Construction. Japan Railways (JR) and Nippon Telephone and Telegraph (NTT) are among the 37 public entities designated.

2) Disaster Headquarters and Defense Organizations

When a tsunami warning is issued or a disaster has occurred, it is important to mobilize officials for the collection and dissemination of information and to orchestrate a rapid disaster response.

When a tsunami warning is issued or a disaster has occurred, rapid mobilization of officials is critical. A variety of situations must be accounted for concretely in the organization of the emergency system and dispatch of safety team.

Precise rules are necessary regarding the establishment and abolition of the Safety Headquarters, including its location and transfer of authority.

Regarding the role of the Safety Headquarters, clear rules are needed on the procedures to implement its decisions as well as measures to deal with command and control of safety units in the absence of their leaders. To insure smooth operations, the Headquarters should be established on the basis of local organizational structures. To avoid vertical division within the organization, those departments responsible for its operation should strengthen lateral checking mechanisms. There must be a clear division of labor which allows for the establishment and deployment of special teams.

Finally, depending on the circumstances, the mobile response of an on-site disaster headquarters may be necessary.
3) Civil Defense

Efforts should be made to build a civil defense organization.

During a disaster, community residents working together prevent further damage. They are an extremely important part of smooth relief efforts and from this perspective, efforts should be made to build up civil defense organizations.

It is necessary to create a favorable environment for civil defense, which includes, dissemination of information, construction of an emergency center, and regular practice of its activities.

In the event of a tsunami, a civil defense organization has the following roles:

1) although it is important to escape to higher ground or upper stories of solid buildings, assisting the sick, elderly or disabled to evacuation is one civil defense task.
2) increasing awareness of tsunami safety through disaster drills, etc. and educating about evacuation sites and routes.
3.3.3 Warning & Communications System

1) Monitoring of tsunamis

   In order to better understand the effects of various coastal features on tsunamis, and to improve readiness, it is important to develop a system for monitoring tsunamis.

   The National Meteorological Agency is making efforts to strengthen tsunami monitoring. However, the announced magnitude of the tsunami could be greater in some areas due to local conditions. As a result, a local system of gauging a tsunami affected by the particularities of the coast is important in developing inundation maps. The following three methods are available:

   1) installation of tide gauges
   2) a system for gathering information from local fishermen
   3) installation of look-outs on high ground

   It is also necessary to collect and store tsunami data.
2) Use of Quantitative Tsunami Forecasting

The National Meteorological Agency has adopted plans to introduce quantitative forecasting for tsunamis at the prefectural level. This valuable information forecasts the estimated height of a tsunami, which is effective as a basis of inundation maps.

The plans called for the introduction of quantitative forecasting in 1999. According to this method, the propagation and numerical model are calculated for an earthquake-generated tsunami. Then an exact estimate of the height of a tsunami for a given prefecture and the tsunami’s time of arrival are estimated. This information enables safer evacuation and appropriate defensive measure to be taken.

Since this information applies to a wider area and is an average, effective planning uses this information in conjunction with data collected from various local shores. For more information on developing an inundation map and its usage, planners should refer to the *Manual for Tsunami Disaster Prediction*. 
3) Warning System

The tsunami warning system should be rapid and accurate.

The Japan Meteorological Agency is required by law to forecast tsunamis. Their warnings are specifically divided into “tsunami watches” and “tsunami warnings.” The flow of the warning system, from the Agency to the general public, is outlined in Chart 3-2 below.

The Agency headquarters and administered weather stations form the center for tsunami warnings. When an earthquake occurs, a tsunami forecast is issued, through the Fire and Disaster Management Agency, National Police Agency, prefectural governments, the Coast Guard, NTT, and Japan Broadcasting Association (NHK). At present, it takes 3-5 minutes for a warning to be issued.

However, following the Hokkaido Nansei Oki Earthquake in 1993, it is estimated that a tsunami over 10 meters was generated which struck Okujiri Island in 3-5 minutes. Several minutes are required to carry out a civilian evacuation and closing of the tidegates, so in the future, stringent efforts must be made to produce a more rapid and accurate warning system.

The following are issues that must be addressed:

1) is it possible for the warning to reach all households; are there areas which communication is difficult
2) are there areas where television and radio reception is impossible
3) are there areas which do not have cable broadcasting
4) are residents complacent about the threat of a tsunami; do they tend to ignore tsunami warnings
5) is it possible to warn fishing boats at sea

The above must be confirmed at the local level. Regarding tsunami warning systems, expansions of networks between the issuing source, mobile, and local wireless have bolstered the wireless warning system. Since 1994, the installation of receptors for the emergency information satellite system has made it possible to retrieve tsunami information from the central warning system.

In coastal areas next to urban centers or tourist and recreational areas, the warning system may not reach non-resident patrons, or their awareness of the dangers of tsunamis may be insufficient, possibly resulting in warnings going unheeded. In such areas, efforts to increase awareness and facilities for the distribution of safety information should be considered.

Finally, networks can be improved by installation of wireless communication between integral parts of community life such as city hall, schools, and hospitals.
3.3.4 Evacuation

1) Evacuation of Residents
2)

Local authorities should have a system in place for rapid and safe evacuation when an evacuation advisory is issued.

When a disaster occurs, or when a warning is issued which may necessitate an evacuation, the mayor issues an advisory or order to evacuate. In areas with no history of tsunamis, however, and even in areas that have been struck in the past such as Sanriku, public complacency and passage of time since the occurrence of a tsunami can negatively affect residents’ willingness or speed to evacuate. To combat this, the promotion of awareness described in section 3.3.6 and practice of tsunami emergency drills in section 3.3.7 are important in building a system for rapid and safe evacuation. Finally, emergency actions undertaken should reflect the nature of the warning.

When a watch has been issued for a tsunami that has a wave height no more than a few centimeters, it is not necessary for residents on land to evacuate, except in the most vulnerable areas. In such a case the warning should be sufficient, but beach and fishing patrons should evacuate. It is also necessary to monitor sea conditions and prepare to close tidegates, etc.

In contrast to the above, when a tsunami warning is issued, on-land defensive measures are required. To develop an evacuation system, simulation methods and models are available (refer to The Ministry of Construction Architectural Research Report, No. 78).

There are cases, however, of a tsunami attack occurring only a few minutes after the earthquake. When a large tremor is felt, or when small tremors occur over an extended period, residents should not wait for a warning to be issued and must know evacuation is required. Such awareness can only be developed through educational programs.

Citizens are advised, “When you feel a strong earthquake, immediately leave the shore and evacuate to a safe area. Vessels should evacuate from the port.” This forms the basis of tsunami awareness and should be stressed throughout educational programs.

What to Do in Case of a Tsunami

(General Public)

1. If you feel a strong earthquake (magnitude 4 or higher) or if the earthquake is weak but slow tremors continue for a long time, leave the shore immediately and evacuate to a safe area.
2. If a warning is issued but you did not feel an earthquake, leave the shore immediately and evacuate to a safe area.
3. Listen for accurate information from the radio, television, or soundtrucks.
4. If a tsunami watch has been issued, it is dangerous to continue swimming or fishing.
5. Tsunami waves attack repeatedly. Don’t move until the warning is over.
2) Evacuation Routes

The following points are important in designing evacuation routes.

1. Selection of suitable routes
2. Sufficient road width
3. Marking of the evacuation routes
4. Installation of streetlamps
5. Notification to the public

The design of evacuation routes from residential districts must take into account the public’s daily life, reduce time required for evacuation and ensure smooth evacuation. The following issues must be addressed.

1. Is the selected route suitable?
2. Is the road wide enough?
3. Are there enough signs indicating the evacuation route?
4. Have lights been installed for a night-time evacuation?
5. Is the public sufficiently aware of the routes?

Lighting and clearly marked signs are especially important during a night-time evacuation. Emergency power sources for street lighting are effective during a power outage caused by the earthquake.

During a tsunami, rapid and safe evacuation is most important. The shortest and most direct route to a temporary evacuation site should be the highest priority. When the topography is unsuitable for such a route, agreement to use public property in the event of an emergency and installation of emergency stairways are measures that should be considered.

Finally, regarding the warning to visitors who may be unaware of area, the evacuation route sign system should be well-designed, standardized, and easy to understand. Signs which can be easily understood by non-Japanese speakers are recommended.
(3) 仮想通貨取引

仮想通貨取引を行う際には、安全かつ信頼性のあるシステムを利用することが重要である。しかし、仮想通貨取引においては、取引者間の信用関係が重要である。したがって、仮想通貨取引においては、取引者間の信用関係が重要である。

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（1）労働者に対する労働の状況

労働者に対する労働の状況については、労働者の労働時間や労働条件などについて調査を行っており、労働者の健康や福祉にも配慮している。また、労働者の労働環境の改善を図り、労働者の労働時間の短縮、休暇の確保なども実施している。

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4) 문제해결을 위한 정책적 제안


문제해결을 위한 정책적 제안을 위하여 다음과 같은 경로를 통해 시행할 수 있는 정책적 제안을 제시하였습니다. 

(1) 재정적 지원


문제해결을 위한 정책적 제안을 위하여 다음과 같은 경로를 통해 시행할 수 있는 정책적 제안을 제시하였습니다. 

(2) 법적 지원


문제해결을 위한 정책적 제안을 위하여 다음과 같은 경로를 통해 시행할 수 있는 정책적 제안을 제시하였습니다. 

(3) 인프라 지원


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(1) **Identificación de la Fecha de Publicación**

(2) **Identificación del Lugar de Publicación**

(3) **Identificación del Autor**

(4) **Identificación del Editor**

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**Detalles de la Publicación**

- Título del Libro
- Nombre del Autor
- Año de Publicación
- Editorial

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**Resumen**

El presente documento describe los siguientes aspectos:

- **Identificación de la Fecha de Publicación**
- **Identificación del Lugar de Publicación**
- **Identificación del Autor**
- **Identificación del Editor**
2) Educational Programs

Improving public knowledge is an important part of safety education.

The legacy of past tsunamis forms the basis of public safety education. Personal accounts of experiences with tsunamis is a valuable part of safety education and should be included in social studies at elementary and junior high school. These accounts, combined with the latest scientific research and an understanding of the current state of preparedness are part of an organized and continued effort of safety education. Participation by local government and public organizations, such as community associations, youth and women’s groups make the program more active.

3) Developing a Safety Manual

The public should be distributed safety manuals that are easily understood.

In addition to general knowledge about tsunamis, the public should know what to do in the event of an attack. A manual with simple explanations should be distributed among residents. The manual should include maps of evacuation sites and routes, as well as evacuation procedures and other pertinent information.
4) 番号 前件名 称

**参考文献**

以下は参考文献です。この文脈で使用される文言を参照して、適宜引用を行いながら、内容を解説します。なお、特に引用箇所の文言は、文献を直接的に引用することを目的としており、それぞれの文献の詳細を参照して解釈して頂くことをお勧めいたします。
1) معلومات الإجابة

هنا كلا الإجابة كسرت فتحة التي تحقق فيها الشروط التي تم ذكرها في السؤال.

(1) يجب أن يكون الإجابة في الشروط المذكورة في السؤال.
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(5) الإجابة لا تتوافق مع الشروط المذكورة في السؤال.

هنا كلا الإجابة غير مطابقة لشروط السؤال. وفي حالة الإجابة التي يتم ذكرها في السؤال.
2) Cooperation from the general public

Cooperation from the general public plays an important role in tsunami preparedness.

In the affected areas, rescue and response are required as follows:

1. Drain water within the levees after the tsunami warning is removed
2. Extinguish fires
3. Aid and rescue of the injured and stranded
4. Search for the missing
5. Inform relief headquarters of the situation on the ground
6. Alleviating public distress by dissemination of accurate information
7. Nightwatches, fire protection, public safety and mutual aid
8. Provide of drinking water, food and medical supplies
9. Assessment of damage
10. Protection of housing

As seen above, the rescue and relief efforts encompass a broad range of responsibilities. Assistance from neighboring, unaffected areas is extremely effective. Such a system can only be built through everyday activity and effort over an extended period of time.
3) Maintenance of Defensive Structures

Coastal defensive structures must be maintained by the appropriate authorities during normal times and emergency situations. In situations where defensive structures are managed by a number of entities, their mutual aid and cooperation ensures a standard response to tsunami hazards.

Coastal defensive structures are intended to protect life and property from the damaging effects of a tsunami. Accordingly, they cannot be allowed to become dilapidated. They must be inspected regularly and any deficiency must be reinforced or repaired.

Various entities may be responsible for their maintenance. When a standard response to a tsunami is required along a coast, authorities must work together to restore rapidly and completely the defensive capability. This is achieved by consolidating information gathering points and networking between the organizations.