Recent development of tsunami disaster reduction management in Japan after the 2004 Indian Ocean Tsunami

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Abstract

The 2004 Indian Ocean Tsunami prompted a review of tsunami disaster prevention measures in Japan. More than anything else, Japanese people were shocked at the power of the video footage taken at the time the tsunami struck. Unfortunately, there are some people who say that a catastrophe like that could not happen in our country. That is an outright lie. What people need to understand is that even in a developed country, unless people evacuate, a tsunami like that could result in a disaster of epic proportions. Japan has experienced countless big tsunamis, and our strategies to deal with them have been praised by the rest of the world as being advanced. Therefore, it is probably natural that citizens of this country feel proud of these measures and confident that a huge disaster would be prevented. However, although big tsunamis keep occurring, many Japanese people do not advocate the need for drastic measures because they occur so infrequently that after one occurs, tens of years to more than 100 years, in other words several generations, may pass before there is another one. The Japanese ordinarily assume a tolerant stance toward nature, but that does not mean that nature is kind. The purpose of this paper is to make clear the improvement of tsunami disaster reduction strategy in Japan after the Indian tsunami. The new situation including soft countermeasures such as a hazard map, quick evacuation and TRUST, which is an early tsunami warning system, was introduced. Finally, Japan's future tsunami strategies in light of these recent events were discussed.

Keywords: disaster reduction, disaster management, disaster reduction strategy, Tokai earthquake, Nankai earthquake, the Indian Ocean Tsunami.

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1 Introduction

The Indian Ocean Tsunami that occurred at the end of 2004 prompted a review of tsunami disaster reduction measures. For example, Kawata *et al* [1] proposed the improvement of tsunami reduction measures to the Japanese government. People all around the world learnt the terror of tsunamis, and thanks to the mass media, "tsunami" became an international word. More than anything else, people were shocked at the power of the video footage taken at the time the tsunami struck. Unfortunately, there are some people who say that a catastrophe like that could not happen in this country. That is an outright lie. What people need to understand is that even in a developed country, unless people evacuate, a tsunami like that could result in a disaster of epic proportions. Japan has experienced countless big tsunamis, and our strategies to deal with them have been praised by the rest of the world as being advanced. Therefore, it is probably natural that citizens of this country feel proud of these measures and confident that a huge disaster would be prevented.

However, although big tsunamis keep occurring, many Japanese people do not advocate the need for drastic measures because they occur so infrequently that after one occurs, tens of years to more than 100 years, in other words several generations, may pass before there is another one. The Japanese ordinarily assume a tolerant stance toward nature, but that does not mean that nature is kind. The words "symbiosis" and "coexistence" are widely used in the discussion of environmental problems, but we need to realize that these concepts represent no more than our own empty desires.

Through the Indian Ocean Tsunami, the terror and cruelty of tsunamis were delivered to people in their living rooms as very real images. There was also important knowledge to be gained and lessons to be learned which must be given serious thought. In this paper, I will discuss Japan's future tsunami strategies in light of these recent events.

2 The formation of disaster culture should start with common sense

Accurate knowledge about tsunamis is essential in order to avoid becoming a victim. In order to ensure that this knowledge results in evacuation behavior, it is important that it becomes part of the culture of everyday life. I will illustrate with some examples.

1) Tsunamis do not necessarily begin with an ebbing wave: In the case of the Indian Ocean Tsunami, the first wave at Phuket in Thailand was an ebbing wave. However, judging from the available video footage, virtually nobody tried to run away from the sea. Even in the case of a reverse fault inter-plate earthquake, it is unlikely that the seabed would rise over a wide area simultaneously. Therefore, tsunamis usually begin with a flooding wave. Of course, they can begin with an ebbing wave as seen in the case of the Indian Ocean Tsunami. The lesson here is that to avoid becoming a victim, if you feel an earthquake you should stay away from the sea; if the sea starts behaving unusually, you should run away.

2) If the tremors from an earthquake last for more than one minute, there will be a tsunami: This is where plate boundary earthquakes differ from active fault earthquakes (intra-plate earthquakes). People must remember that there are earthquakes, called tsunami earthquakes, which produce big tsunamis even though they only produce small tremors. When the Kii Hanto-Oki earthquake (M 6.9) occurred on September 5, 2005, the actions of coastal residents seemed pitiful to tsunami specialists such as me. The idea that "the tremors were small, so the tsunami will be small too" is terribly misconceived. This misconception was the reason 22 thousand people died during the Meiji Sanriku Tsunami in 1896. The tremors only measured a seismic intensity (JMA scale) of 2 or 3, and although 20 to 30 minutes passed before the tsunami reached the shore, the majority of residents made no move to evacuate. There is a significant possibility that the Keicho Nankai earthquake was an earthquake of this type. Residents just do not know these things.

3) Tsunamis that occur on the Pacific coast result in a series of big waves that batter the coast over a period of six hours: When the magnitude of an earthquake exceeds 8 on the Richter scale, it will produce repeated tsunamis. In cases like this, people must assume that big tsunamis will occur one after another for at least six hours. Fishing vessels must not hurry back to port, and residents who have evacuated to higher ground must stay there for at least six hours.

4) Ebbing waves are most powerful where the land along the coast slopes down towards the sea: In this case, tsunamis accelerate back towards the sea, dragging with them residents and rubble. Once this occurs, the search for dead bodies becomes very difficult. Of the 3,000 victims killed during the 1933 Showa Sanriku Tsunami, only the bodies of 1,500 were found. The rest sank to the seafloor.

Without basic knowledge like this, the risk of falling victim to a tsunami is high. Without the development of a disaster culture in which people avoid harm by acting based on knowledge, there will never be any reduction in the amount of damage caused by disasters.

3 The realization of a tsunami disaster reduction system through selective concentrated investment

No matter how big or small a tsunami we are dealing with, damage cannot be avoided completely. The practical approach is disaster reduction, which involves reducing as much as possible the amount of damage caused, working under the assumption that damage will occur. If a tsunami is small enough, then disaster reduction may be achievable. Disaster prevention is a special case of disaster reduction. Let us then explore the sorts of methods that can be used to reduce victims and material damage. As long as there is no miracle solution, damage can only be reduced through the combined use of a number of different measures. This means that there is a need for a disaster reduction strategy under which disaster reduction tactics (actual measures) can be combined. Furthermore, this strategy must be based on values of some kind. Without values, efforts can only result in the development of across-the-board projects under the name of

"focused investment", as was the case in Japanese public works of the past. It is because such projects cannot be tolerated in the current fiscal climate that a policy shift towards "selective concentrated investment" was made. This policy shift was based on the idea that in achieving in the most efficient way the disaster reduction objectives of a particular region and the elevation of its standards of living, brick-and-mortar disaster reduction facilities only form one part of the social disaster reduction system pointed out by Kawata [2] as shown in Fig. 1.

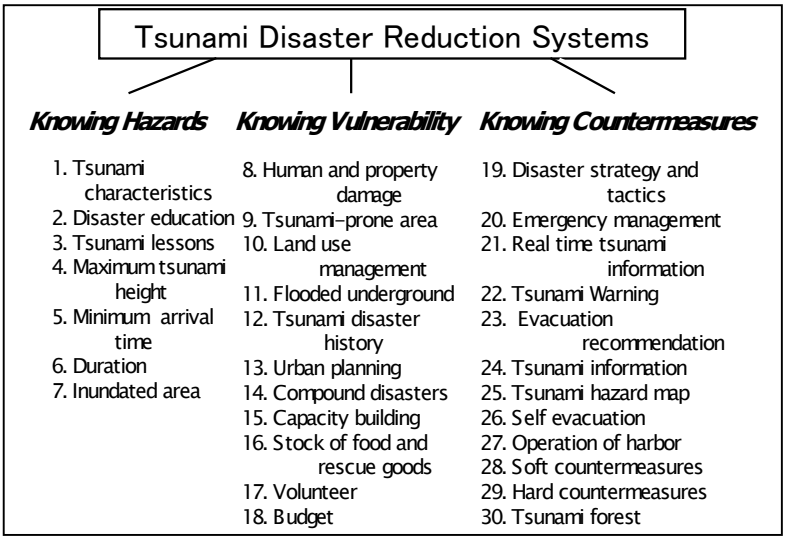

Figure 1: Tsunami disaster reduction systems with 30 components.

Other necessary steps are the reformation of the decision-making process for investment in disaster reduction, and the adoption of principles of self-responsibility. The former involves making local residents the decision-making entity, and the latter recognizes that the failures and risks that accompany the results of decisions made by society must be accepted by society. Herein is the essence of the importance of self-help efforts. However, these efforts must also be accompanied by the thorough disclosure and provision of information. In regard to disaster reduction measures, a detailed and specific medium-to-long-term implementation plan must first be created. In addition, each item in the previously mentioned social disaster reduction system must be stated specifically in order of priority and with reference to a time-line. The necessary finances must also be prepared with reference to the time-line, and must be consistent with the medium-to-long-term balance of the whole budget.

This kind of medium-to-long-term plan should first be drafted not by the country or by prefectures, but by local bodies. These local bodies do not necessarily have to be cities, towns or villages. It would be preferable to use divisions that are meaningful in terms of disaster reduction. This is because the

functions of disaster reduction measures are best understood by local residents. Because disaster reduction measures are ways of reducing and avoiding risk, and because people have different perceptions of risk and how it should be handled, it could be said that the functions of disaster reduction measures are defined by the values of the residents who live in the areas exposed to those risks. The national government and the prefectural governments, assuming that regional disaster reduction targets and specific disaster reduction measures have been established locally, should limit their involvement to making adjustments from the perspective of overall consistency, and to the formation of large-scale disaster reduction measures that apply to wide areas. Finally, judgments relating to local disaster reduction should, as a rule, be left to those local bodies to make. Disaster reduction is based on self-help efforts, and it is very important to encourage the adoption of "principles of self-responsibility".

4 Strategic plans for tsunami disaster reduction

Figure 2 shows the structure of a medium-to-long-term strategic plan for tsunami disaster reduction. It is comprised of goal, objectives, targets, policies/measures and action plans).

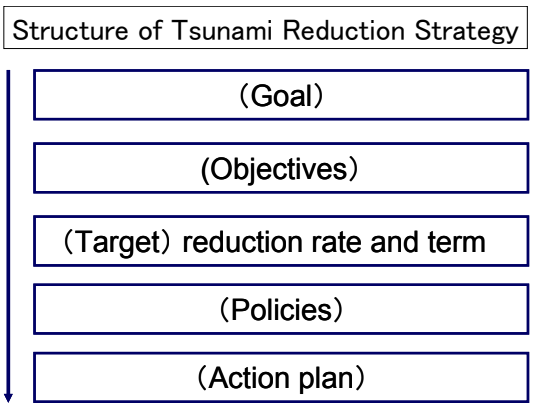

Figure 2: Long term structure of tsunami disaster reduction.

These components have been based on a constant ideal for which governments, municipalities and other organizations strive. That ideal might be reducing the number of casualties from the Nankai earthquake to zero, for example. However, in places where tsunamis of 5 m or more are expected strike the shore within ten minutes after the occurrence of an earthquake, this would be difficult to achieve in reality. Therefore, an aim could be the objectives that a municipality, for example, sets for the next several to five years in relation to the achievement of its ideal. One such objective was recently announced by the national government: that of halving present damage prediction figures over the

next ten years. Targets are specific figures. Policies describe what specific measures are necessary to achieve these objectives. Special measures laws such as the Large-Scale Earthquake Countermeasure Law relating to the Tokai earthquake and the Promotion Law relating to the To-Nankai and Nankai earthquakes are examples of such policies. After policies are formulated, plans for specific measures are made and then implemented through projects.

For example in the case of tsunami disaster reduction, a municipality must first evaluate the extent of its resources (and its weaknesses). In other words, it must assess its crisis management capabilities by examining its history of tsunami damage, which shapes the culture of everyday life, by assessing its land use plans, the possibility of compound disasters, its damage evaluation capabilities and administrative capabilities. This includes everything related to people, things, information and finances (Resource Assessment). Next, it must quantitatively assess factors such as specifically what kind of tsunami damage is predicted, the probability that such an event will occur and the likely magnitude of external forces involved (Risk Assessment). At the same time, the specific content of measures, and the practicality and effectiveness of disaster reduction plans must be examined. Errors made in evaluations based on these examinations will prevent the realization of effective disaster reduction measures before the event (Disaster Reduction Capability Assessment). After performing these three assessments, targets are set, measures proposed and Action Plans drafted and implemented. There is also a need to establish a feedback circuit whereby progress of the action plan is evaluated at various stages during the project, with the possibility of starting all over again from the three assessments if progress is found to be unsatisfactory. Figure 1 shows an example of tsunami disaster reduction summarized from this point of view. It is important to note that things change depending on the region.

It is important to continually evaluate initiatives like this by performing SWOT analysis. Feedback can then be used to assist in their continued application over the long-term. Given this kind of perspective, it might even be possible to receive approval from relevant parties, before a tidal wave occurs, for a plan to dramatically reduce the disaster potential of all areas on a tsunami hazard map where town flooding of more than 5 m is expected, by not allowing the construction, after damage is suffered, of houses with the same structure as before, instead raising land levels through public works. There needs to be awareness that disaster reduction must be based on long-term strategic plans. We applied this method for tsunami disaster reduction strategy in Osaka Prefecture.

5 The biggest lessons learned from the Sumatra earthquake for Japan

Three years have passed since the Sumatra earthquake occurred, and details that were not known initially have gradually become clear. This earthquake was caused by the breaking, over approximately 1,000 kilometers in the north-south direction, of three segments on the boundary of the Indo-Australian and Eurasian plates. The irregular way the splitting occurred and the magnitude of the

earthquake produced have presented big issues for the advancement of earthquake disaster reduction in Japan. We know that in this earthquake, three segments lying north-south, each possessing energy in the order of magnitude 8, moved simultaneously. We also know that each of these segments, counting from the south, had not caused an earthquake for 143, 123 and 63 years respectively. The fact that multiple segments faulted simultaneously after differing periods of time adds plausibility to the claim that the Tokai, To-Nankai and Nankai earthquakes may occur simultaneously in the future. Although 151, 61 and 59 years have passed since these earthquakes last occurred, it is now clear that this difference in elapsed time is in no way a constraining factor for simultaneous occurrence. We also know that plate destruction in the Sumatra earthquake continued for approximately 10 minutes. Destruction in the northernmost segment in particular was even slower than in a tsunami earthquake, making it clear that this segment did not contribute very much to the production of tremors or tsunamis. If this had occurred at a normal fracture velocity and caused a reverse fault earthquake, it is thought that the tsunami produced would have been five to six meters high and would have struck densely populated areas of Bangladesh and India in the deepest parts of the Bay of Bengal, resulting in the death of millions of people. The fact that only 63 years had passed since the last earthquake occurred was probably a factor behind the production of a weak earthquake this time. If that were the case, the same phenomenon may be repeated in the To-Nankai and Nankai earthquakes if they occurred now. This does not justify complacency, of course, but the Sumatra earthquake has certainly presented us with a number of scenarios that relate to how the Tokai, To-Nankai and Nankai earthquakes may occur.

Furthermore, summing the seismic magnitudes of the three segments that caused the Sumatra earthquake definitely does not give 9. The figure is much smaller. From this, it follows that if the Tokai, To-Nankai and Nankai earthquakes occurred simultaneously, their combined magnitude may be greater than 8.7, the simple sum of their individual magnitudes. These issues will undoubtedly be subjected to further detailed analysis by seismologists in the future, but we cannot ignore the facts that we have now. We have reached a stage where concepts such as super-earthquakes and super-tsunamis must be considered when creating disaster reduction and reduction strategies.

6 Tokai, To-Nankai and Nankai earthquake problems

The occurrence of Tokai, To-Nankai and Nankai earthquakes as shown in Fig. 3 are very urgent and they accompany with tsunamis. Historically, tsunami damage was huge in comparison with earthquake damage. Therefore, how to reduce the tsunami damage is essential. Table 1 shows the estimated damage. This expands with the damage link of the earthquakes and tsunamis, and, up to now, has become a super-large area disaster that has not been experienced. Moreover, last 60 years, our social structure has rapidly changed and social vulnerability has also increased year by year. Especially, the lifeline damage controls the progress condition of the recovery works of the stricken area. If electricity is the most

important especially lifeline, and Tokai, To-Nankai and Nankai earthquakes happen, the Chubu Electric Power Co., Inc. jurisdiction where all thermal power and nuclear power plants where it accounts for so 92% of the total power generation are located in the region more than six minus in the seismic intensity of JMA scale should determine a long-term power failure.

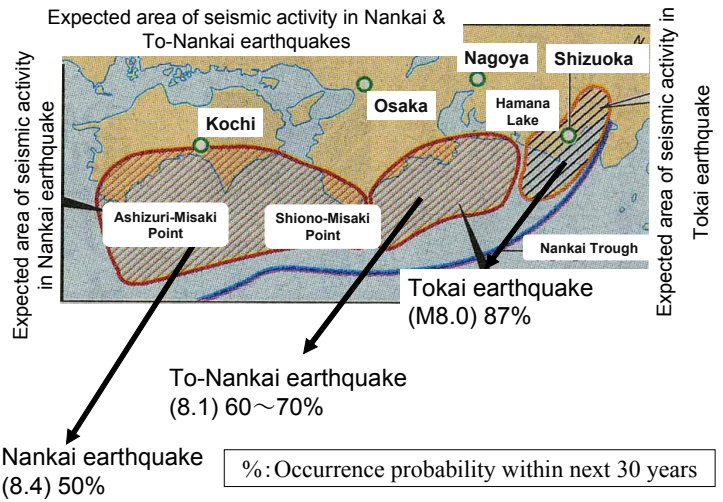

Figure 3: Seismic zone of the Tokai, To-Nankai and Nankai earthquakes and their occurrence probability.

Table 1: Estimated damage caused by the Tokai, To-Nankai and Nankai earthquakes and the 1995 Kobe earthquake.

Estimation of damage caused by possible EQs
(by technical investigation committees of Central Disaster Management Council)

(Maximum cases)	Tokai EQ	Tonankai & Nankai EQ	Kobe EQ 1995
Victims (persons)	9,200 (7,900 by strong tremors)	18,000 (8,600 by tsunamis)	6,436
Houses destroyed	260,000	360,000	105,000
Economic loss (billion yen)	37,000	57,000	10,000

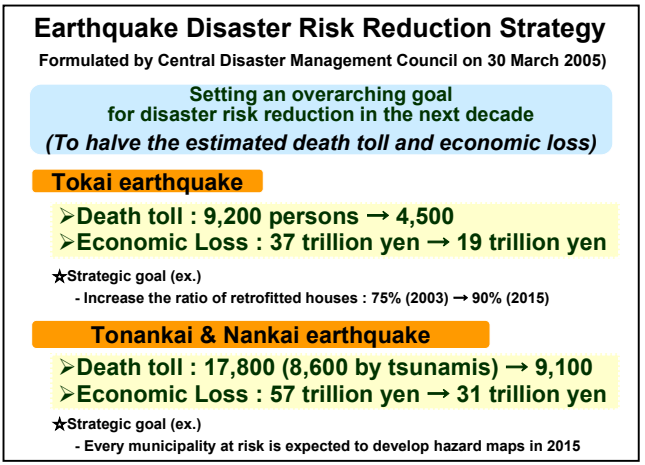

Figure 4: Objectives of the earthquake and tsunami disaster risk reduction strategy of the Tokai, To-Nankai and Nankai earthquakes.

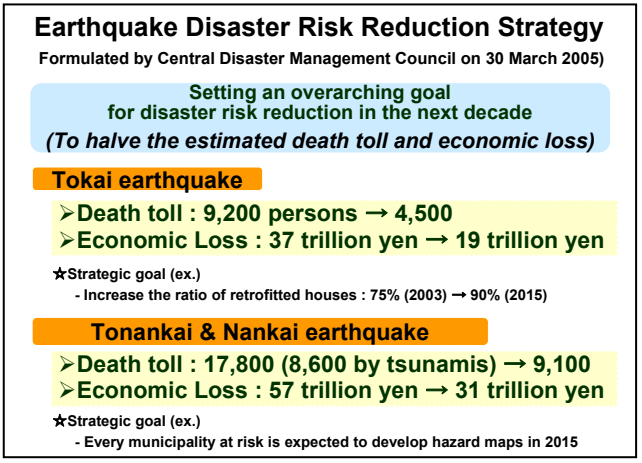

Figure 5: Prioritized actions to reduce preventive tsunami victims due to the Tokai, To-Nankai and Nankai earthquakes.

In 1978, our government brought a Large-Scale Earthquake Countermeasure Law into force. The law focuses on Tokai earthquake. The outline of the earthquake disaster risk reduction strategy is shown in Fig. 4. Especially for tsunami, the prioritized actions to reduce possible tsunami victims are introduced in Fig. 5.

We proposed the following efforts to reduce tsunami damage. 1) Early dispatch of tsunami warning because Japan Meteorological Agency usually forgets the existence of residents as customers of information, 2) Utility of

measured seismic intensity meter located in every municipality to image coming tsunamis, 3) Promotion of hazard map and enlightenment residents who can not understand to apply it, 4) Senior citizen measures to reduce damage through health care, 5).

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7 Conclusion

The tsunami damage caused by the Sumatra earthquake gave Japan an opportunity to review its measures against tsunamis. One result of this process has been the Ministry of Land, Infrastructure and Transport's proposal for tsunami measures that has already been opened in the homepage. My assertion is that these tsunami measures should be implemented under a medium-to-long-term disaster reduction strategy. As if in an expression of agreement, the Cabinet Office, as I mentioned earlier in this paper, announced a strategy to halve damage figures over the next ten years. Before saying "that's impossible", we should recognize the importance of working towards an objective. Even if a tsunami occurs before the project is completed, the damage sustained should be less severe than initial predictions.

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