https://doi.org/10.20965/jdr.2016.p0285

Survey Report:

Revision of Flood Control Act and Measures for Underground Shopping Complexes

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[Received July 31, 2015; accepted February 3, 2016]

Underground spaces are enclosed spaces that collect aboveground floodwater, which causes the inundation height to rise rapidly and thus makes them extremely dangerous spaces from the standpoint of water disasters. Due to the changing rainfall patterns in recent years, incidences of inundation damage to underground spaces have increased. In this situation, the Ministry of Land, Infrastructure, Transport, and Tourism of Japan revised the Flood Control Act in May 2015. This paper provides an overview of this latest revision.

Keywords: underground spaces, underground shopping complexes, the Flood Control Act, rainfall inundation, Anticipated Inundation Areas

1. Introduction

Underground spaces are enclosed spaces that collect aboveground floodwater, which causes the inundation height to rise rapidly and thus makes them extremely dangerous spaces from the standpoint of water disasters.

Underground spaces were inundated from the flooding of the Mikasa River in Fukuoka City in June 1999 and in Shinjuku ward by torrential rains in July of the same year; both cases led to the deaths of people trapped in underground rooms. Indeed, incidences of inundation damage to underground spaces have increased in recent years, such as the inundation of the Misasagi Station of the Kyoto Municipal Subway Line caused by the flooding of the Anjoji River within the Yodogawa River System in September 2013.

The Ministry of Land, Infrastructure, Transport, and Tourism of Japan has implemented inundation measures for underground shopping complexes and other such structures to reduce the damage in times of flooding based on the Flood Control Act and related regulations. Based on recognition of the current situation, however, it revised the Flood Control Act in May 2015, and revisions were made regarding the system of Anticipated Inundation Areas as follows.

- While the law before it was revised only to target floods, rainfall inundation (inundation due to the failure of sewage systems and other drainage facilities that carry water away from localized downpours of short duration) and high tides were newly added as targets.
- The target rainfall of Anticipated Inundation Areas for floods was changed from the design rainfall (targeted rainfall designated for each river for flood control purposes) before revision to the maximum anticipated rainfall levels.

These changes were made to strengthen the system of Anticipated Inundation Areas, and provisions were set forth to strengthen policies and measures regarding evacuation, etc., from underground shopping complexes in the respective Anticipated Inundation Areas.

This paper provides an overview of the latest revision.

2. Inundation Measures for Underground Shopping Complexes and Other Facilities Based on the Previous Flood Control Act

2.1. Flood Control Act

The meteorological and topographical conditions in Japan make it highly susceptible to disasters due to floods or high tides. For this reason, river improvements and other flood control projects have continuously been carried out in Japan throughout its long history, and such flood control projects must continue to be implemented vigorously in the future, as well.

However, flood control projects involve huge costs and require extremely long periods to complete, and so the Flood Control Act was enacted in 1949 to emphasize the need for "flood fighting activities," i.e., human activities aimed at protecting human lives and properties from disasters and reducing the damage level when disasters have actually occurred or are about to occur.

In recent years, in addition to flood fighting activities in the narrow sense, such as protecting embankments in the event of floods, efforts have been made to strengthen the law by setting up early warning and evacuation systems and providing flood information so that evacuations can take place safely, as in the establishment of the system of Anticipated Inundation Areas with the 2001 revision of the Flood Control Act.

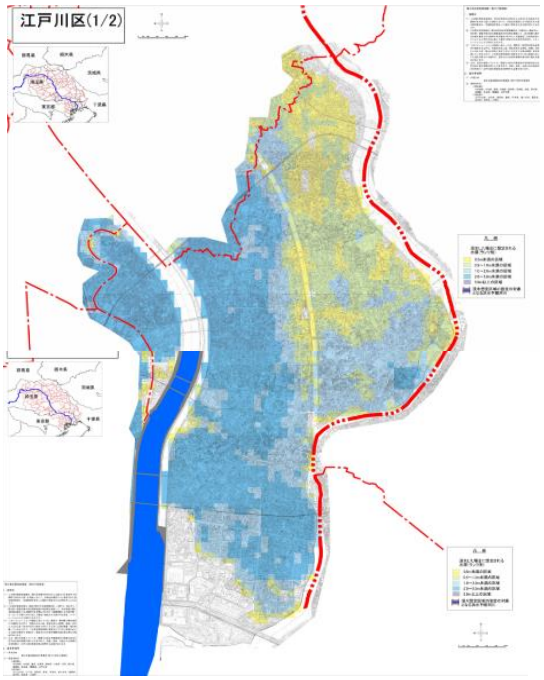


Fig. 1. Example of Anticipated Inundation Area.

2.2. Anticipated Inundation Areas and Wide Dissemination of Water Level Information

In the Flood Control Act, prior to the 2015 revision, either the Minister of Land, Infrastructure, Transport, and Tourism or the prefectural governor was required to designate rivers that, in the event of flooding, harbored the risk of causing a great loss to the national economy or extensive damage, and do the following for each designated river.

- Designate Anticipated Inundation Areas (areas in which inundation is expected to occur when a flood is caused by the design rainfall, **Fig. 1**).
- In cases where the river reaches a water level at which an alert must be issued to warn of the possible occurrence of a disaster (hereafter "Special Alert Water Level," **Fig. 2**), communicate this information (hereafter "Water Level Information") to the mayors of the municipalities and the residents in the Anticipated Inundation Areas.

As of March 2015, Anticipated Inundation Areas had been designated for approximately 2,000 rivers in Japan.

2.3. Drawing up the Evacuation Securement and Inundation Control Plan for Underground Shopping Complexes

In the Flood Control Act prior to the 2015 revision, the municipal disaster management councils were required to set forth, in the municipal regional disaster prevention plans, the names and locations of underground spaces that are used by an unspecified large number of people within the Anticipated Inundation Areas and that require a smooth, rapid evacuation (hereafter called "underground shopping complexes") as well as the method of relaying the Water Level Information to those underground shopping complexes.

The administrators/managers of the underground shopping complexes specified in the municipal regional disaster prevention plans (hereafter called "target underground shopping complexes") were required to draw up an Evacuation Securement and Inundation Control Plan[1], conduct evacuation drills, and set up a selfdefense flood control organization (i.e., a volunteer-based organization that carries out floodfighting activities for the facilities they administer or monitor).

The Ministry of Land, Infrastructure, Transport, and Tourism has produced and made available to the public the "Guideline for Drawing Up an Evacuation Securement and Inundation Control Plan for Underground Shopping Complexes" to assist the administrators/managers of underground shopping complexes with drawing up Evacuation Securement and Inundation Control Plans.

As of March 2015, approximately 1,100 underground shopping complexes in Japan had been designated "target underground shopping complexes," of which approximately 700 facilities[2], or 60%, had drawn up an Evacuation Securement Plan or Evacuation Securement and Inundation Control Plan.

3. Inundation Measures for Underground Shopping Complexes in the 2015 Revision of the Flood Control Act

3.1. Expansion of the Systems of Anticipated Inundation Areas and Dissemination of Water Level Information

(1) Expansion of Anticipated Inundation Areas with regard to floods

As mentioned in Section 2.2, the Anticipated Inundation Areas prior to the 2015 revision of the Flood Control Act were designated based on the design rainfalls of the respective rivers. However, due to changing rainfall patterns in recent years, there have been occasional cases in which evacuation sites designated as such on the hazard maps that were prepared by municipalities and based on Anticipated Inundation Areas became inundated, thus forcing secondary evacuations, such as when the evacuation site inside the polder along the Onotani River of the Kumano River System became inundated due to torrential rainfall in the Kii Peninsula in 2011.

With the 2013 revision of the Disaster Countermea-

1. The Inundation Control Plan required by the Flood Control Act is a plan for implementing the flood control measures necessary for evacuation, such as securing the necessary time for evacuation, and does not mandate the implementation of measures to protect the facilities.
2. Drawing up an Evacuation Securement and Inundation Control Plan was made mandatory fairly recently, in the 2013 revision of the Flood Control Act, prior to which only an Evacuation Securement Plan had been required. This figure represents the number of target underground shopping complexes that have drawn up either an Evacuation Securement Plan or an Evacuation Securement and Inundation Control Plan.

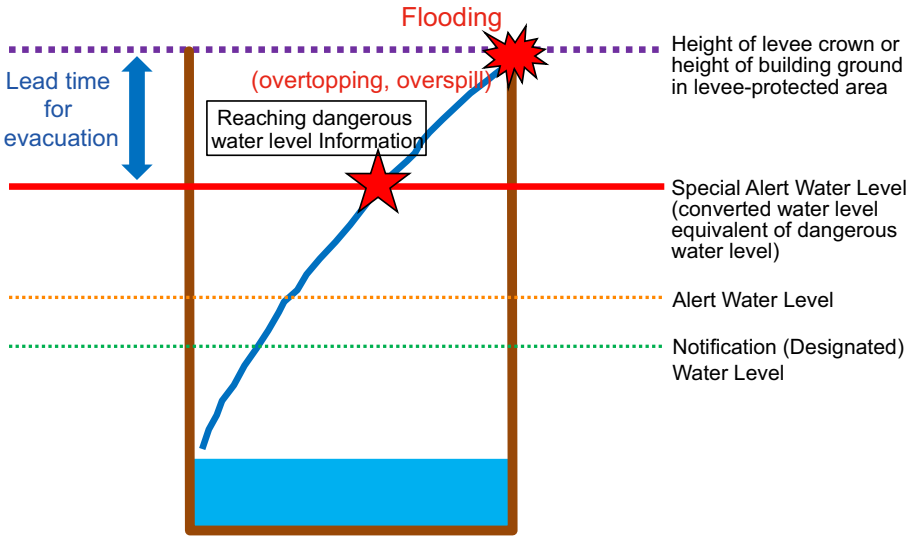


Fig. 2. Conceptual diagram of Special Alert Water Level.

sures Basic Act, evacuation to the upper floors of a building, called "vertical evacuation," became legally recognized, which has resulted in a strong move among municipalities to use vertical evacuation actively.

In such circumstances, it was recognized that use of the Anticipated Inundation Areas based on design rainfalls were possibly no longer appropriate when considering evacuation securement. Consequently, the target rainfall used to determine Anticipated Inundation Areas was changed from the "design rainfall" to the "maximum anticipated rainfall level" in a move to reevaluate the current Anticipated Inundation Areas. This has resulted in expansion of the scope of the Anticipated Inundation Areas, which is expected to increase the number of target underground shopping complexes as well.

Determination of the "maximum anticipated rainfall level" is described on a website[3] of the Ministry of Land, Infrastructure, Transport, and Tourism.

(2) Establishment of the systems of Anticipated Inundation Areas and dissemination of Water Level Information regarding rainfall and high tides

Although the Flood Control Act prior to the 2015 revision considered only floods in the systems of the Anticipated Inundation Areas and dissemination of Water Level Information, incidences of rainfall inundation have increased in Japan in recent years, and extensive damage due to high tides has occurred frequently overseas, such as that in New York City from Hurricane Sandy or in the Philippines from Typhoon Haiyan.

In view of this situation, the latest revision of the Flood Control Act has included rainfall and high tides in addition to floods as the targets for Anticipated Inundation Areas and Water-Level Information dissemination, and it has adopted the use of "maximum anticipated levels," as in the case of floods. As a result, Anticipated Inundation Areas will henceforth be designated maximum anticipated levels for three types of phenomena: floods, rainfall, and high tides.

Specifically, the prefectural governors or municipal mayors are charged with designating those sewer systems that may incur extensive damage due to rainfall, and the prefectural governors with designating those coastal areas that may incur extensive damage due to high tide. They are also required to designate the Anticipated Inundation Areas based on the maximum anticipated levels of rainfall or high tide for the sewer systems or coastal areas, respectively. As a result, the administrators/managers of target underground shopping complexes located in rainfall and high-tide Anticipated Inundation Areas are now required to draw up Evacuation Securement and Inundation Control Plans, as in the case of floods.

Determination of the maximum anticipated rainfall and high-tide levels is described on a website[4] of the Ministry of Land, Infrastructure, Transport, and Tourism.

Furthermore, regarding the dissemination of Water-Level Information for rainfall and high tides, Special Alert Water Levels have been established for sewer systems and coastal dikes, and a system has been set up to relay Water Level Information to residents in the Anticipated Inundation Areas. In particular, since rainfall can quickly lead to inundation, notifications have been sent to the municipalities to ensure rapid dissemination of Water-Level Information based on rainfall using early warning emails and other means.

(3) Status of underground-connected shopping complexes in relation to Anticipated Inundation Areas

Since the inundation of underground spaces can spread via subway networks or underground passages, under-

3. http://www.mlit.go.jp/river/shishin_guideline/pdf/shinsuisoutei_honnbun_1507.pdf

4. http://www.mlit.go.jp/river/shishin_guideline/kaigan/takashio/tebiki_shinusi.pdf

ground spaces that may become inundated in this manner should ideally be included when determining Anticipated Inundation Areas. For this reason, the Ministry of Land, Infrastructure, Transport, and Tourism has issued an ordinance to the effect that major underground shopping complexes that can be anticipated to be inundated via the subway or underground passages, even when the aboveground part is not anticipated to be inundated, may be designated as Anticipated Inundation Areas within the framework of the latest revised Flood Control Act.

However, subway networks and underground passages have complex structures, the specific details of which require a lengthy time to grasp before carrying out an inundation analysis. Furthermore, there is a relatively low need to designate underground shopping complexes in which inundation will occur after some time has passed from the standpoint of evacuation.

Thus, in the practical operation of the system, efforts to strengthen the evacuation system for underground shopping complexes shall begin with designation of those underground shopping complexes that are relatively close to the outer perimeters of the aboveground areas anticipated to be inundated.

3.2. Establishment of Standards for Evacuation Securement and Inundation Control Plans for rainfall Anticipated Inundation Areas

Since rainfall can quickly lead to inundation, it is a particularly dangerous form of disaster for underground spaces. For this reason, the Ministry of Land, Infrastructure, Transport, and Tourism has issued an ordinance stating that, when drawing up Evacuation Securement and Inundation Control Plans for target underground shopping complexes in rainfall Anticipated Inundation Areas, it is necessary to confirm that all users of the underground shopping complex in question will be able to evacuate safely.

The specific method of confirmation is set forth in a Notification from the Ministry of Land, Infrastructure, Transport, and Tourism, in which a floor inundation depth of 30 cm and flow per unit width on stairs of 0.11 m^3/s are given as the conditions[5] under which it will be difficult to evacuate by walking; all users of the underground shopping complex in question must be able to evacuate and reach an area above ground from various parts of the underground shopping complex without passing such difficult spots.

3.3. Promoting Coordination of Underground Shopping Complexes with Connecting Buildings

Inundation of an underground shopping complex can occur not only from water flowing in from the entrances and exits administrated by that underground shopping complex but also from buildings and facilities that are connected underground (hereafter called "connecting buildings"). Furthermore, in rainfall inundation, which occurs quickly, it will often be difficult to secure sufficient time for people to travel to the nearest evacuation site; therefore, the use of connecting buildings as evacuation destinations should be considered as a viable option.

Based on recognition of the importance of coordination between an underground shopping complex and connecting buildings as a measure to ensure evacuation, the latest revision of the Flood Control Act includes a clause that requires that underground shopping complexes solicit the views of the connecting buildings that can greatly affect evacuation when drawing up their Evacuation Securement and Inundation Control Plans.

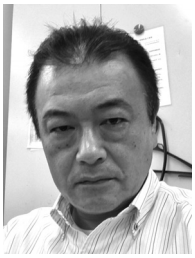
In addition, to facilitate the joint production of Evacuation Securement and Inundation Control Plans by underground shopping complexes and connecting buildings, the Regional Development Bureau is planning to coordinate, in cooperation with the local governments, the establishment of committees composed of underground shopping complexes and connecting buildings while targeting major underground shopping complexes.

4. Conclusion

We have described the contents of the latest revision of the Flood Control Act, focusing on measures for underground shopping complexes. Another revised item is the inclusion of target underground shopping complexes that are in the planning and construction stages.

Due to the changing rainfall patterns in recent years, underground spaces will be exposed to increasingly high risks of inundation. The Ministry of Land, Infrastructure, Transport, and Tourism reaffirms its duty to administer the revised Flood Control Act properly and undertake vigorous efforts to strengthen countermeasures against the inundation of underground spaces.

5. http://www.mlit.go.jp/river/shishin_guideline/bousai/saigai/tisiki/sinsui_tebiki/



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