



兵庫県
Hyogo Prefecture

International Recovery Forum 2020

Infrastructure development plan for tsunami risk reduction

- Measures to prevent and reduce disasters in preparation for huge tsunamis –

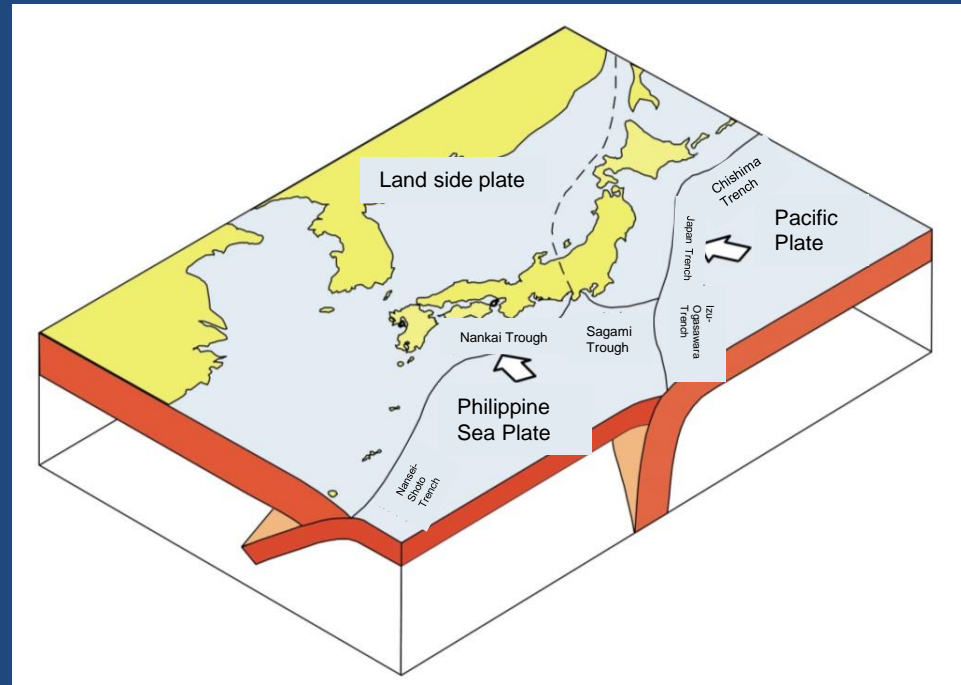
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Technology Planning Division
Public Works & Development Department
Hyogo Prefectural Government

Nankai Trough earthquake

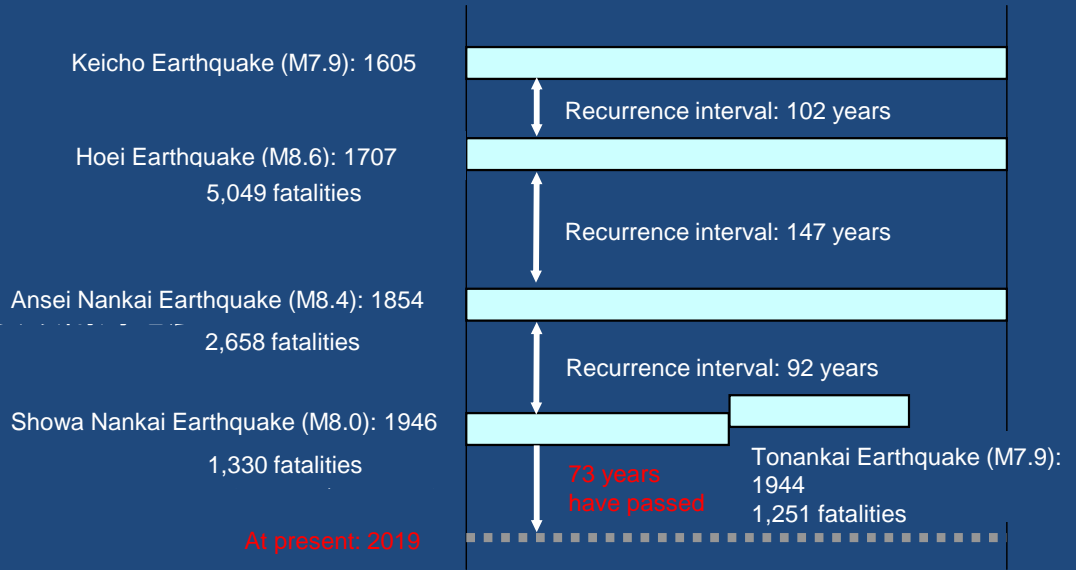
The Nankai Trough is a long and narrow submarine basin formed by the subduction of the Philippine Sea Plate under the Eurasian Plate.

Around the Nankai Trough, huge earthquakes and tsunamis occur about every 100 years, causing severe damage.



Classification of earthquakes (Size of next earthquake)	Earthquake probability		
	Within 10 years	Within 30 years	Within 50 years
Nankai Trough M8–M9	About 30%	About 70–80%	About 90% or higher

Based on estimates by the Headquarters for Earthquake Research Promotion of Japan (Jan. 2019)



Largest tsunamis caused by Nankai Trough earthquake (L2)

Awaji area

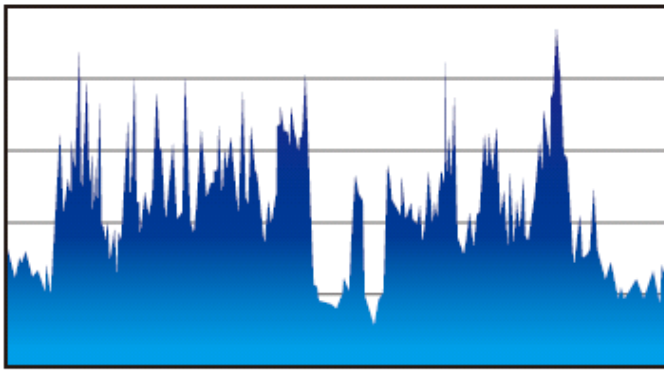
Hanshin area

8.1 m	Minami Awaji City
5.3 m	Sumoto City
3.1 m	Awaji City

4.0 m	Amagasaki City
3.9 m	Kobe City
3.7 m	Nishinomiya City

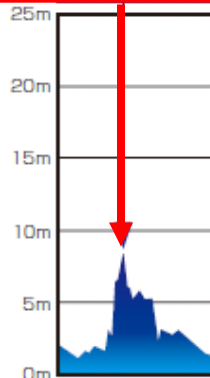


Tosashimizu City
Tsunami height 21 m



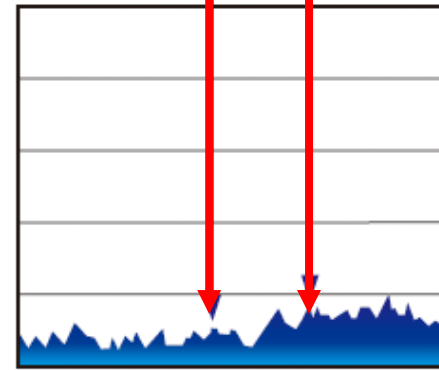
① Pacific Coast (Shikoku)

Minami Awaji City
Tsunami height 8.1 m



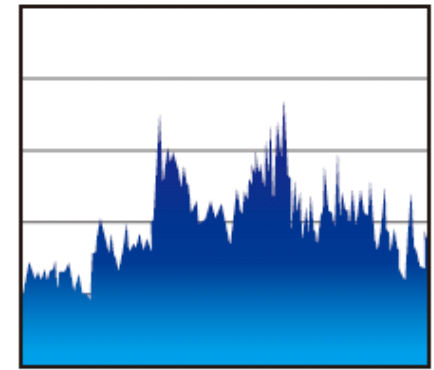
② Awaji Island

Himeji City
Tsunami height 2.5 m



③ Harima, Kobe, Hanshin

Nishinomiya City
Tsunami height 3.7 m



④ Pacific Coast (Kii Peninsula)

Kushimoto City
Tsunami height 16 m



Infrastructure development plan for tsunami risk reduction (Measures against tsunamis caused by Nankai Trough earthquake)

Systematically promoting measures against tsunamis by strengthening and preventing subsidence of tide embankments, and reinforcing tide gates

Tsunamis covered by the plan:

Two levels of tsunamis (L1 and L2) based on frequency

Period covered by the plan: FY2013–2023

- 1) Complete measures for **priority reinforcement areas**, and other areas connected to housing blocks, in 10 years
- 2) Complete urgent and important projects in 5 years (relocation of tide gates, measures for reinforcing earthquake resistance, etc.)

Estimated project cost: About 64 billion yen

1. Measures against two levels of tsunamis

Level-1 tsunamis (occurring roughly every 100 years, M8.4)

Structural measures: Prevent seawater from penetrating inland (excluding the southern part of Awaji Island)

a) Protection from tsunamis:

- 1) Strengthening tide embankments (securing sufficient height, maintaining soundness)
- 2) Prompt, secure closure of land locks, etc. (introducing automatic, remote control, or electric systems)

Level-2 tsunamis (largest-scale tsunamis, M9.0 class)

Structural measures: Minimize inundation damage caused by tsunamis

b) Reinforcement of existing facilities:

- 1) Measures to prevent subsidence (liquefaction) of tide embankments, etc.
- 2) Measures to prevent seawater from flowing over tide embankments, etc., measures against backwash (measures to prevent scouring of foundations), etc.

c) Minimize damage caused by tsunamis:

Relocation of tide gates to downstream, etc.

Non-structural measures: Support evacuation to save lives (common to level- 1 and -2 tsunamis)

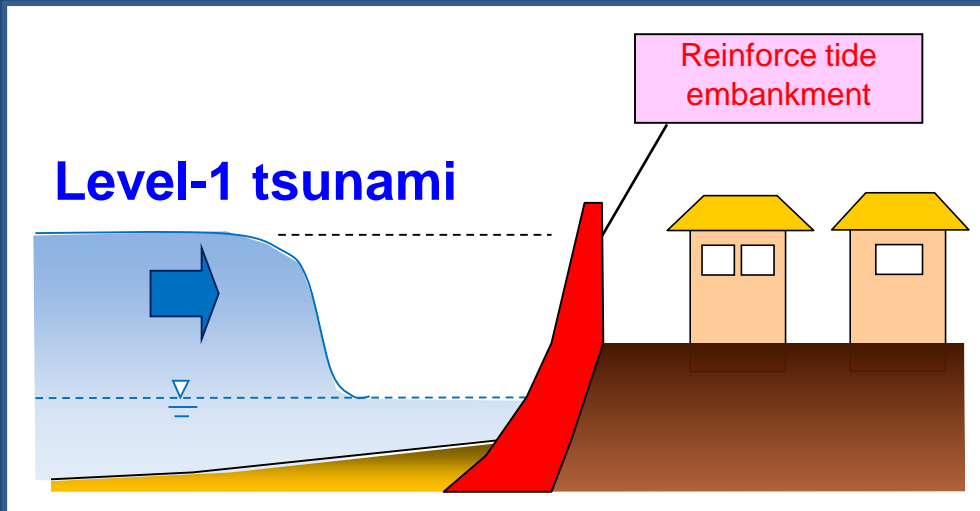
d) Support for evacuation:

Installation of stairs on road slopes, provision of information such as images taken by cameras at ports, etc.

Major structural measures for Level-1 tsunamis

1) Reinforcement of tide embankments L = 1.8 km, reinforcement of river embankments L = 0.7 km

Construct tide embankments, etc. for areas not high enough against tsunamis



Reinforce tide embankment for protection from tsunami

Reinforcement of tide embankment (Fukura Port)

2) Introduction of automatic, remote control or electric closure system (land lock, etc.)

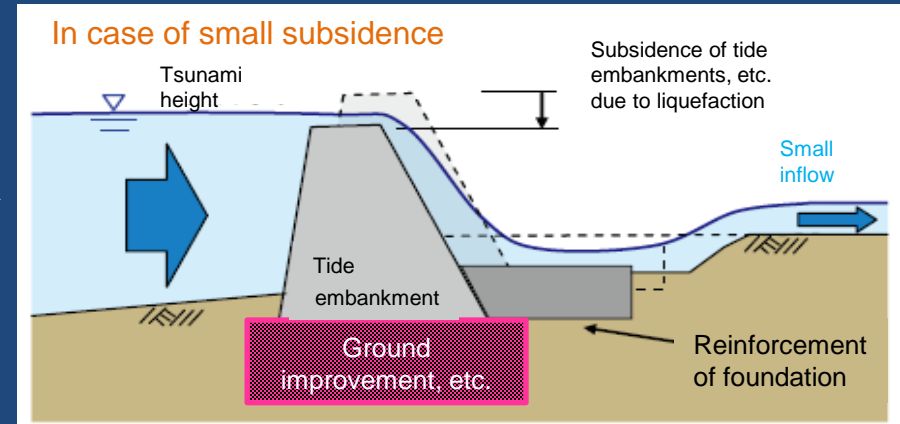
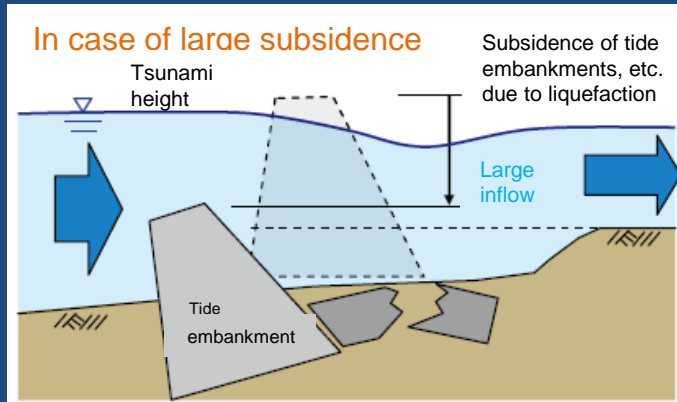


Introduced electric land lock system (Amagasaki Nishinomiya Ashiya Port)

Major structural measures for Level-2 tsunamis

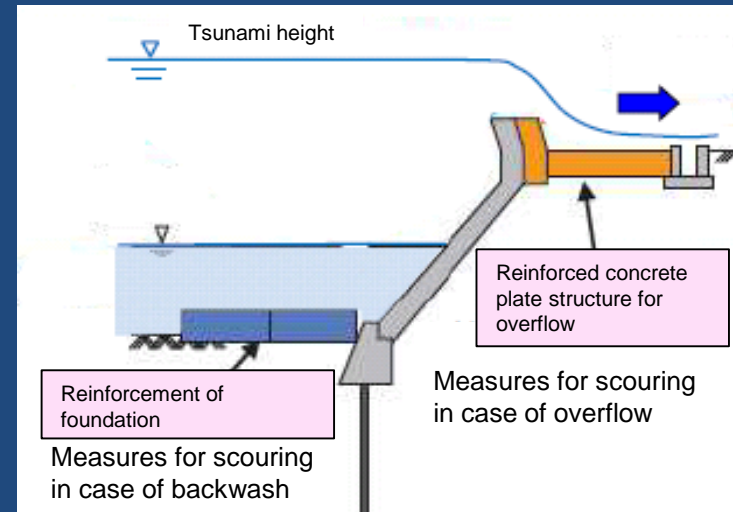
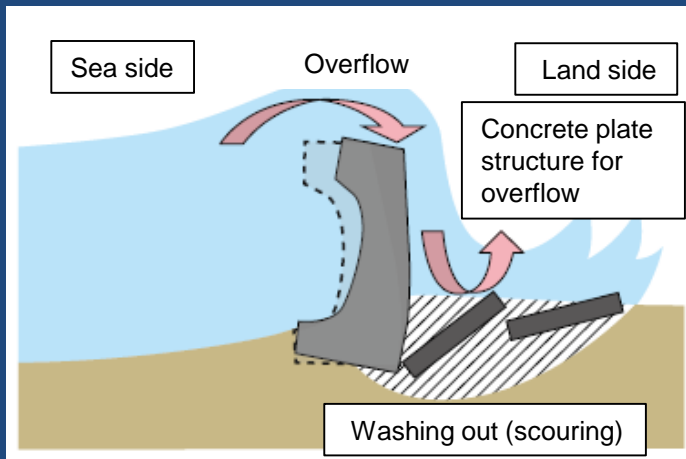
1) Measures to prevent subsidence of tide embankments, etc. $L = 4.7 \text{ km}$

Ground improvement to prevent loss of function due to liquefaction of foundation ground



2) Strengthen tide embankments, etc. to prevent seawater from penetrating inland $L = 10.3 \text{ km}$

Reinforce tide embankments, etc. to make them resilient and durable against scouring, etc. caused by overflow and backwash



2. Priority reinforcement areas

Seven districts, expected to suffer severe inundation damage due to Level-2 tsunamis, etc., were designated as “Priority reinforcement areas.” All measures to be completed in 10 years.

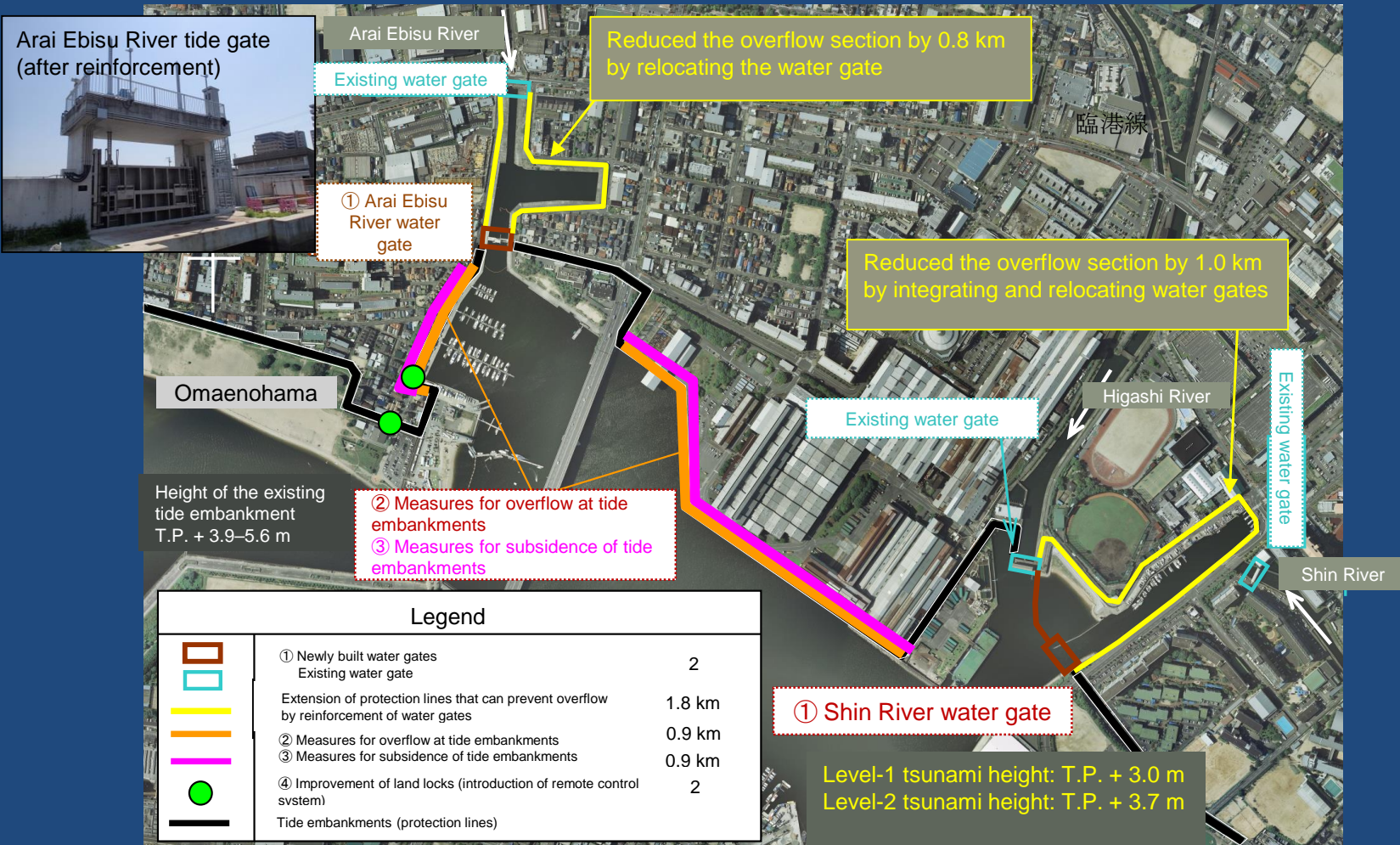


Priority reinforcement areas:

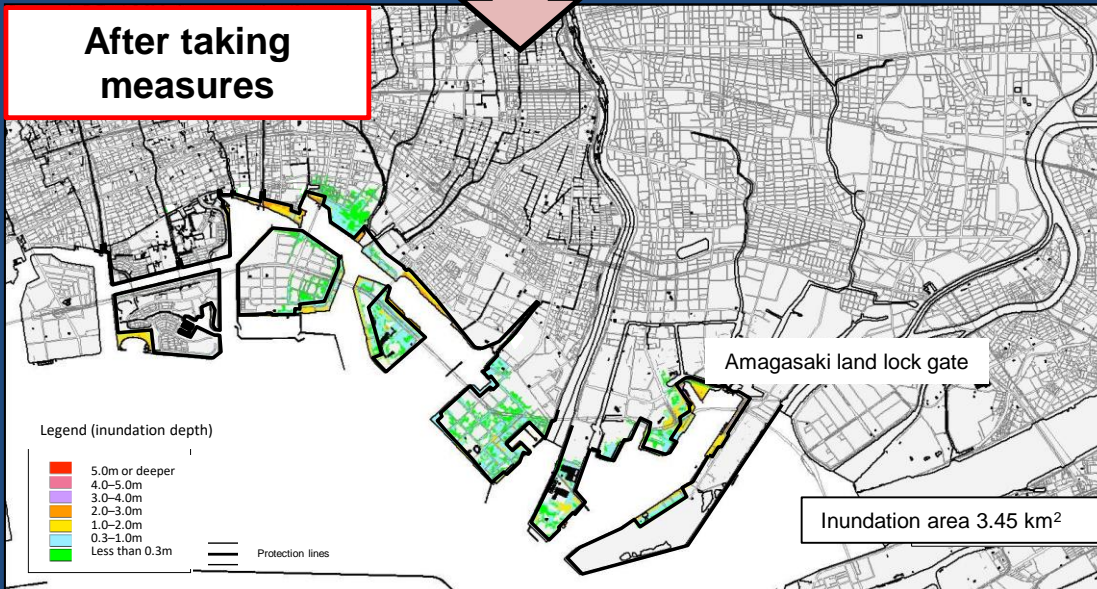
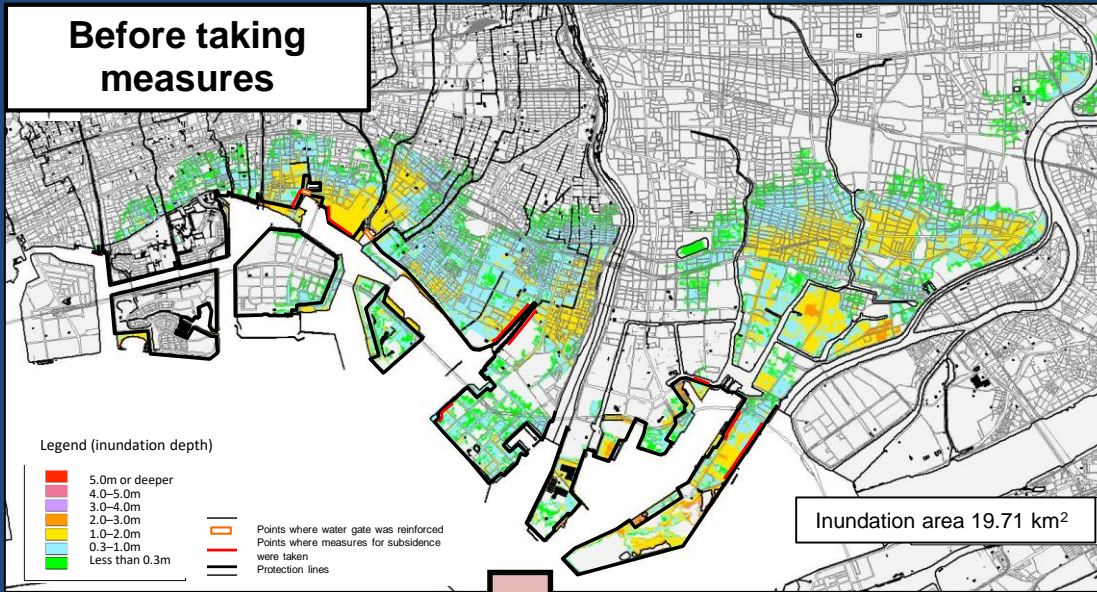
- ① Fukura Port
- ② Ama Port
- ③ Nushima Fishing Port
(the above ports are in Minami Awaji City)
- ④ Sumoto area
(Sumoto City)
- ⑤ Amagasaki Nishinomiya Ashiya Port
[Amagasaki area]
(Amagasaki City)
- ⑥ Amagasaki Nishinomiya Ashiya Port
[Naruo area]
- ⑦ Amagasaki Nishinomiya Ashiya Port
[Nishinomiya and Imazu area]
(the above ports are in Nishinomiya City)

Measures for L2 tsunamis in **priority reinforcement areas**, **Amagasaki Nishinomiya Ashiya Port [Nishinomiya and Imazu]**

- 1) Relocation of tide gates to downstream (Arai Ebisu River tide gate: relocation completed in 2015, Shinkawa tide gate)
- 2) Reinforcement of tide embankments to prevent seawater from penetrating inland (measures to prevent scouring of foundations)
- 3) Measures to prevent subsidence of tide embankments
- 4) Improvement of land lock (introducing remote control system)



3. Effects of structural measures (for L2 tsunamis)



Effects (areas in Hyogo Pref. excluding Kobe City)

1) Inundation area within the embankments was reduced by about 80% (4,019 ha → 639 ha)

2) In the areas still expected to be inundated, the depth of inundation in housing areas has been reduced to less than 30 cm, enabling people to take action to evacuate.

(excluding the southern part of Awaji Island)

Inundation area of major municipalities (areas within embankments)

Municipality	Before taking measures	After taking measures
Amagasaki City	945 ha	53 ha
Nishinomiya City	842 ha	163 ha
Ashiya City	62 ha	0 ha
Sumoto City	153 ha	39 ha
Minami Awaji City	853 ha	274 ha

4. Measures to support evacuation [Non-structural measures]

1) Evacuation support for road and other facility users



Emergency evacuation stairs (Sumoto Nadaka Shusen (Sumoto City))

2) Provision of real-time information to citizens of the prefecture

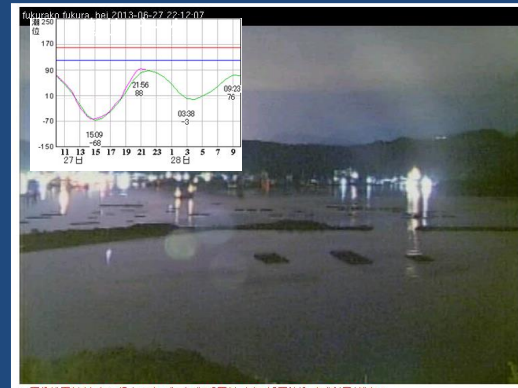


Image of the camera installed at Fukura Port

3) Raising awareness of disaster prevention and dissemination of disaster prevention learning



CG hazard map



Fukura Port Tsunami Disaster Prevention Station "Uzumaru" (Disaster Prevention Learning Facility)