REPORT

FIELD INTERNSHIP FOR TSUNAMI AND STORM SURGE PREVENTION FACILITIES

Contents

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1. **Internship title:**

"Field internship for tsunami and storm surge prevention facilities"

2. **Objective:**

In this field internship, the student will visit several places regarding to tsunami and storm prevention facilities in Osaka and Tokyo port. The knowledge from Kansai University and water/ocean museum hopefully can broaden student's mind and supported student's view for his research.

3. **Participant**

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Student ID : G170269
Affiliation : Graduate School for International Development and Cooperation (IDEC), Hiroshima University, Japan

4. **Schedule Plan**

Date	Activity
13 March 2018	• Study visit to Kansai University • Visit tsunami and Storm Surge Disaster Prevention Station, Osaka
14 March 2018	• Observe Osaka's flood control gates and storm surge prevention structures along: - Aji river gate - Kizu river gate - Shirinashi river gate • Go to Tokyo
15 March 2018	• Observe flooding control gates and area around Tokyo port
16 March 2018	• Visit Tokyo Maritime Museum • Visit Water Science Museum
17 March 2018	• Observe flooding control gates and area around Tokyo port
18 March 2018	• Back to Hiroshima University

*due to visited location workday, the schedule may be changed

5. Report

5.1 Study visit to Kansai University

We went to Kansai university and met Dr. Eng. Tomohiro Yasuda as Associate Professor in Coastal Engineering, Department of Civil, Environmental and Applied System Engineering, Faculty of Environmental and Urban Engineering. My supervisor, Assoc. Prof. Han Soo Lee, explained tsunami & storm surge modelling. Also he explained a bit regarding Adaptive Mesh Refinement (AMF) that he is working now in Seamless (tsunami & storm surge) inundation model. The beneficial of AMR is the reduction of computational time with a high accuracy. For further works, AMR or any model related to coastal/ocean will be studied by his students. He hoped to simulate AMR and apply the model in Yasuda-sensei works which is tsunami inundation in Wakayama Prefecture. Yasuda-sensei gave his idea for the feedback and gave us some references not only for model but for each person thesis research.

Figure 1 Photo of Chess Lab members with Lee-sensei (right) and Yasuda-sensei (second from right) at Kansai University (left picture) and Kansai University logo (right picture)

5.2 Disaster Reduction and Human Renovation Institution (DRI)

Kobe earthquake "The Great Hanshin-Awaji Earthquake" occurred at 5:46 JST of January 17, 1955 with 7.3 magnitude earthquake centered in the northern part of Awaji Island in Hyogo Prefecture. It hammered the nearby metropolitan area that many elderly persons called home and wreaked enormous damage including more than 6,400 dead. The DRI has inherited the experiences and lessons of the Great Hanshin-Awaji Earthquake so that it can disseminate information necessary to prevent and reduce disasters. Visitors acquire accurate knowledge about disasters and their prevention from exhibits, films, and stories told by earthquake survivors.

Figure 2 Time showing 5:46 when The Great Hanshin-Awaji Earthquake occurred (left). Comparison between disaster in Kobe and Fukushima which both of them caused tesunami after the earthquake happened (right).

Visitor casn imagine the power of the earthquake in 1.17 Theater with their movie "Hit at 5:46" for over 7 minutes. It shows the tremendous destructive power of Kobe earthquake which is portrayed using sound and dramatic images on a room with big screen. After that, visitor will be brought to realistic dioramas reproduce devastated streets just after the Great Hanshin-Awaji earthquake and let watch documenter showing towns, people, and the problems faced during the recovery and reconstruction process after the earthquake up to present day. Other movie shown in Heart Theater (3D) with titled "Scars of a Tsunami" and theater showing the threat of wind and water disasters documentation.

DRI divides the exhibition into several section in each floor, in example Memories Corner, Reconstruction from the Earthquake Corner, Miracle of the Planet of Life, Disaster Protection and Reduction Workshop, Gallery, etc. In Memorial corner, exhibited earthquake related-material along with stories of those who donated the materials. The real documents are shown in chronological order and by theme. Some videos are comparing the disaster area of then and now. The process of disaster recovery in personal lives and communities, portrayed in dioramas are shown "in the road to recovery" section. Information about earthquake disasters is introduced with computers. People lives and aspects of the towns in the reconstruction process after earthquake are explained with graphics. Sometime, they invite and give stories and experiences by the storytellers in person. Not only limited about Kobe earthquake, documentary images of recent natural disaster around the world are shown disaster impact Gallery.

Figure 3 The road to recovery after the earthquake chronologically from left to right

In the Experience Protection and Reduction against Disaster section, they provide magnitude scale and seismic energy, disaster prevention & reduction kit and seismic experience stage. The staff shows structure building behaviour due to incoming disaster.

Figure 4 Magnitude scale comparison of 6.0, 7.0, 7.3, 8.0 from right to left respectively and 9.0 on above.

Location:
Hyogo Earthquake 21st Century Research Institute,
The Great Hanshin-Awaji Earthquake Memorial,
Disaster Reduction and Human Renovation Institution
1-5-2, Wakinohama Kaigan-dori, Chuo-ku, Kobe City 651-0073
TEL. 078-262-5050 (exhibition room), TEL. 078-262-5058 (Library)
URL: http://www.dri.ne.jp/

5.3 Tsunami and Storm Surge Disaster Prevention Station

Figure 5 Station/building name

The Tsunami/Storm Surge Disaster Prevention Station comprises the Disaster Prevention Building and Display Building. The former building provides collective control for tsunami and tidal surge protection facilities, such as seawalls and gates, administered by the Nishi Osaka Flood Control Office. They also provide theater, called DYNACLUB, where dynamic images are displayed seamlessly on the front, right and left sides, even on the floor, the use of sound effects generated by a floor vibro-acoustic speaker further makes visitor feel as if the visitor were caught in real life tsunamis. This facility helps visitor experience the fear of tsunamis in an overwhelming, dynamic atmosphere.

Osaka is below sea level and often inflicted by tsunami and tidal surge disasters. Areas below sea level are land areas whose surface is lower than average sea level at high tide. At the beginning of Showa period (~1927) a large volume of underground water was pumped up for industrial use, causing serious problems such as subsidence. Nowadays, approximately 40 km^2 of areas are below sea level, home to approximately 1.08 million people. Osaka have been hit by typhoon, such as Muroto (1934), Jane (1950), 2nd Muroto (1961) which gave death & injuries to people, and submerged many houses. Then, Osaka build many protection facilities, in example tidal surge protection gate, tide gate, coastal improvement, super levee, and drainage pump station.

Figure 6 Areas below sea level in Osaka which indicates with red area

The earth is covered by approximately 10 bedrocks called “plates”. Earthquakes often occur on plate boundaries. In the Nankai through, earthquakes happen when the deformation generated by plate subduction reaches the limit, causing a sudden basement slip. When this happens at the sea bottom, the vibration from the slip is conveyed to the ocean’s surface, generating tsunamis. Japan is surrounded by Eurasia Plate, Pacific Plate, North American Plate and Philippine Sea Plate. It has been identified that giant

earthquakes occurred in the Nankai Through in the past in a 90-to 150 year cycle. It has found that in the three expected epicentre areas (Nankai, Tonankai, and Tokai through) three earthquakes often occur together in a short period of time.

It predicted that Nankai earthquake will happen within 30 years with 50%-60% probability and within 50 years with 80%-90% probability while Tonankai earthquake will occur within 30 years with 60%-70% and within 50 years with more than approximately 90% probability. Tsunamis generated by the Tonankai/Nankai earthquakes will hit Osaka coastal areas in the near future. In 2003, Osaka Prefecture conducted a tsunami simulation on the assumption that the largest-scale Nankai earthquake would occur (examining tsunamis in terms of height, arrival time and current speed). The tsunami heights indicated are expected maximum heights based on the assumption that earthquakes occur at high tide.

Figure 7 The predicted wave height and arrival time of tsunami if earthquake from Nankai through.

Knowledge to protect our life from tsunami disaster is exhibited at the end of the section. They give several points to do before and after evacuation if the disaster occurred. Osaka Prefecture is developing a collective management (remote monitoring, control, motorization, etc.) of tide gates and (iron) tide protection gates for opening/shutting operations. If disaster happen, The Japan Meteorological Agency (JMA) releases Early Warning immediately after occurrence of an earthquake. Tsunami warning will be given when the potential earthquake is followed by a tsunami. Such information is systematically provided to citizen immediately in variety of ways, such as TV, radio, PC (through the web), loudspeaker car, fax, mobile phone, self-defense force, fire department, etc.

Location:
Tsunami and Storm Surge Disaster Prevention Station,
2-1-64, Enokojima, Nishi-ku, Osaka 550-0006
TEL. 06-6541-7799
URL: http://tsunami-osaka.jp

5.3 Museum of maritime Science

Japan is surrounded by the ocean in all directions and has drawn its strength from the sea since ancient times, developing as a maritime nation that relies heavily on marine resources. It can be said that important role of Japan on the international stage has its foundations in its development of maritime industries such as shipping and ship-building. In the years to come, the oceans will continue to play an important role in Japan's economic and cultural development as well as its ability to contribute on a global scale. As Japan moves from being a country protected by the sea, to one protects the sea, the museum of maritime science aims to deepen public understanding an awareness of the oceans through a variety of proactive initiatives that highlight the culture of the ships and the sea.

Figure 8 Resources that can be found in Japan's sea (left) and method to conduct data from the sea (right).

Existed many structure outside the museum, such as large screw propeller, Lighthouse, Battleship Mutsu main gun, superconducting electromagnetic propulsion system, Soya ship, and deep exploration ship. Inside the exhibition annex, visitor can see japan historical ship, from ancient, warship, and recent navy ship model. Seas of japan are shown in bathymetry map of Japan and its surrounding. Sometimes they held canoeing and canoe sailing class in training pool beside museum main building.

Figure 9 Bathymetry and topography in Japan and its surrounding.

Antarctic Research SOYA

Figure 10 Antarctic Research Ship Soya.

Soya was built in 1938 as a cargo icebreaker. Following her service during World War II, she was used as a repatriation ship and then a lighthouse supply ship. From November, 1956 to April, 1962, she made six trips to the Antarctic as Japan's first Antarctic research ship. Until her retirement in 1978, the Japan Coast Guard used Soya as a patrol ship. Soya has been moored at the Museum of Maritime Science as part of its permanent exhibit since May, 1979.

In order to facilitate museum's renovation, all exhibitions in the main building have been temporarily closed.

Location:
Museum of Maritime Science
3-1 Higashi yashio, Shinagawa, Tokyo 135-8587
TEL. 03 (5500) 1111
URL: http://www.funenokagakukan.jp

5.4 Tokyo Water Science Museum

This is a museum which explores wonders of water from a scientific view as well as allowing one to deepen their interest in water and the waterworks in experience style. The museum provides aqua tour and exploration of Ariake Water Supply Station which is an actual functioning facility that shows how water arrives in our home. The museum divides each floor as each section, such as aqua trip, aqua forest, aqua laboratory, aqua town, aqua showcase and aqua park.

Visitor will be brought to the room of Aqua trip on the 3rd floor and watch film titled "Hear the Song of Water". The film shows the journey of a drop water and trace its journey into 'Big Cycle of Water' supported by the projected scenes on four screens (forward, left, right, and ceiling). Aqua forest section outside previous room shows aerial views of the forest as the source of water supply. Some exhibit illustrates certain indispensable tasks carried out by forest in the process of water generation, and the deep relationship between the two. It is introduced Tokyo has pure and high-quality water as gift of great nature. The vast forest area located around upper Tokyo reaches of Tama River is managed by the Tokyo Bureau of Waterworks as water resource forest.

In the Aqua laboratory, visitor can have amazing experiences with water. The exhibit introduces how through a combination of elements focused on water purification processes and related technology. Three water treatment technologies in particular flocculation, Ozonation Treatment, Biological Activated Carbon Adsorbing Treatment have been adapted into games which provided by museum so the visitor can enjoy and understand the processes of creating tasty water. Five types of experiment concerned with water quality are prepared, such as Bermuda triangle, water vortex, water pressure, Bernoulli, etc. Also, the staff carries out a number of demonstration/experiment which change regularly. Aqua town section explains the role of water in daily lives (kitchen, bathroom, laundry, etc.) through miniature of houses, schools, offices, factories, and other buildings.

Figure 11 Soil layer from forest (left) and method/procedure to create tasty water displayed in wall (right).

Location:
Tokyo Water Science Museum
3-1-8 Ariake Koto-ku, Tokyo
TEL. 03-3528-2366
URL: http://www.mizunokagaku.jp

5.5 Flooding Control Gates

Osaka is an alluvial plain with low ground height, formed mostly by the flood of Yodo River and Yamato River. These river gradients are relatively moderate and it is nearly the tide zone up to the foot of Ikoma Mountain. Since it is a low ground, it is often suffering damage from flooding, so many flood control projects have been done since ancient times. Major disaster occurred due to the storm surge caused by the 2nd Muroto typhoon in 1964 when the damage was enormous. As a permanent storm surge countermeasure project, the emergency three-year plan was decided, construction of tidal facility was carried out and completed in 1964. However, in consideration of society, economic situation and ground subsidence, it was necessary to further strengthen the maintenance of tidal facilities. In 1964, the "*Osaka Storm Surge Protection Countermeasures Permanent Plan*" was drawn up, and a tidal flood gate including three large flood gates was built.

Table 1. Observed Flood Gates Location in Osaka

Name / Location	Longitude	Latitude
Kizu River	135^0 28” 45.75’ E	34^0 39” 3.96’ N
Shirinashi River	135^0 27” 49.98’ E	34^0 39” 30.36’ N
Aji River	135^0 27” 22.03’ E	34^0 40” 31.70’ N

Figure 12 Miniature of Flood Gate construction in Aji River (left) and the arch-shaped flood gate with red color indicates when the water gate is closed (right) (http://www.pref.osaka.lg.jp/nishiosaka/emergency/high-tide.html).

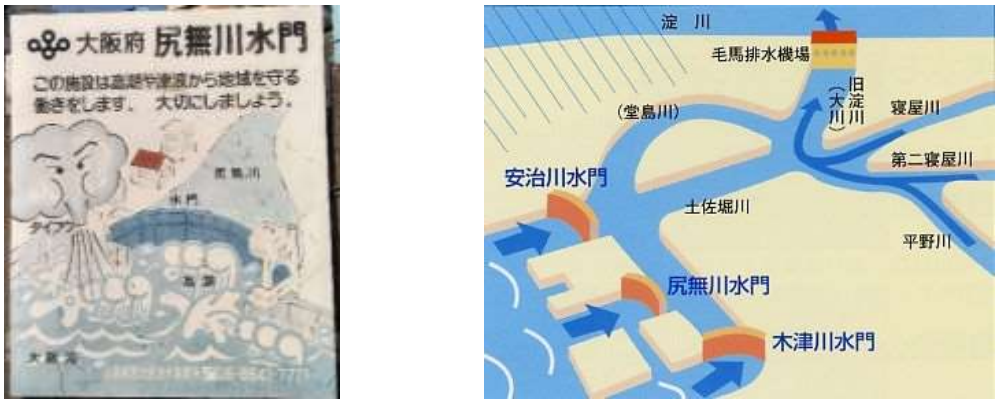

Figure 13 Illustration of Flood Gate protect city from high tidal and high wind waves. When Flooding Gates prevent the incoming waves, the water from river will be diverted to Yodo River (http://www.pref.osaka.lg.jp/nishiosaka/emergency/high-tide.html).

Tokyo Port which located deep within Tokyo Bay is highly isolated to the southwest and has very shallow waters. This port is highly susceptible to the effects of high tide and rising water levels are considered as high waters. Tokyo Port shoreline protection facilities have been developed since 1961, such as outer levees, flood gate, and drainage pumping sites designed to protect land from high tides. During the Great Tohoku Earthquake which occurred on March 11, 2011, the closing of floodgates worked to prevent damage from the tsunami. Floodgates and pump stations have been built in the early 1960s through the middle 1970s. Flood Control Gates in Tokyo bay are divided into several area: Koto district, Morning tide area, Tsukiji district, Konan district, and Shikugawa area. Tokyo Waterfront City.

Table 2. Observed Flood Gates Location in Tokyo

Name / Location	Longitude	Latitude
1	139^0 50’ 8.59” E	35^0 39’ 7.94” N
2	139^0 49’ 18.04” E	35^0 38’ 49.09” N
3	139^0 48’ 28.33” E	35^0 38’ 44.51” N
4	139^0 47’ 54.83” E	35^0 38’ 55.47” N
5	139^0 47’ 14.45” E	35^0 39’ 44.82” N
6	139^0 46’ 3.38” E	35^0 39’ 30.96” N
7	139^0 45’ 50.87” E	35^0 39’ 23.38” N
8	139^0 45’ 31.4” E	35^0 39’ 5.48” N
9	139^0 45’ 28.88” E	35^0 38’ 45.92” N
10	139^0 45’ 7.55” E	35^0 38’ 6.63” N
11	139^0 44’ 57.37” E	35^0 37’ 27.81” N
12	139^0 44’ 53.82” E	35^0 37’ 7.96” N
13	139^0 48’ 31.1” E	35^0 39’ 54.44” N
14	139^0 48’ 8.82” E	35^0 39’ 54.28” N
15	139^0 47’ 38.02” E	35^0 39’ 47.74” N
16	139^0 46’ 32.3” E	35^0 39’ 16.26” N
17	139^0 46’ 20.44” E	35^0 39’ 31.12” N
18	139^0 46’ 37.14” E	35^0 39’ 43.75” N
19	139^0 45’ 5.65” E	35^0 33’ 23.8” N
20	139^0 45’ 0.4” E	35^0 33’ 31.19” N
21	139^0 44’ 46.26” E	35^0 34’ 8.65” N
22	139^0 44’ 37.41” E	35^0 34’ 15.77” N
23	139^0 44’ 24” E	35^0 34’ 29.12” N

The flood gate is installed at the boundary between outer waters divided by outer levee and the inner waters. When the water rises due to storm surge, it will close the gate and prevent the rise of water level in the inner watershed. Three kind of flood gates are installed in Port, roller gate, swing gate, and sector gate.

6. Daily activity

Date	Daily Activity
13 March 2018	I went to Kansai University using shinkansen with my supervisor and 2 member from Chess Lab. We met Dr. Eng. Tomohiro Yasuda as Associate Professor in Coastal Engineering in Kansai University. Our supervisor explained tsunami and storm surge modelling. Then, Yasuda-sensei gave his idea and other material that can support further our research. The plan was visit Tsunami and Storm Surge Disaster Prevention Station, Osaka, however Tuesday is their closed day thus we change our plan. Yasuda-sensei suggested us to go to Disaster Reduction and Human Renovation Institution (DRI) in Kobe. We visited there after we took our lunch. The DRI showed exhibition regarding The great Hanshin-Awaji earthquake which happened in January 17, 1995. DRI has inherited experiences and lesson from the earthquake for necessary prevention and reduction in the upcoming disaster. On the evening, my supervisor and other lab members went back to Hiroshima University while I went to Osaka. I went to the booked accommodation, took a stroll, searched for bicycle rental and prepared for tomorrow's activity.
14 March 2018	I checked out and went to bicycle rental in the morning. Since in previous day I could not visit Tsunami and Storm Surge Disaster Prevention Station, then today I put it in my schedule. First location was Kizu river, the location was near industrial area and it was quite hard to see the flood gate. Next location was Shirinashi river with its distance from the Kizu river about 1.7 km. The last one was in Aji river with 2 km distance from previous gate. Each coordinate of the location explained in previous section. The last location was near Osaka aquarium, I tried to visit it since it related to marine/ocean. On the afternoon, I visited Tsunami and Storm Surge Disaster Prevention Station, Osaka. The staff explained earthquake due to subduction of the plates around Japan, tsunami which had been occurred, also the process of flood control gates protect the city. They let me watch fictional documentary about tsunami in their big room (DYNACUBE) to realize how big natural disaster that we faced. A tried to go to Osaka Museum of History to see Osaka in the past since Osaka located near coast and have strong relation on maritime. On the night I went back to Shin-Osaka station to continued visiting places in Tokyo using shinkansen. I did not realize that I did a mistake due to booking date of accommodation in Tokyo. Thus, I searched a room nearby Tokyo station and prepared for next day's activity
15 March 2018	I searched rental bicycle in the morning and found few, however I faced the problem. I could not rent bicycle since the rental need my passport which I forgot to bring, other rental did want to rent their bicycle. Moreover, I could not use *bike town sharing* since the whole *app* use Japanese. To be able continued visit flood gate, I chose to take public transportation and walked to each location. I visited 12 flood gates, but one of them was too far to reach. Also, two of them can be seen in some tourist places (Hama-Rikyu garden) , so I came inside though it paid.

16 March 2018	In the morning I went to visit 3 flood gates before I went to the mosque to weekly pray. The plan was only visit museum related to water/ocean in Tokyo, but since the plan was changed, I should visit another flooding gates. I visited Museum of Maritime Science. They displayed many Japan ship, from ancient ship, war ship, shipping ship, up to exploration ship. The main building shaped like a large ship. However, the main building had been closed from 2011 for renovation and it was not opened yet. Other exhibition that could be seen was Soya arctic research ship, lighthouse, large screw propeller, etc. From afternoon up to night, I searched several flooding gates before I went back to my accommodation.
17 March 2018	I visited Tokyo Water Science Museum. This museum explores water from scientific view and deepen water interest. I saw a movie about journey of a drop water until it can be used in daily life. That was good place, but most part of the museum use Japanese that hardly to understand. Since Tokyo Sewerage Museum is nearby previous museum, thus I visited it. They displayed many exhibitions regarding sewer system in Japan. Even though the museum was more suitable for children, but the knowledge of water purification, reconstruction, etc. was explained conveniently.
18 March 2018	I went to Tokyo Waterworks Historical museum in last day. Finally, I went back to Hiroshima on evening and arrived in Hiroshima University at night.

7. Conclusion

The student had visited several Flood Gates and museums related to ocean. The obtained knowledge from field internship made the student realize more that coastal structures are necessary, not only protecting city and people behind them but also sign of development city in utilize marine sector for shipping and economic field. It was stated, Japan will face many natural disasters in future, particularly earthquake and tsunami caused by Nankai through. Thus, this internship encourages more the student to deepen his knowledge and apply in coastal field.

APPENDIX

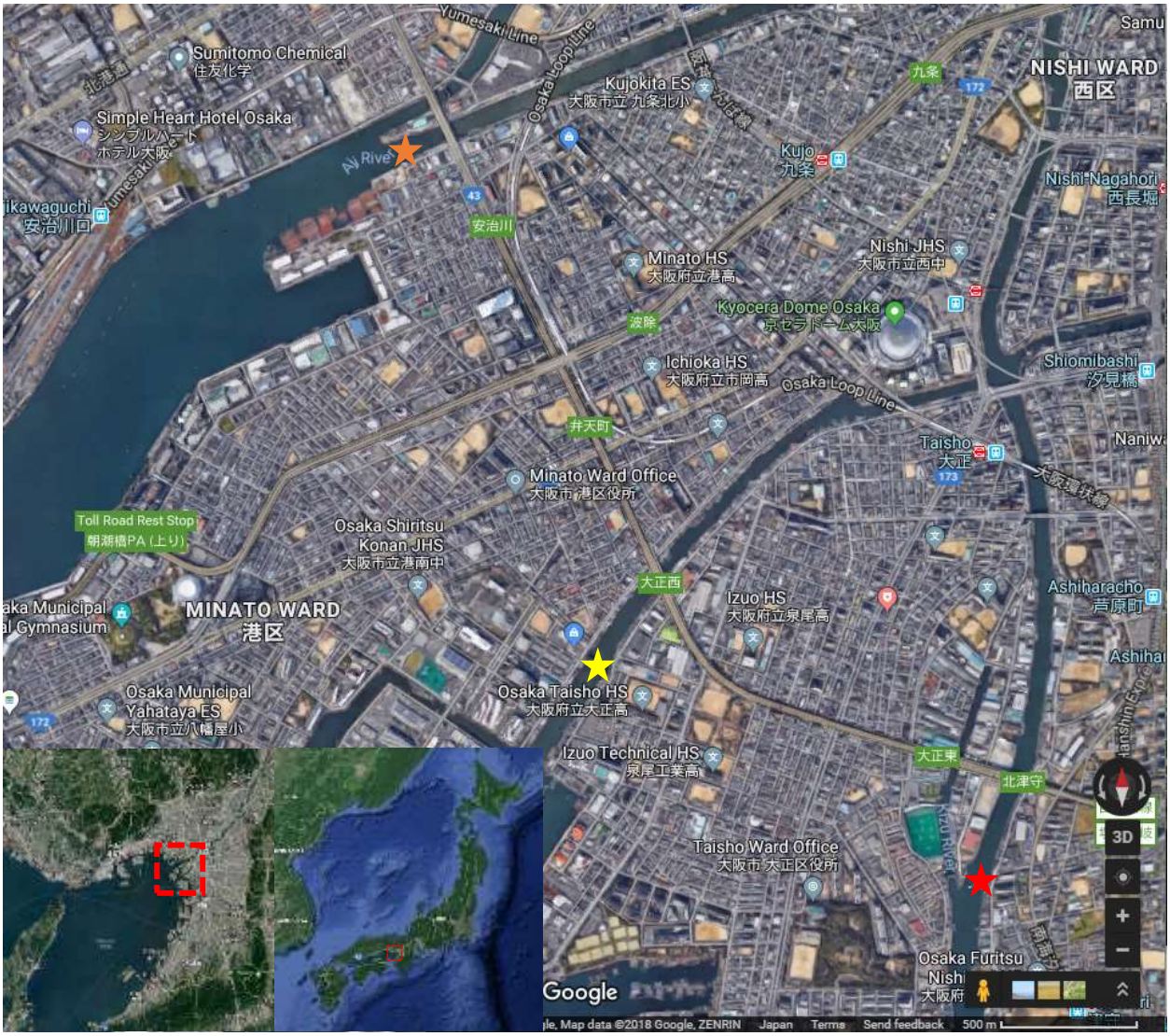

Figure A1.1 Map of Osaka with star indicates the location of Flood Gates. The red star located in Kizu River, yellow star in Shirinashi River, and orange star in Aji River.

Figure A1.2 Flood Gate in Kizu River

Figure A1.3 Flood Gate in Shirinashi River

Figure A1.4 Flood Gate in Aji River

Figure A2.1 Map of Tokyo Bay with round indicates the location of Flood Gates. The red number inside the circle is the number of visited Flood Gate.
(http://www.kouwan.metro.tokyo.jp/yakuwari/takashio/shisetsu/suimon/)

Figure A2.2 Flood gate no.2

Figure A2.3 Flood gate no.3

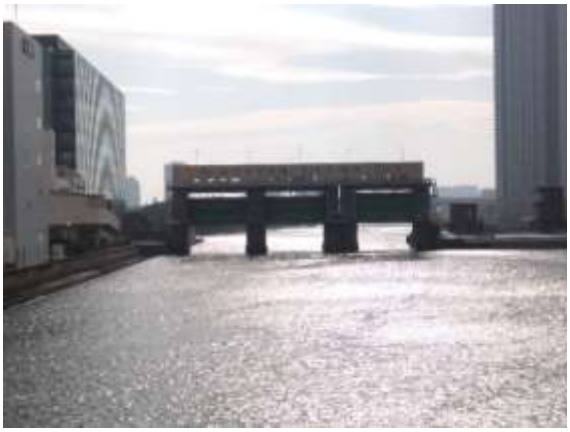

Figure A2.4 Flood gate no.4

Figure A2.5 Flood gate no.5

Figure A2.6 Flood gate no.6

Figure A2.7 Flood gate no.7

Figure A2.8 Flood gate no.8

Figure A2.9 Flood gate no.9

Figure A2.10 Flood gate no.10

Figure A2.11 Flood gate no.11

Figure A2.12 Flood gate no.12

Figure A2.13 Flood gate no.13

Figure A2.14 Flood gate no.14

Figure A2.15 Flood gate no.15

Figure A2.16 Flood gate no.16

Figure A2.17 Flood gate no.17

Figure A2.18 Flood gate no.18

Figure A2.19 Flood gate no.20

Figure A2.21 Flood gate no.21

Figure A2.22 Flood gate no.22

Figure A2.23 Flood gate no.23