Advanced maritime transportation and port planning

1. Outline of Studies and Activities

出来事Event	Research background	Research	Reflection of results
Since the 1990s (Expansion of global supply chain) (Larger container vessels etc.) Since the 2000s (Progress of hub port development in East Asian countries)	・Necessity to strengthen the international competitiveness of Japan's ports due to the economic development of Asian countries and progress in port development ・Progress in increasing the size of containerships and other vessels ・Obligation to carry AIS by international convention	**■Accumulation and expansion of maritime data and analysis of trends** ・Analysis of global container shipping movements (2001-) ・Analysis of container movements between Asia and North America (2002-) ・NILIM-AIS system operation and analysis of water area and berth usage (2004-) ・Provision of real-time information on vessel movements to the Collins system (2009-)	**○Port policy formulation, evaluation, etc.** Super Hub Port Policy (2004-) International Container Strategic Port Policy (2010-) International Bulk Strategic Port Policy (2011-) **○Medium- and long-term port policies** PORT2030 (formulated in July 2018) **○PIANC Guidelines** ・No. 121 Design Guidelines for Inbound and Outbound Passage (2014)
2008-2009 Lehman Shock / Global recession 2011 The Great East Japan Earthquake Expansion of cruise ship calls Decrease in sea ice in the Arctic Ocean, Panama Canal expansion Worsening of congestion in port areas	・Necessity to stipulate the performance of technical standards ・Necessity to improve the accountability for public works investment ・Improving the performance of large cruise ships ・Necessity to respond to national resilience	**■Advancement of water area facility planning methods** ・Development of the detailed design of fairway planning (2001-2006) ・Development of J-Fairway software (2005-) ・Analysis of vessel evacuation from Tokyo Bay during the Great East Japan Earthquake and calculation of the scale of required berths (2011-2013) ・Study on the development and use of water area facilities for high-performance cruise ships (2017-2019) ・Study on the development of water area facilities for large typhoons (2019-)	**○Revision of Technical Standards and Commentary for Port Facilities (2007)** Part 3: Action and Material Strength Conditions Chapter 8 Vessels 1. Main specifications of the subject ship Part 4 Facilities Chapter 3 Waterway Facilities 2. Routes 3. Anchorage Chapter 5 Mooring Facilities 2. Quays 2.1.1 Quay specifications Chapter 7 Cargo Handling Facilities 3.5 Container terminal area
Large typhoon damage 2020 Global spread of new coronavirus 2020 Five-year accelerated measures for disaster prevention, load reduction, and national land resilience	・Inadequacies of the general method for terminal size calculations ・Shortage of workers at ports and harbors ・Development of remote automation at port terminals	**■Advancement of port terminal planning methodology** ・Calculation of standard vessel and berth specifications (2001~) ・Development of a model for calculating the size of container terminals (2001-2006) ・Analysis of behavior of large bulk vessels during offloading (2011-2014) ・Research on remote automation of container terminals (2019-) ・Research on measures to maintain hinterland transportation of international maritime containers (2021-)	**○Revision of Technical Standards and Commentary for Port Facilities (2018)** Action and Material Strength Conditions Chapter 8 Vessels 1. Main specifications of the subject ship Facilities Chapter 3 Waterway Facilities 2. Routes 3. Anchorage Chapter 5 Mooring Facilities 2. Quays 2.1.1 Wharf specifications Facilities (Reference) Chapter 2 Specialty Wharf

*NILIM partially in charge and involved

Ports and harbors, as hubs of international logistics, are affected by various factors such as technological innovation in maritime transport, global socioeconomic trends, and the growth of ports in neighboring Asian countries, and these conditions have been changing from time to time over the past two decades. In order to maintain the international competitiveness of our nation's ports and ensure that they remain safe and efficiently usable under these circumstances, we have been analyzing maritime data for policy support as well as revising the standards for port facility planning (planning standards).

Research Activities 1: Accumulation, expansion, and dynamic analysis of maritime data

<Background/Issues> The rapid economic growth of neighboring Asian countries led to their development of ports and harbors, which in turn affected containerized cargo movement to and from Japan. In addition, shipping companies have been increasing the size of their vessels, including container vessels, in order to pursue economies of scale. At the same time, given the advances in information and communication technology and the global momentum to strengthen navigational safety measures, the International Maritime Organization (IMO) amended the SOLAS Convention whereby ships must be equipped with the automatic identification system (AIS).

<Research Outline and Results Implementation> By studying and implementing policies to strengthen the competitiveness of Japanese ports, including the Super Hub Port Policy, we accumulated maritime data from around the world, analyzed container flows in Japan and other Asian countries, and continued to analyze trends in container vessel size and other factors to support policy planning and implementation. In addition, since a detailed analysis of vessel movements has become possible using AIS data, we have developed a data collection system in cooperation with regional development bureaus, etc., developed analysis software, and provided support for a real-time information provision system to improve the logistics efficiency. In addition, we worked to understand the changes in global transportation trends through the use of satellite data, publicized the results of our analysis, and issued press releases.

Research Activities 2: Advancement of water area facility planning methods

<Background/Issues> In the planning of water area facilities, mainly for navigation channels and anchorage areas, the water depth, channel width, and other parameters have been described in standards based on formulas derived from the experience of maritime professionals (specification rules). However, the demand for performance standards and the need to improve the accountability for public works investments call for more efficient planning standards based on a clearer theory and rationale, while maintaining the objective of ensuring safe vessel navigation. On the other hand, as vessels have become larger and more maneuverable, as typified by pod-type cruise ships, there is an increased need for safety assessments when vessels enter ports. Furthermore, the Great East Japan Earthquake and other tsunamis and large typhoons that have hit Japan and caused damage to ports and harbors have created a need to address the issue of national land resilience.

<Research Outline and Results Implementation> In order to improve the situation, a new fairway planning standard was developed in collaboration with the Nautical Institute of Japan, which explicitly incorporates the ship's maneuverability and navigational environment, and is reflected in the technical standards. In response to the increase in the number of cruise ships, we used AIS to analyze the actual use of water areas when turning around, and we conducted model tests to evaluate ship maneuverability. In addition, detailed analysis of vessel behavior in the event of natural disasters such as the Great East Japan Earthquake, which poses a high navigational risk to ports and harbors, was conducted to support the administrative work for national land resilience.

Research Activities 3: Advancement of port terminal planning methodology

<Background/Issues> In planning a container terminal, it is necessary to calculate the berth specifications and terminal scale. However, since various methods were used for the latter, a unified planning method was required for each terminal size calculation. In addition, given the concerns about a mid- to long-term shortage of workers in Japan, efforts to remotely automate cargo handling have progressed in order to improve the working environment at port terminals and enhance the safety of cargo handling.

<Research Outline and Results Implementation> We developed related methods for container terminal planning, taking into consideration performance specifications and the continuous increase in vessel size. We also studied terminal improvement measures to support remote automation by improving existing terminals, and we developed planning methods to accommodate multiple calls by large bulk vessels as indicated in the International Bulk Strategic Port Policy.

2. Main Research Results

Research Activities 1: Accumulation, expansion and dynamic analysis of maritime data

○We have continuously published the trends in container ship size increases, port call results, and container cargo flow between Asia and North America in the form of NILIM Technical Notes and external papers. In addition, we have continuously conducted analyses to support the study and implementation of the Super Hub Port Policy, the International Bulk Strategic Port Policy, and the International Container Strategic Port Policy.

○The NILIM-AIS system has been established for the integrated acquisition and accumulation of AIS data acquired by NILIM and maintenance bureaus, etc. The data is used to provide administrative support by analyzing the use of major shipping routes and berth utilization rates, and is also provided to the Collins system operated by the MLIT in real time.

○We have conducted joint research with JAXA and other organizations to analyze the actual state of the Northern Sea Route (NSR) navigation using satellite AIS data, and have issued press releases on the results.

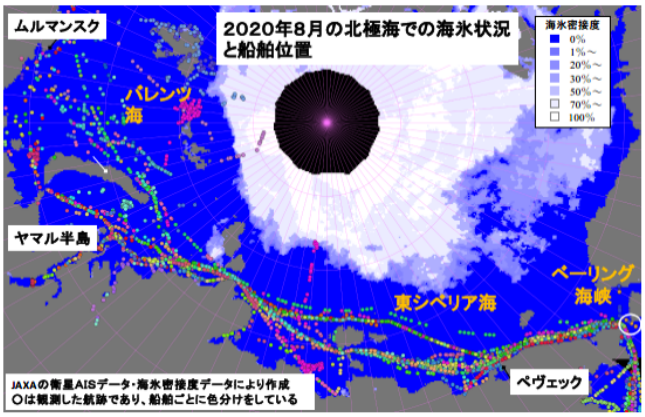

Figure: Example of analysis of actual conditions of NSR navigation (JAXA satellite data)

Research Activities 2: Advancement of water area facility planning methods

○The scale of water area facilities has conventionally been defined based on the ship's characteristics (e.g., the water depth in a navigation channel is 1.1 times the ship's draft), but we have developed a method (detailed design of fairway planning) jointly with the Japan Society of Navigational Engineers for evaluating ship motions based on navigation conditions, such as wind and swell, and planning water area facilities. The method is reflected in the technical standards and incorporated into the International Association of Navigational Sciences Guidelines No. 121 (Harbor Approach Channels: Design Guidelines), contributing to the international community. Since the calculation process for the second category is complicated, we developed the J-Fairway

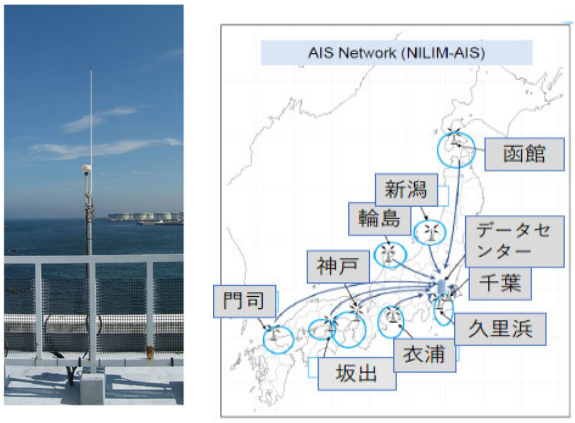

Figure: AIS antenna and NILIM-AIS system

Program that enables the calculation of route parameters by inputting the conditions into an Excel sheet, and we distributed it to relevant parties in Japan and overseas.

○In the aftermath of the Great East Japan Earthquake, many people evacuated offshore, and it was pointed out that there was a shortage of anchorage areas for this purpose.

○For large cruise ships, which are becoming more sophisticated, we used AIS data to conduct an empirical analysis of the size of the berthing area when turning around, and we proposed a guideline for the size of the water area required to safely enter a port. In addition, by evaluating the maneuverability of large cruise ships through model tank tests, the second category of route planning was applied to large cruise ships, and a draft revision of the technical standards was prepared.

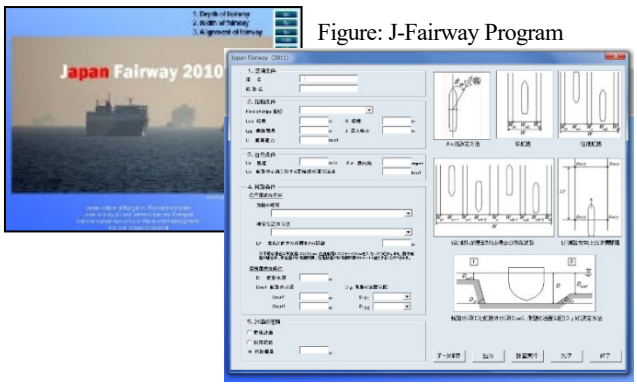

Figure: J-Fairway Program

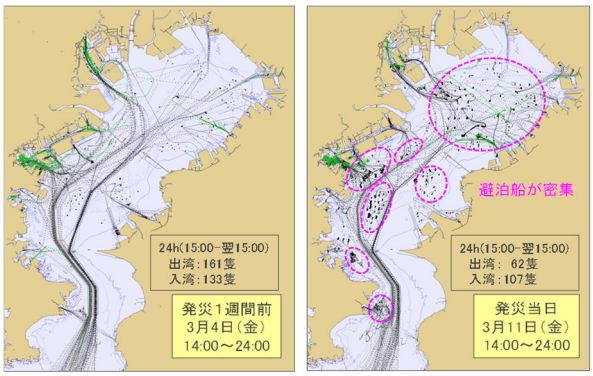

Figure: Evacuation of vessels in Tokyo Bay at the time of tsunami attack (left)

Research Activities 3: Advancement of port terminal planning methodology

○In order to respond to the performance specifications in container terminal planning and the frequent increase in vessel size, a new terminal size calculation method that takes terminal yard capacity into consideration was developed and reflected in the technical standards.

○Standard vessel and berth specifications for major vessel types were analyzed and reflected in the technical standards. In addition, in order to support multiple port calls under the International Bulk Strategic Port Policy, we developed a method to calculate the draft of major bulk vessels at the time of loading reduction, and reflected the method in the technical standards.

○To support remote automation by improving existing terminals, we examined methods for changing the layout at remote automation terminals and verifying the terminal capacity after remote automation.

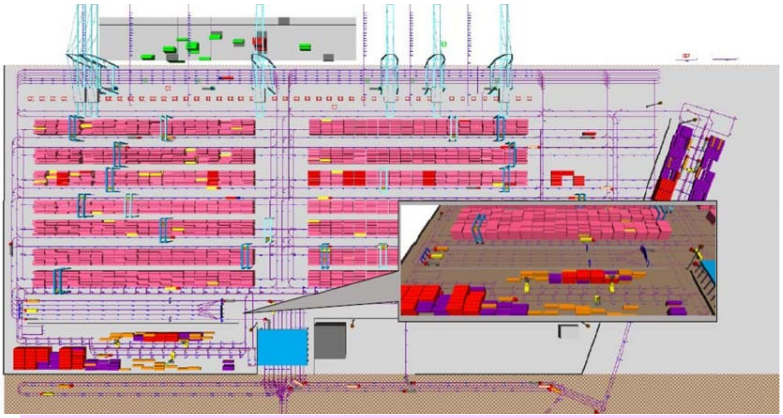

Figure: Example layout of remote automation terminal (Verification simulation screen)

3. List of related reports and technical documents

■Accumulation and expansion of maritime data and related dynamic analysis (Major items)

1) NILIM Technical Note No. 6　http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0006pdf/ks0006004.pdf

2) NILIM Technical Note No. 18　http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0018.htm

3) NILIM Technical Note No. 420 http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0420.htm
4) NILIM Technical Note No. 768 http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0768.htm
5) Provision of information on the actual state of navigation in the Arctic Ocean routes (Press release in March every year since 2017)

■Research related to the advancement of water area facility planning methods (Major items)

1) NILIM Research Report No. 110 http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0110.htm
2) NILIM Technical Note No. 782 http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0782.htm
3) NILIM Technical Note No. 1052 https://www.ysk.nilim.go.jp/kenkyuseika/pdf/ks1052.pdf
4) NILIM Technical Note No. 1119 https://www.ysk.nilim.go.jp/kenkyuseika/pdf/ks1119.pdf
5) NHK Metropolitan Area Network, "Vessel movements at the time of the Tokyo Bay tsunami attack" (Aired April 12, 2016)

■Research related to the advancement of port terminal planning methods (Major items)

1) NILIM Research Report No. 10 http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0010.htm
2) NILIM Research Report No. 28 http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0028.htm
3) NILIM Research Report No. 45 http://www.nilim.go.jp/lab/bcg/siryou/rpn/rpn0045.htm
4) NILIM Technical Note No. 676 http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0676.htm
5) NILIM Technical Note No. 834 http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0834.htm

4. Future Outlook

To strengthen port connectivity and ensure safe use of water facilities, maritime data will be analyzed and port planning standards will be developed with safety and economic considerations in mind. Two issues are raised in this process. The first is to respond to the progress of digitalization. For example, as terminal operations become more automated, data on cargo handling performance will be accumulated, which can be used to further improve efficiency. It would be beneficial to integrate the acquisition and use of data while taking real-time data into account, for example, by building a platform for port operations. The second issue is to respond to the need for national land resilience. In the event of a tsunami or typhoon, appropriate evacuation and anchoring of vessels will be necessary, and a more detailed analysis of vessel behavior during emergencies is required, as well as the expansion of related standards to ensure safe use of water areas while taking into consideration the increase in external forces.