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Supporting Decision-Making via Integrated Visualisation of Railway Operations and Weather / Disaster Information: JEMAPS Use Cases

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Abstract

East Japan Railway Company pursues "ultimate safety" amidst increasing natural disaster risks. To support rapid decision-making for safe and stable transport, JR East developed the "JR East Mashup Probe System". This web-based platform integrates vast internal and external data, displaying railway operation status – including train locations, diagrams, and congestion levels – alongside real-time weather and disaster information on a unified map interface. This paper outlines JEMAPS's capabilities and its critical role during recent events, such as heavy rains and tsunami warnings, where it enabled headquarters and local dispatchers to understand complex situations accurately. Furthermore, the system aids in rescue planning by visualising trains stopped between stations and acts as a vital tool in disaster prevention drills using simulated data. The paper also discusses the recent expansion of JEMAPS to tablet devices in late 2025. This development empowers field employees, including station staff and train crew, with independent situational awareness, facilitating faster response times. Finally, future prospects are presented, including enhanced equipment monitoring and potential external information sharing to help customers ensure their own safety during emergencies.

Keywords: railway operations, meteorology, disaster, safety and stability, geographic information system, digital twin, big data.

1 Introduction

East Japan Railway Company (hereinafter referred to as "JR East") operates an extensive railway network spanning the Kanto, Tohoku, and Koshinetsu regions. With the ultra-high-density commuter network of the Tokyo metropolitan area and the intercity Shinkansen network serving as its two main pillars, the company's railway business plays a vital role as a critical infrastructure supporting the economic and social activities of Eastern Japan. In 2025, JR East renewed its previous group management vision and announced, "To the Next Stage 2034". To realise the "ultimate safety" and "security (peace of mind) for all people" set forth in this new vision, and to ensure that everyone, including customers and JR East Group employees, feels this "security (peace of mind)", we are engaged in business innovation and the creation of new value based on the "evolution" and "deepening" of our technical capabilities. As part of this initiative, we began developing the "JR East Mashup Probe System" (hereinafter referred to as "JEMAPS") in 2020. JEMAPS is a platform that displays vast amounts of internal and external data on a map in a visually easy-to-understand manner in near real-time. It was launched in June 2022 as a web browser-based platform accessible by employees from internal intranet PCs [1].

In JEMAPS, it is possible to display not only information regarding our railway operation status but also information regarding weather and disasters simultaneously (Figure 1). With weather disasters becoming more severe and frequent in recent years, and the occurrence of the Tokyo Metropolitan Inland Earthquake or the Nankai Trough Earthquake predicted in the near future, preparedness for natural disasters is becoming increasingly important for railways. JEMAPS supports employees in gathering relevant information rapidly and accurately and making decisions for the purpose of safe and stable railway transport and ensuring the safety of customers and employees when natural disasters are anticipated or have occurred [2]. This paper presents the overview of JEMAPS, and then discusses its actual use cases and future prospects.

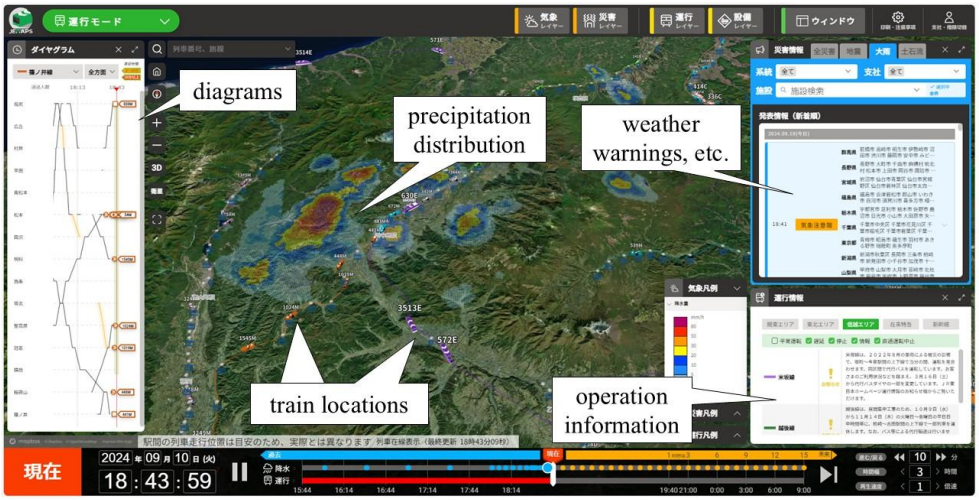

Figure 1: Overview of the JEMAPS interface. In addition to the operation status of each line section (train locations, diagrams, operation information such as delays and

suspensions), it is possible to display map views regarding various weather conditions (the screen shows an example of precipitation distribution) and issued weather warnings, etc.

2 Overview and Functions of JEMAPS

JEMAPS can display railway operation status and information regarding weather and disaster prevention on a map in near real-time. Furthermore, since JEMAPS continues to accumulate this data, it is possible to easily display information from past points in time. This section introduces the basic functions of JEMAPS.

2.1 Operation Status Display Function

Approximate train locations, delays, and congestion levels can be displayed on the map. As for congestion levels, the system not only displays the estimated number of passengers on each train (estimated from the load applied to each carriage by passengers) as a numerical value, but also varies the height of the train icon according to the number of passengers to express the congestion level. This makes it easy for anyone to understand the situation intuitively through clear visuals (Figure 2). Additionally, for delayed trains, coloured bubbles are displayed around the train icon to make it easier to grasp the delay status while ensuring visibility (yellow bubbles are displayed for minor delays, and red bubbles for extended delays).

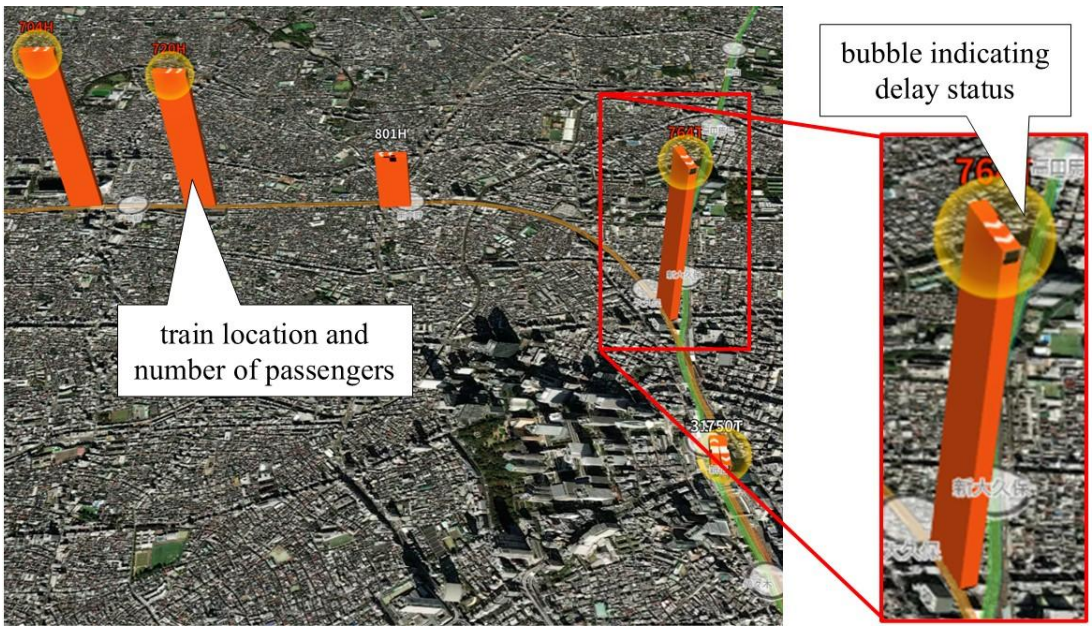

Figure 2: Display of train operation status. In addition to the operation status of each train (approximate location and number of passengers, etc.), train delay status can be displayed.

Furthermore, it is possible to display train diagrams for each line section and operation information for trains within the JR East area, allowing for a unified understanding of operation status for both conventional lines and Shinkansen (Figure

3, Figure 4). Since the beginning of development, we have continued to gradually expand the line sections for which operation status can be displayed, and it is now possible to display the operation status of all line sections (69 lines) within the JR East area.

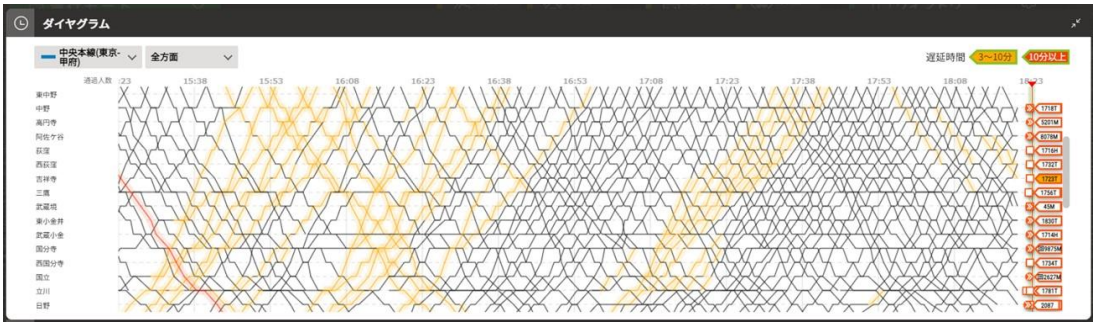

Figure 3: Display of train diagrams. It is also possible to grasp delay status based on actual running record.

Figure 4: Display of train operation information (example of Kanto region). It is possible to display operation information such as operation suspensions, delays, and cancellations through a combination of the route map on the left, where colours indicate status (e.g., red for suspended, orange for delayed), and the table on the right, which provides specific details for each line section.

2.2 Weather Information Display Function

Regarding weather information, JEMAPS handles data such as weather, temperature, precipitation, snowfall, lightning strikes, and typhoons. This information is provided by the Japan Meteorological Business Support Centre and is displayed on the map via mesh grids (maps of weather, temperature, precipitation, etc.) or point data (locations of lightning strikes, etc.) (Figure 5).

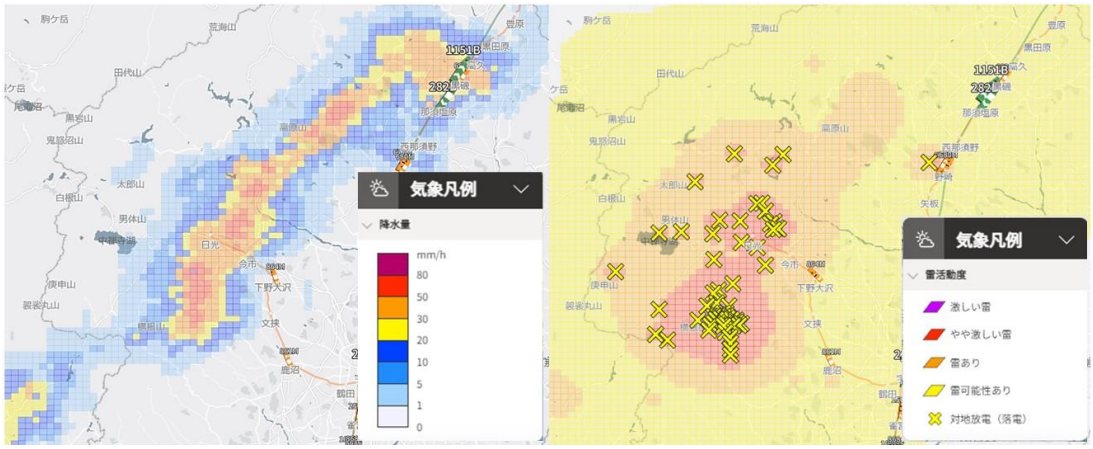

Figure 5: Display of weather information. The example shows precipitation distribution on the left (the legend indicates the hourly precipitation measured in millimetres per hour), and lightning activity level distribution (the colours of mesh grids range from yellow to purple, indicating increasing levels of lightning activity) and lightning strike locations (yellow X symbol) on the right, for the same area at the same time during heavy rain and lightning.

2.3 Disaster Information Display Function

Regarding disaster information, JEMAPS handles weather-related data such as emergency warnings, warnings, and advisories, risk distributions for inundation, floods, and landslides, and earthquake-related data such as earthquake early warnings, major tsunami warnings, tsunami warnings/advisories, and estimated seismic intensity distributions. This information is provided by the Japan Meteorological Business Support Centre and the National Research Institute for Earth Science and Disaster Resilience via "Shared Information Platform for Disaster management (SIP4D)", or via L-Alert (Disaster Information Sharing System) from The Foundation for Multimedia Communications. Based on this data, JEMAPS displays information regarding disasters on the map when heavy rain or earthquakes occur (Figure 6; see also Figure 10 for an example of earthquake information display during disaster prevention drills).

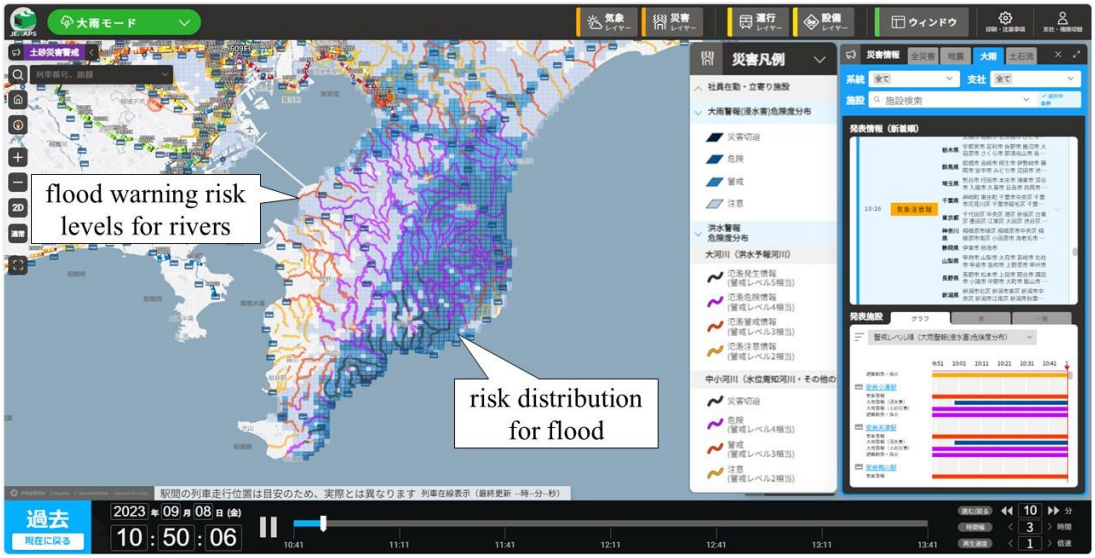

Figure 6: Display of disaster information. The example shows inundation risk distribution via mesh grids and flood warning risk levels for rivers via colour coding during heavy rain.

In addition, facility information such as our stations, crew depots, and maintenance staff field offices is registered in JEMAPS. This allows employees to grasp weather warnings and estimated seismic intensities occurring at those facilities. Since this information can be overlaid with railway operation status, it is possible to understand operation status and weather/disaster information in a unified manner.

3 Use Cases of JEMAPS

3.1 Application in Natural Disasters

A head office control centre is established at the head office, and in addition, 12 regional headquarters and branch offices are established within the JR East area, with dispatch centres belonging to each regional headquarters/branch office managing train operations in their respective operating areas or line sections. The head office control centre performs a wide range of duties, including arranging through-trains between companies, disseminating various information, and deciding on passenger rescue measures during transport disruptions. When disasters such as typhoons, heavy rain, or earthquakes occur, it is necessary to understand the overall picture of what is happening within our jurisdiction in a limited amount of time. To meet this necessity, the head office control centre displays JEMAPS constantly on desk monitors. When a disaster report is received, JEMAPS is utilised to grasp weather disaster information in addition to operation status such as train locations and the number of passengers. Similarly, in the dispatch centres of each regional headquarters and branch office, there are cases where JEMAPS is constantly displayed on monitors and utilised. JEMAPS is used as a reference when disseminating information or making situational judgments, such as by cross-referencing information available from JEMAPS with

information aggregated from the dispatch centres of each regional headquarters/branch office and field offices.

A practical example of using JEMAPS to grasp weather information is the heavy rain in the Tohoku region starting July 25, 2024, which caused damage to several of our railway lines (Figure 7). JEMAPS is utilised not only for long-lasting heavy rain like in this case but also for the significant impact on train operations caused by localised torrential downpours, which have intensified in recent years. Due to the measurement of precipitation in finer ranges and improved forecast accuracy, even when operations are suspended due to poor visibility or track submersion caused by localised torrential downpours, it is becoming possible to assess the prospects for resuming operations to some extent based on weather data. We anticipate that it will become realistically possible to formulate operation resumption plans with higher accuracy in the near future.

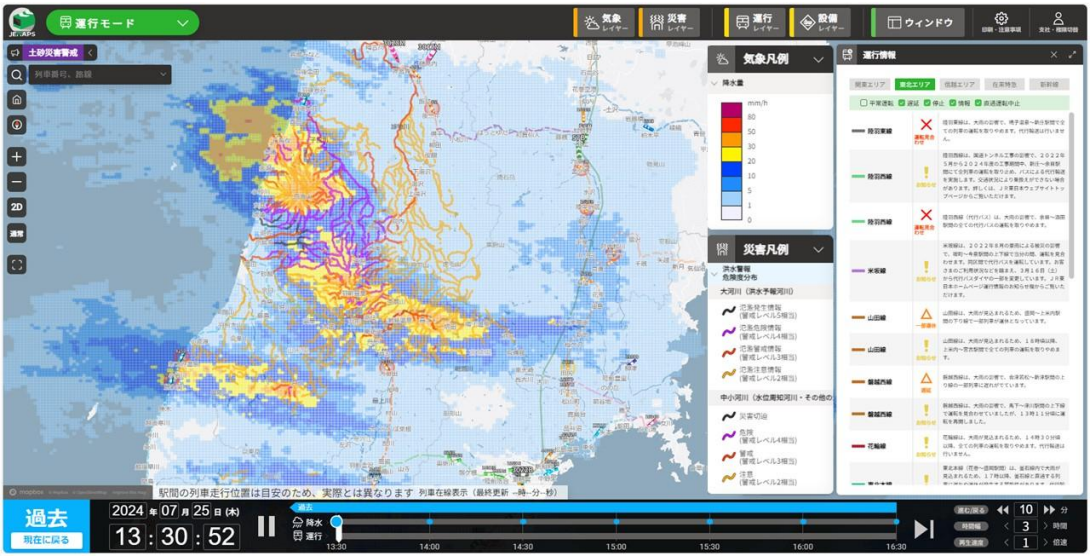

Figure 7: Display of heavy rain situation in Tohoku region on 25 July 2024. Precipitation distribution is displayed via mesh grids, and flood warning risk levels for rivers are displayed via colour coding.

In JEMAPS, coastal areas at risk of tsunami arrival are displayed, allowing users to identify all stations, crew depots, and maintenance staff field offices under tsunami warnings and advisories in one place (Figure 8). On 30 July 2025, following a massive M8.8 earthquake off the Kamchatka Peninsula, tsunamis occurred over a wide area of the Pacific Ocean. Tsunami warnings and advisories were issued in Japan from Hokkaido to Kanto and the Izu Islands, and further to the western Pacific coast, and evacuation information was also issued in some areas. In accordance with our tsunami response manual, we suspended operations on sections where tsunami warnings or advisories were issued. Operations remained suspended on certain sections until evacuation orders were lifted. (In our jurisdiction, the warnings were downgraded to advisories on the same day, allowing for a gradual resumption of service.) When tsunami warnings cover extensive areas for a prolonged period, it is anticipated that

accurately managing all information manually will become extremely challenging. Therefore, JEMAPS was utilised as a means of information acquisition to ensure the safety of employees as well as customers, not only at the head office control centre and the dispatch centres of each regional headquarters/branch office but also at stations and staff field offices.

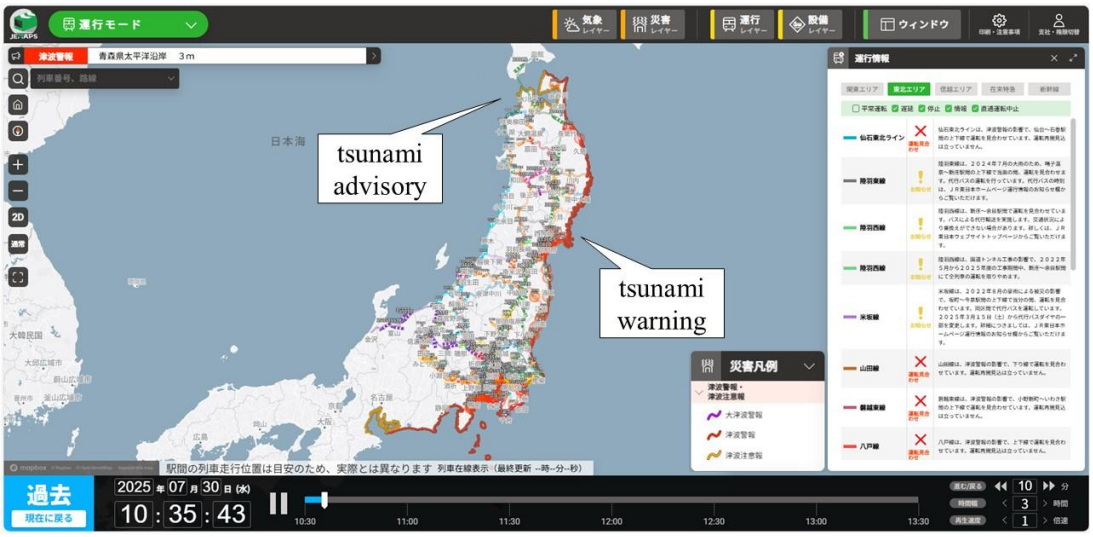

Figure 8: Display of issuance status of tsunami warnings and advisories on 30 July 2025. Displayed with coastal lines (red: tsunami warning, yellow: tsunami advisory).

JEMAPS has a function that allows users to identify at a glance how long trains have remained stationary between stations and approximately how many passengers are on board (Figure 9). If a train is stopped for a long time due to a disaster or similar event, there is a risk of secondary disasters such as passengers waiting inside the train becoming unwell, so urgent rescue is required. In particular, if air conditioning equipment cannot be used during the summer, the temperature inside the train becomes extremely high, increasing the risk of heatstroke. For this reason, JEMAPS is utilised as reference information when estimating the number of people required for rescue, the distance to the nearest station, and arranging alternative transport means such as buses.

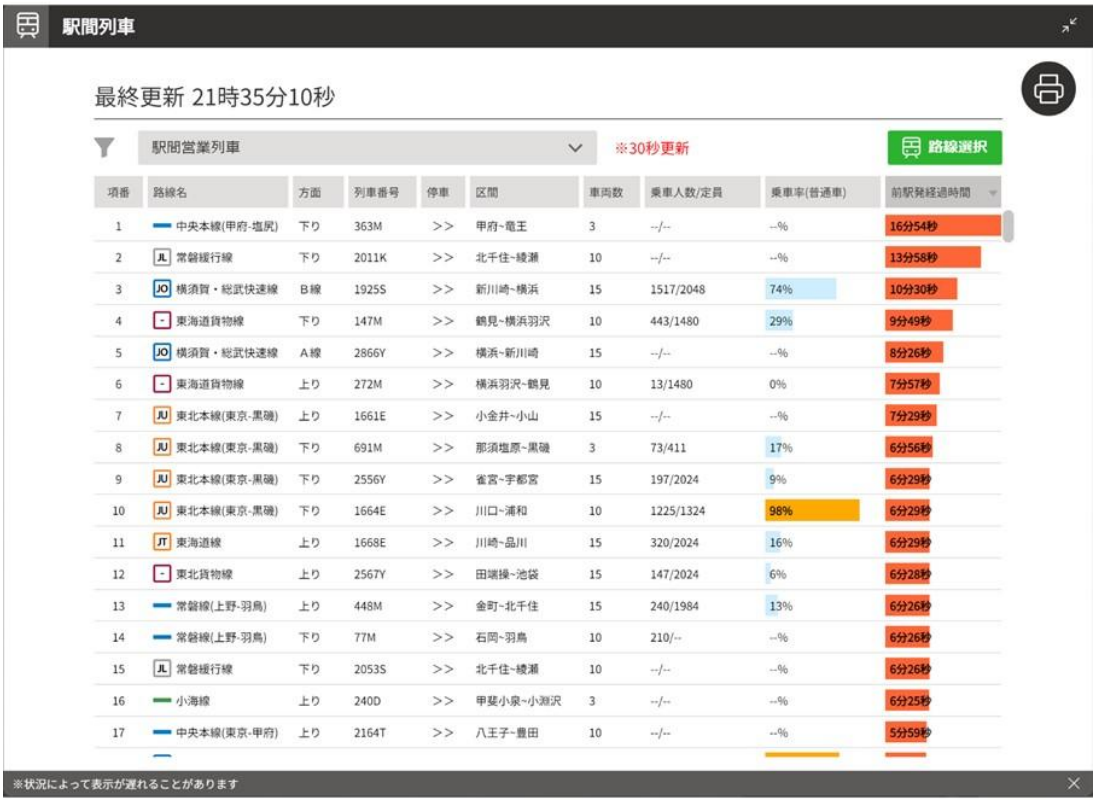

Figure 9: Information display of trains between stations. It is possible to confirm the number of passengers and the elapsed time since departure from the previous station for trains located between stations.

3.2 Practical Application to Emergency Response Drills

Our company conducts disaster prevention drills every year, and during these drills JEMAPS verification environment has been used for information sharing (we leverage the verification environment—originally intended for user testing during new feature development—for training purposes). In 2025, assuming a situation where the Tokyo Metropolitan Inland Earthquake occurred, we load dummy data into the verification environment of JEMAPS to display the seismic intensity distribution of the earthquake and the status of train operation suspensions due to the earthquake impact, thereby confirming the damage situation and impending dangers (Figure 10). These drills have been conducted since 2023, including the simulations of the Tokyo Inland Earthquake in 2023 and the Nankai Trough Earthquake in 2024.

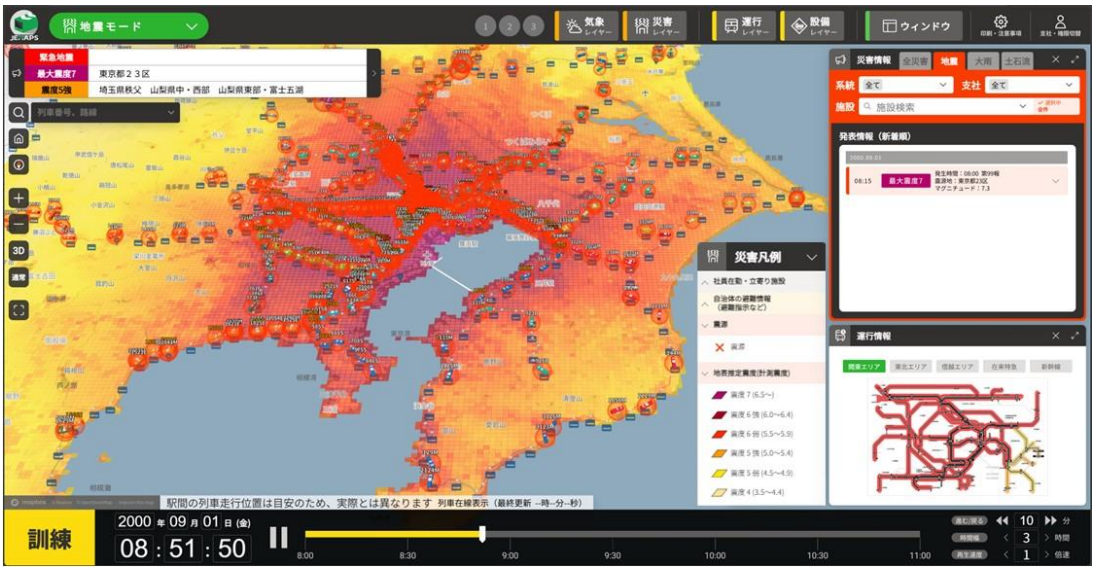

Figure 10: Display of disaster information utilised in 2025 disaster prevention drill. Example displaying seismic intensity distribution via mesh grids assuming the Tokyo Metropolitan Inland Earthquake occurred during the disaster prevention drill (demo data).

By displaying the damaged situation according to the time scale of the scenario during the disaster prevention drill, we believe we were able to create a drill situation with a greater sense of urgency and realism, contributing to the improvement of employees' response capabilities during actual disaster occurrences. Furthermore, while it is assumed that vast amounts of information will flood in during an actual disaster, we reaffirmed the effectiveness of this platform, feeling once again that it would be realistically impossible for responding employees to correctly gather disaster-related information and share it amongst concerned parties simultaneously with other responses without a platform like JEMAPS.

Although demo data was used in the aforementioned disaster prevention drills, JEMAPS can display data by going back to the past, so it is possible to refer to information from when a disaster actually occurred. Therefore, when reviewing the quality of actual disaster responses, we assume it can be verified based on past data from JEMAPS. We believe that, as a result, this will lead to the revision of existing response policies, and so forth.

4 Deployment to Tablet devices

Previously, JEMAPS was a web browser-based platform only accessible through our intranet PCs, but we have built a tablet application compatible with iPadOS® and started trial use from October 2025. This application possesses the same core functionality as the conventional JEMAPS introduced in Chapter 2, along with new functions exclusive to the app. Specifically, when viewing a specific station, it is possible to display weather warnings and disaster information issued for that station (left of Figure 11). Additionally, we established a push notification function using

iPadOS® features for weather warnings and disaster information issued for the current location grasped by the tablet or for our stations, crew depots, and maintenance staff field offices registered by each user of the app (right of Figure 11).

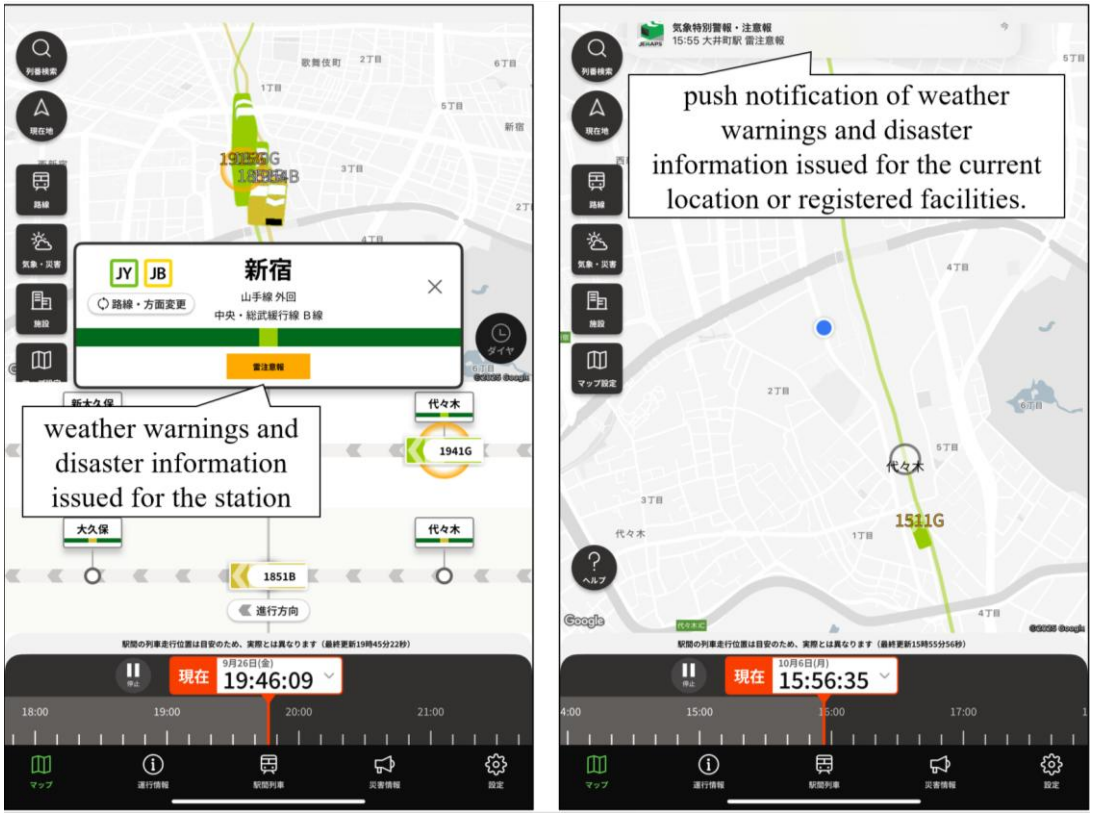

Figure 11: Screen of tablet application. The screen on the left shows weather warnings and disaster information issued for the relevant station in a station-specific display, and the screen on the right shows receiving issued weather warnings and disaster information via push notification.

This application is scheduled for full use in February 2026, and it will allow station staff and train crew who were not previously lent intranet PCs, or employees in situations where intranet PCs are unavailable in the field, to utilise JEMAPS. We expect that this will lead to faster responses to instructions from the head office or branch offices, etc., and support independent judgment by station staff and train crew and maintenance staff handling on-site responses when natural disasters are anticipated or have occurred.

5 Future Prospects

Although not introduced in this paper, JEMAPS also holds some data regarding railway-related equipment and is also utilised as a means of prioritising situational awareness of equipment and inspections during disaster occurrences. Besides this, it also possesses SNS functions for rapidly understanding the situation on the ground and sharing information, which is utilised to strengthen coordination between the head

office, branch offices, dispatch centres, and the field during disaster occurrences. We plan to augment functions to aggregate and display the situation occurring on the railway frontline using JEMAPS in the future. We wish to continue evolving and utilising JEMAPS as a platform that supports safe and secure railway transport services in preparation for natural disasters.

6 Conclusion

In this paper, we introduced the overview of JEMAPS, use cases mainly during natural disasters, the deployment of JEMAPS to tablet devices, and future prospects. Although we are currently at the stage of promoting further utilisation and dissemination of this platform within the company, we would like to consider expanding it outside the company in the future so that customers themselves can acquire information in times of emergency and utilise it to ensure their safety. Safety is something we must create ourselves. We hope that the development and utilisation of JEMAPS will support this goal, and we will continue our efforts in the future.

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