

# Development of New Disaster Information System

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## ABSTRACT

Waterworks are a critical lifeline that supports both civilian lives and urban activities. Because they are so critical, they necessitate the establishment of a reliable water supply system and the strengthening of existing crisis management systems. For this reason, the Osaka Municipal Waterworks Bureau is structuring a disaster information system. This disaster information system centralizes management and shares disaster-related information such as damage information, restoration activity information, and emergency water supply information during times of disaster such as earthquakes. By utilizing this system, quick and accurate situational analysis can be conducted, and countermeasures can be decided upon. This paper reports upon the functions and characteristics of disaster information systems, the thinking behind the final decisions regarding the functions of the system, and expected practical uses for the system during times of disaster.

## PREFACE

Waterworks are a critical lifeline that supports prosperity of civilian life and advanced urban activities, and providing a stable water supply is their main objective. By engaging in various earthquake provisions such as earthquake-proofing its distribution pipes/purification facilities and constructing distribution reservoirs, the Osaka Municipal Waterworks Bureau has strived towards the establishment of a highly reliable water supply system and a strengthened crisis management system in order to provide secure water supply in both normal and disaster conditions such as earthquakes. On January 17<sup>th</sup>, 1995, the Great Hanshin and Awaji earthquake caused tremendous damage to a great majority of lifelines that city functions were built upon. The resulting prolonged water outage from damaged waterworks was an especially devastating blow to civilian lives, which necessitated further strengthening of crisis management systems by waterworks services. Since then, the Osaka Municipal Waterworks Bureau has worked to structure a disaster information system as a part of its efforts to strengthen reliability of its information communication system during times of disaster. Operation of this system has commenced in December of 2003.

It has been approximate 12 years since the current disaster information system was put into place. During that time, the Bureau has drawn up the “Osaka Municipal Waterworks Bureau’s Business Continuity Plan (BCP)”, which indicates actions plans during times of disaster. Furthermore, the Bureau’s work environment has undergone change during this time. Such changes include the introduction of other works systems, such as attendance management systems and finance and procurement management systems. By updating the disaster information system, coordinating data with other work systems, and creating BCP-relevant forms, the Bureau has reconstructed the system with a focus on improving usability and operability. It is planning to start operations for this system as a newly updated version, starting November of 2015.

## CURRENT WATERWORKS SERVICES IN THE CITY OF OSAKA

The Osaka Municipal Waterworks Bureau has been supplying water to Osaka city area since its establishment in 1895. It has developed its facilities and pipelines since then, and its current status is shown (Table 1 and Figure 1).

Table 1: Current waterworks services in the City of Osaka

Commencement of Operation	Nov. 13 <sup>th</sup> , 1895	Daily Water Supply Capacity	2,430,000m <sup>3</sup>
Population Served	2,690,214	Maximum Daily Supply <sub>(2014.4-2015.3)</sub>	1,286,700m <sup>3</sup>
Number of Households Served	1,536,275	Average Daily Supply <sub>(2014.4-2015.3)</sub>	1,168,309m <sup>3</sup>
Number of Employees	1,557	Total Length of Water Conduits and Distribution Pips	5,223km

(All numbers as of the end of March, 2015)

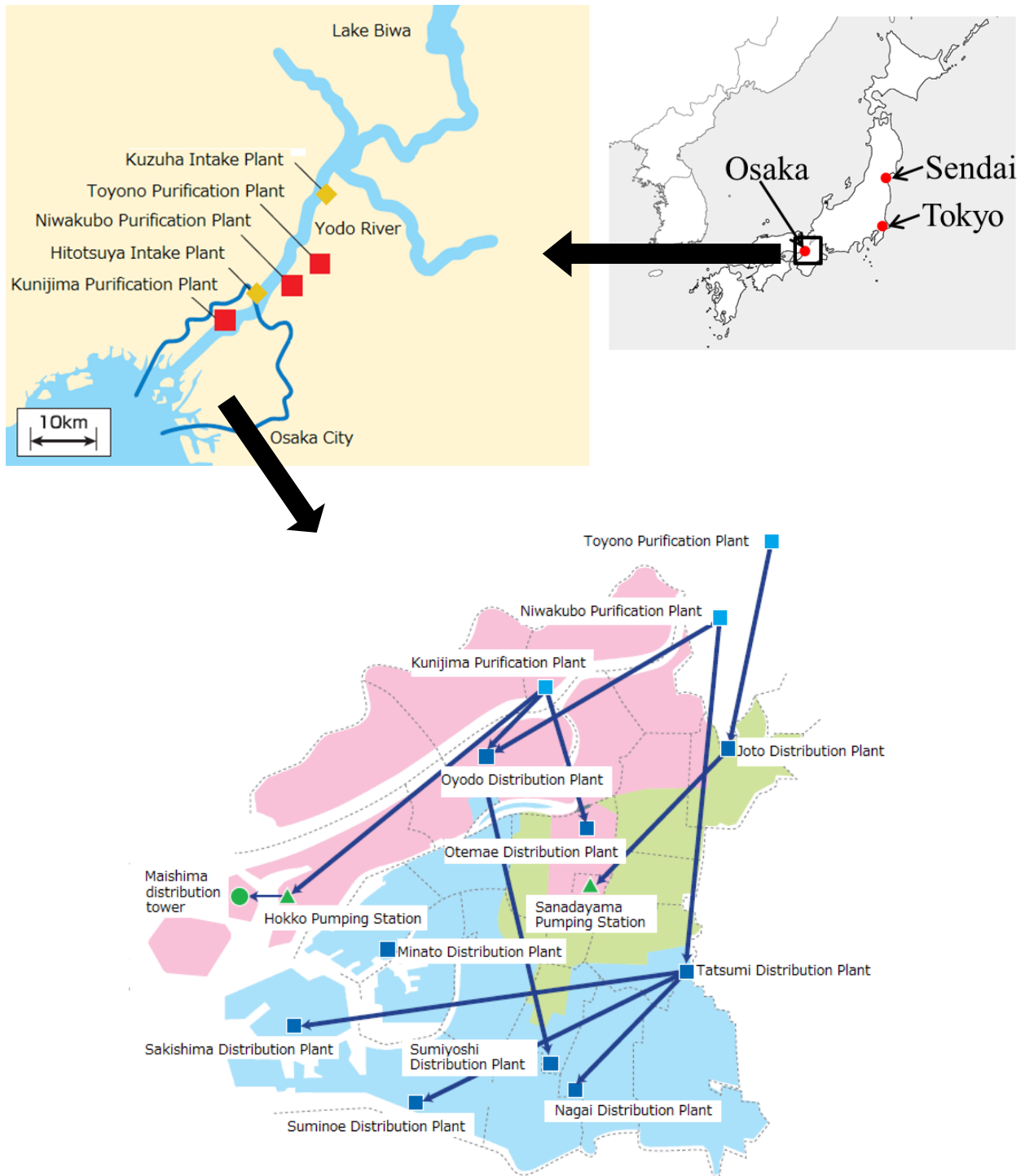
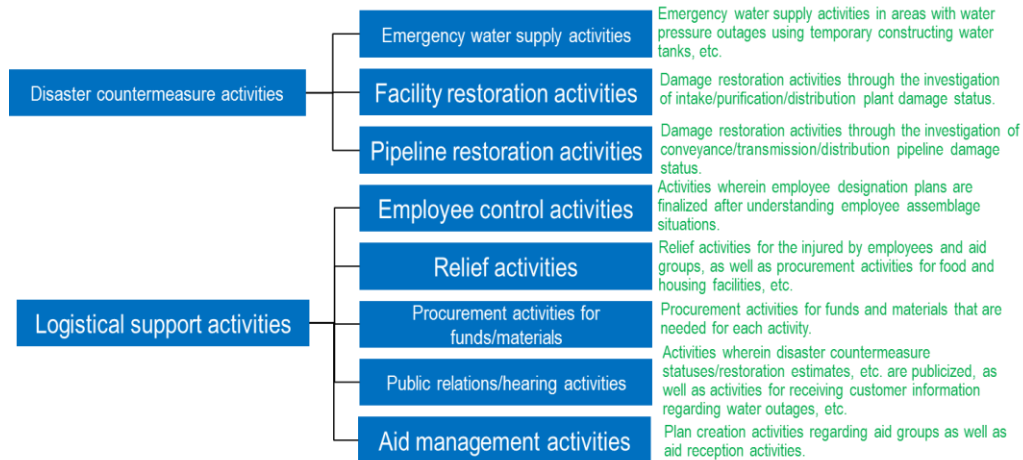


Figure 1: Locations of purification plants and water distribution reservoirs in the City of Osaka

## OSAKA MUNICIPAL WATERWORKS BUREAU'S DISASTER COUNTERMEASURES

The BCP drawn up by the Osaka Municipal Water works Bureau in March of 2010 details action plans for a system that makes early recovery of waterworks services or continued waterworks services possible, even during times of disaster. The BCP states that during times of disaster, waterworks units should be established as lesser organizations belonging to the Osaka Disaster Countermeasures Headquarters, and details the actions that each waterworks units should take, such as emergency water supply activities, facility restoration activities, pipeline restoration activities, etc. (Table 2).

Table 2: Main activity details for each waterworks unit



## CHARACTERISTICS OF THE NEW SYSTEM

The disaster information system aims to support activity implementation, which includes the establishment of an organized immediate-response system, quick and accurate situational analysis, and counter-method decision-making, through the realization of centralized management and sharing of disaster-related information such as damage information, restoration activity information, and emergency water supply information during times disaster.

As a characteristic of the new system, the server equipment is installed in a remote data center so that the system will still be operational even during times of disaster.

The current disaster information system operates using a designated device that is installed per organization. Now, to account for disaster-time situations where a high volume of information must be entered by a limited number of devices, the new system will be operable on devices that each employee uses in his or her daily work routine, with the expectation that these employees will be familiar with how to operate their routinely-used devices, making disaster-time use of the system go smoothly.

Furthermore, the Osaka Municipal Waterworks Bureau has introduced work systems apart from the disaster information system, which include pipeline information management system which manages pipeline information by utilizing computer mapping systems and water distribution information management systems that collect real-time information regarding water pressure, flow levels, water quality data, etc. from telemeters installed in purification plants/water distribution reservoirs and city-wide pipelines. It has also introduced the attendance management system, which manages when employees clock in and out, etc., and the finance and procurement management system, which manages delivery and reception of goods, etc. To lessen the need for workers to register the same data to multiple systems during disasters, information entered into these work systems is also sent to the disaster information system, and is also displayed in the disaster information system.

The new system is functionally structured to fit the needs of the newly-formulated BCP, and has also been given additional functions that enable the creation of fixed reports and forms, etc. needed to report and collect information during disasters when it is necessary to do so swiftly.

## BASIC STRUCTURE OF THE NEW SYSTEM

As functions for supporting activities during times of disaster, the new system contains disaster situation comprehension functions, pipeline restoration information management functions, emergency water supply information management functions, facility restoration information management functions, and logistical support activity management functions. The outline of these functions is detailed in Table 3, as follows.

Table 3: Outline of system functions

<b>Disaster situation comprehension function</b>	A function that centralizes and manages information regarding damage status and restoration activities of waterworks facilities during times of disaster, and aids in swift and decisive decision-making.
<b>Facility restoration information management function</b>	A function that allows for the understanding of damage/restoration statuses of water intake/purification/distribution plants, the water storage level and quality of purification/distribution reservoirs, etc., and supports restoration activities for facilities.
<b>Emergency water supply information management function</b>	A function that allows for the understanding of emergency water supply activities in areas with water outages, and supports the implementation of emergency water supply activities.
<b>Pipeline restoration information management function</b>	A function that, by inputting data such as the seismic intensity scale into the disaster information system, allows for the understanding of the scale of damage estimated right after the onset of disaster, and supports damage investigations of conveyance/transmission/distribution piping and implementation of piping restoration.
<b>Logistical support activity management function</b>	A function that supports the implementation of miscellaneous activities that will arise in conjunction with emergency countermeasure activities, such as understanding employee attendance statuses, managing goods/materials, public relations functions, managing aid groups from other cities, etc.

In during times of disaster, the system will be utilized to organize and share information such as damage and activity statuses through the registration of information by each waterworks unit, using the system's pipeline restoration information management functions and emergency water supply information management functions. Furthermore, the disaster information system has a function that creates reports based on entered information. Items that should be detailed in the reports are organized beforehand so that information necessary by Headquarters to make decisions can be collected. Headquarters must comprehend the entirety of the damage and activity status information pertaining to the disaster that has been reported to them via each unit and the disaster situation comprehension function, and will give instructions to each unit regarding courses of actions to take, along with information disclosure to outside parties in the form of press conferences etc. (Figure 2).

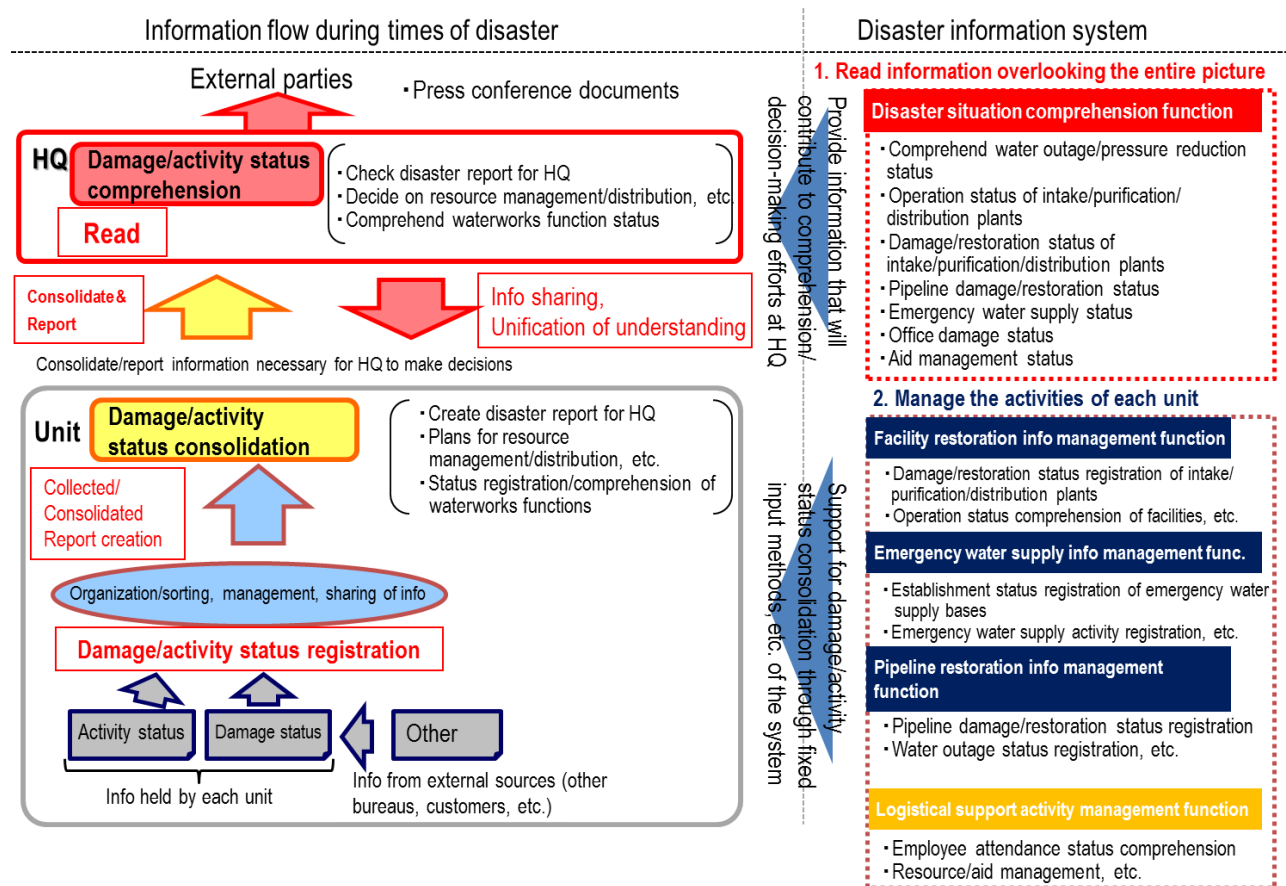


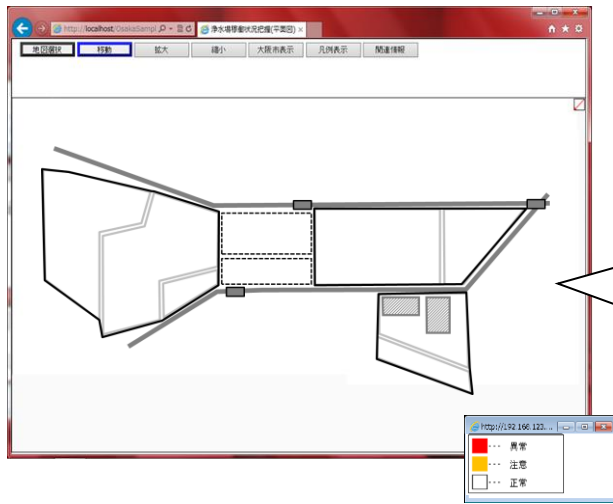
Figure 2: Utilization methods for the disaster information system in times of disaster

## FUNCTIONS OF THE SYSTEM

### Facility restoration information management function

This function registers and manages damage restoration statuses of water intake/purification/distribution plants via site floor plans and water purification processing flow charts (Figure 3). It also allows for registration/management of results from emergency water quality tests conducted by the water quality unit. Using the system makes it possible to know whether water intake/purification/distribution plants are operating normally or if they are damaged.

Furthermore, this function is able to coordinate data with the water distribution information management system, and can collect real-time information regarding the amount of water being processed in purification plants, along with water quality, amount of water stored in purification/water distribution reservoirs, distribution amounts, etc. (Figure 4).

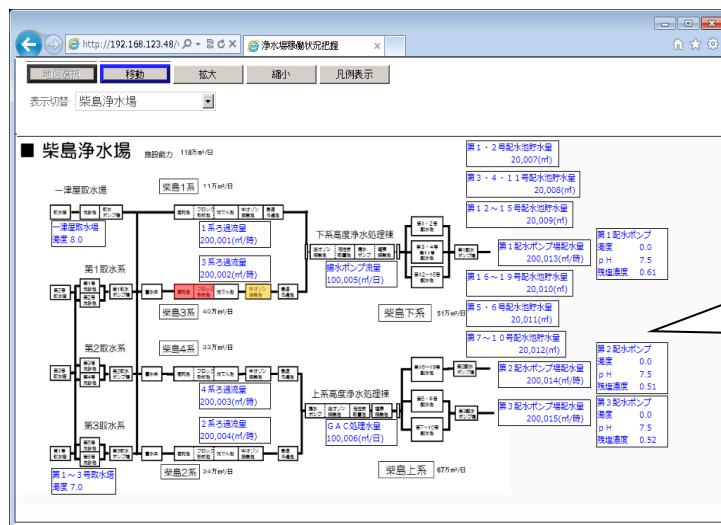


By selecting individual facilities from the purification plant's, etc. floor plan and entering damage statuses, the damaged facility is highlighted and displayed in color.

Furthermore, selecting the facility highlighted in color allows users to check registered damage details.

- Stopped facility: Red
- Abnormal functions: Yellow
- No abnormalities: White

Figure 3: Damage restoration information of water intake/purification/distribution plants



Facility operation statuses (flow amount, turbidity, pH, residual chlorine concentration, etc.) during each step of the water purification process is displayed.

Figure 4: Operation status information of purification/distribution plants

## Emergency water supply information management function

In the event that a water outage occurs during times of disasters, Osaka Municipal Waterworks Bureau will conduct emergency water supply through two methods: the first, which is the “base water supply method,” where water is supplied at a central base by establishing temporary constructing water tanks and temporary constructing water supply valves in large-scale evacuation areas and evacuation shelters (schools, etc.).The second is the “delivery water supply method”, where water supply trucks deliver water to tanks of key facilities such as medical facilities.

This function registers and manages establishment statuses of emergency water supply bases and installation statuses, etc. of temporary constructing water tanks and temporary constructing water supply valves for relevant facilities involved in base water supply and delivery water supply (Figure 5). This allows for efficient comprehension of the emergency water supply activity status in areas with water outages.

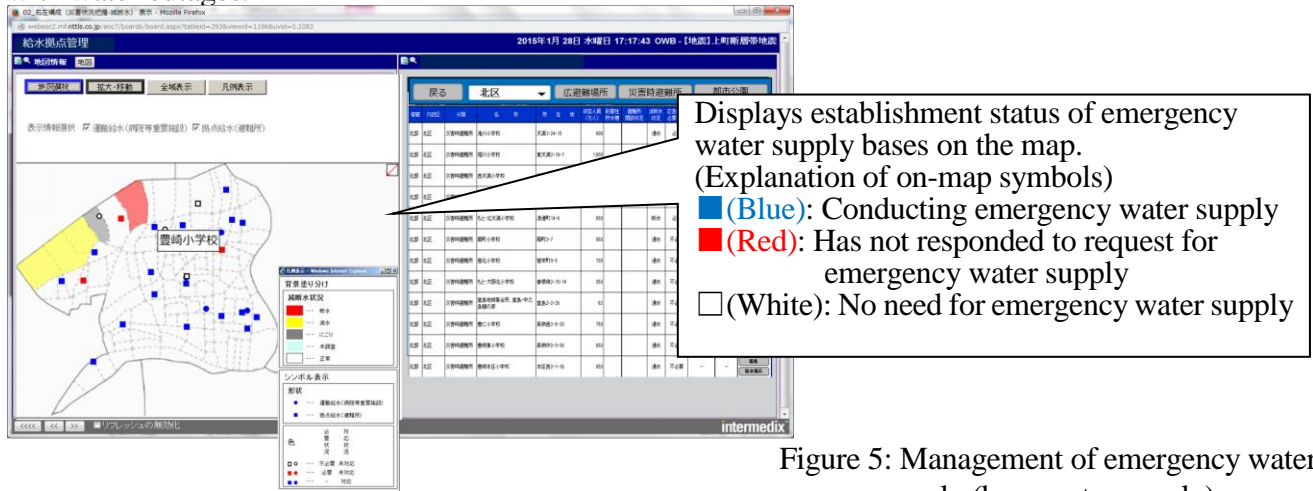


Figure 5: Management of emergency water supply (base water supply)

## Pipeline restoration information management function

### (1) Damage prediction function

During times of informational blanks and confusion directly after the outbreak of a large-scale earthquake, this function supports the establishment of swift initial onset structures such as requests for aid to other cities, through predictions of damage levels depending on the hypocenter and seismic intensity scale and comprehension of the breadth of pipeline damage.

Furthermore, the system includes a function that displays, on a map, regions that are predicted to undergo water outages (water pressure reduction) based on water pressure information that has been relayed from distribution telemeters installed in municipal areas. These predictions are to be used in on-site damage status investigations (Figure 6). It also contains a function where information reported, etc. by civilians regarding water outages can be recorded as references for on-site investigations.

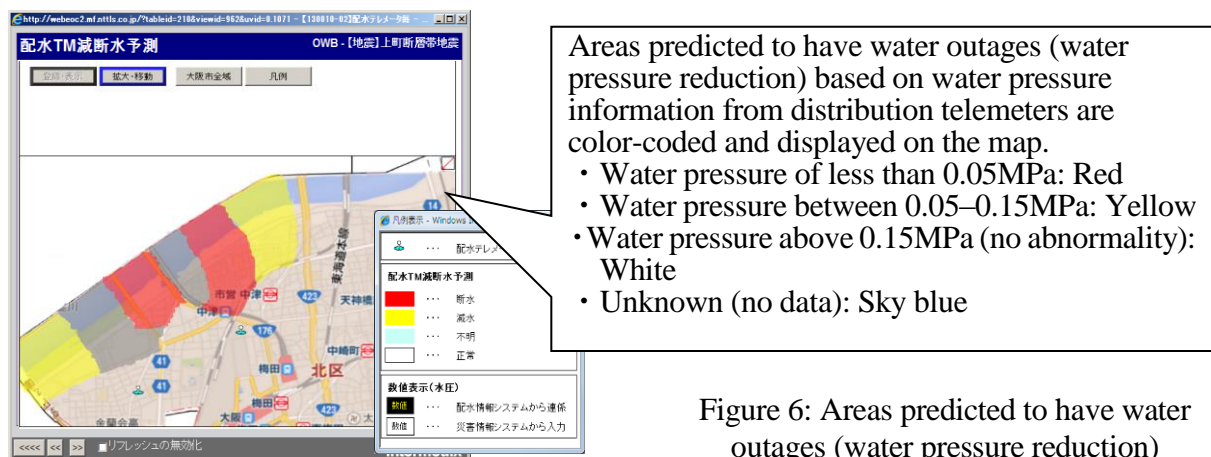


Figure 6: Areas predicted to have water outages (water pressure reduction)

*(2) Water outage (water pressure reduction) status comprehension, pipeline damage restoration management*

This function registers/manages, on a map, pipeline damage information, restoration activity information, and water pressure decrease statuses based on damage investigation results gathered by pipeline restoration units (Figure 7). Furthermore, regarding pipeline damage information, by taking the information that has been registered into the pipeline information management system and coordinating that data, they can be processed, and displayed on the disaster information system. This allows for precise comprehension of the damage situation of city-wide pipelines, which contributes to the drawing up of emergency water supply plans or emergency restoration plans.

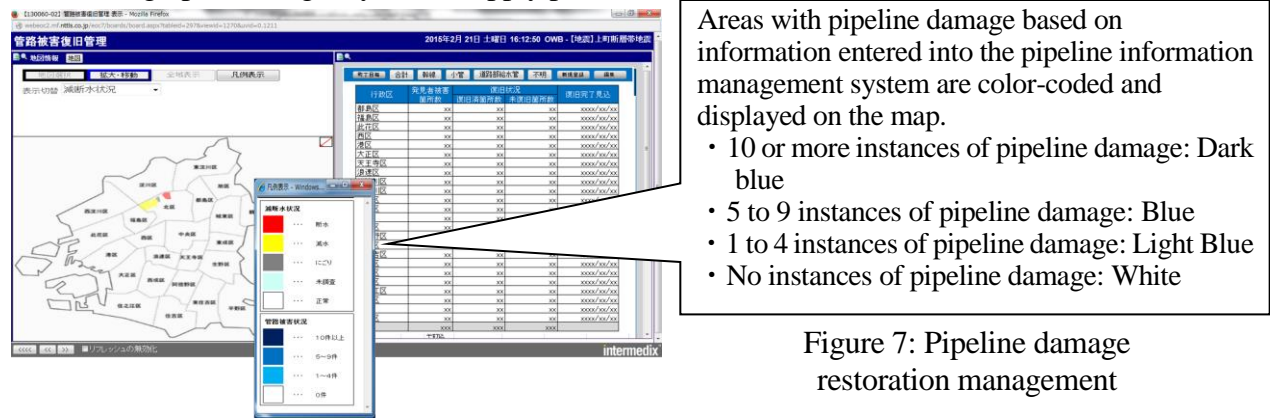


Figure 7: Pipeline damage restoration management

**Logistical support activity management function**

*(1) Management function for goods/equipment*

This function manages the amount of goods and equipment necessary for actions during times of disaster, which include piping material, emergency water supply equipment for temporary constructing water tanks and temporary constructing water supply valves, etc., vehicles such as water supply trucks, and food. This function allows for easy understanding of which goods/equipment are in shortage, making procurement/aid requests run more smoothly. The amount of piping material that is on the possession of the Bureau is displayed in the disaster information system, and data is received from the finance and procurement management system.

*(2) Employee assemblage status comprehension function*

This function allows for easy understanding of the attendance status of Osaka Municipal Waterworks Bureau employees during disasters. By receiving data from the attendance management system, the number of employees in attendance can be displayed on the disaster information system. (Figure 8). This allows for human resources to be tracked, and contributes to the establishment of employee designation plans for disaster countermeasure activities.

*(3) Report creation function*

This function creates fixed reports and forms (disaster reports) in accordance with the BCP through the automatic processing of water outage statuses, emergency water supply and damage restoration information for waterworks facilities, etc. that has been registered by each waterworks unit. Disaster reports created by this function are used in countermeasure meetings held at the Bureau's headquarters, as well as for public information to be released to customers, as press conference material, or information to be posted on the Bureau's online homepage.

*(4) Aid management function*

This function records number of aid members and equipment in their possession, as well as implementation statuses of aid activities that are performed by aid groups from third party water suppliers, etc. The function allows for easy understanding of capabilities and activity statuses of aid groups, as well as for appropriate activity requests to be sent to said aid groups that are within their abilities.





Employee attendance statuses are processed and displayed by organization based on the information received by the attendance management system (a system that manages attendance, etc. of employees).  
 [Display details (Example)]  
 ○○ Division  
 Total # of employees: ○, ○ employees in attendance, ○ employees in attendance in other offices

Figure 8: Employee assemblage status indication function

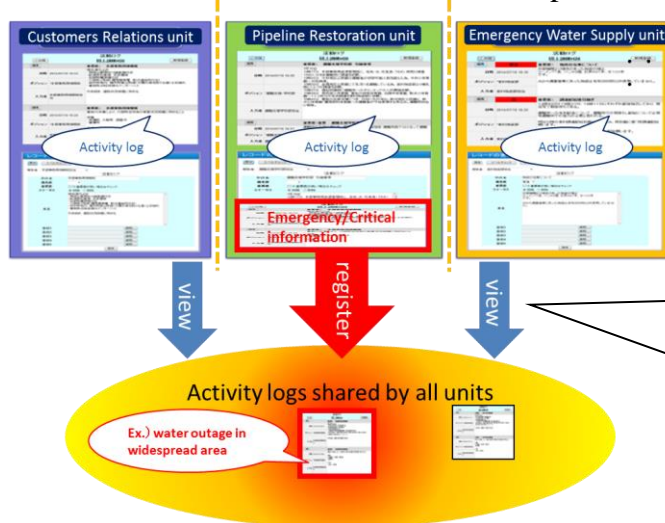
## Other functions

### (1) Activity logging

In times of disaster, many pieces of information are bound to get muddled, and information that does not fit the fixed reporting patterns of the functions outlined above is expected to appear. This type of information is usually the kind that is written up on whiteboards, etc., such as instructions/orders, response records, handover information, know-how, and directives, and can be valuable information when managing disaster-time activities. Therefore it becomes necessary to have a function to record these types of information as category-free comments. The function allows for free input of information such as activity statuses, tasks, and directives conducted by relevant waterworks units, and makes handover of tasks and information sharing go more smoothly (Figure 9). Furthermore, if organization-wide sharing of critical or emergency information becomes necessary, it is possible to conduct universal information sharing by changing the settings.

### (2) Communications processing form

When taking action during times of disaster, there are bound to be many instances of additional instructions from headquarters, as well as work and adjustments requested from related organizations. This function registers/processes these communication items for smoother implementation of requests and orders that are exchanged between waterworks units (Figure 10). Because this function records communications items into the system, it prevents the forgetting of requests and failure to take action. It is an effective function when proceeding with disaster-time activities.



Countermeasures against disasters are recorded by organization, allowing information to be shared/viewed within the organization.  
 Furthermore, critical/emergency information can be shared/viewed regardless of organizations.

Figure 9: Activity logging

ID	優先度	対応状況	重要度	日時	送信元/送信先	送信先	件名	依頼内容	回答	送信	回答内容
624	中	未対応		2014/11/10 15:13:49	飲料管理部	避難支援-学校部	防護物置について	【2013/01/30 01:33:18】 影1,5000枚、毛布1000枚を届けます。購入先を取返してください。	【本部署事務局運営管理班mhwest at 15:13:41 on 2014/11/10】		
625	高	未対応	*	2013/12/13 11:19:57	避難支援-学校部	避難支援-学校部	避難者対応について	【2013/01/30 01:34:08】 生活学習協会のセンターです。避難者の多量で対応できません。人員の確保と避難者の移動も考えさせていただきます。	【本部署事務局総務班WebEOC Administrator at 11:19:53 on 2013/12/13】		
620	高	未対応	*	2013/10/02 00:18:06	避難支援-学校部	避難支援-学校部	避難所閉鎖	【2013/01/30 01:28:52】 豊洲北小学校です。点検で一部壊壊しました。今後も危険な状況です。対応をお願いします。			
627	高	未対応		2013/10/02 00:16:20	生活再建支援PJJT	生活再建支援PJJT	引渡(証明)の発行場所	【2013/01/30 01:35:31】 引渡(証明)市民窓口の開設等については、区役所ではなく(東区)小学校体育館でお願いします			
621	中	未対応		2013/10/02 00:15:06	本部署事務局 運営管理班	本部署事務局 運営管理班	車両の手配について	【2013/01/30 01:30:52】 台手配をお願いします			
619	中	未対応		2013/10/02 00:14:53	本部署事務局 運営管理班	本部署事務局 運営管理班	稼働可能な車台数について	【2013/01/30 01:28:18】 稼働していない車が何台あるか取返してください			
616	高	未対応		2013/10/02 00:14:35	生活支援部	生活支援部	インフラの被害状況	【2013/01/30 01:24:39】 各所の被害状況を報告してください			

Records instructions and requests passed between organizations. The organization that receives the request, etc. can record their performed action with respect to the request, etc.

Figure 10: Communications processing form

## CONCLUSION

As stated throughout this report, the disaster information system is a system that consolidates the Osaka Municipal Waterworks Bureau’s activity and damage statuses in times of disasters. Because information that needs to be input in a fixed procedure is being organized preemptively, as well as the forms and papers that are used to input this information, employees are encouraged to record information that will be necessary in times of disaster, which allows for secure accumulation of data even during states of confusion during disasters. Furthermore, by utilizing the system, executive employees who give instructions and perform adjustments for disaster countermeasures can accurately comprehend the ever-changing state of affairs, and can draw up plans/make decisions swiftly and carefully for disaster countermeasure plans, etc.

However, because the disaster information system is not one that is used for usual operations, the main task of the Bureau is to find a way to improve the Bureau’s employees’ proficiency in the system. By taking advantage of integrating the new system into the in-office devices that are used for normal operations, the Bureau will create a system structure wherein each employee can practice utilizing the system during their daily operations. The Bureau also aims to improve proficiency in system operations by introducing robust training and induction courses that utilizes the system.

When managing disaster countermeasures, it is also important to conduct inspections and make revisions when necessary. The Osaka Municipal Waterworks Bureau conducts continuous improvements on the BCP and the functions of this system through PDCA cycles, and aims for the improvement of business sustainability by performing corrections of functions as necessary.

## References

- 1) Yamano et al: Introduction of the Waterworks Bureau’s Disaster Information System, 4<sup>th</sup> U.S.-Japan Earthquake Countermeasure Workshop (Jan. 2005)
- 2) Hayashi et al: Structure of the Disaster Information System, Journal of Japan Water Works Association, No. 832, p10–19

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