Asset Management Contributing to Disaster Risk Reduction
Experience and Challenge in Sendai Wastewater Utility

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JAPAN
Outline of Sendai City and Sendai Wastewater Utility

Sendai City
- The economic center of the Tohoku region
- Bullet Train: Tokyo–Sendai about 1.5 hours
- Coach: Narita Airport–Sendai about 5 hours
- Population: 1,086,377 (2017.10)
- Modern city in harmony with nature

Sendai Wastewater Utility
- A part of Sendai City municipal government
- 119 years (The 3rd earliest sewer construction in JPN)
- The coverage of wastewater facilities is 99.6%
- The sewer and drainage length is 4,801km
- 5 wastewater treatment plants
- The biggest WWTP, Minamigamo treats 300,000m³/day
At 4pm, March 11, 2011
Minamigamo WWTP was completely devastated by the tsunami
  - The restoration cost was about 575 million dollars

Emergency fuel shortage was a big problem to operate facilities

About 102km of pipes within 4578km were damaged

138 domestic wastewater treatment tanks had to be repaired

Outline of damages on the wastewater infrastructure

- Evacuation to the rooftop
- Damage of pumping facility
- Inundation by the Tsunami
- Road collapse
- Liquefaction
- Displacement by tremor
Recovery of Sendai Wastewater Utility

Response measures based on the BCP

Temporary wastewater treatment by the contact oxidation process

Tsunami-proof and eco-friendly facility (build-back)

Restoration and reconstruction

Pipelines

Restoration of damaged pipelines

The by-pass pipe to back up the most important trunk sewer has been constructing

Flood prevention measures in ground subsidence areas after the earthquake
## History of Sendai’s Asset Management

<table>
<thead>
<tr>
<th>Year</th>
<th>Strategy Development</th>
<th>Implement The Strategy</th>
<th>IT System Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Inspection in Australia</td>
<td>Establishment of AM strategy Office</td>
<td>GIS renewal</td>
</tr>
<tr>
<td>2008</td>
<td>Development of strategy</td>
<td>Great East Japan Earthquake</td>
<td>O&amp;M Data</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td>Decision making criteria</td>
<td>Workflow system</td>
</tr>
<tr>
<td>2011</td>
<td>Objective management, KPI, PI</td>
<td>Risk management framework</td>
<td>Internal audit</td>
</tr>
<tr>
<td>2012</td>
<td>Start of AMS &amp; AM Policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Certification</td>
<td>Rehabilitation planning</td>
<td>Business process management</td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td>Maintenance management system</td>
</tr>
</tbody>
</table>
Completion to develop sewage system → A lot of problems appeared

- Deterioration
- Disaster risks
- Personnel reduction
- Budget cut

Formulated the AM implementation strategy to resolve problems

- Detail analysis of internal business issues
  - Business processes
  - IT systems
- Design solutions in reference to AU’s good practices
  - Hearing in Australia
  - Process benchmarking
- Consideration of business Environment
  - National subsidy system
  - ISO

Asset management implementation strategy

- Objective management
- Risk management
- Decision making criteria
- Long-term cost forecast

- Reengineering business processes and organization
- Developing framework of condition monitoring (including the sampling CCTV survey of pipe networks)
- Developing IT system (GIS, Workflow sys., Maintenance calendaring sys., etc.)
- Training programs and systems
- Internal Audit
Sendai Wastewater Utility acquired the first certification of ISO55001 in Japan.
GIS improving in asset management development

- AM requires accurate data of assets and usable GIS
- IT systems were installed and improved according to necessary functions of the management system
- Various data were integrated and linked to the registers

Cross-referencing

Sewerage register (GIS)

Sewer Condition
CCTV survey system
Maintenance management sys.

Complaint and failure

Sewer pipeline risk

Equipment register

Emergency survey
Business processes support the AM system

- Jobs of staff members are redesigned for collecting information and controlled by process flows and IT systems.

Let's input the survey results!
Circulate it to the manager!

Well, the survey result shows…
After confirmation, I circulate it to …

Click this case, maintenance management sys. will open

Inbox of workflow sys.

Without authorization, the staff member cannot move to the next step

The processes and IT systems contribute to recording asset failures and natural events such as an flooding

Manager

Graphic user interface of Maintenance management sys.

Staff members

After inputting the result, click the button
Let's input the survey results
Circulate it to the manager!
Major risks in SWU were identified

- Equipment deterioration
- Pipe deterioration
- Earthquakes
- Inundation

Risk matrix

- Consequences
  - Social
  - Management
  - Triple bottom line

- Likelihoods
  - Rank of likelihood
    - failure rate, condition, etc.

- Items of consequences
  - Repair cost etc.
  - Pollution load etc.
  - Amount of flow
  - Amount of traffics etc.

- Rank of consequences

Risk level

Risk mitigation measures

Displayed pipe failure risk

Prioritization based on risks and costs by decision making criteria
Drafting the mid-term (AM) plan based on the AM system

- Risk based approach
- Long-term view
- Prioritization
- Aligning with objectives

Projects to mitigate risks are listed up

Decision making criteria

<table>
<thead>
<tr>
<th>Name of project</th>
<th>Cost</th>
<th>Risk score</th>
<th>Mean risk</th>
<th>Risk/Cost</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>xx rehabilitation</td>
<td>¥50M</td>
<td>100000</td>
<td>50000</td>
<td>200</td>
<td>⬤</td>
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<tr>
<td>XY flood prevention project</td>
<td>¥140M</td>
<td>250000</td>
<td>25000</td>
<td>178</td>
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<tr>
<td>ZZ pump renewal</td>
<td>¥5M</td>
<td>10000</td>
<td>10000</td>
<td>200</td>
<td>△</td>
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<tr>
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<td>¥120M</td>
<td>120000</td>
<td>10000</td>
<td>100</td>
<td>△</td>
</tr>
<tr>
<td>YZ drainage project</td>
<td>¥80M</td>
<td>15000</td>
<td>15000</td>
<td>19</td>
<td>×</td>
</tr>
</tbody>
</table>

Prioritizing projects based on risks and costs

Cash flow forecasting

Budget frame based on estimated risks

The mid-term business plan and objectives
The new GIS improved efficiency of the damage survey immediately after the disaster.

Simple rules, procedures and IT systems were necessary for external staffs to conduct the survey.

The GIS was set up to browse information of pipes and record the survey data.

Data input time become drastically shorter in the survey.

User-friendly systems are necessary for disaster recovery.
Benefits of preparation for disaster

- Effect of earthquake resistant measures
  - In Japan, the pipe lining method is used for enhancing earthquake resistance of pipe.
  - According to the damage survey result, lined pipes didn’t damage at all.
  - The national ministry prepares a subsidy system and a design standard for earthquake resistant measures.

<table>
<thead>
<tr>
<th></th>
<th>Total length</th>
<th>Damaged length</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sewer pipelines</td>
<td>4,758km</td>
<td>102km</td>
<td>2.1</td>
</tr>
<tr>
<td>Lined pipes</td>
<td>72km</td>
<td>0km</td>
<td>0</td>
</tr>
</tbody>
</table>

Pipe lining method is effective to enhance earthquake resistance
Influence of the disaster to our measures

- Budget increase after the disaster and asset management

  - The national ministry revised the design standard after the disaster.
  - The risk criteria of the utility was revised based on the new standard.
  - As a result, the budget for rehabilitation including earthquake resistant measures has been increased more than twice before the disaster.
Maintaining and improving the capability for disaster

- An emergency survey drill is conducted every year with other cities, service providers and contractors.
- Survey results are used in asset management activities such as risk analysis, CCTV survey and rehabilitation.

Damage survey procedures, criteria and IT systems are incorporated into our AM system.

New mobile devices are tested in the drill and will be installed into daily operation.

Sendai method was used in the damage survey of the Kumamoto Earthquake.
To build ‘Disaster-resilient and Environmentally friendly city’ is a long journey.

Sendai Wastewater Utility incorporates disaster resistant measures and activities into the asset management system.

We continue to improve our asset management system and make efforts to reduce disaster risk.
Thank you !