

Improving the Safety of Water Lifelines

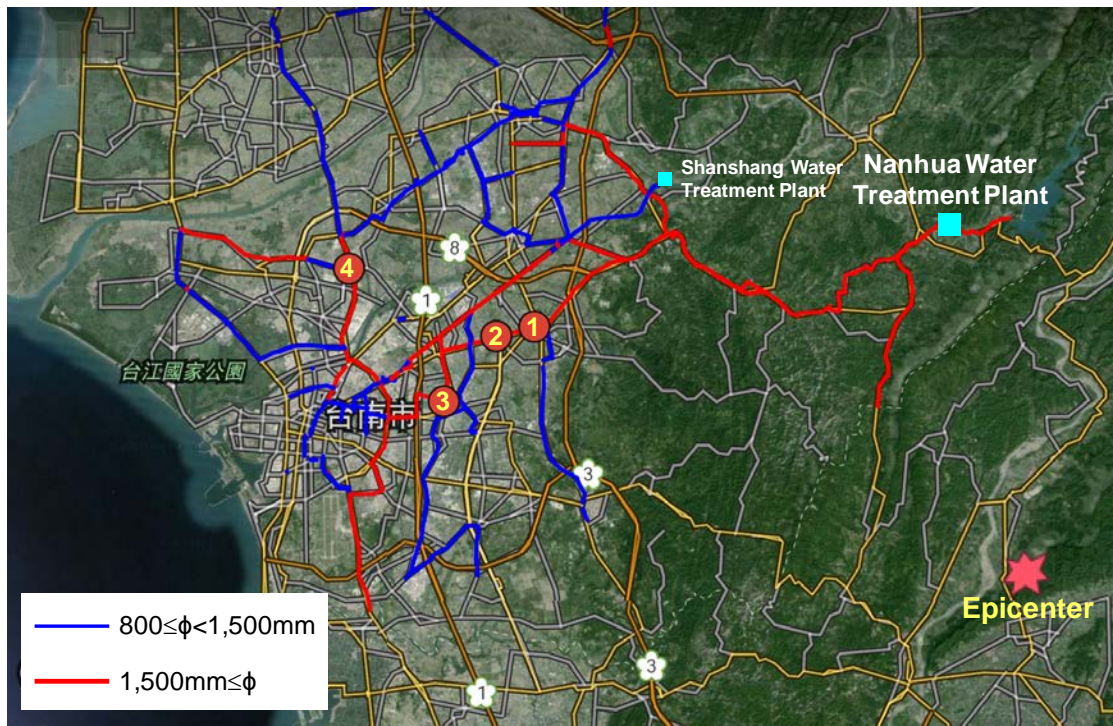
Gee-Yu Liu (劉季宇), NCREE

Chi-Chi earthquake (1999/9/21, $M_w 7.6$)



- ✦ **The only common outlet of Feng-Yuan Water Filtration Plants**
- ✦ **Serving 70% of water demand from Taichung (740,000 customers) before event**

Meinong earthquake (2016/2/6, M_L 6.6)



- Four major damage sites in water mains
- Water supply completely resumed on 2/24 (18 days after)



Leaks occurred along a $\phi 2000\text{mm}$ steel pipeline 1,205-meter long, which was installed by pipe jacking method at a depth of 8 meters.

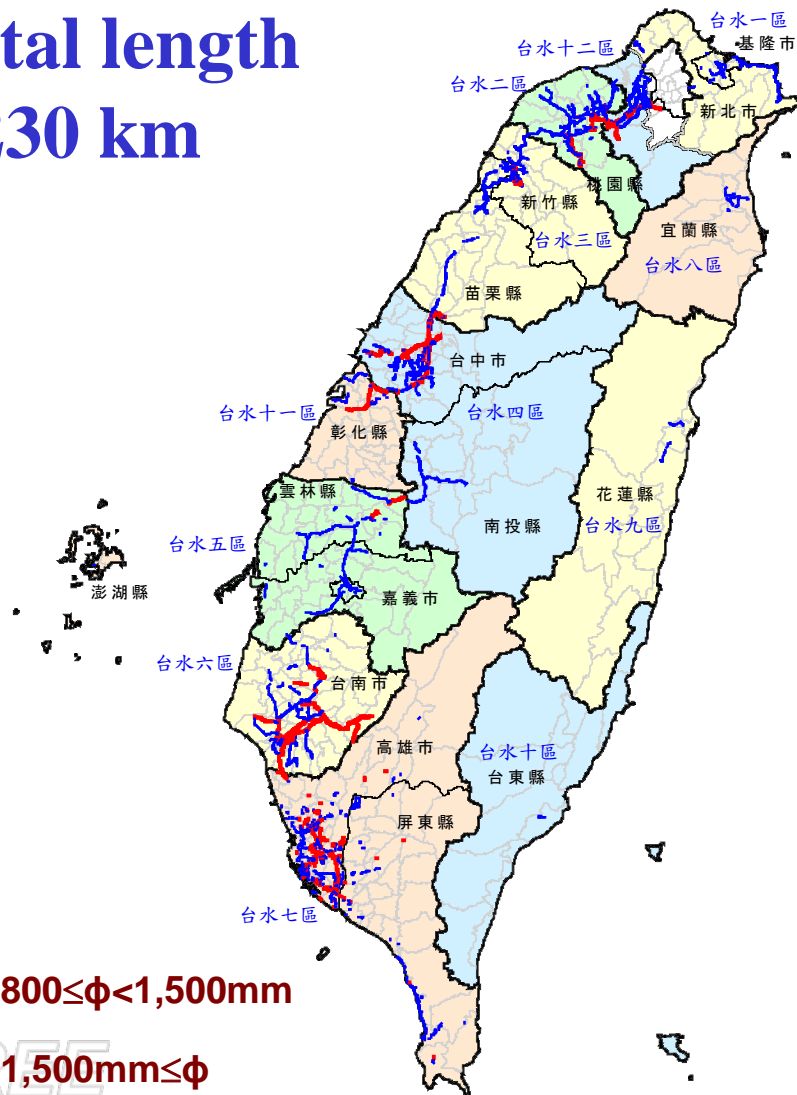


$\phi 2000\text{mm}$ pipes were damaged due to the collapse of a 16-story building.

First 8 days were for life rescue only.

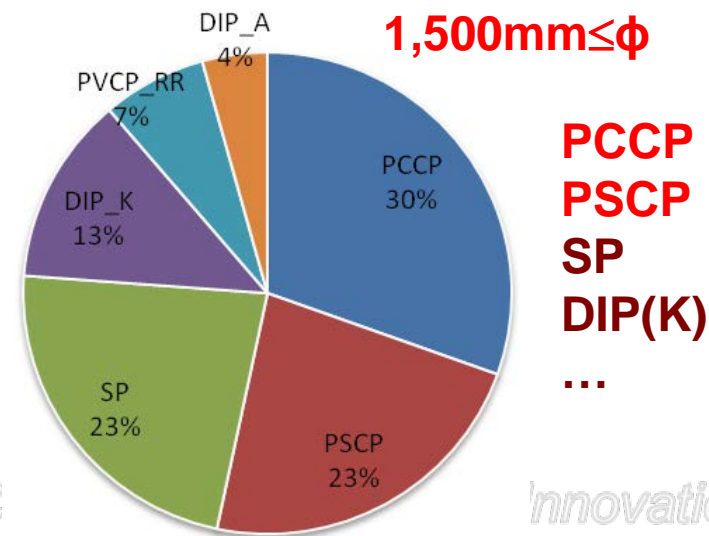
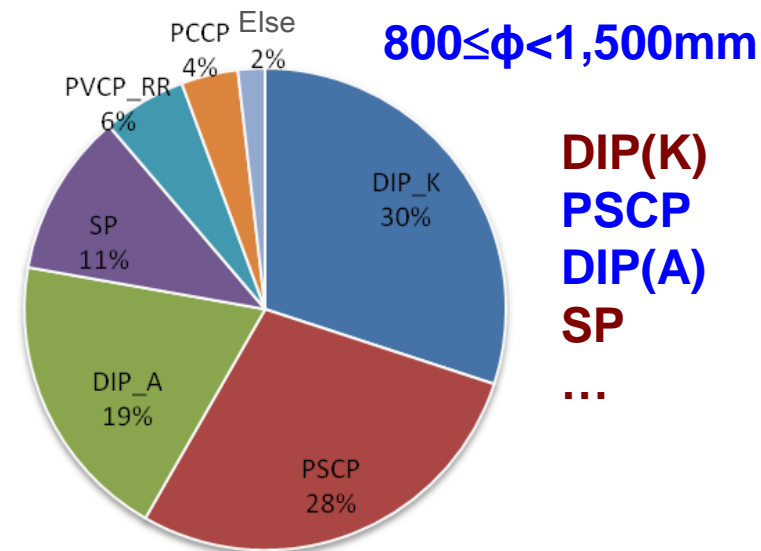
Water transmission pipelines in Taiwan

Total length
2,230 km



800 ≤ φ < 1,500 mm

1,500 mm ≤ φ



NCREE

C

Innovation

Risk assessment

Quantitative risk assessment completed

Hazard

- ▶ Strong motion, fault crossing, soil liquefaction, landslide

Vulnerability

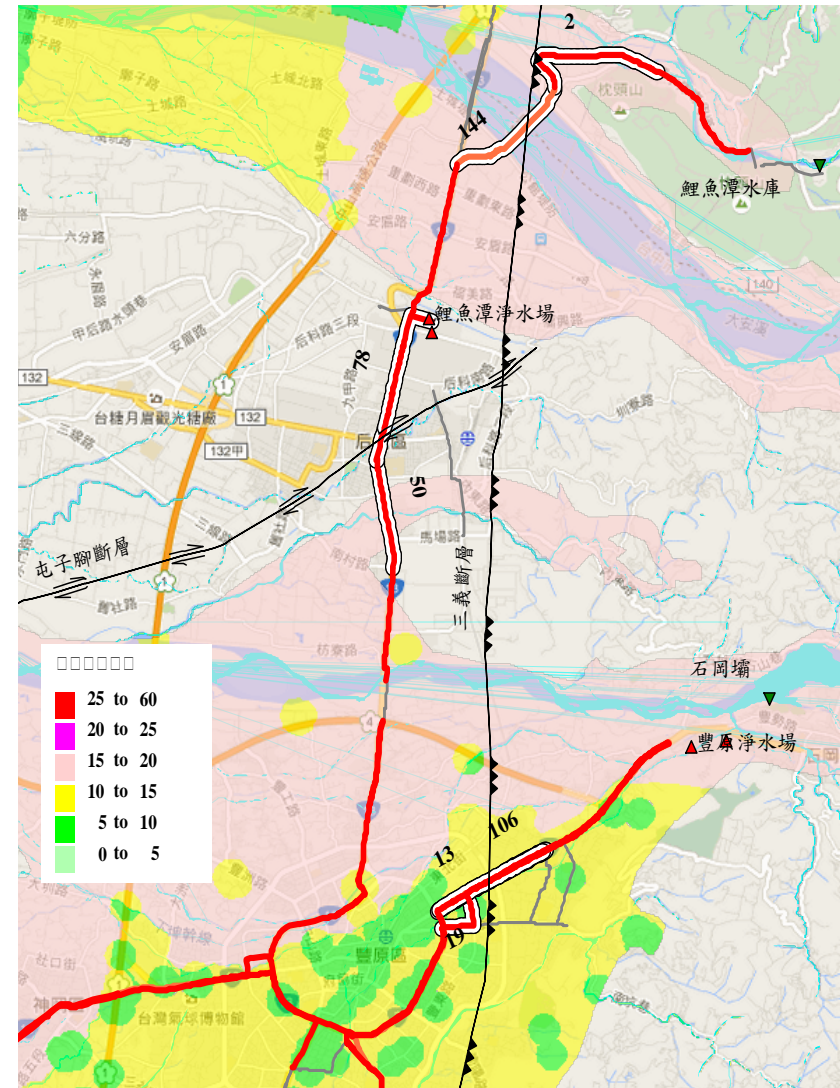
Importance

Among 1,687 pipelines from all water mains, 232 are suggested to be retrofitted:

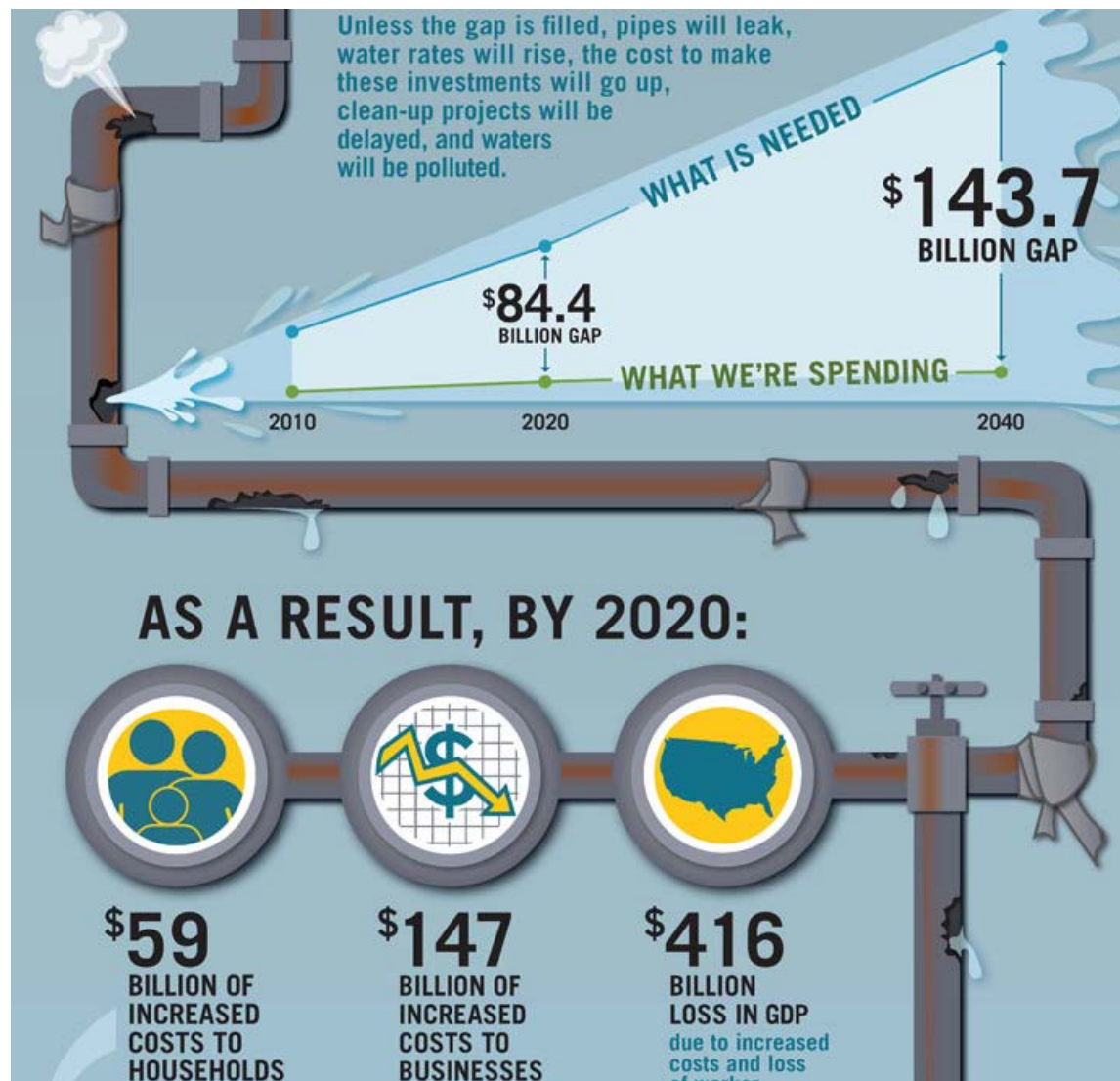
● **First priority: 82**

● **Second priority: 97**

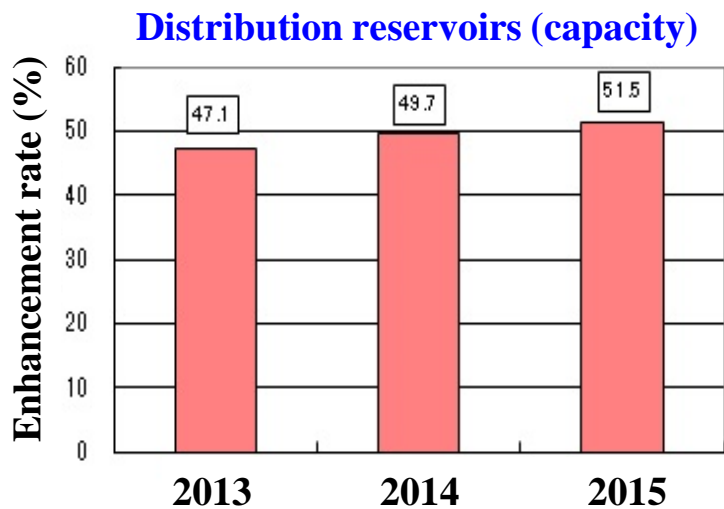
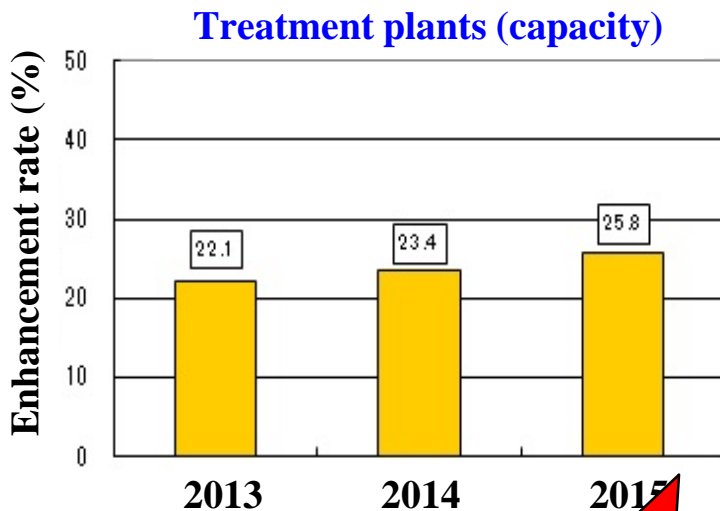
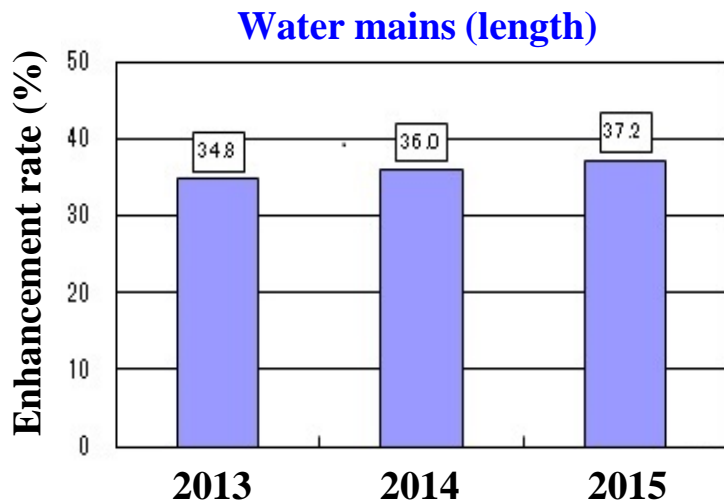
● **Third priority: 53**



How about the U.S.?



How about Japan?



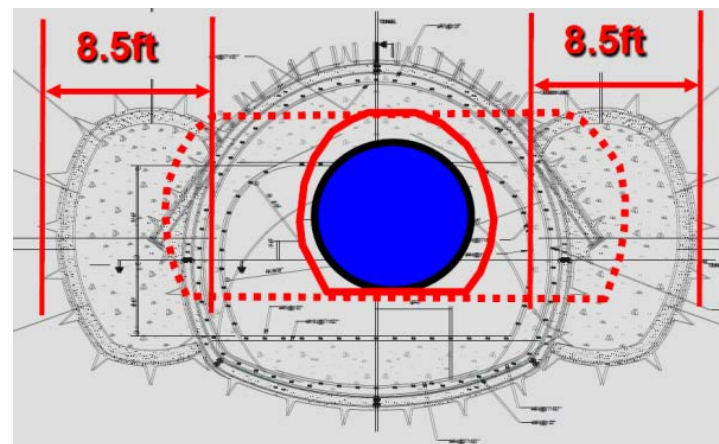
(Source: Ministry of Health, Labor and Welfare, Japan)

Countermeasures



DN150 NS-type

**Japan NS-type DIP in typhoon
(courtesy Prof. Miyajima)**



**Enlarged bypass tunnel vault for
fault offset (courtesy EBMUD)**



**Temporary HDPE bypass lines for
fault crossing (courtesy EBMUD)**

Future needs in Taiwan

- ✦ **Seismic guidelines for buried pipelines**
 - Pipes in liquefiable soil
 - Pipes at a reverse fault crossing
- ✦ **Assessment method for water systems**
 - System (and inter-system) serviceability and response
- ✦ **Pipe seismic testing**
 - Axial and flexural testing
 - Split sandbox testing (?)

Thanks for your attention!