


A New Alarm System for Detecting of Landslide



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- Landslide Hazard Detection System using Radio Type Extensometer
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Introduction

- Landslide
 - Significant social problem which causes to loss of precious lives in Korea and Japan
 - It provokes to mitigate its harmful action and to detect its movement earlier.
 - Data Acquisition Method in Field
 - Helpful to minimize loss of disaster
 - Manual
 - Data is recorded on the spot.
 - Semi auto
 - Data is recorded in data logger at regular time interval.
 - Cable type full auto
 - Data is recorded in observation post through cable without delay.
 - Radio type full auto
 - Data is recorded in observation post by radio without delay.

Introduction

Year	Total Number of The Deceased	Number of the Deceased by Landslide	Proportion (%)
Average	128	29	22.7
The total	1,276	288	22.6
1993	69	12	17.4
1994	72	6	8.3
1995	158	28	17.7
1996	77	2	2.6
1997	38	6	13.2
1998	384	103	26.8
1999	89	23	25.8
2000	49	18	36.7
2001	70	16	22.6
2002	270	75	27.8

Damage of Lives by Landslide in Korea
(1993~2002)

Year	The Deceased	Cost of Rehabilitation (million WON)
Average	33	82,330
The total	163	411,650
1998	92	85,313
1999	23	34,285
2000	7	15,757
2001	6	25,766
2002	35	250,529

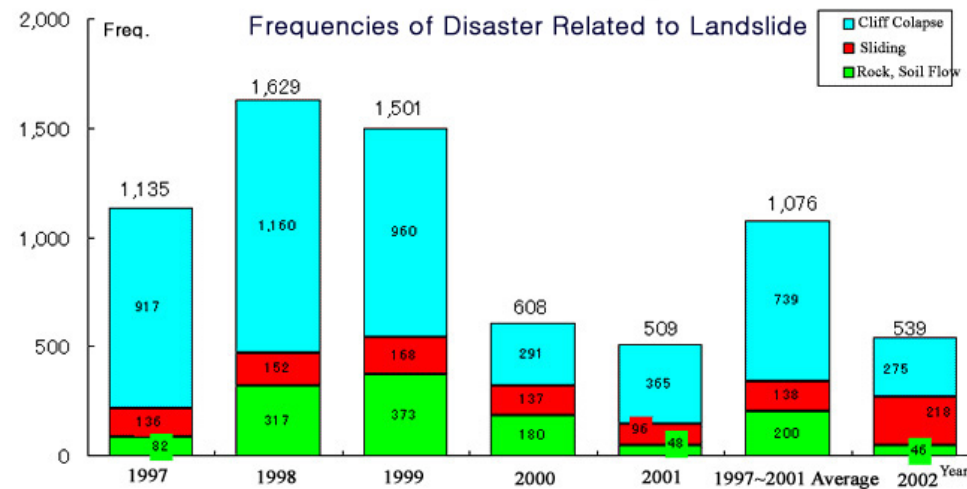
Damage of Lives by Landslide in Korea
(1998~2002)

Introduction

	The deceased	The wounded	House totally damaged	House partially damaged	Facilities Partially damaged	Freq. Of Disaster
Rock and Soil flow	2	-	6	2	18	46
Sliding	-	-	3	4	19	218
Cliff collapse	2	1	5	11	64	275
Total	4	1	14	17	101	539

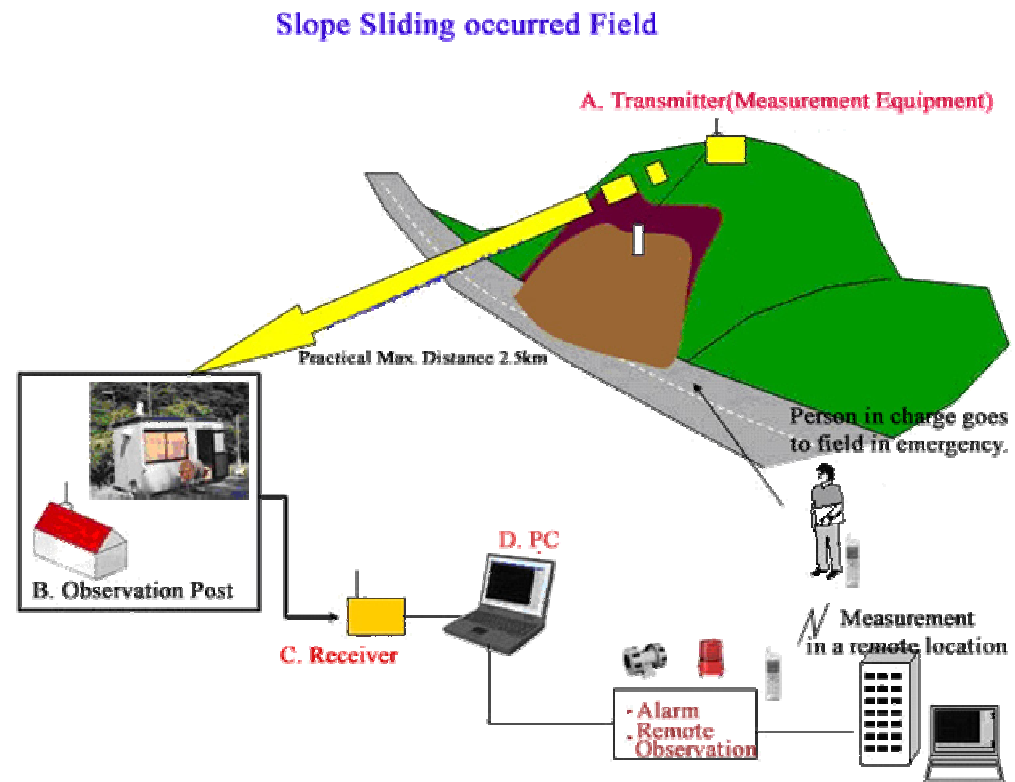
Damage of Lives and Property by Landslide in Japan (2002)

Frequencies of Disaster Related to Landslide in Japan (1997~2002)



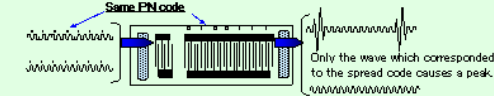
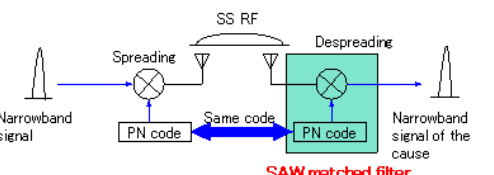
Outline of Landslide Hazard Detection System

- ❑ Extensometer
- ❑ Transmitter
- ❑ Receiver
- ❑ Personal Computer
- ❑ Alarm Equipment



SS Communication

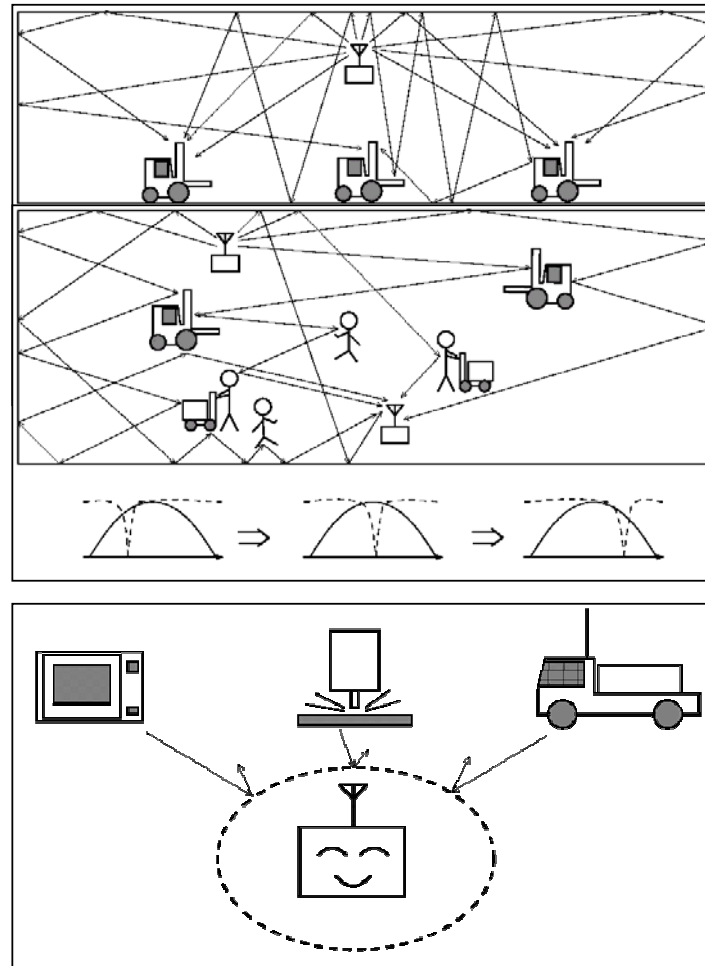
- ❑ Spread Spectrum Radio Communication
- ❑ It can be communicated at long distance and transmitted data in large quantities simultaneously.
- ❑ Advantage
 - Anti-multipass
 - ❑ No effect of movement, obstacles.
 - Anti-Jamming
 - ❑ No effect of jamming.
- ❑ Disadvantages
 - Circuit is Complicated.
 - High cost is needed.

Title	Spread Spectrum Radio Communication																
Core Technology	<p>Combined SAW device (a matched filter with a delay line)</p> 																
Outline	<p>[Principle] The modulation form that data are spread onto the frequency domain.</p>  <p>[Feature]</p> <ol style="list-style-type: none"> Secure communications If spread code isn't known, it can't be restored. Interference rejection Interference is rejected during despreading. Multi-path protection Multi-path interference is handled during despreading. <p>4. High-speed data transmission is possible.</p> <p>[Spec. (SS Wireless modem SS-7)]</p> <table border="1"> <tr> <td>Frequency Band</td> <td>2.4GHz band (ISM band)</td> </tr> <tr> <td>Modulation Type</td> <td>Direct Sequence Spread Spectrum</td> </tr> <tr> <td>Output Power</td> <td>10mW/MHz</td> </tr> <tr> <td>Radio Data Rate</td> <td>1.16Mbps</td> </tr> <tr> <td>Error Detection</td> <td>CRC-CCITT (16bit)</td> </tr> <tr> <td>Error Correction</td> <td>ARQ</td> </tr> <tr> <td>Media Access Protocol</td> <td>CSMA/CA</td> </tr> <tr> <td>Interface</td> <td>EIA-232D</td> </tr> </table>	Frequency Band	2.4GHz band (ISM band)	Modulation Type	Direct Sequence Spread Spectrum	Output Power	10mW/MHz	Radio Data Rate	1.16Mbps	Error Detection	CRC-CCITT (16bit)	Error Correction	ARQ	Media Access Protocol	CSMA/CA	Interface	EIA-232D
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SS Communication

□ Advantages

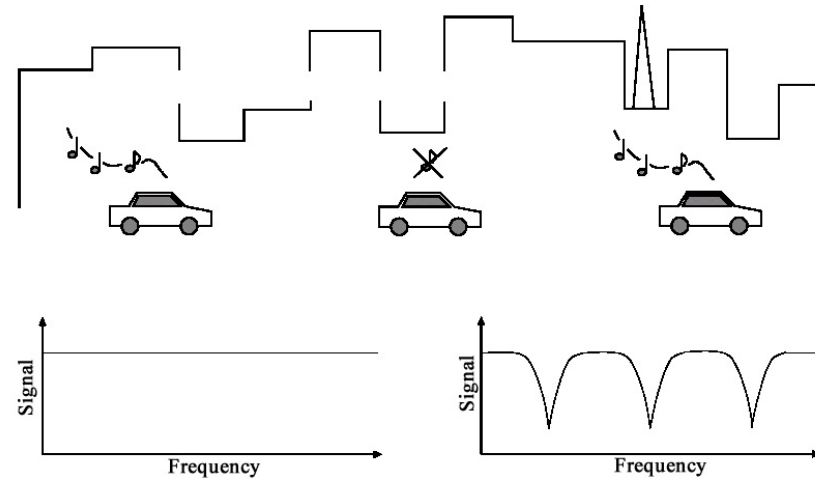
- Anti-multipass
 - It can be communicated in moving condition and free from surrounding obstacles.
- Anti-Jamming
 - No effect of jamming (e.g. microwave, welding machine, illegal radio station, and so on.)



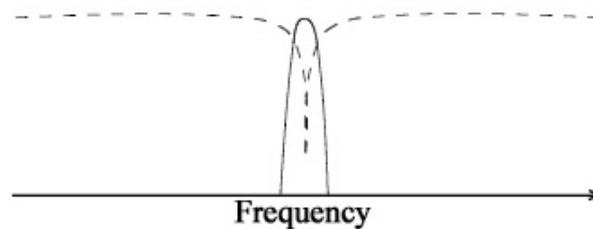
SS Communication

□ Multipass

- If you drive a car, situation that FM radio can not be heard is occurred.
 - Because of reflection wave

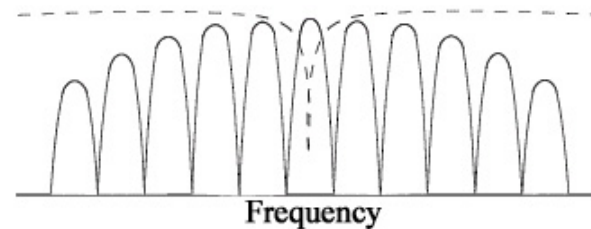


Other Communication
Signal can not be received.



Data is composed of one part.

SS Communication
Signal can be received.



Data is composed of multiple parts.

Advantages of Radio Type Extensometer

- ❑ No needs to install any cable
 - Construction work is free from inconvenience and interference.
 - It is possible to install rapidly.
 - It can be safe against lightning.
 - No damage results from wild animal biting.
 - It can avoid waste of cables.

- ❑ Measurements can be performed in safe location with optional antenna. (Max Distance 2.5km)

- ❑ Much longer battery durability (3~6months) due to much smaller electric power to operate.

Application of Data

□ Data Saved

- Installing No.
- Measuring equipment No.
- Sequential Data No. from the point of starting to measure
- Amount of extension
- Voltage of measuring equipment

Application of Data

□ Example of data saved

■ 1, 36, 1025, 2520, 80

- 1 : the first measuring equipment installed in field
- 36 : Measuring equipment has ID No. 36
- 1025 : 10250 min. has passed since installing
 - If it measures every 10 min, $1025 \times 10 = 10250$ min.
- 2520 : Extension amount of wire is 2520 dots
 - If 1 dot = 0.06854mm, $2520 \times 0.06854 = 172.7208$ mm
- 80 : Amount of voltage of measuring equipment
 - Practically, $80 \times 20.2 \div 127 = 12.7$ V

Application of Data

□ Data Analysis Method

- Guideline using Extensometer in Japan
- 「Report on Construction of Measuring Movement in Landslide Risky Zone」 written by Express Highway Research Foundation of Japan (1988)

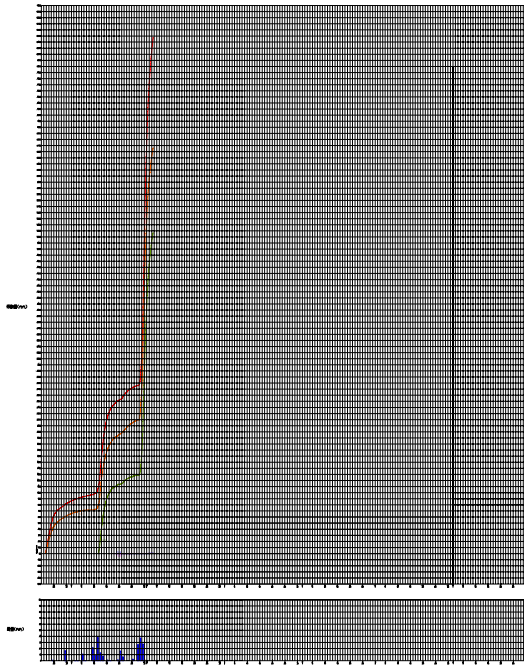
Procedure	Regularly Instrumentation	Planning Countermeasures	Implementation of Countermeasures	Alert Level Residents Evacuation
Velocity of Ground Surface Movement	Less 5mm/10days	5 ~ 50mm/5days	10 ~ 100mm/day	More 100mm/day

「Report on Movement Measurement Construction in Site had Sliding Risk」
Express Highway Research Foundation of Japan, 1988

Application of Data

■ Example

- Prediction of ground movement using relation of ground movement–rainfall



- Conditions of large scale landslide in this field
 - Rainfall more than 20mm/day.
 - Rainfall over 20 consecutive hours.
- Based on the weather forecast, if it is expected rainfall more than 20mm/day.
 - Construction is required to stop.
 - When it sounds alarm, residents take refuge instantly.

Application of Data

□ Prevention Landslide

■ Local Disaster Prevention

- It is important to prevent from local loss of lives and properties due to rain, earthquake.

- Study of prevention against disaster is required to residents, government agencies, and specialists.

- To improve accuracy of local risk prediction
 - Study of premonitory symptoms of risk
 - Practical use of NOBITA system

Application of Data

- Example of Local Disaster Prevention
 - DAITOUCHYO, OHARAGUN, SHIMANEKEN
 - Frequent rockfall
 - Large scaled countermeasure cannot be executed due to insufficient budget.
 - Residents can have knowledge to detect premonitory symptoms and to take an action based on the emergency manual.



Local Disaster Prevention



Taking part in the prevention against disaster, residents recognize an indication from data measured by NOBITA system and organize a patrol voluntarily. When risk is predicted, it sounds alarm by NOBITA system (Patrol, Automatic Notification) automatically, refuge can be performed instantly.



Verification by Nobita system



Warning message would be sent to cellular phone of a person in charge.



Risk is informed to residents through patrol lamp.

Application of Data

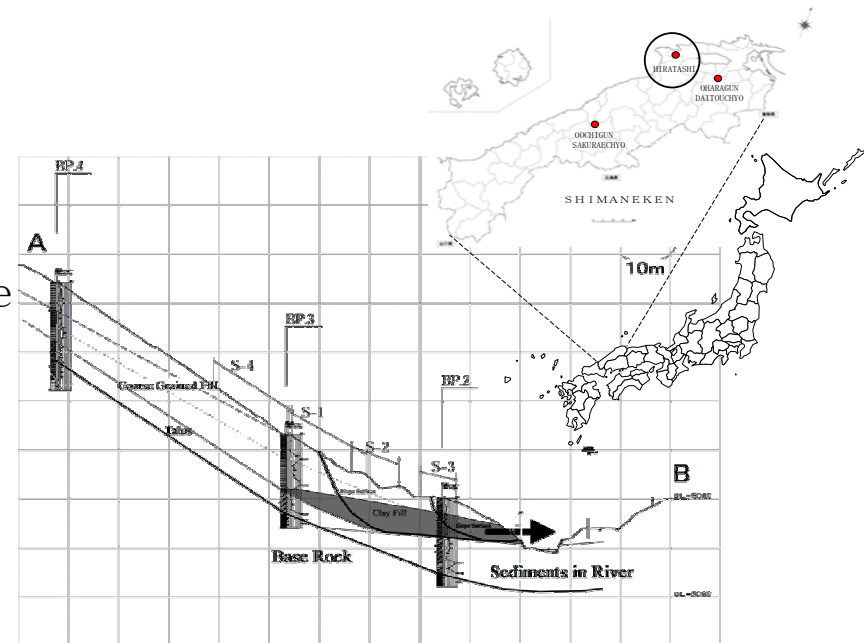
□ Prevention Landslide

■ Countermeasure against Disaster

- It is important to prevent secondary disaster and to prepare for urgent, permanent countermeasure.

■ Example

- HIRATASHI , SHIMANEKEN
- Part of landslide that were discarded by stone quarry.
- NOBITA system was utilized not only to observe the state of landslide but also to notify premonitory symptoms.

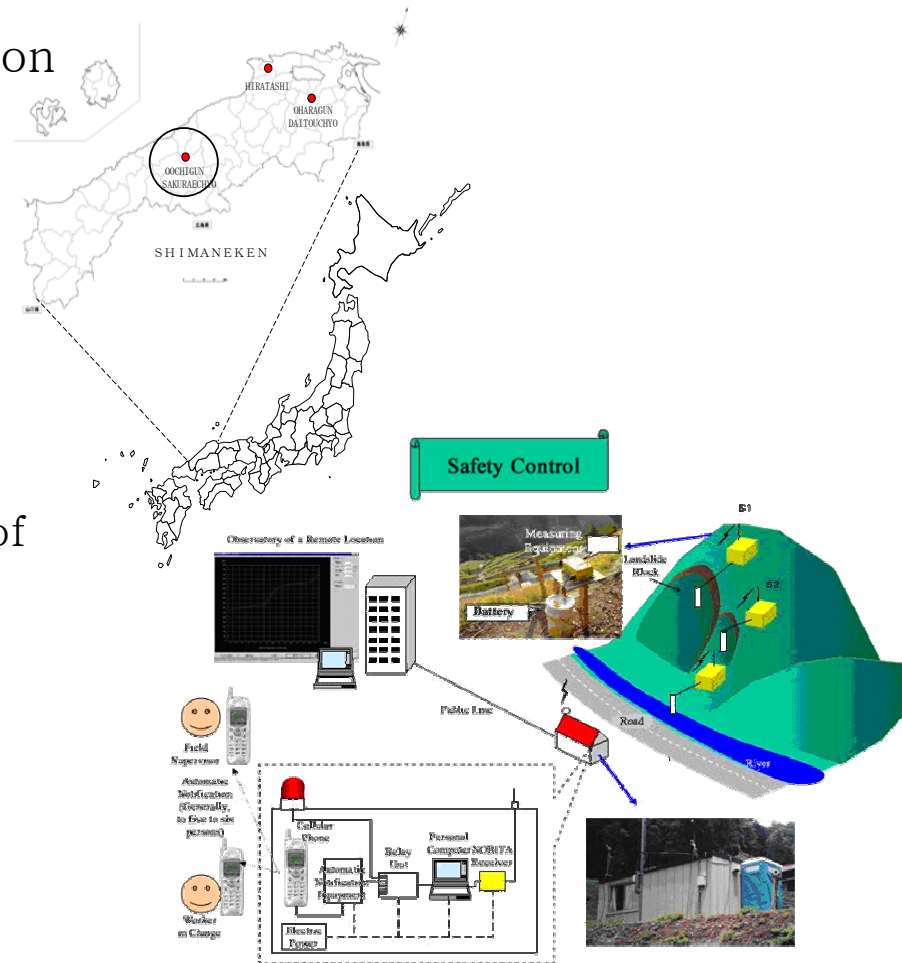


Application of Data

- Prevention Landslide
 - Construction Safety Supervision
 - It is considered that too conservation safety control program at design stage is uneconomical.
 - The most vulnerable site to landslide with regard to budget should be chosen.
 - Execution of accurate safety control allows safer and more economical construction.

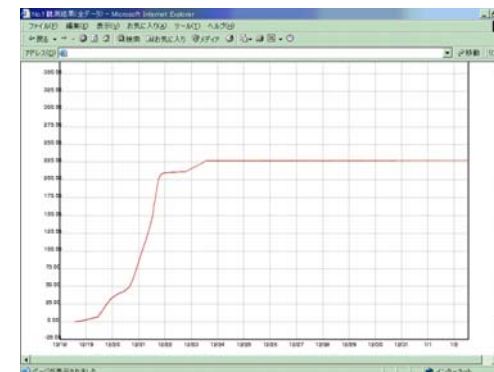
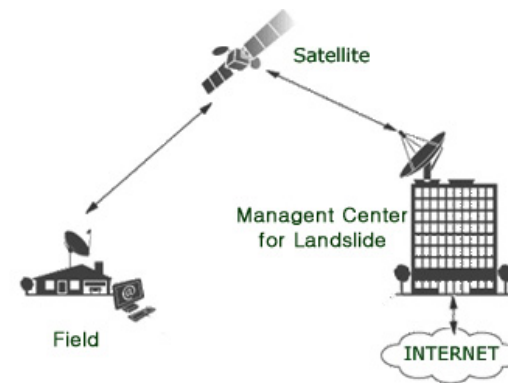
Application of Data

- Example of Construction Safety Supervision
 - SAKURAECHYO , OCHIGUN , SHIMANEKEN
 - Mudstone opencut
 - For ensuring safety of labor and controlling safety of landsliding



Improvement Targets

- ❑ Establishing of Central Management System for Landslide using radio type extensometer, satellite, webcam, and so on.
- ❑ Systematized equipment to acquire the data anywhere through internet.
- ❑ All in one system
 - E.g. extensometer, hyetometer, piezometer, pipe strain gauge
- ❑ More economical system in cost



Conclusion

- ❑ To decrease soil disaster, detection system is necessary to be used broadly in the field.
 - such as NOBITA system, related manual, local disaster prevention study

- ❑ System should be improved up to perform more efficiently and properly according to condition of the field.