

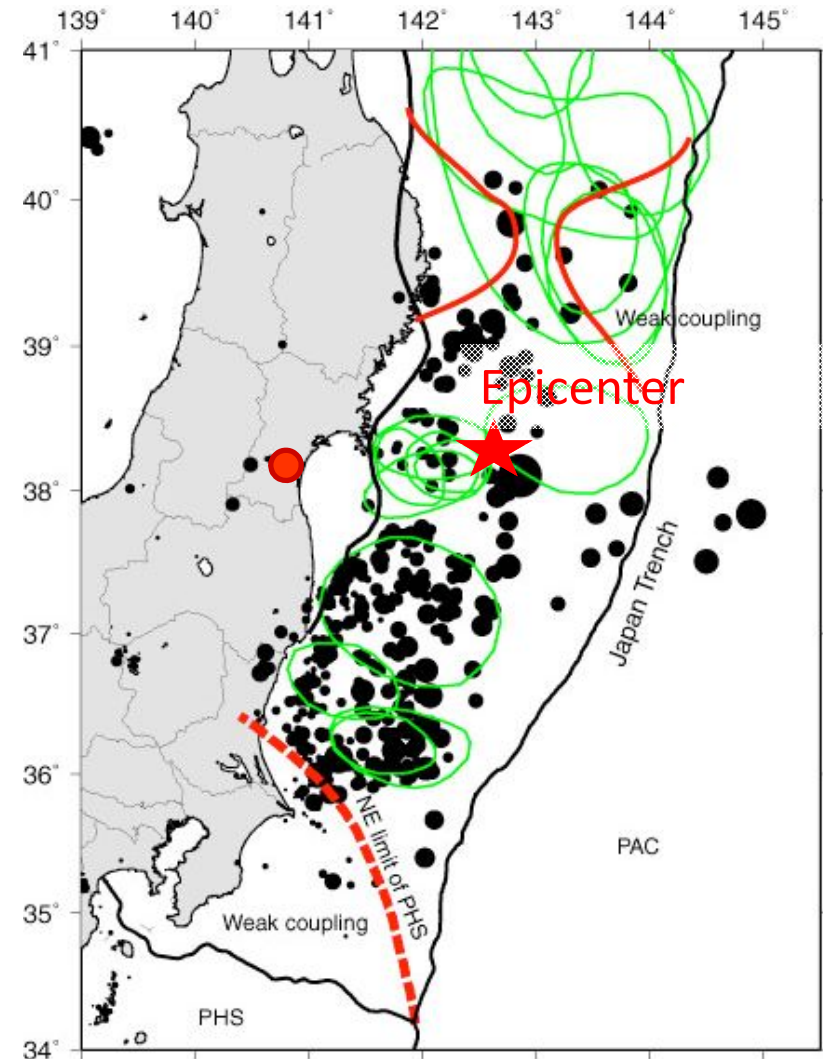
Toward Advance Open Air PA Systems to Convey Disaster Information Timely and Properly

SUZUKI, Yôiti

Research Institute of Electrical Communication &
Graduate School of Information Sciences,
Tohoku University

Tohoku University is located in Sendai

- Sendai is the capital of Miyagi Prefecture & center of Tohoku District of Japan
 - ca. 1M habitants
 - Nicknamed as a city of green woods
- It is located 200 km direct west of the epicenter of the earthquake on 11 March, 2011



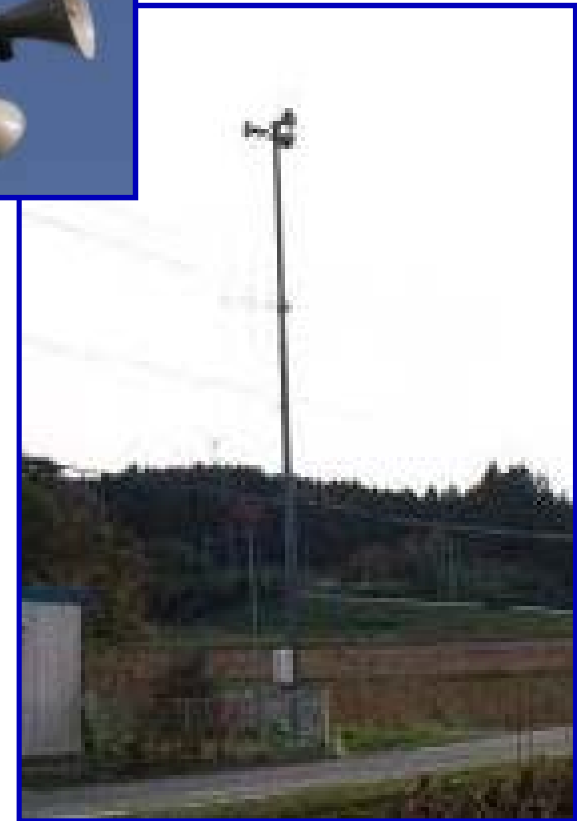
Extremely high tidal waves attacked coastal wood (Sendai Plain 仙台平野)

March 11, 15:56



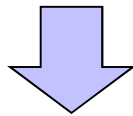
The “Disaster public-address radio network”

- Most of the rural areas in Japan is covered by out-door public address system
- This system is called the “disaster public-address (PA) radio network”



Problems revealed by the Tohoku Earthquake

- On March 11, 2011
 - Only around half of the citizens got the alarm of extremely high tidal wave by this public PA system
- Problems:
 - Tower destruction
 - Electric power down
 - Low intelligibility

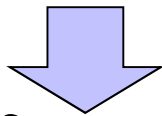


This is what we want to solve!



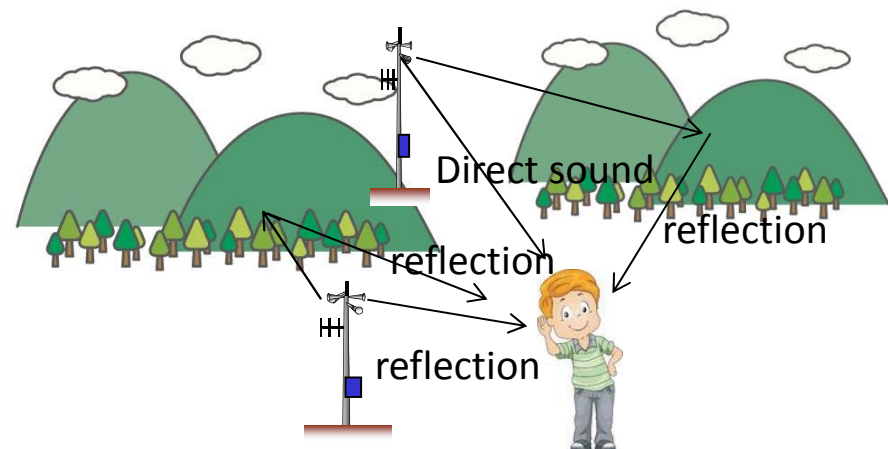
Low speech intelligibility problem

- Long path echo & sound mixture problem
 - From plural towers, sounds with large delay times of a few to even 10 seconds are mixed to arrive at a listener



- This often makes the speech sound hard to understand
 - This problem, however, has not examined almost at all

- It is, therefore, important to describe the detracting characteristics of the long-path echoes on speech intelligibility



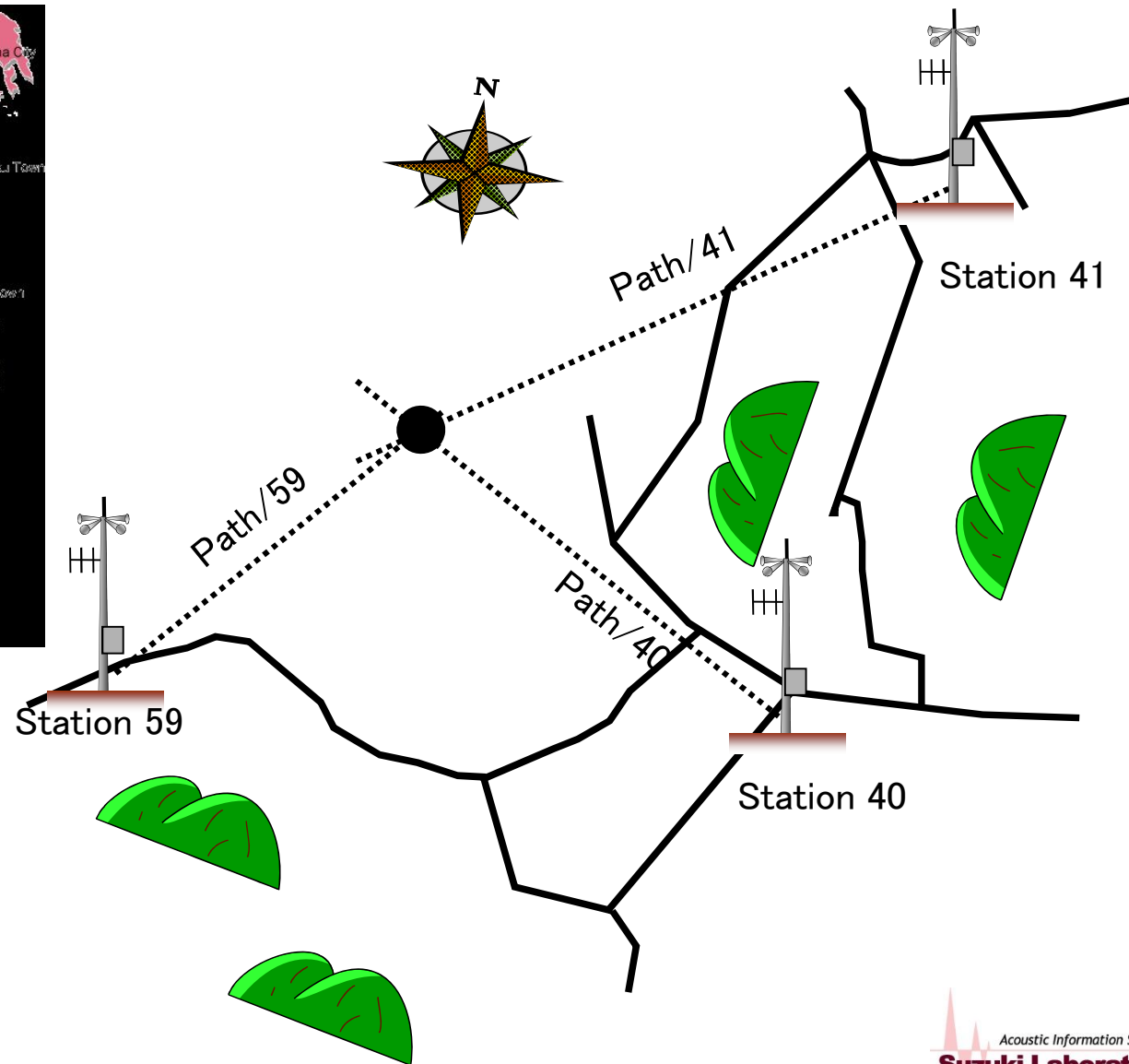
Long-path echoes make the intelligibility extremely low!

Measurement at Higasi-Matsushima City on Nov. 11, 2011

- Objective: Measurement of the long-distance acoustic transfer functions with various sounds
- Scheme: As one of Urgent Projects 2011 by RIEC Director's leadership



Locations of 3 stations measured

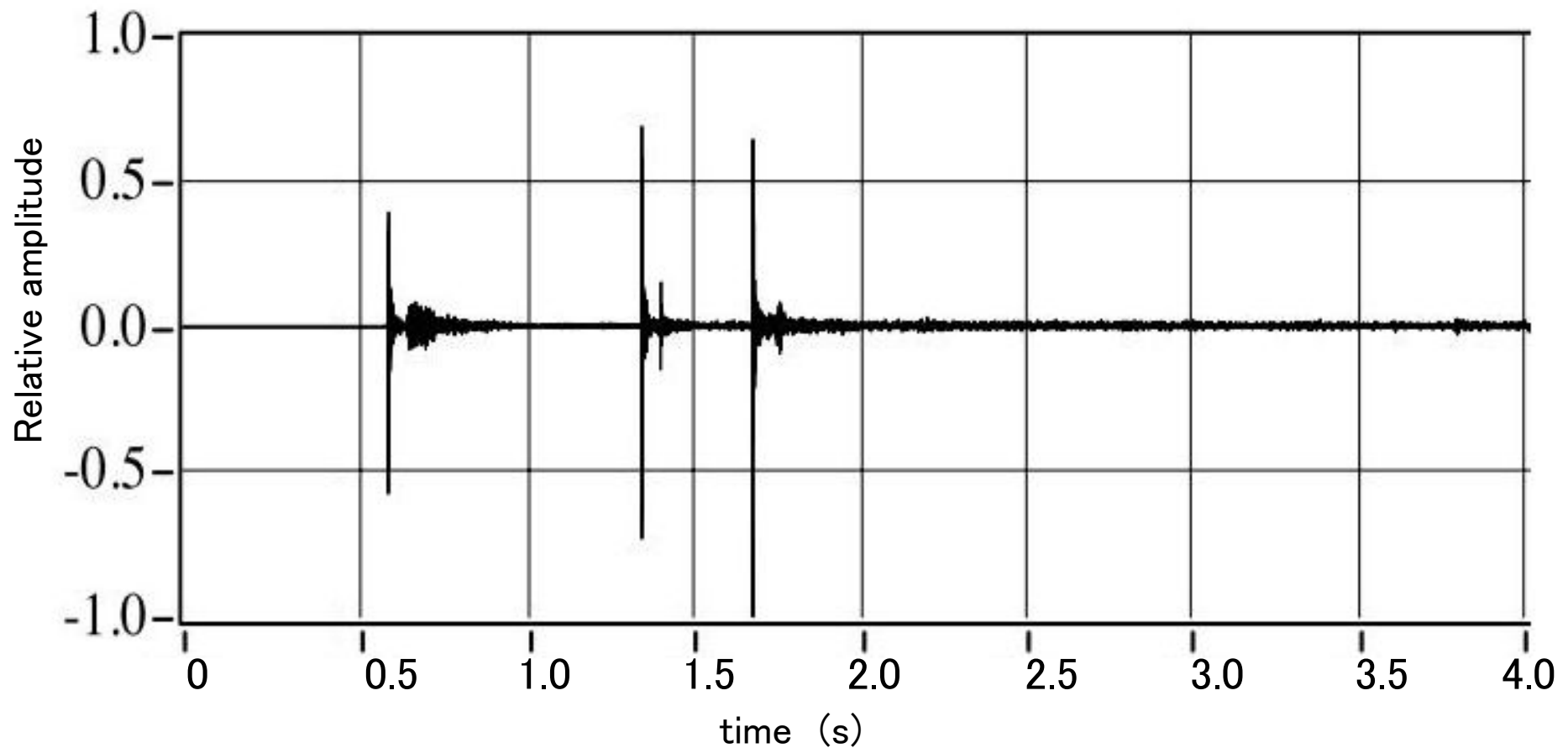


Scenes of the measurement on 2 Nov. 2011



An example of the impulse responses

- Impulse responses corresponding to the 3 stations are heavily mixed



Speech signals convolved with a measured impulse response

- A measured impulse response (IR)



- Phrase 1

- Dry source signal
- Signal convolved with the IR



- Phrase 2

- Dry source signal
- Signal convolved with the IR



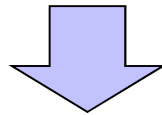
- Words

- Dry source signal
- Signal convolved with the IR

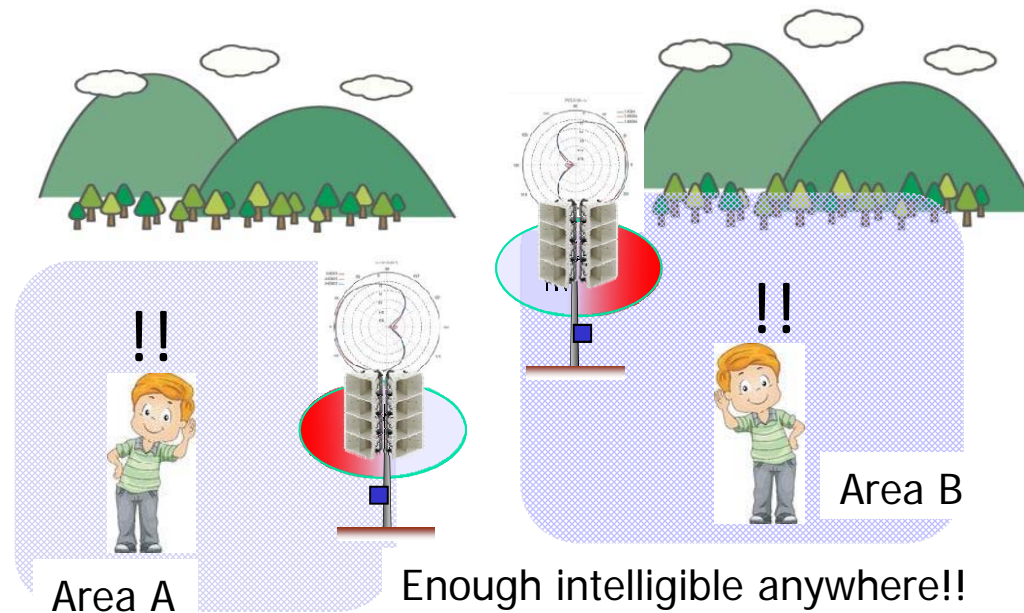


A new project for optimal system design

- Our efforts 2011 revealed that appropriate design methods of the PA system is highly required

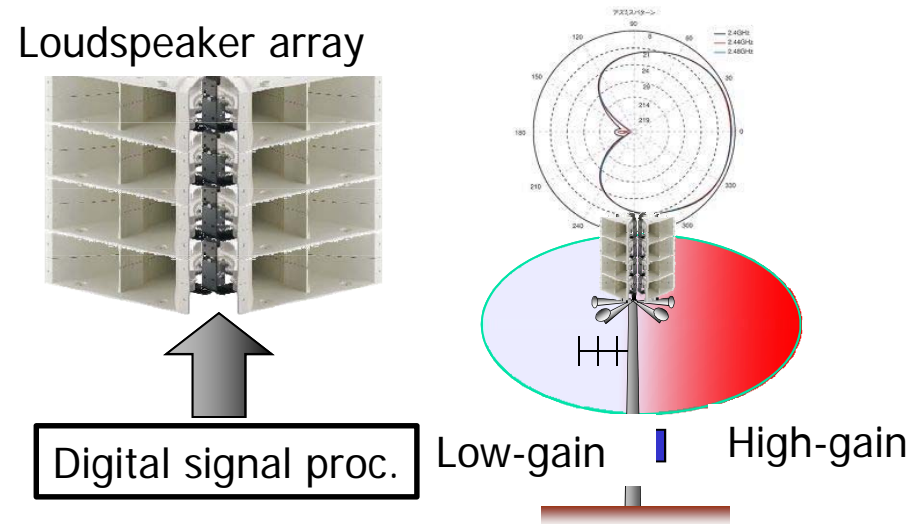


- We have got a grant from Ministry of Internal Affairs and Communications (MIC)



R&D to improve speech intelligibility

- GIS based impulse response estimations
- Evaluation of long-path echoes on speech intelligibility
- Directivity control by phased array technology
- Network based system characteristic control etc...



• Directivity control for loudspeaker array

Measurement at Higashi Matsushima on 28-30 May, 2012

- Objectives
 - Measurement of PA system directivities
 - Measurement of intelligibility with long-path echoes



Scenes of intelligibility measurement

- Speech intelligibilities were measured for speech signals from one and three system(s)

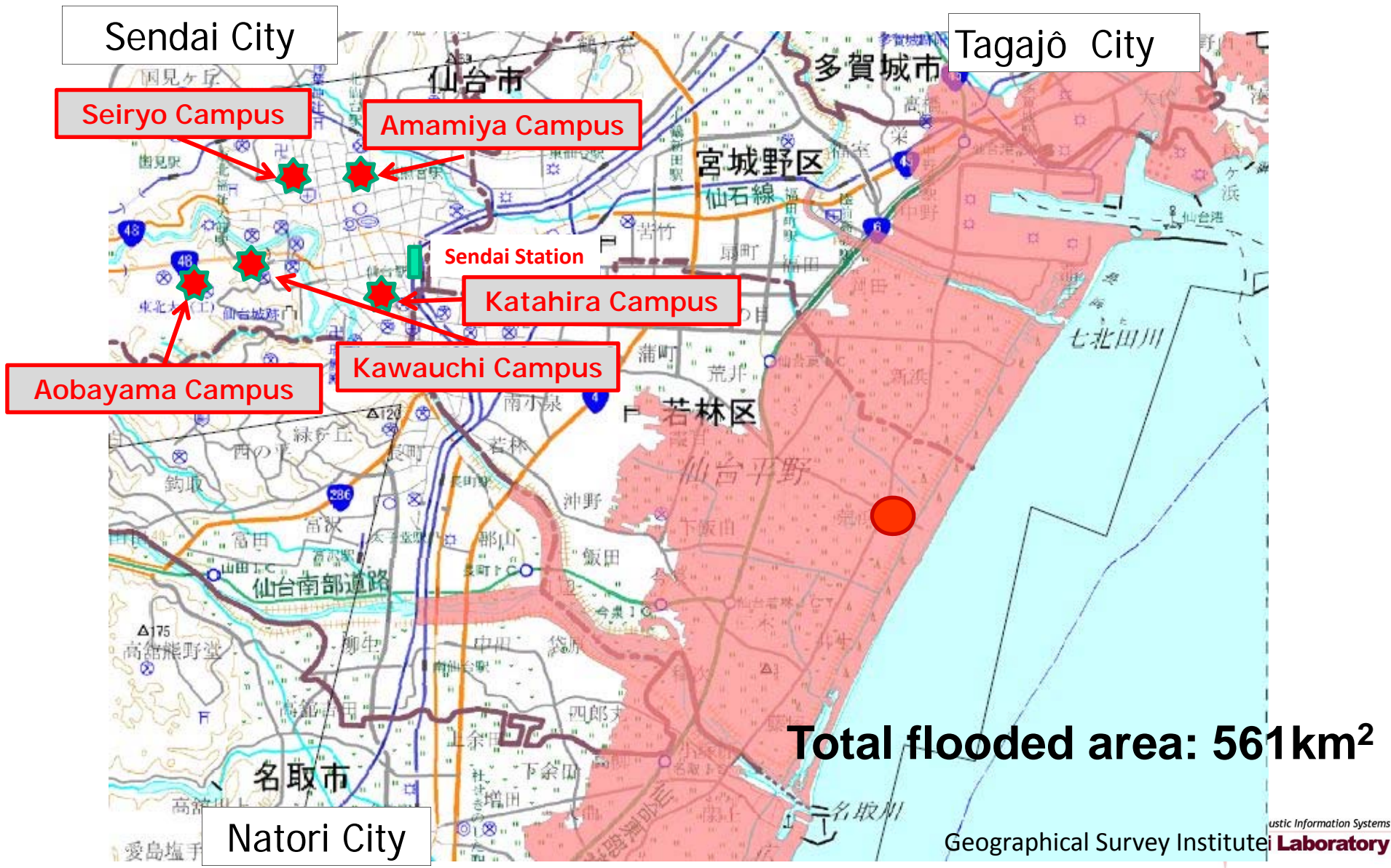


Hearing test of one PA system



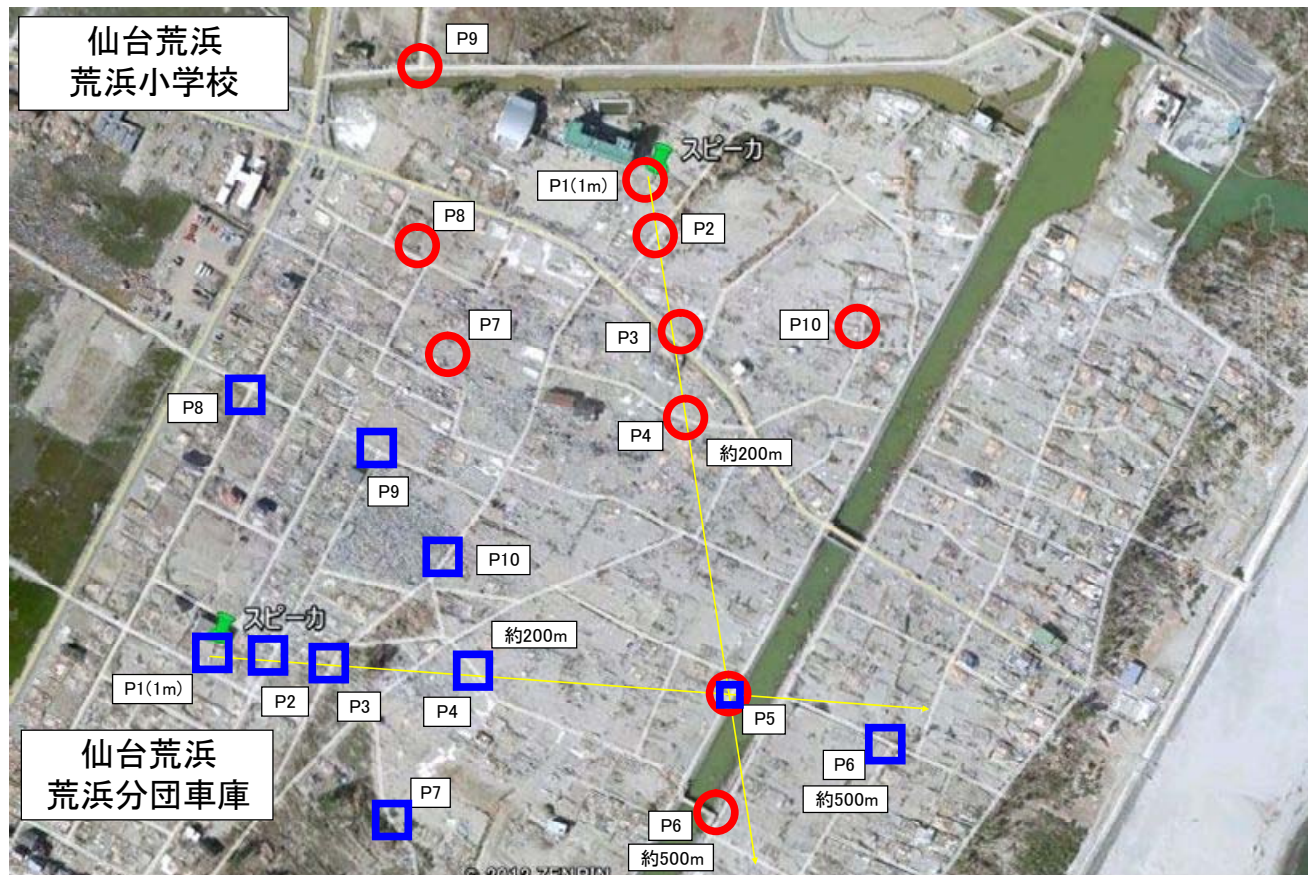
Hearing test when 3 PA systems mix

Measurement was also held at Arahama (荒浜), a flooded area in Sendai (31 May & 1 Jun 2012)



Measurement in Arahama, Sendai

- Transfer functions and directivities were measured sea-coast area of Sendai



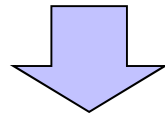
Scenes of measurement in Arahama

- Transfer functions and basic characteristics for directivity control were examined

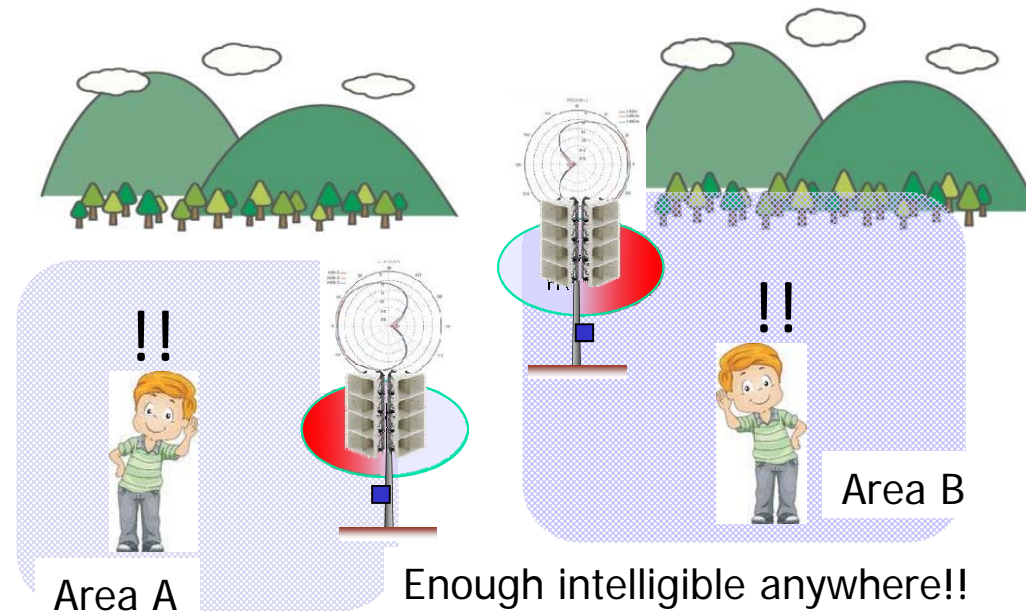


Our goal for the immediate future

- We are examining estimation & evaluation method of open-air PA system performances



- Service area design method of the PA system



Optimum design method of the service areas

Colleagues & Acknowledgement

- Team members
 - Saito F, Cui ZL, Sakamoto S (Tohoku University)
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