Prediction, Control and Assessment of Environmental Noise

- Environmental noise, **Prediction and Mitigation**
- Environmental noise, **Assessment and Evaluation**

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near my house・・・・・

Recently, residential houses were built, but now a house is for sale.

This situation is probably due to **road traffic noise.**

Keio University hospital, Shinanomachi, Tokyo

Cancer institute hospital, Ariake, Tokyo

Noise control in urban space is important to ensure healthcare facilities to be quieter for patients, communication among people

Toranomon hospital, Toranomon, Tokyo

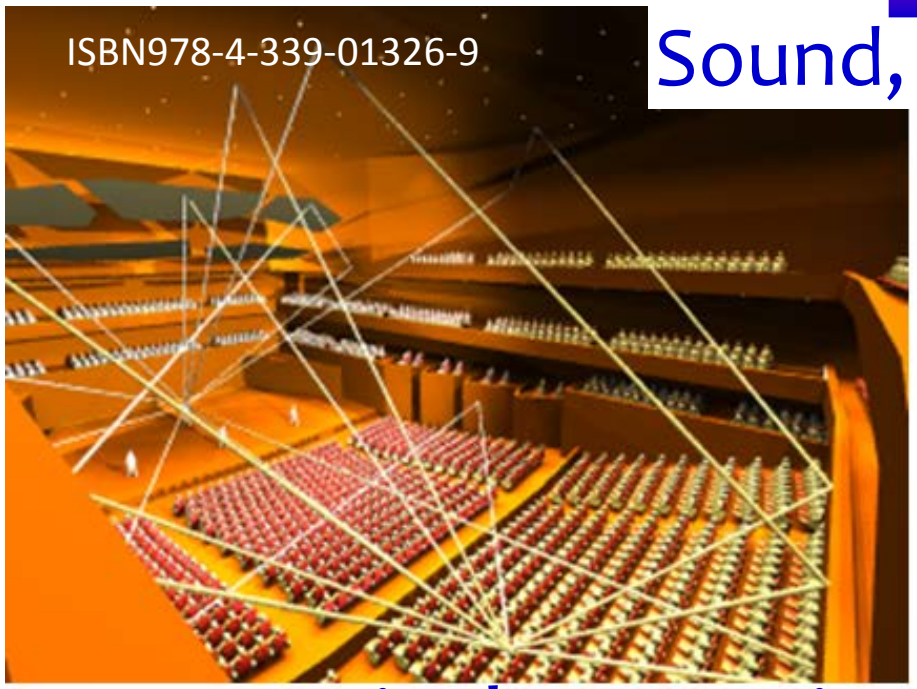
Sound, noise and human life

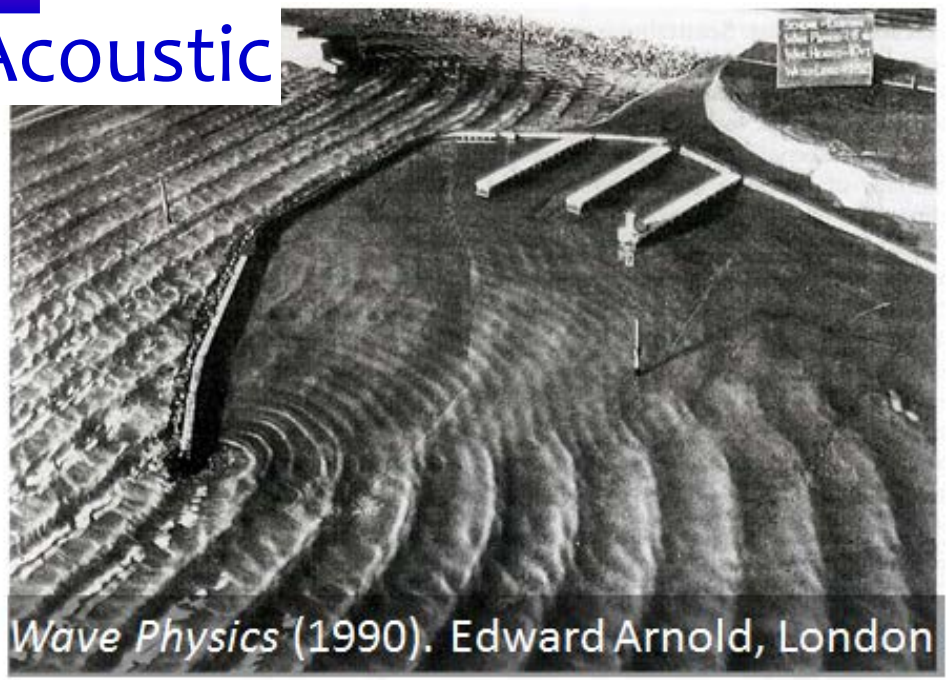
Inhabitants of the city are exposed to noise everyday.

How analyze this physical phenomena?

Noise

Sound, Acoustic





Geometrical Acoustics

Acoustic Energy Particle

as a beam

Wave acoustics

Governed by **wave equation**

$$\nabla^2 p - \frac{1}{c^2}\frac{\partial^2 p}{\partial t^2} = 0$$

Geometrical Acoustics

Acoustic Energy Particle
as a beam

Cannot consider
diffraction effect

Free from Scale problem

Wave acoustics

Governed by
wave-equation

Can consider
Diffraction
Interference

Limited by Scale problem

Small scale ⟷ Large scale
Short wavelength ⟷ Long wavelength
Enable ⟷ Limited to
High frequency ⟷ Low frequency

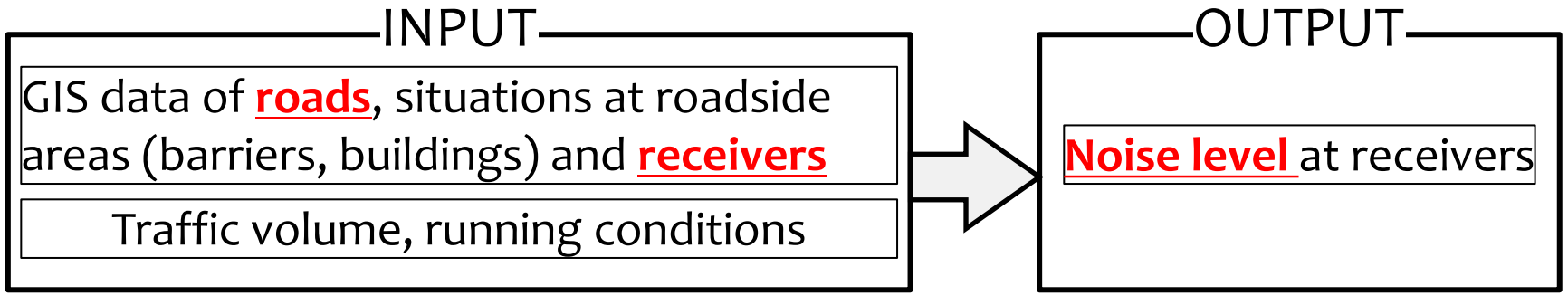
Sound speed 340 m/s

Frequency (Hz)	20 kHz	20 Hz
Wavelength(m)	1.7 mm	17 m

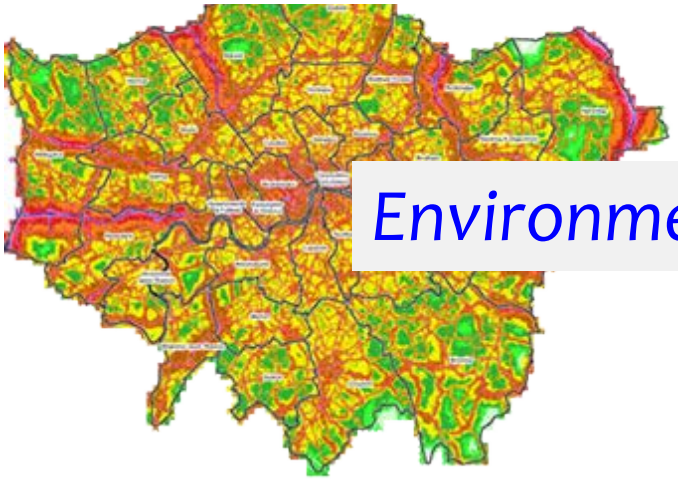
Estimate physical situation of road traffic noise

ASJ RTN-Model 2013
(published by The Acoustical Society of Japan)

PREDICTION and **ASSESSMENT** of road traffic noise in Japan



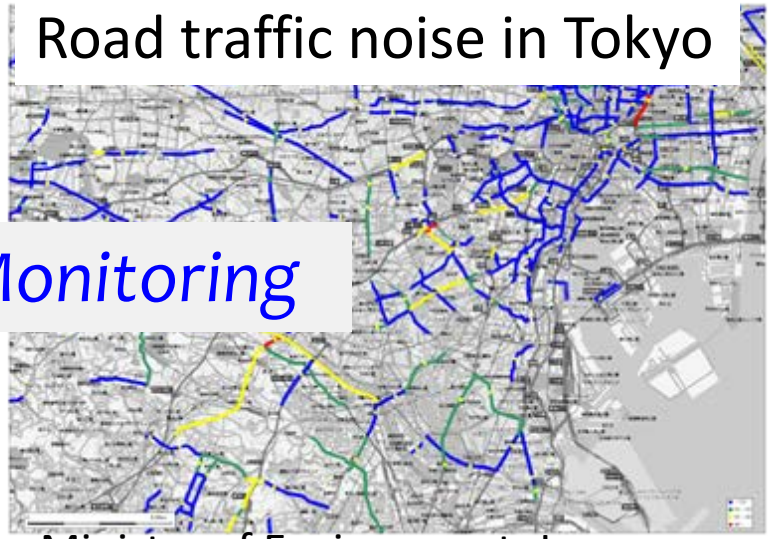
London noise map



From website of Department for Environment Food & Rural Affairs

Environmental Monitoring

Road traffic noise in Tokyo



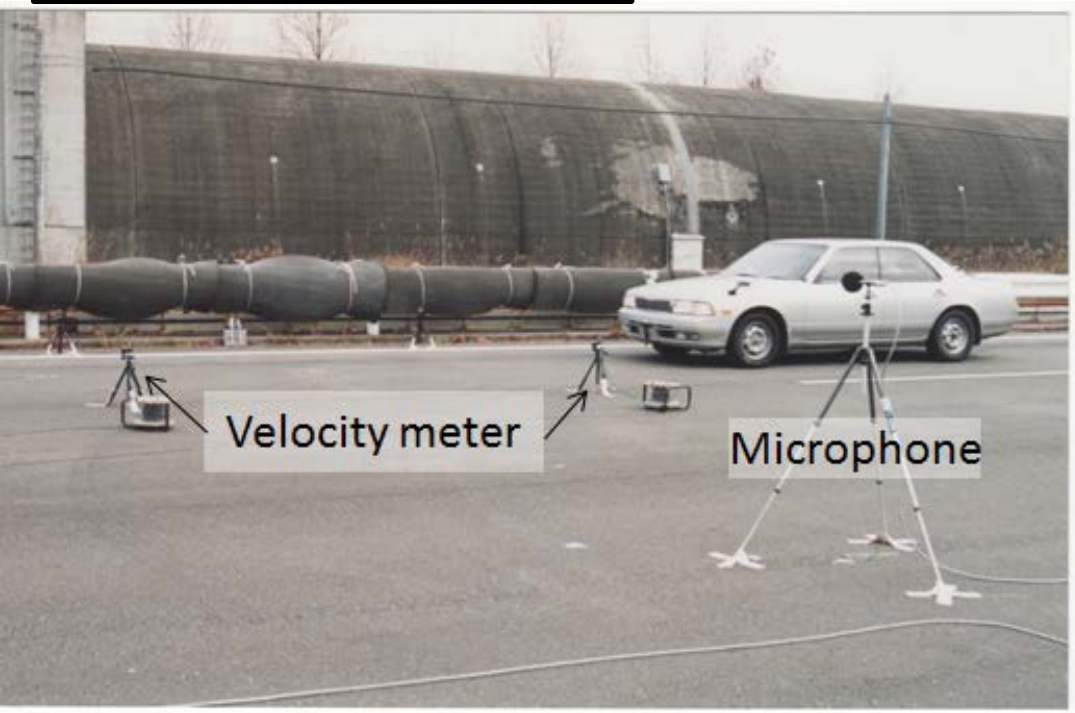
Ministry of Environment, Japan

http://tenbou.nies.go.jp/gis/monitor/

Energy-base road traffic noise prediction method

ASJ RTN-Model 2013
(published by The Acoustical Society of Japan)

Source
Noise Generation
→ Propagation →
Receive
Effect on man



$$L_{WA,} = a + b\log_{10}V + C$$

$$C_i = \Delta L_{\text{surf},i} + \Delta L_{\text{grad},i} + \Delta L_{\text{dir},i} + \Delta L_{\text{etc},i}$$

Road surface　Gradient　Directivity　Etc.

Energy-base road traffic noise prediction method

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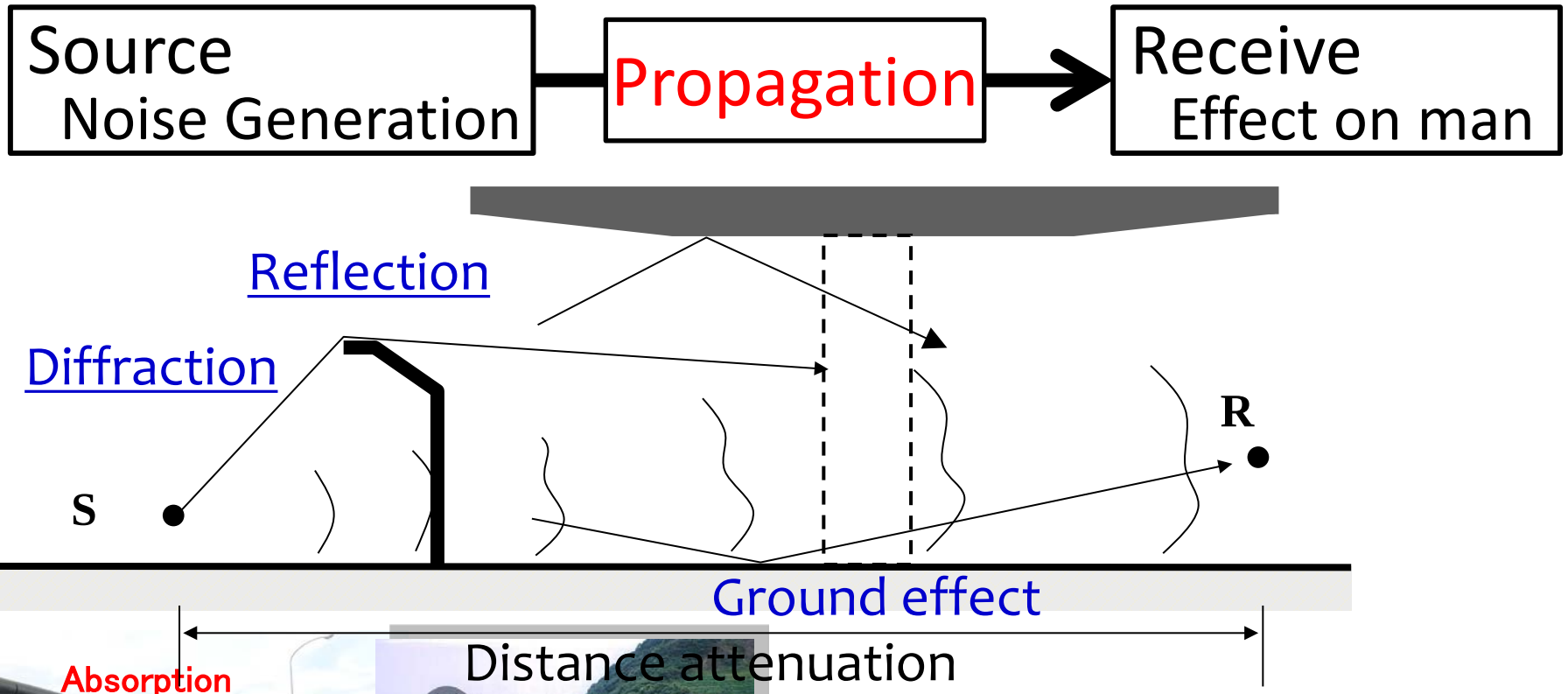
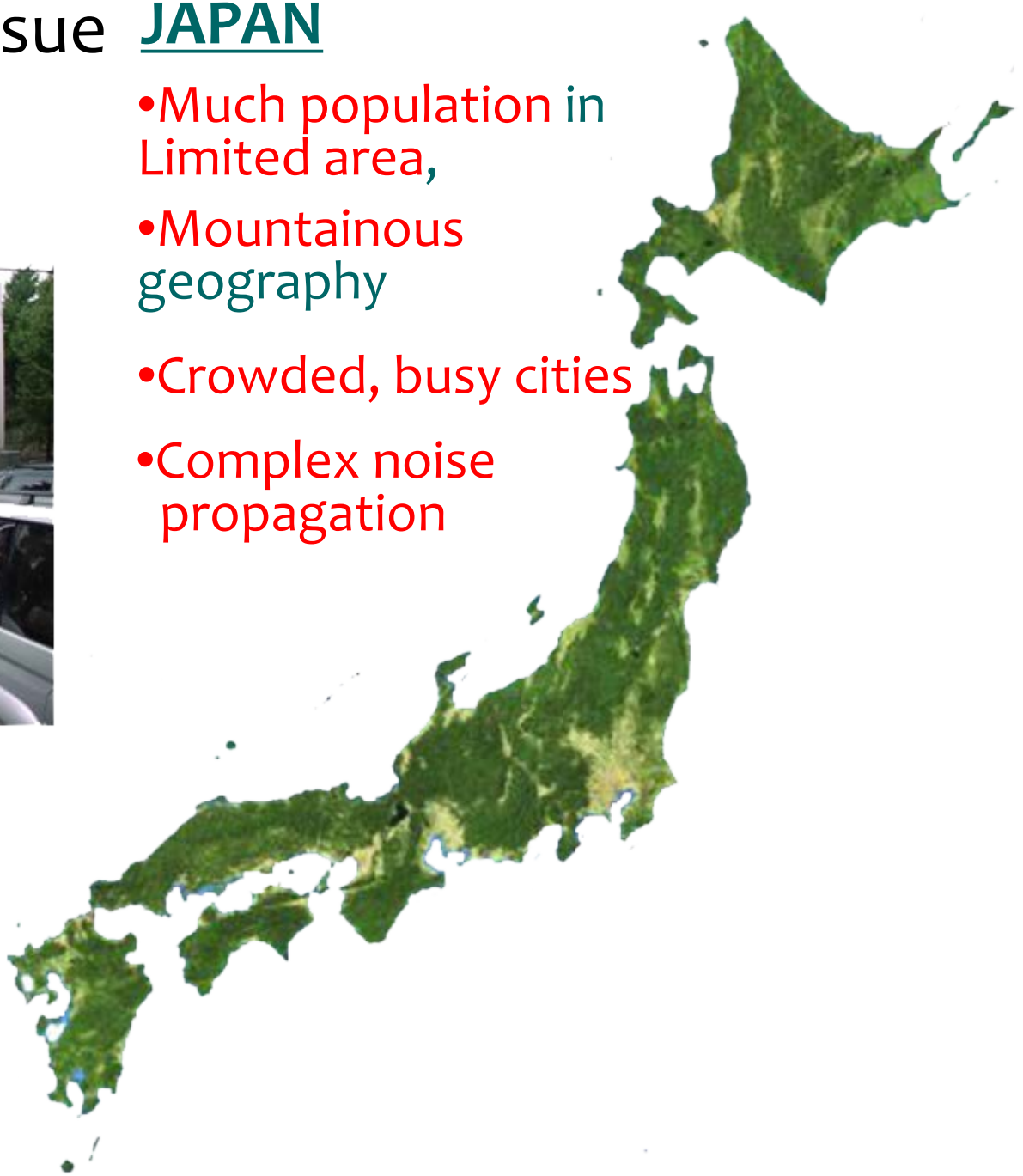


Road traffic noise issue

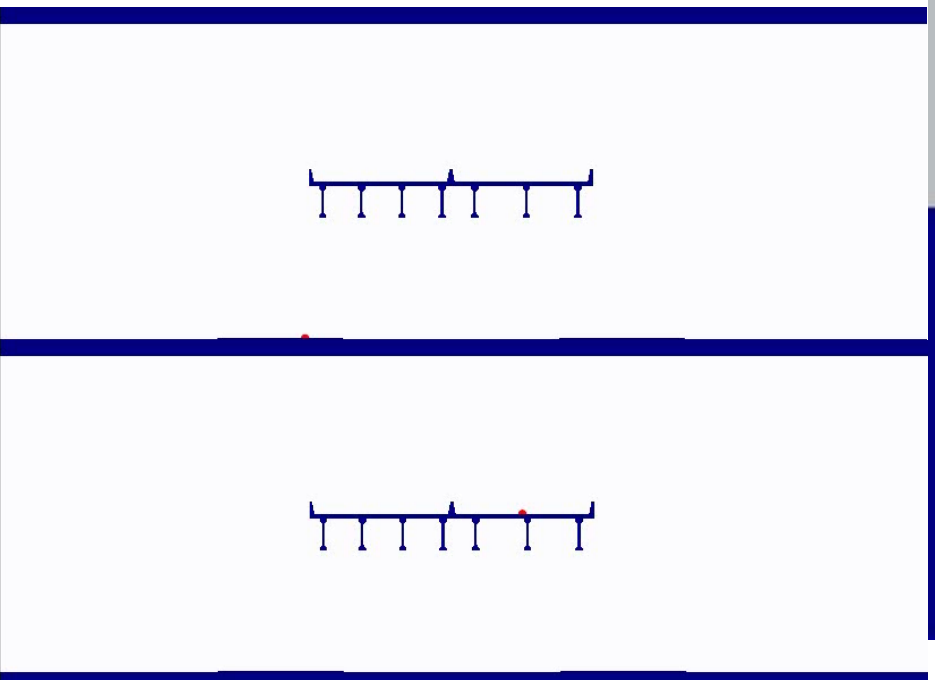
Large city like Tokyo

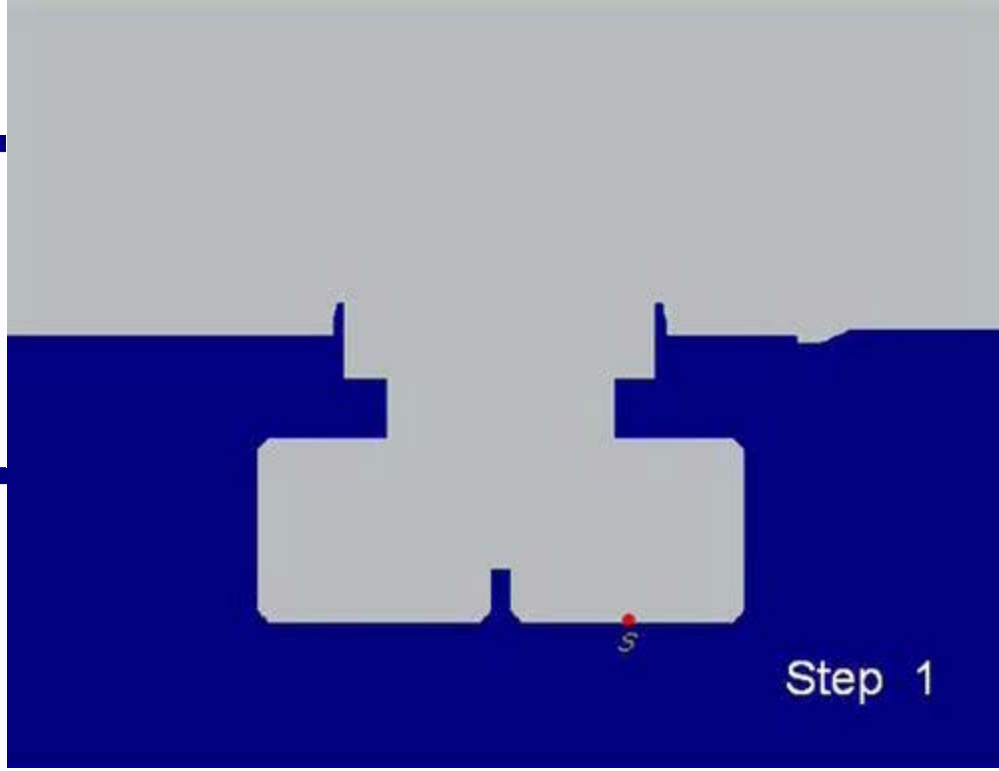
JAPAN

- Much population in Limited area,
- Mountainous geography
- Crowded, busy cities
- Complex noise propagation



Special road sections






Road tunnel


Overhead road


Semi-underground road

Calculation method ------ based on Wave theory

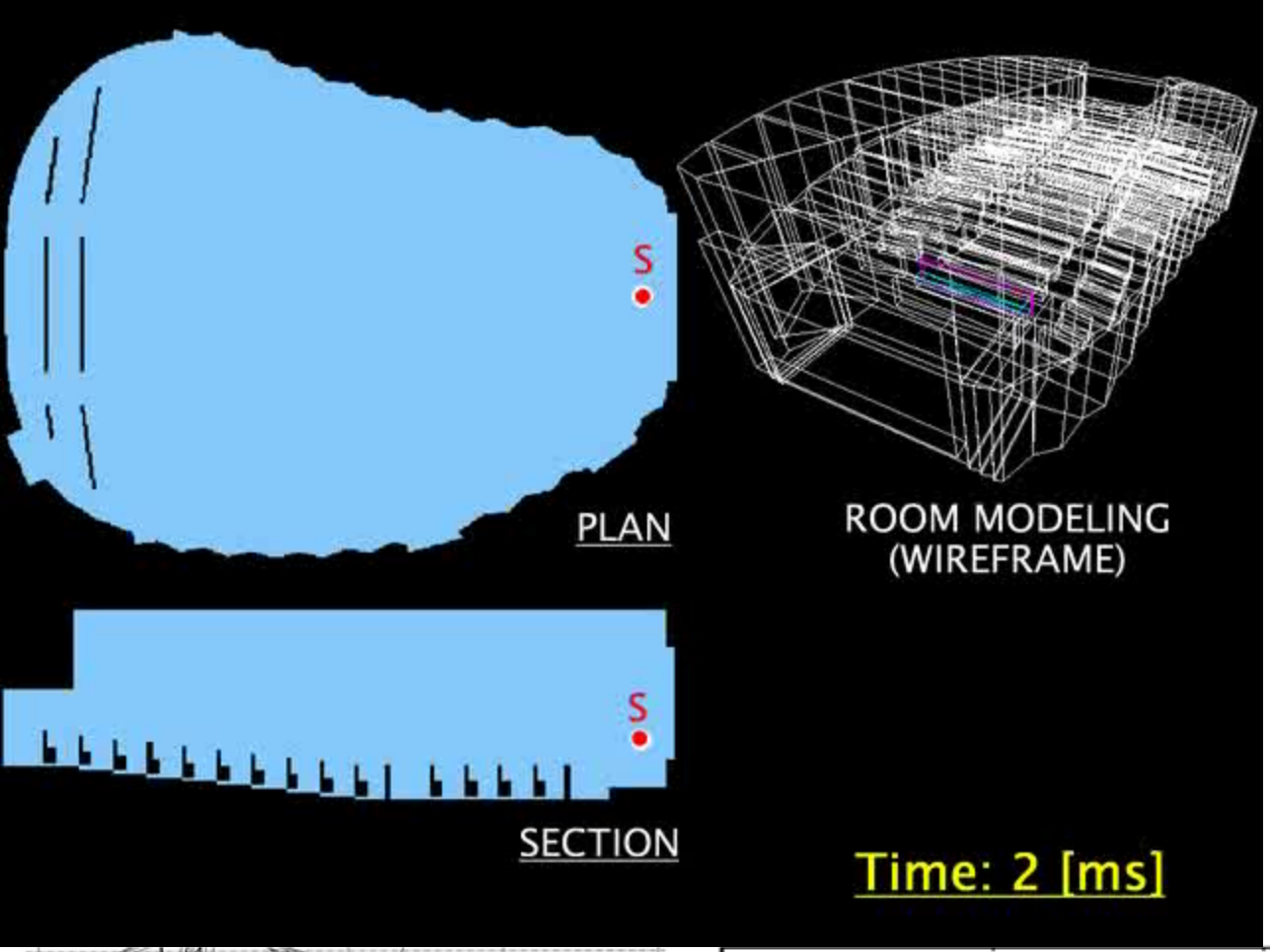
Euler's Eq. $$\rho \frac{\partial u_{x_i}}{\partial t} + \frac{\partial p}{\partial x_i} = 0$$

Continuity $$\frac{\partial p}{\partial t} + \kappa \sum_i \frac{\partial u_{x_i}}{\partial x_i} = 0$$

solve the equations by Finite Difference Method

Firstly applied to room acoustical problem

Photo 2 View from stage

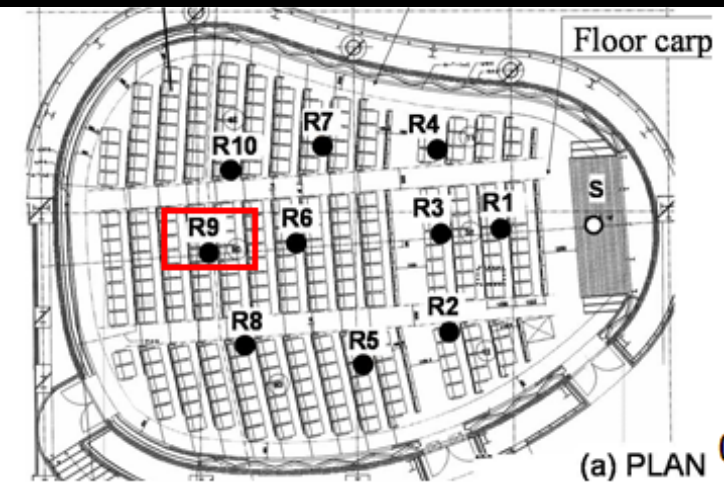


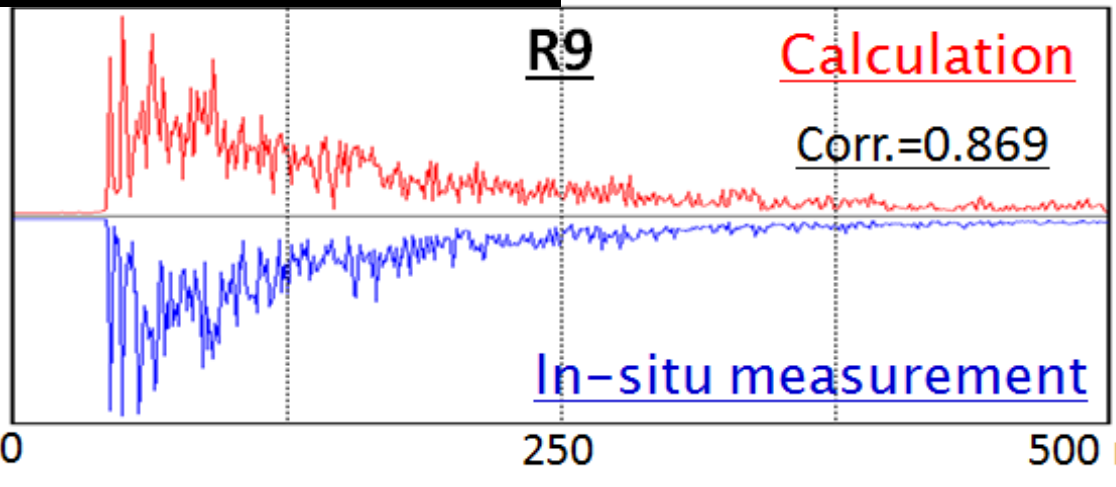
Express complex wave phenomena

Diffraction,

Interference,

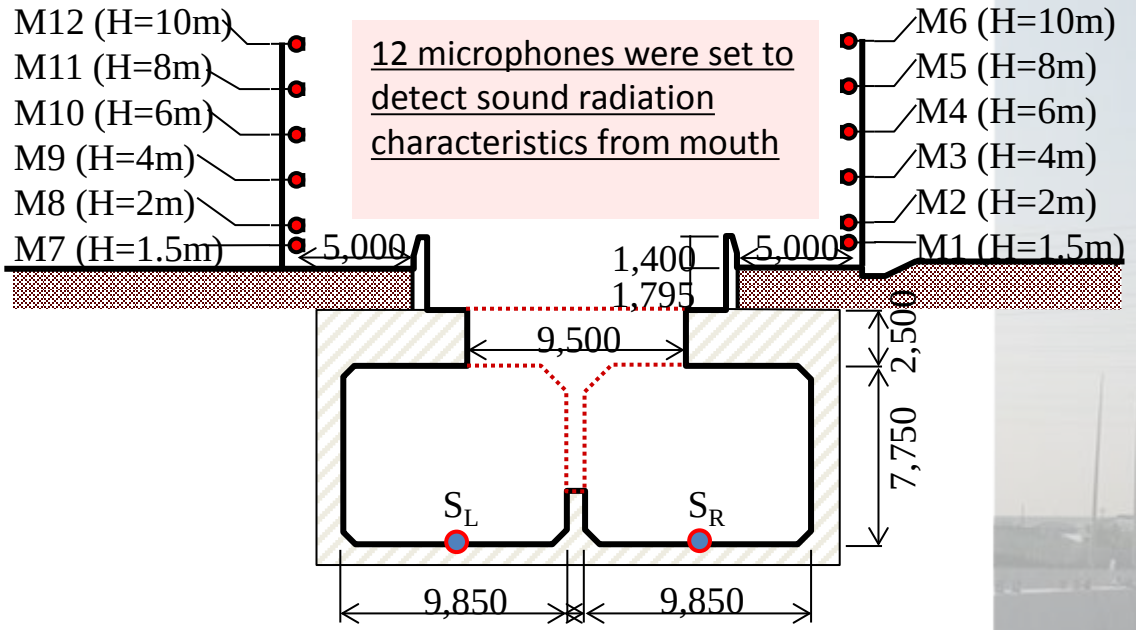
Refraction



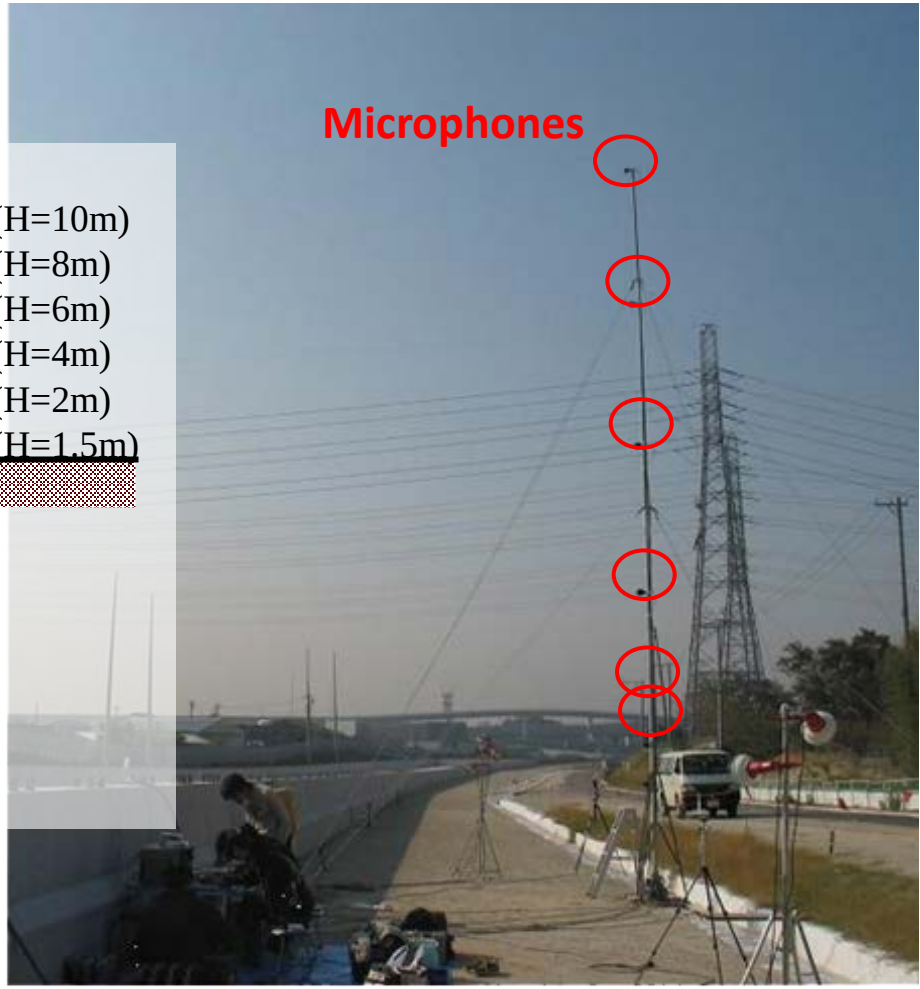


An example of
special road sections
Semi-underground road

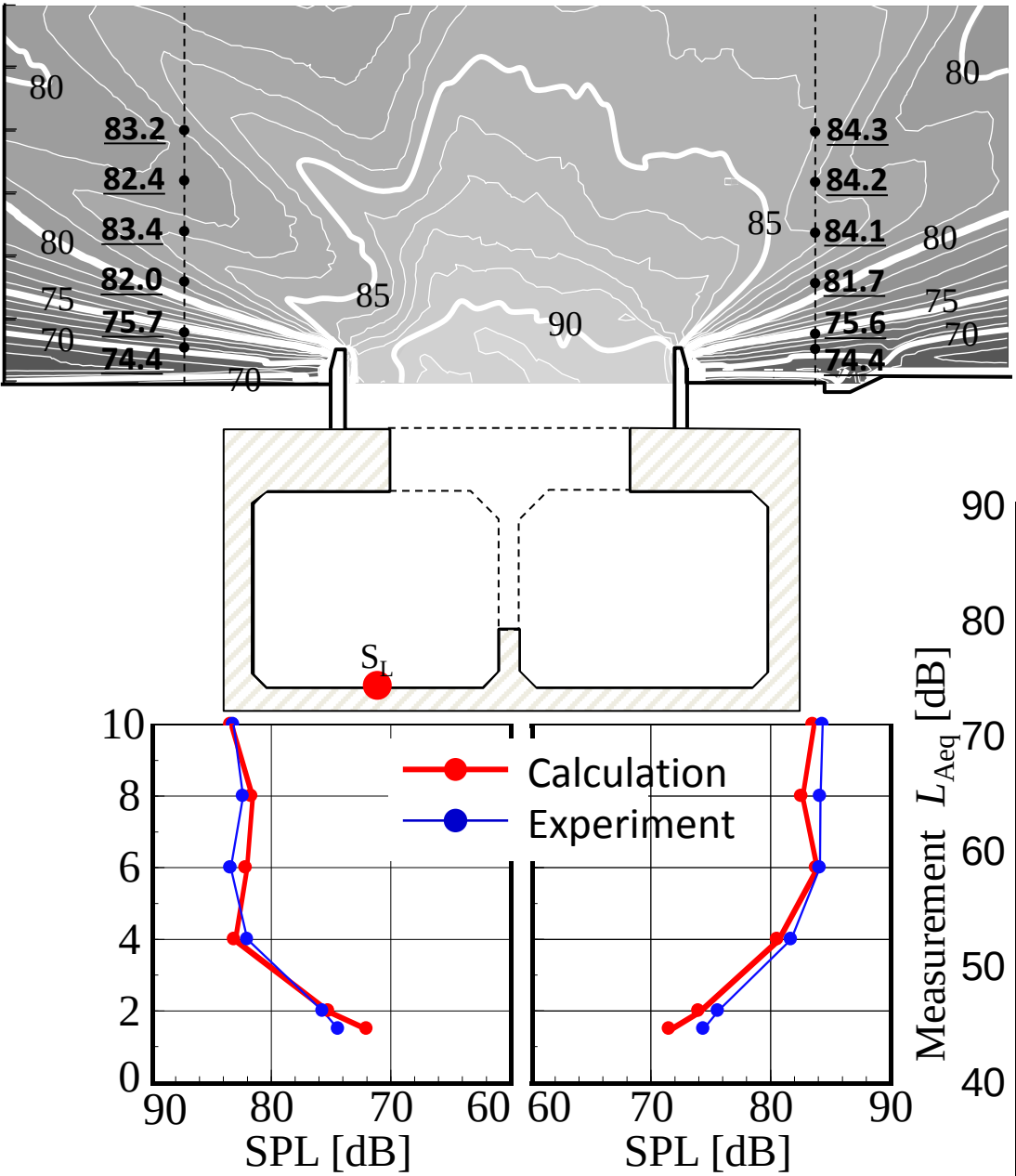
Applied to noise propagation problem



12 microphones were set to detect sound radiation characteristics from mouth

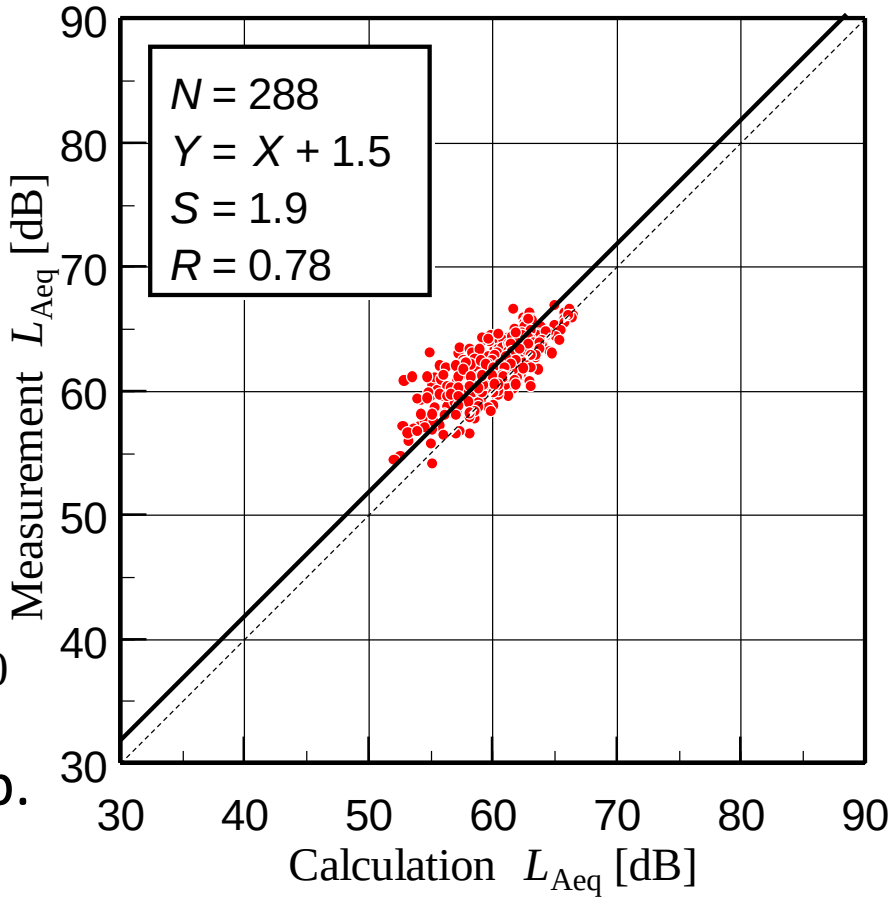


An example of special road sections Semi-underground road



Comparison between Calc. vs Exp.
O.A.(125 Hz – 2 kHz)

Validation for real road structures

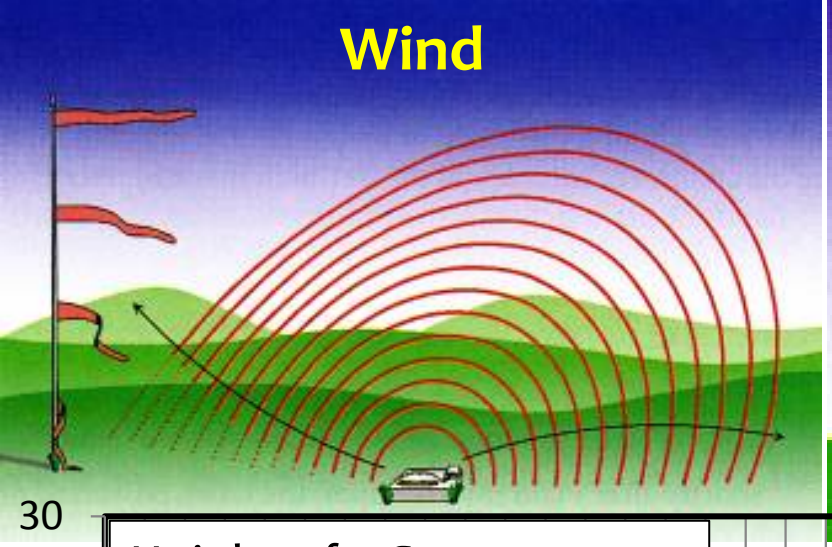


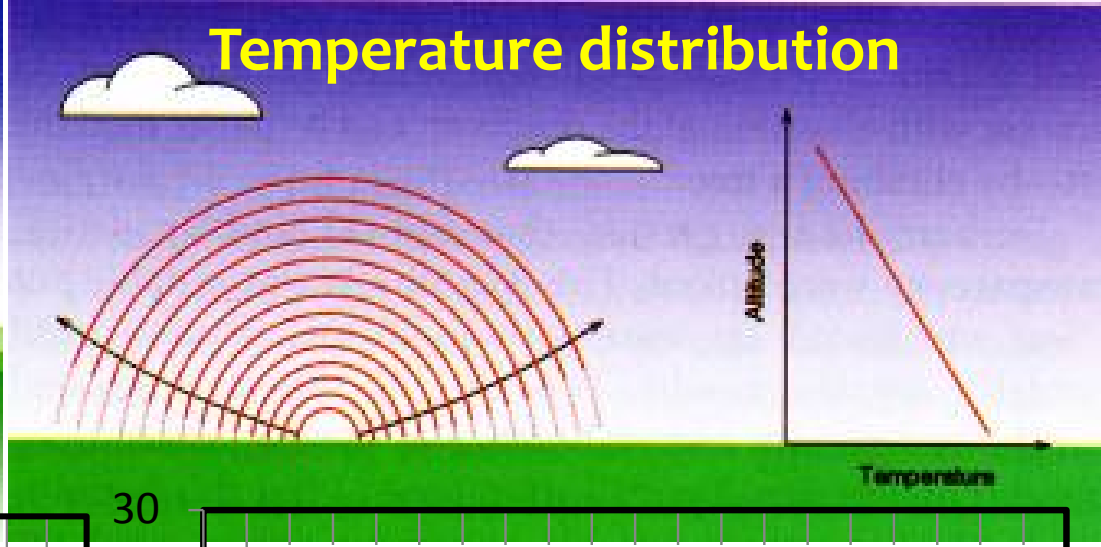
Remaining future work

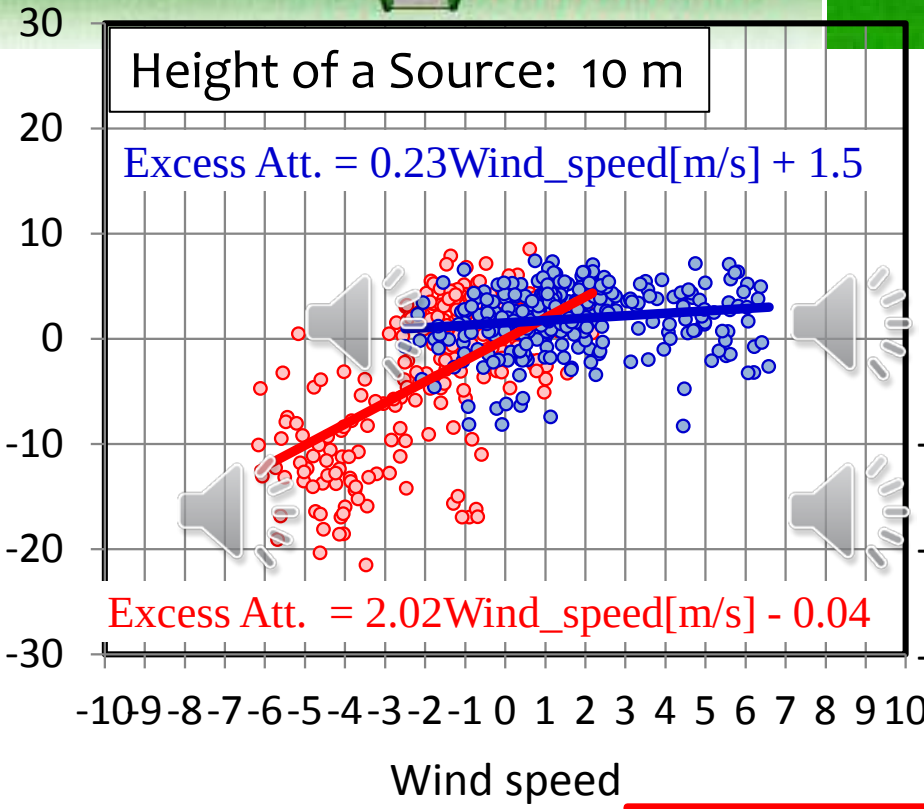
Meteorological effect influences fluctuation of noise level

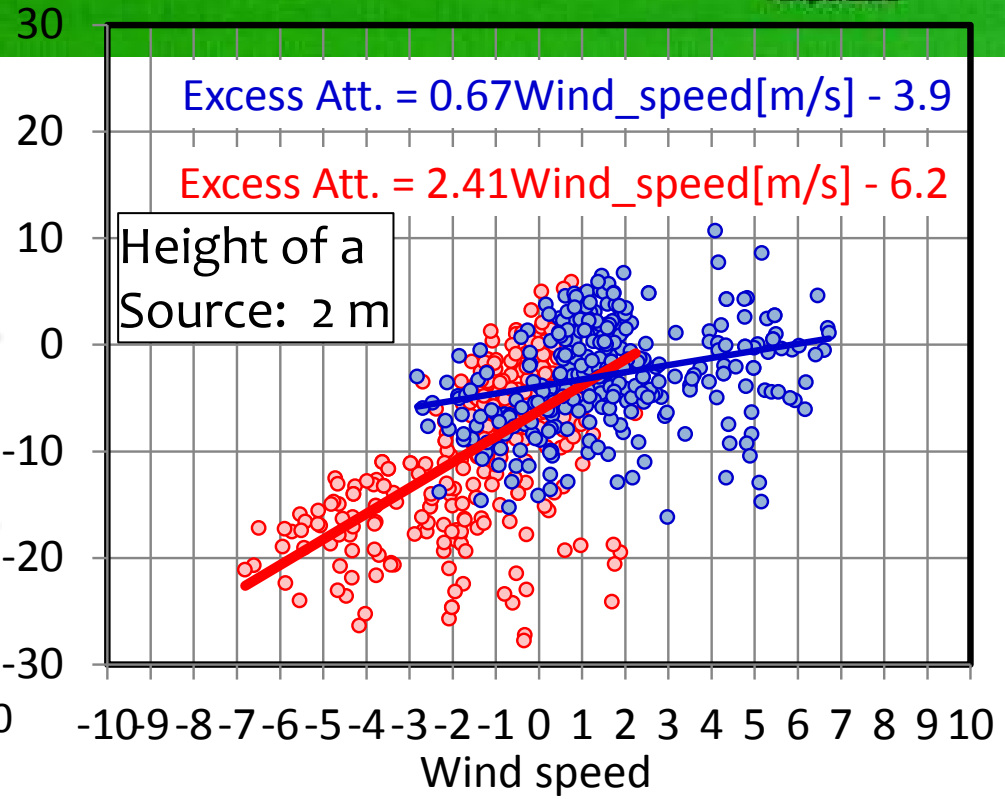
Development of accurate model taking the effect into account is important.

2013.7.9-17 Field experiment on long range outdoor sound propagation









Excess attenuation vs wind speed

How estimate? What is evaluated?
Average enough? or variation how do we think?

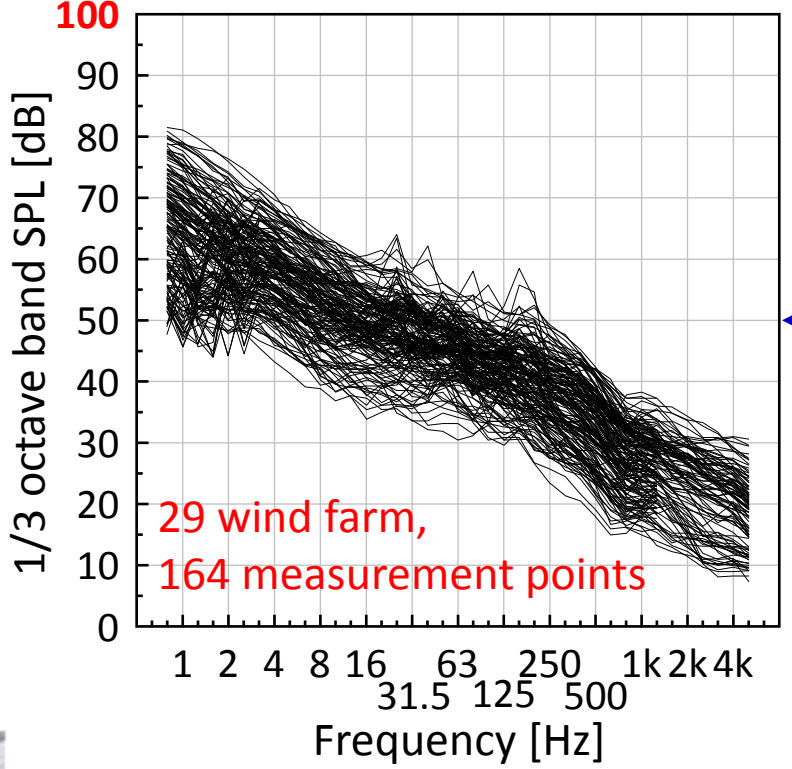
Estimate psycho-acoustical effect of environmental noise

WIND TURBINE NOISE
(Recent environmental noise issue)

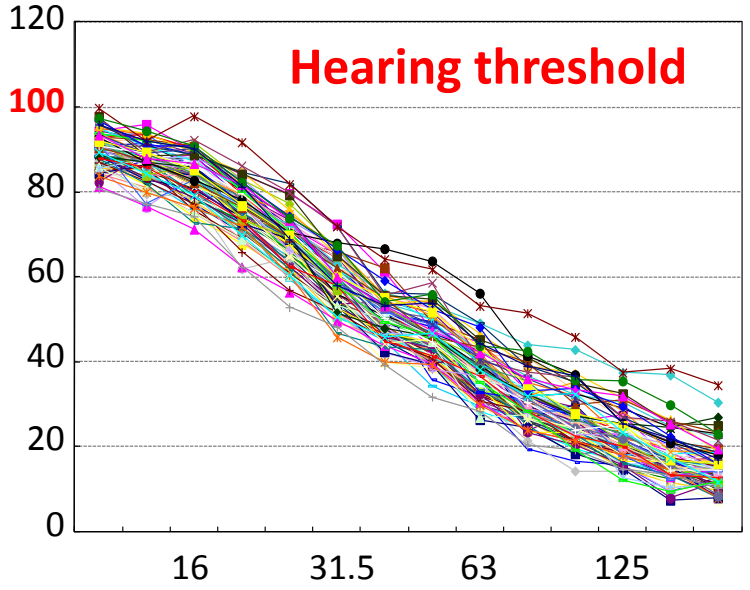
Constructing wind turbine generators was subject to Environmental Impact Assessment Law (2012.10-)

Method of assessment ???
Area and points
Evaluation criteria
Time span, periods, and *etc.*


Field measurement


100
90
80
70
60
50
40
30
20
10
0
1/3 octave band SPL [dB]
29 wind farm,
164 measurement points
1 2 4 8 16 31.5 63 125 250 500 1k 2k 4k
Frequency [Hz]


Psycho-acoustical experiment
16 woofers +
1 loudspeaker
Suspended floor finished with thin carpet


120
100
80
60
40
20
0
Hearing threshold
16
31.5
63
125

Infrasound components included in the wind turbine noise (WTN) may not be audible.

But Low and middle frequency components included in the wind turbine noise are surely audible. (Serious problem)

Then, the infrasound component included in WTN surely does not influence human health? (Difficult problem to be solved)

Problem by multimodal perception

Aural

Visual

How can we investigate the effect properly
Is investigating with engineers enough?
Is collaboration with medical field necessary?

Summary

Various sources・・・・, for example

Sound

Noise

Annoyance???
Quality of environment???

Generation

Propagation

Criteria ⇔ effect

loudness

Human life

Generation

Wave theory

Propagation

Geometrical acoustics

Criteria effect