

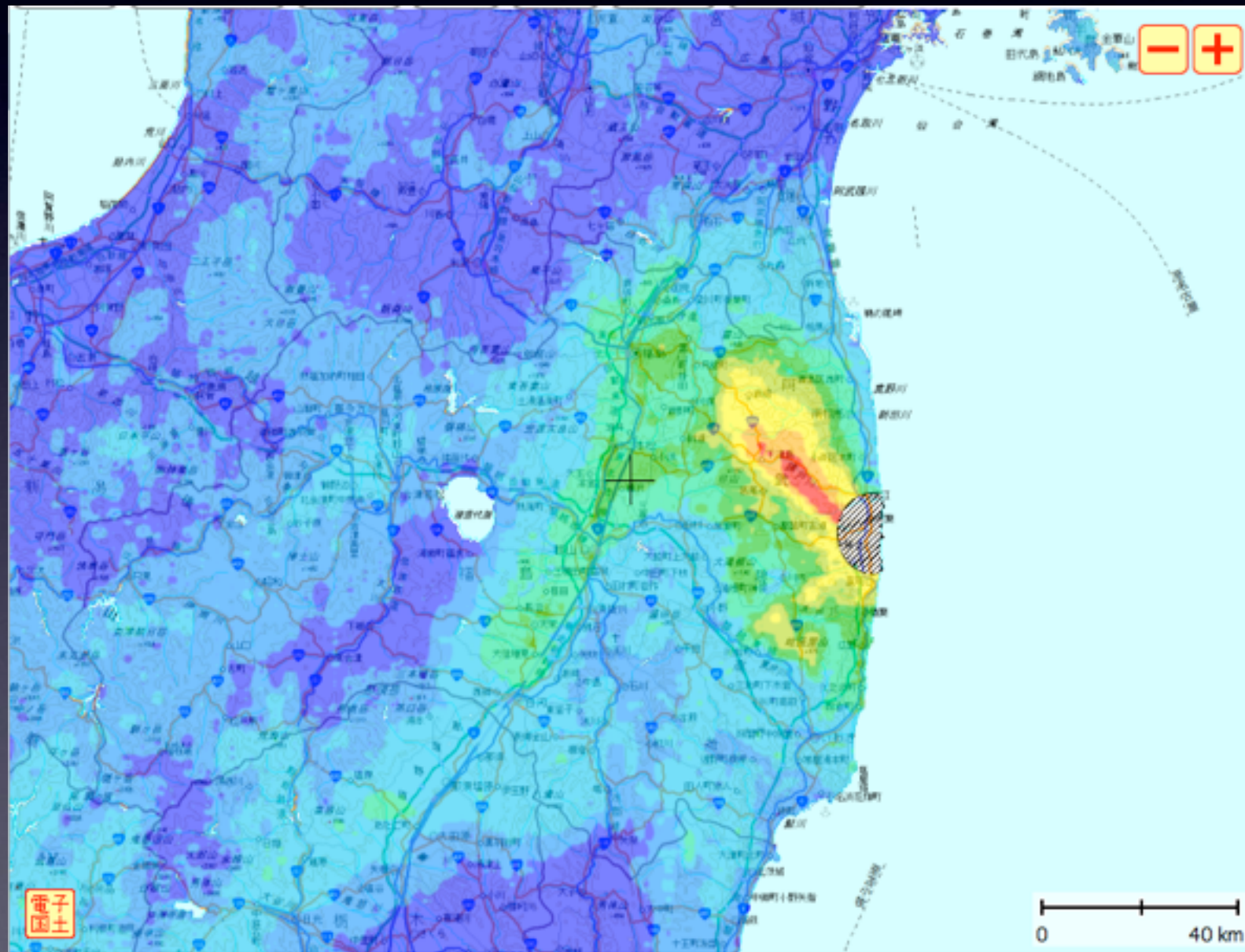
Development of a Car-borne Survey System, KURAMA

Minoru Tanigaki
Research Reactor Institute, Kyoto University

Backgrounds

Nuclear Disaster

Radiation Map is Essential

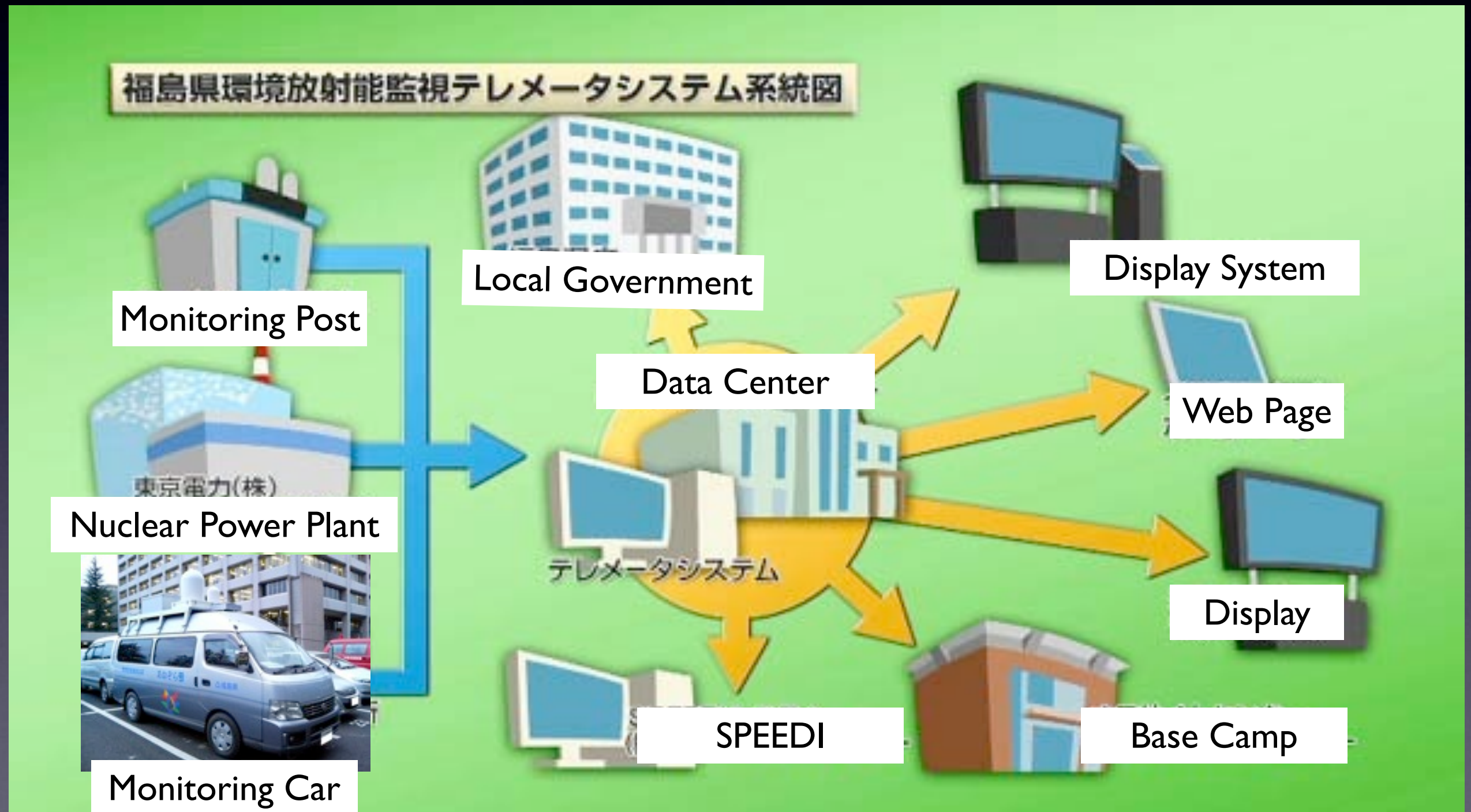


- Contamination
- Exposure Dose
- Evacuation
- Decontamination

(taken from <http://ramap.jaea.go.jp/map/map.html>)

Monitoring Scheme in Fukushima

Based on an Exclusive Network

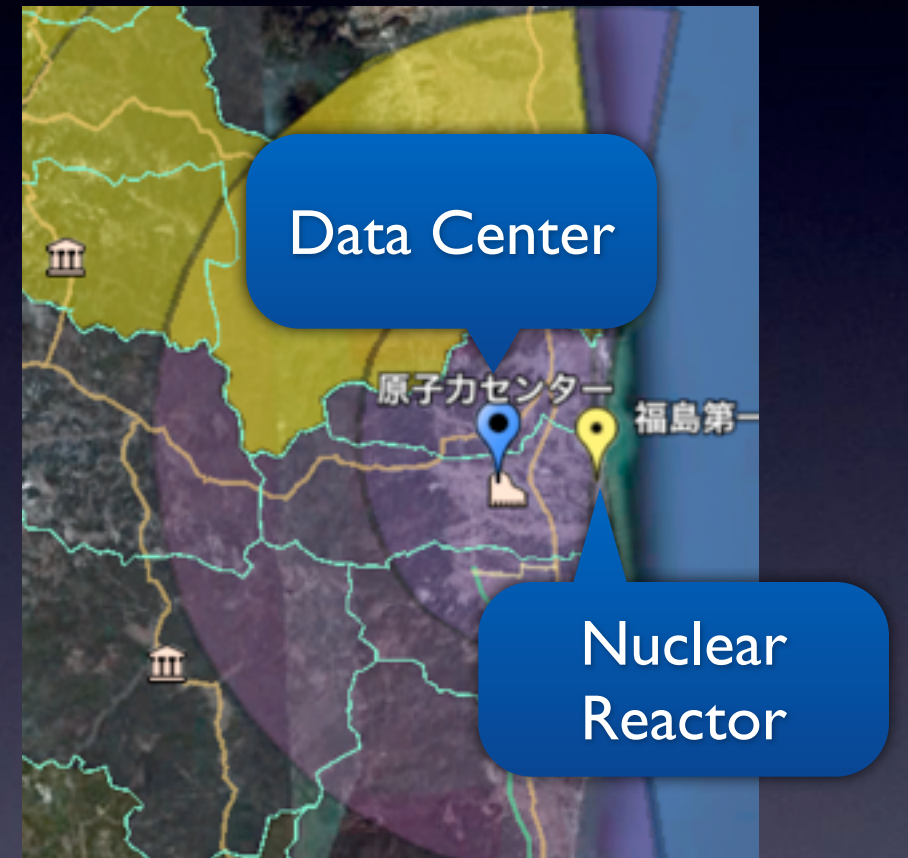
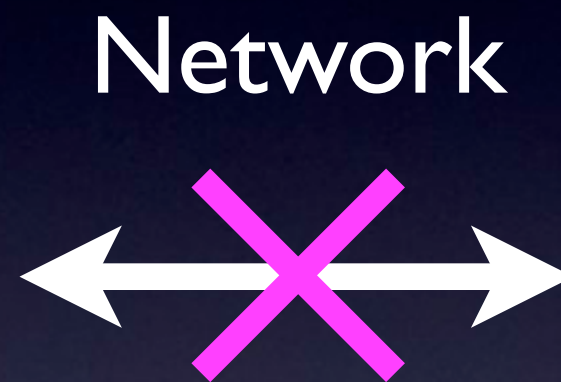


Nuclear Accident in Fukushima

Critical Damage on Monitoring Scheme



Contaminated
Monitoring Car



Shut Down of Data Center

Monitoring by Human

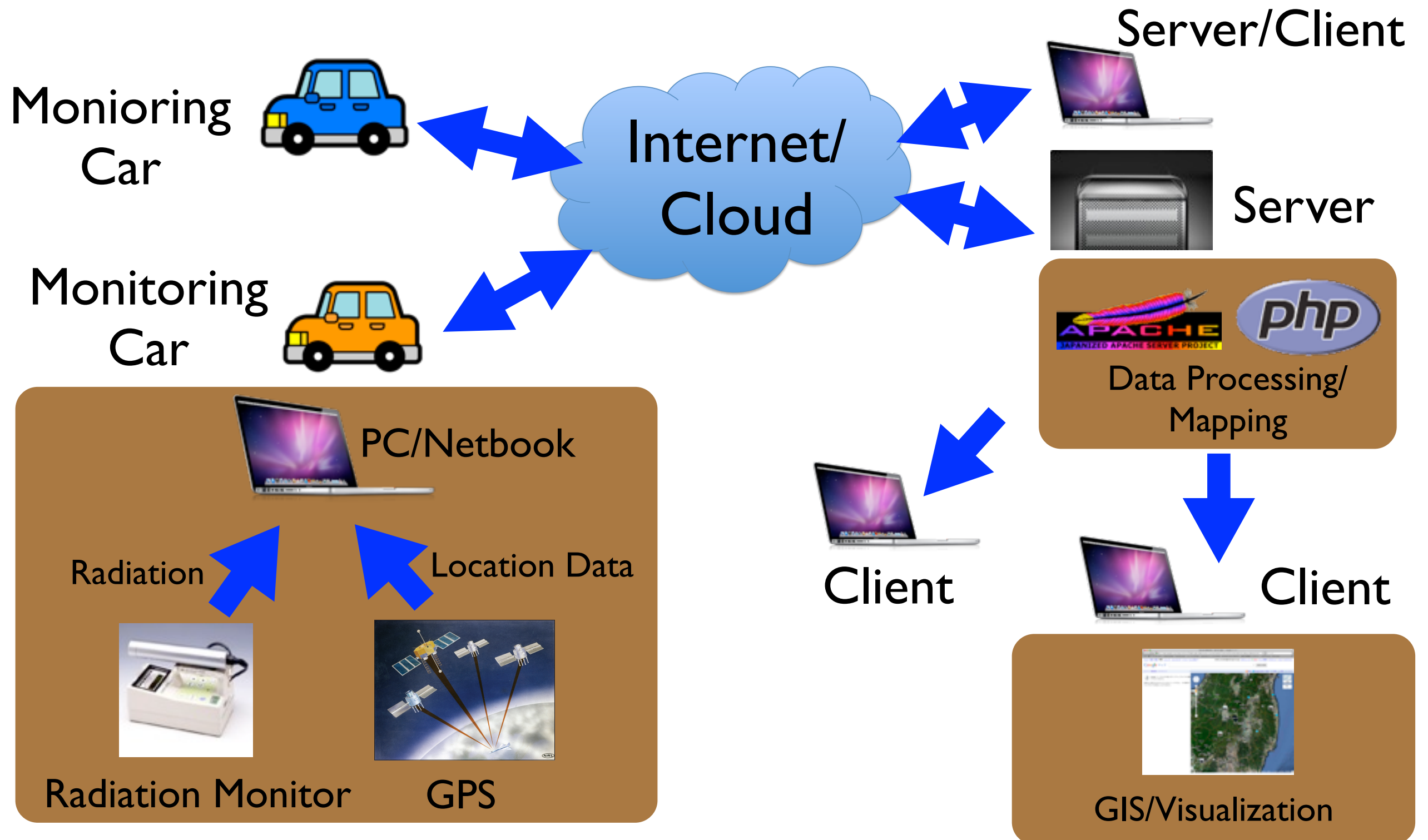
KURAMA

KURAMA

(Kyoto Univ. Radiation Mapping System)

- Mapping Quickly, Precisely, in Wide Area
- No Special Monitoring Car
- Realtime Data Sharing
- Realtime Visualization

System Configuration



In-vehicle Part

Measure, Store, Transmit Air Dose Rate

MAKUNOUCHI
(Interface Box)

W-CDMA
Mobile Router

Survey Meter

Laptop PC

GPS



In-vehicle Part

Measure, Store, Transmit Air Dose Rate

MAKUNOUCHI
(Interface Box)

W-CDMA
Mobile Router

Survey Meter

Laptop PC

GPS



KURAMA on a Car

Attatched to
Grip



Data Communication

Poor Coverage by Mobile Network



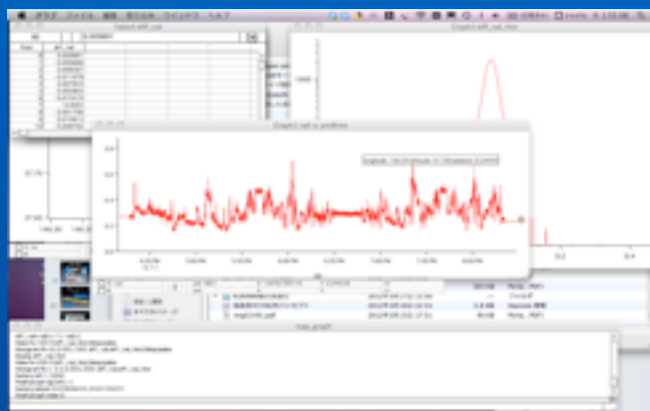
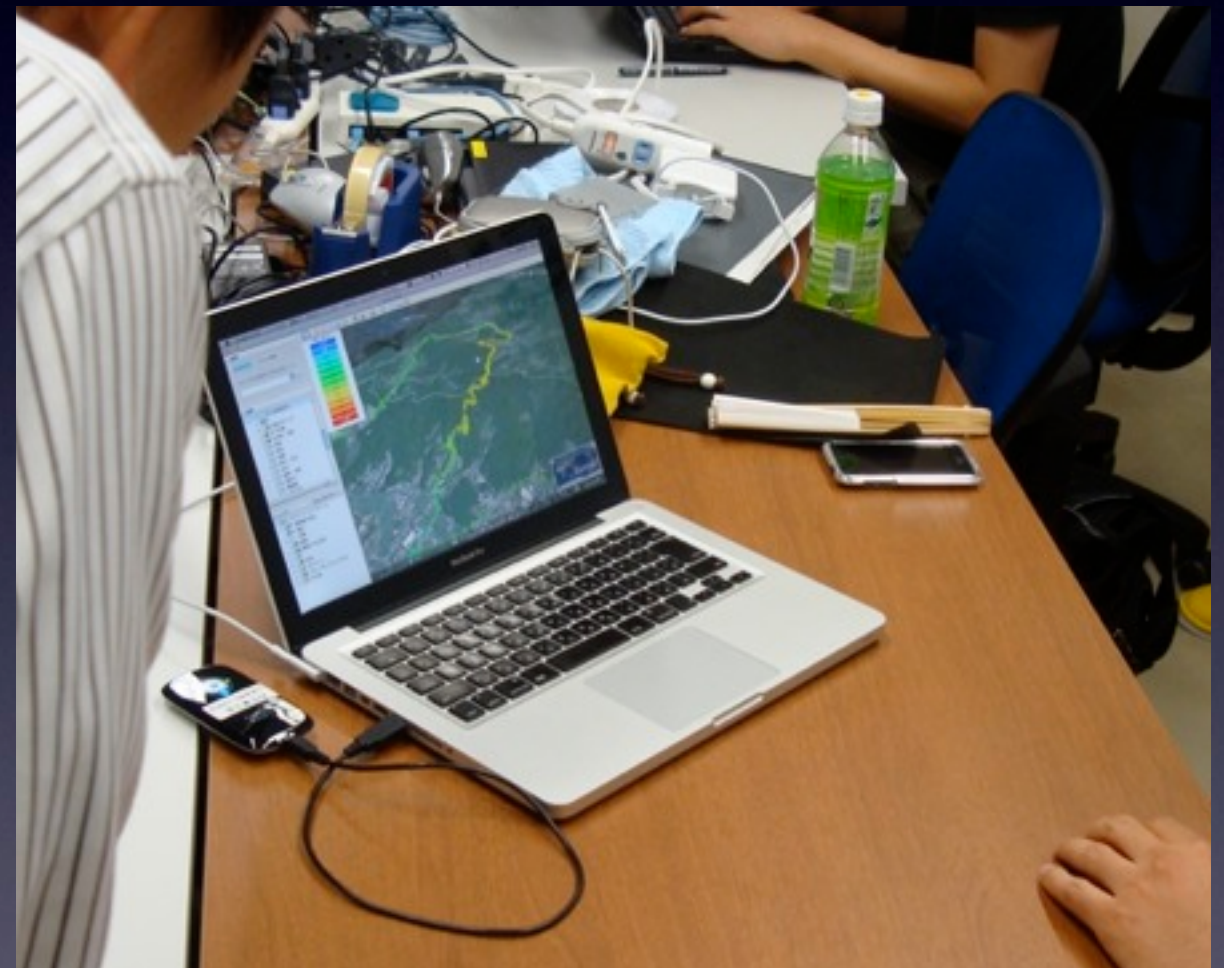
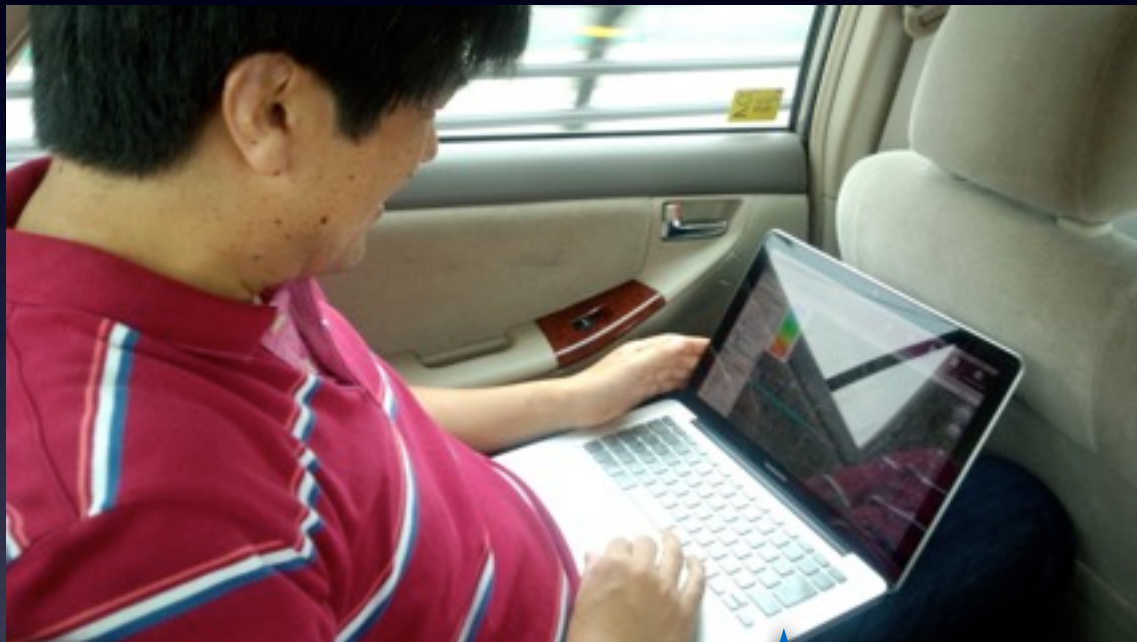
Dropbox

- Frequent Sync
- Sync under Intermittent Connection
- Backup Files Available for One Month
- Available on Various Platforms

Sharing Data Files Updated by In-vehicle PCs

“Data Center”

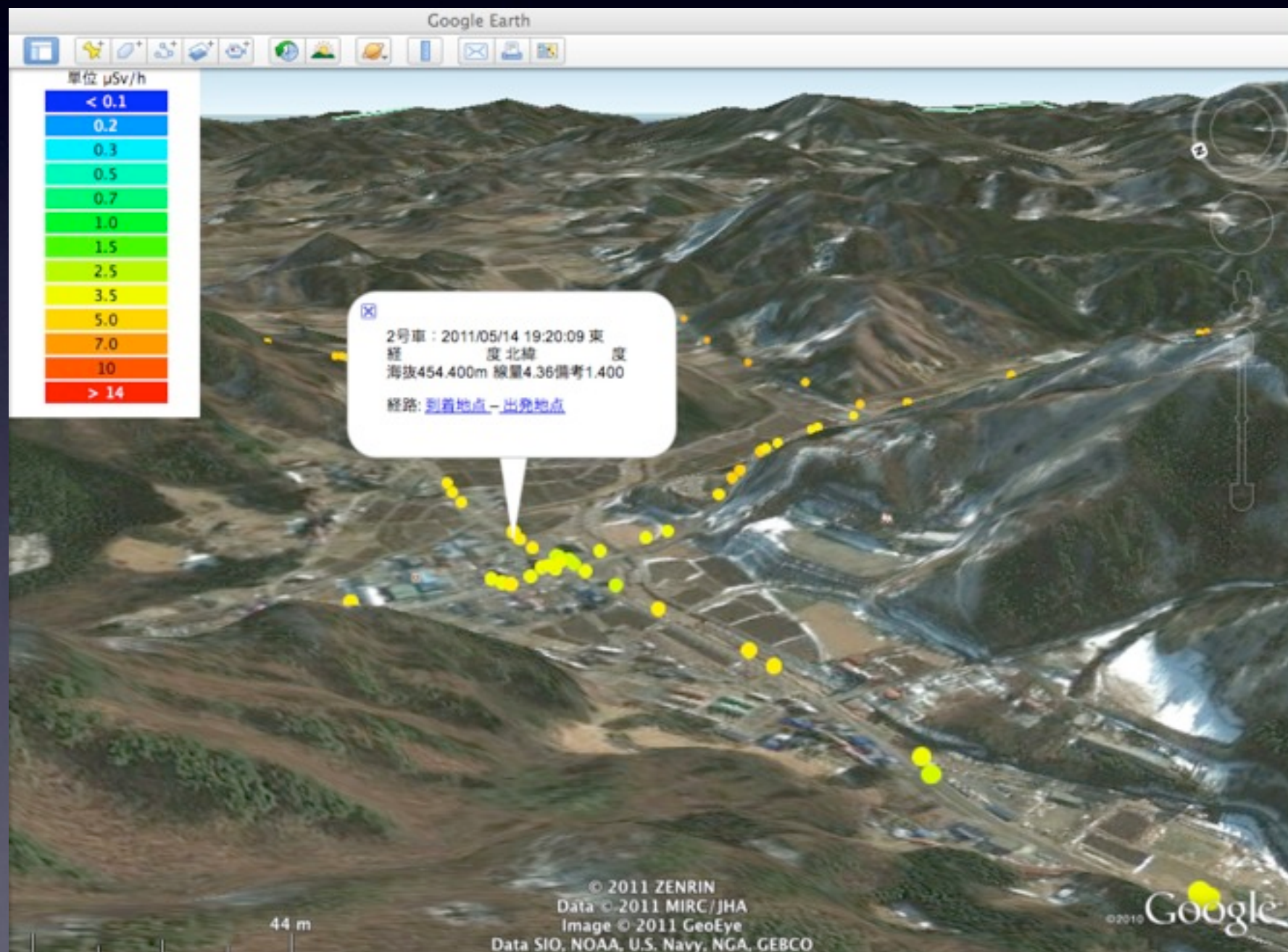
Mobile & Cloud



Detailed Analysis

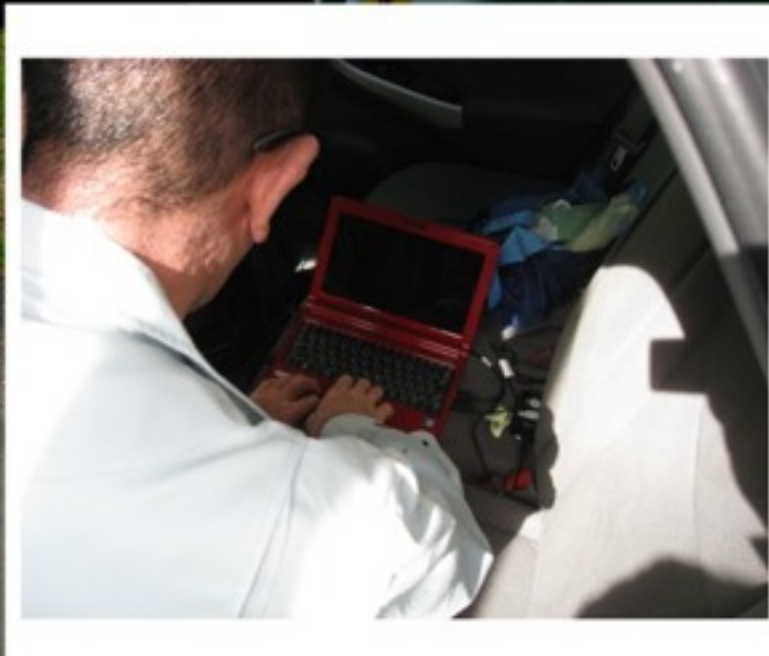
Visualization on Google Earth

Dynamically Generating KML File by Apache & PHP



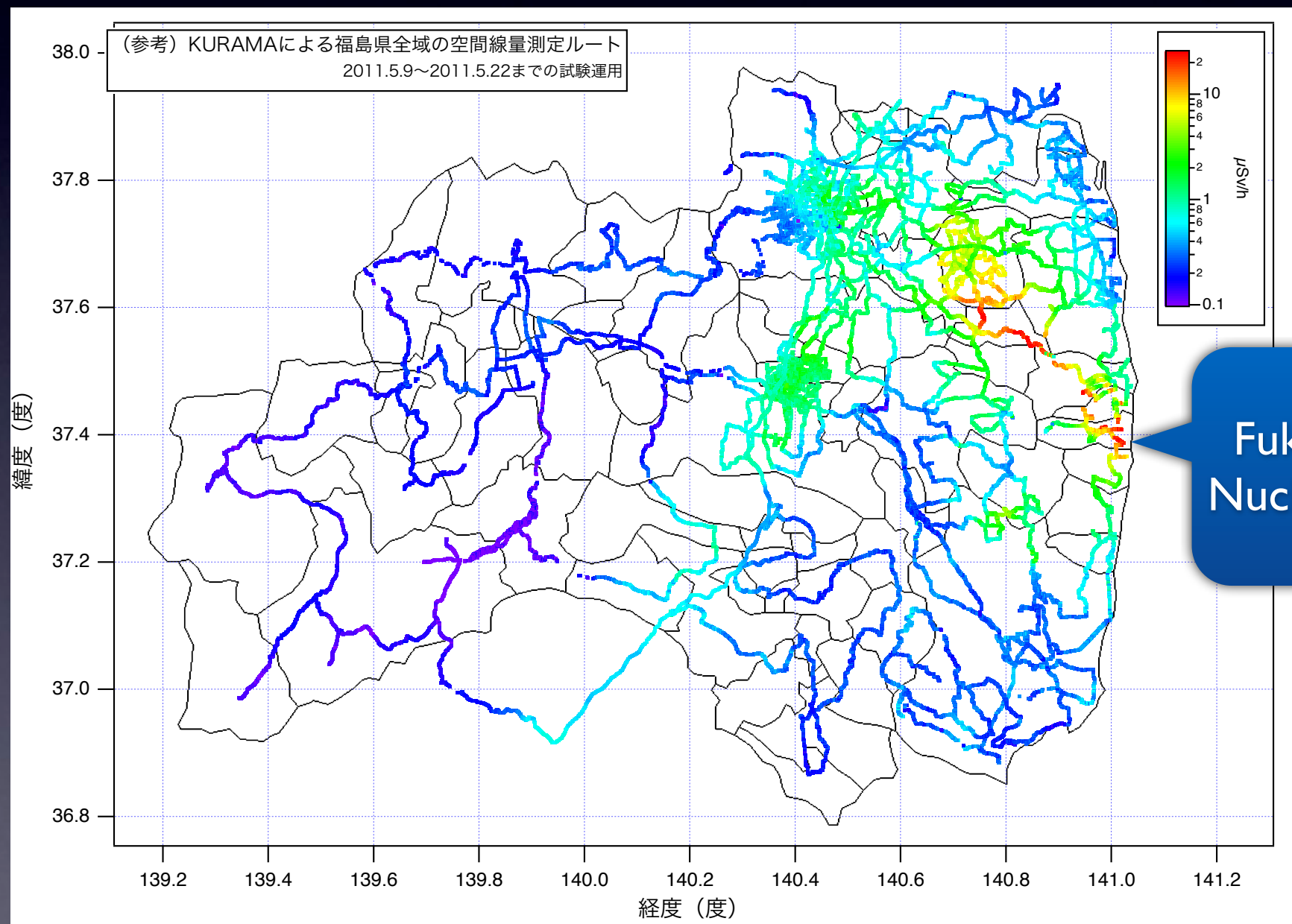
Field Test with Fukushima Prefecture

Driving around 20,000 km for Two Weeks



Result

Confirming Usability, Establishing Procedure,
Finding Problem

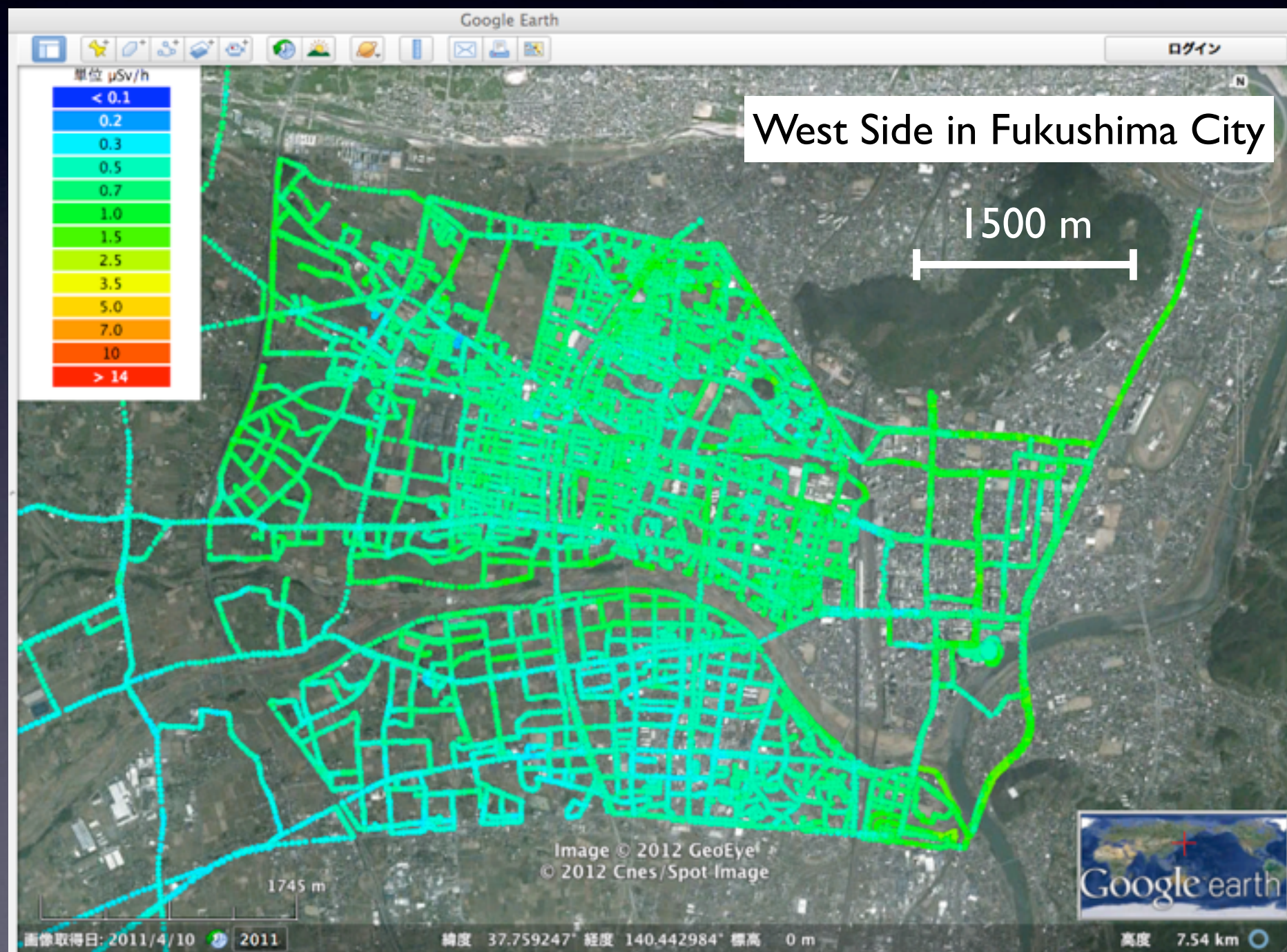


Fukushima Daiichi
Nuclear Power Plant

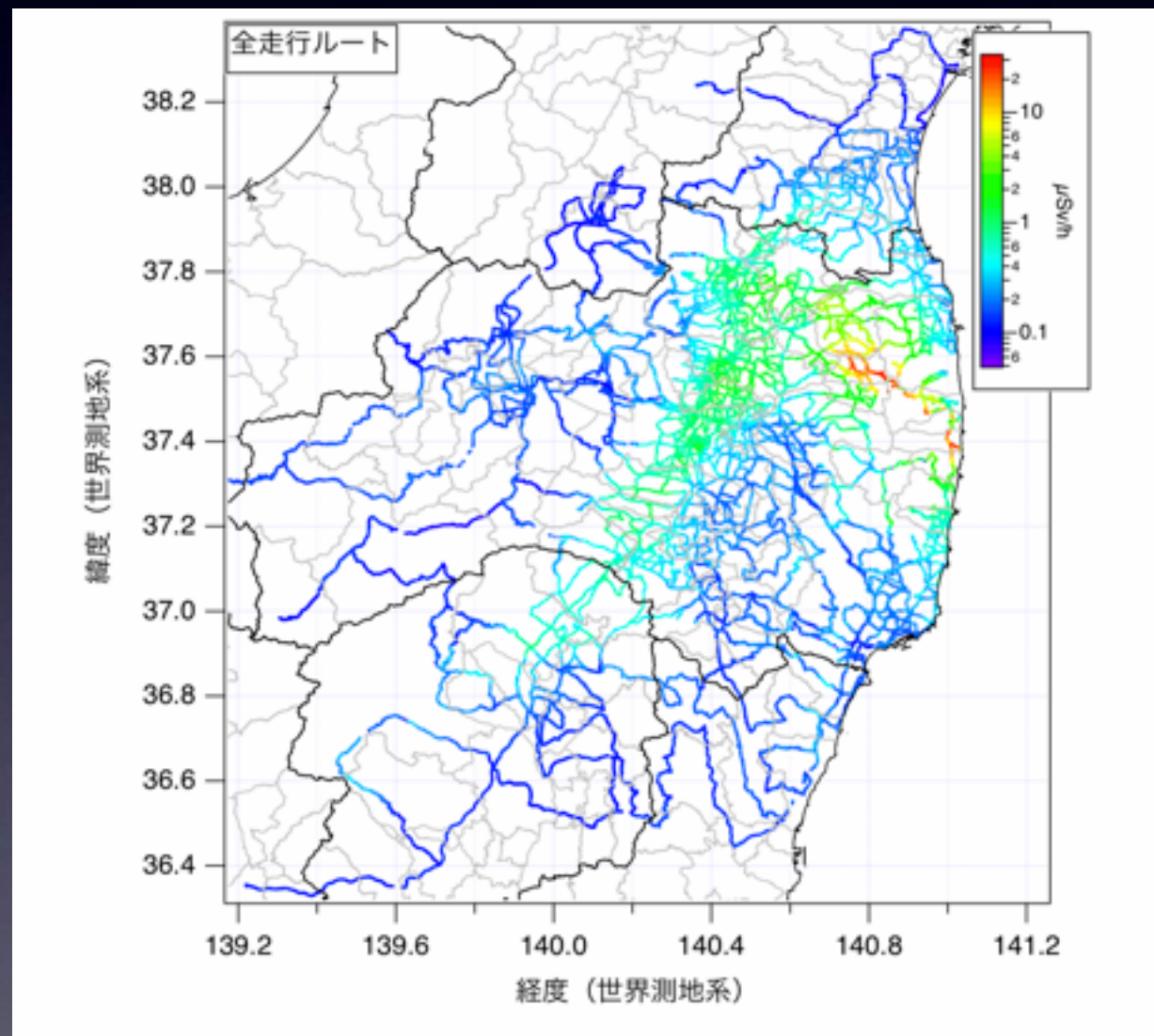
Fukushima Prefecture

Precise Mapping for Every Municipality

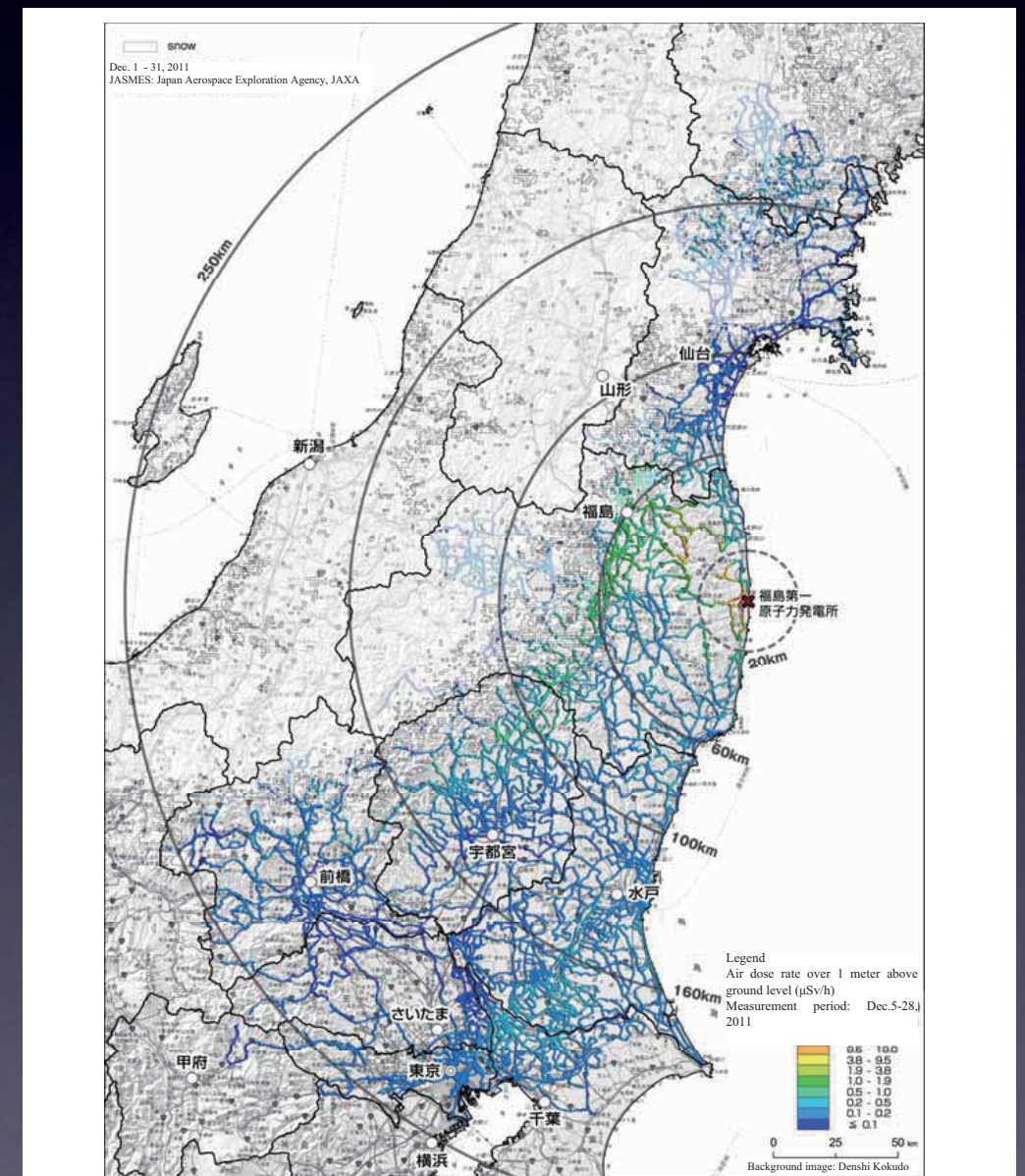
<http://www.pref.fukushima.jp/j/soukoukekka.htm>



Ministry of Education, Culture, Sports, Science & Technology (MEXT)



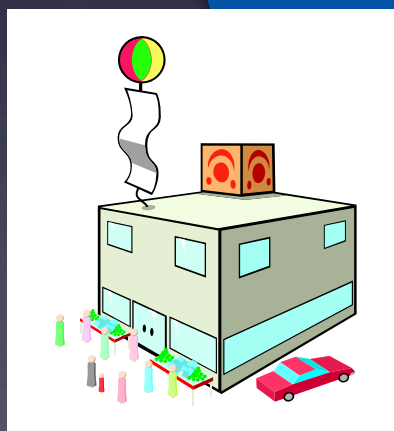
First : June 2011



Second : Dec. 2011

KURAMA-II

If KURAMA Becomes Small & Autonomous...

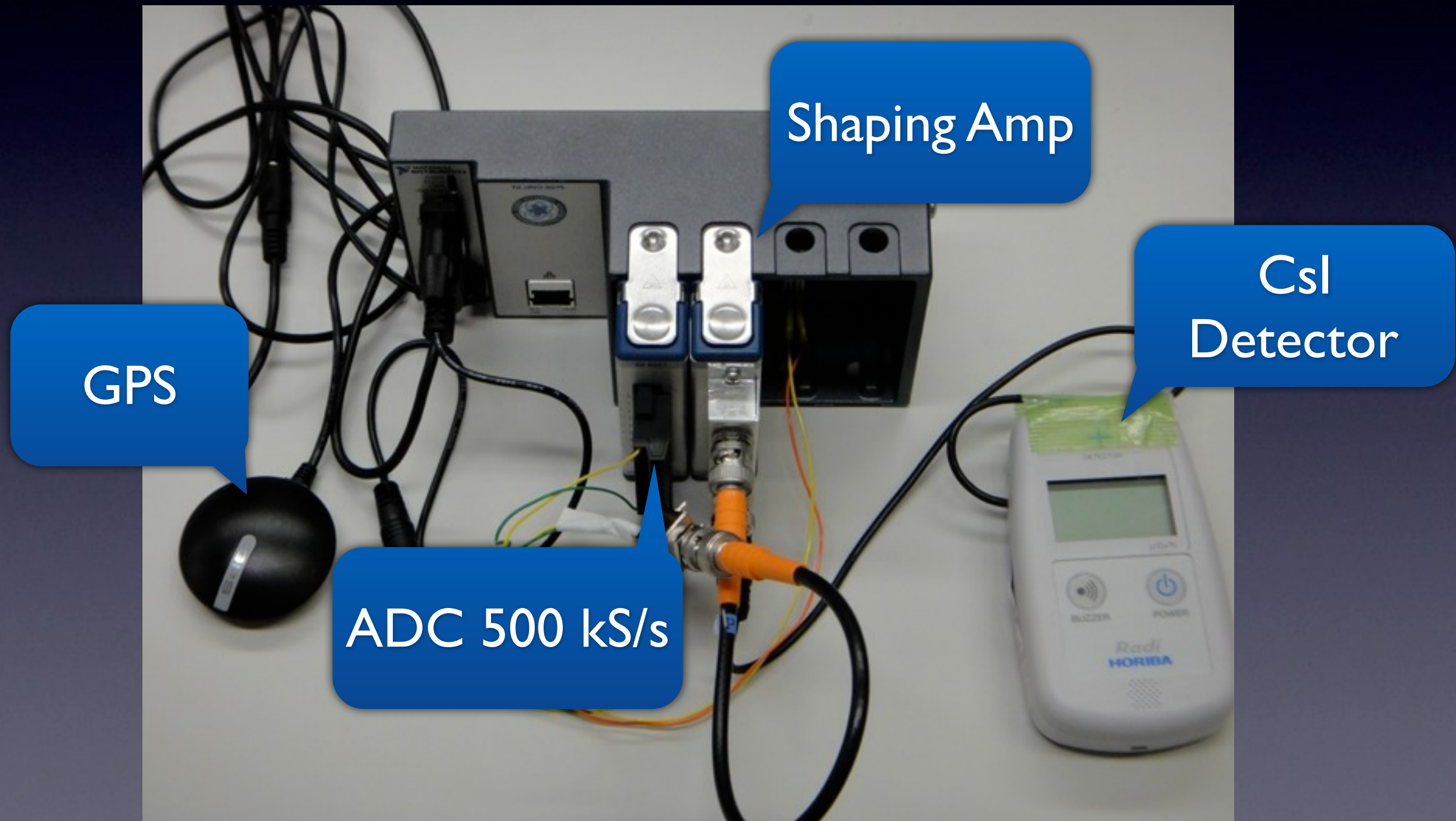


Living Area

Continuous Monitoring in Living Area by Buses, Bikes etc.

Prototype of KURAMA-II

NI CompactRIO & FPGA Programming



Hamamatsu C12137

Compact, USB-bus Powered CsI Detector



C12137 (3.4 cc)



C12137-01 (36 cc)

KURAMA-II

NI CompactRIO & Hamamatsu C12137



Palmtop Size!!

KURAMA-II

Placing inside a Toolbox for Handling



34.5cm×17.5cm×19.5cm

KURAMA-II on City Bus

In Cooperation with Fukushima Kotsu Co. Ltd.



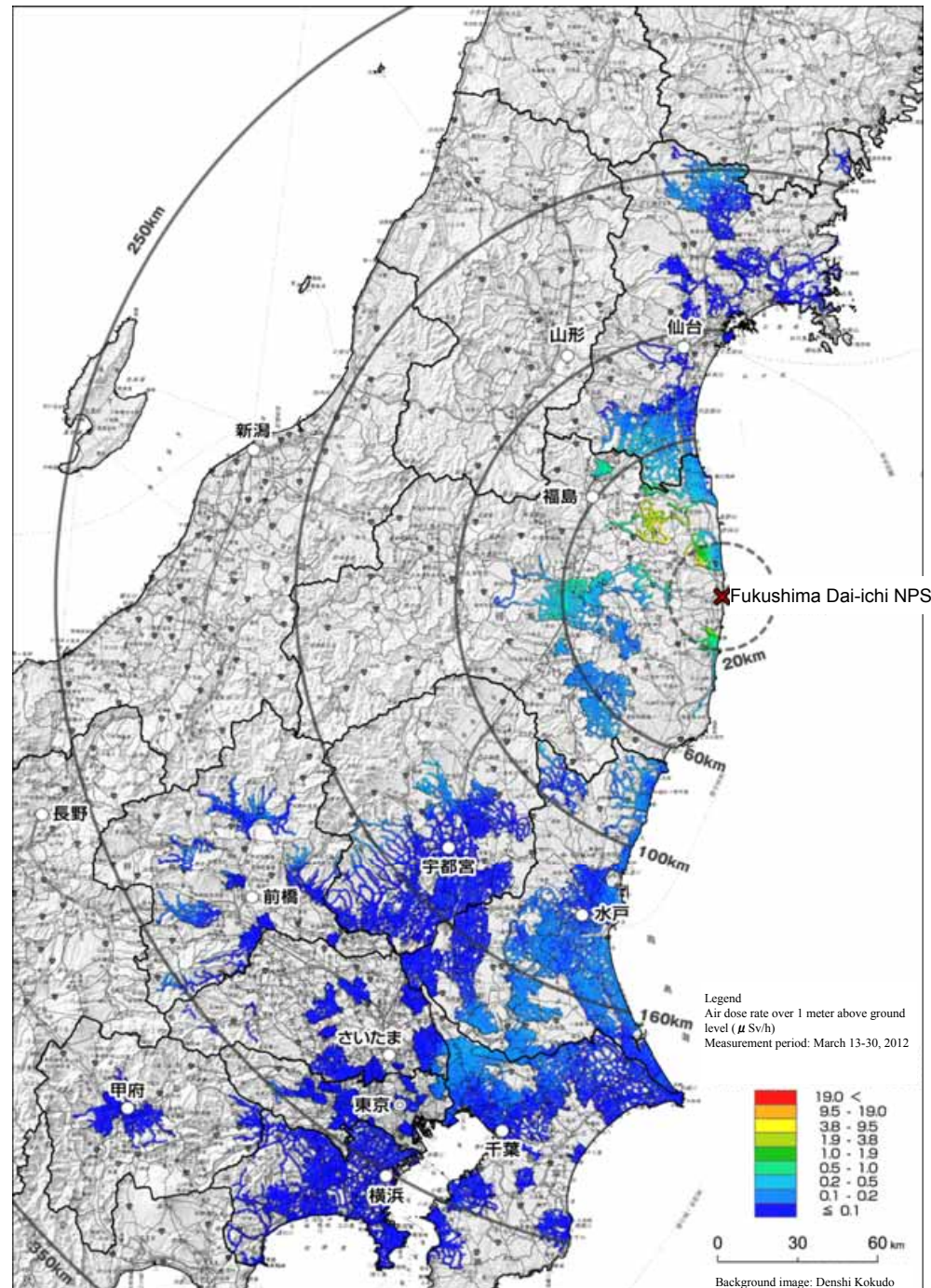
Field Test on a City Bus

Field Test in Progress since Dec. 2011



Third Measurement by MEXT in March 2012

100 KURAMA-II Operated
in Eastern Japan

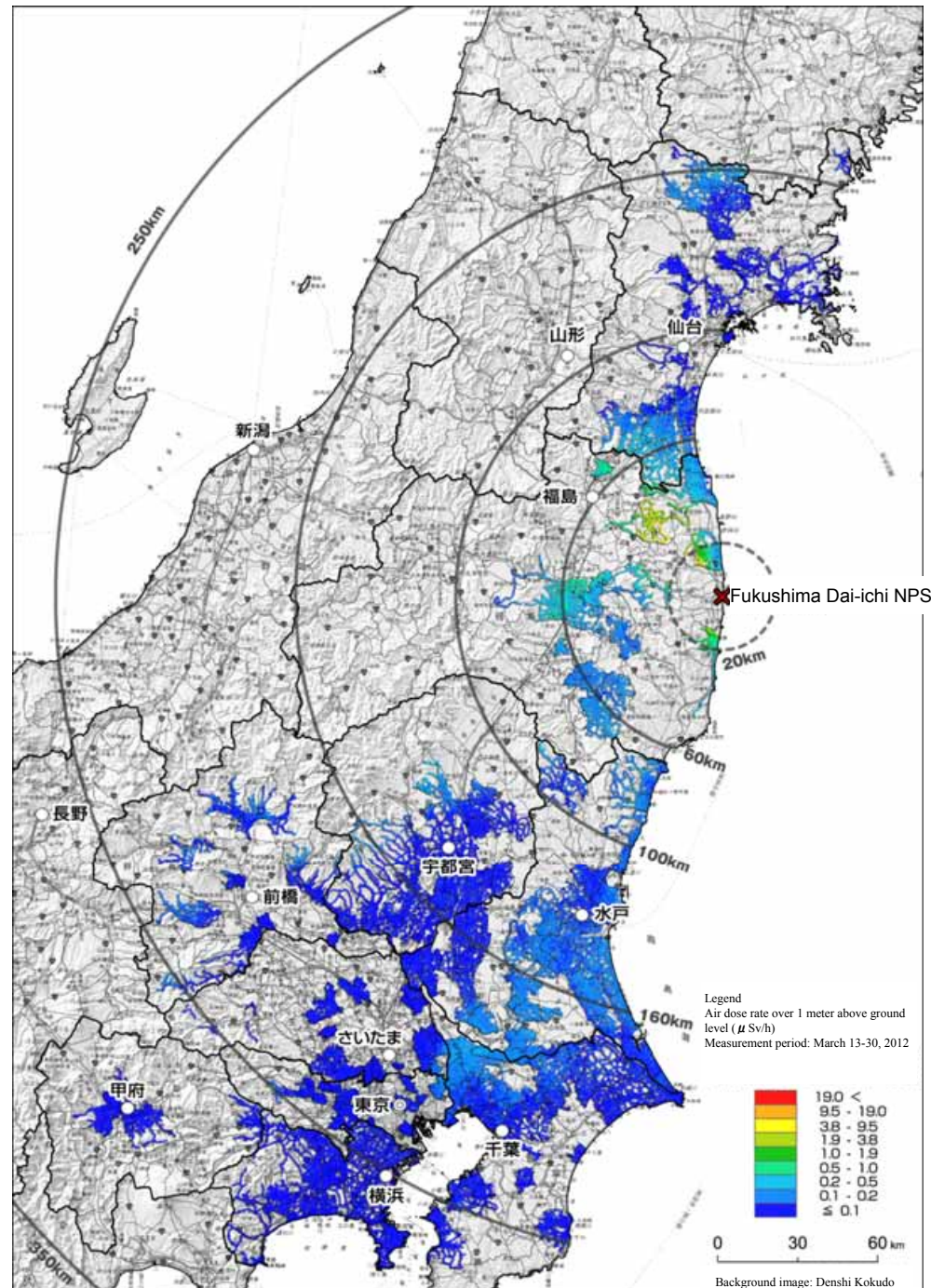


※This map includes air dose rates due to natural radionuclides.

Third Measurement by MEXT in March 2012

100 KURAMA-II Operated
in Eastern Japan

Scalability Proven



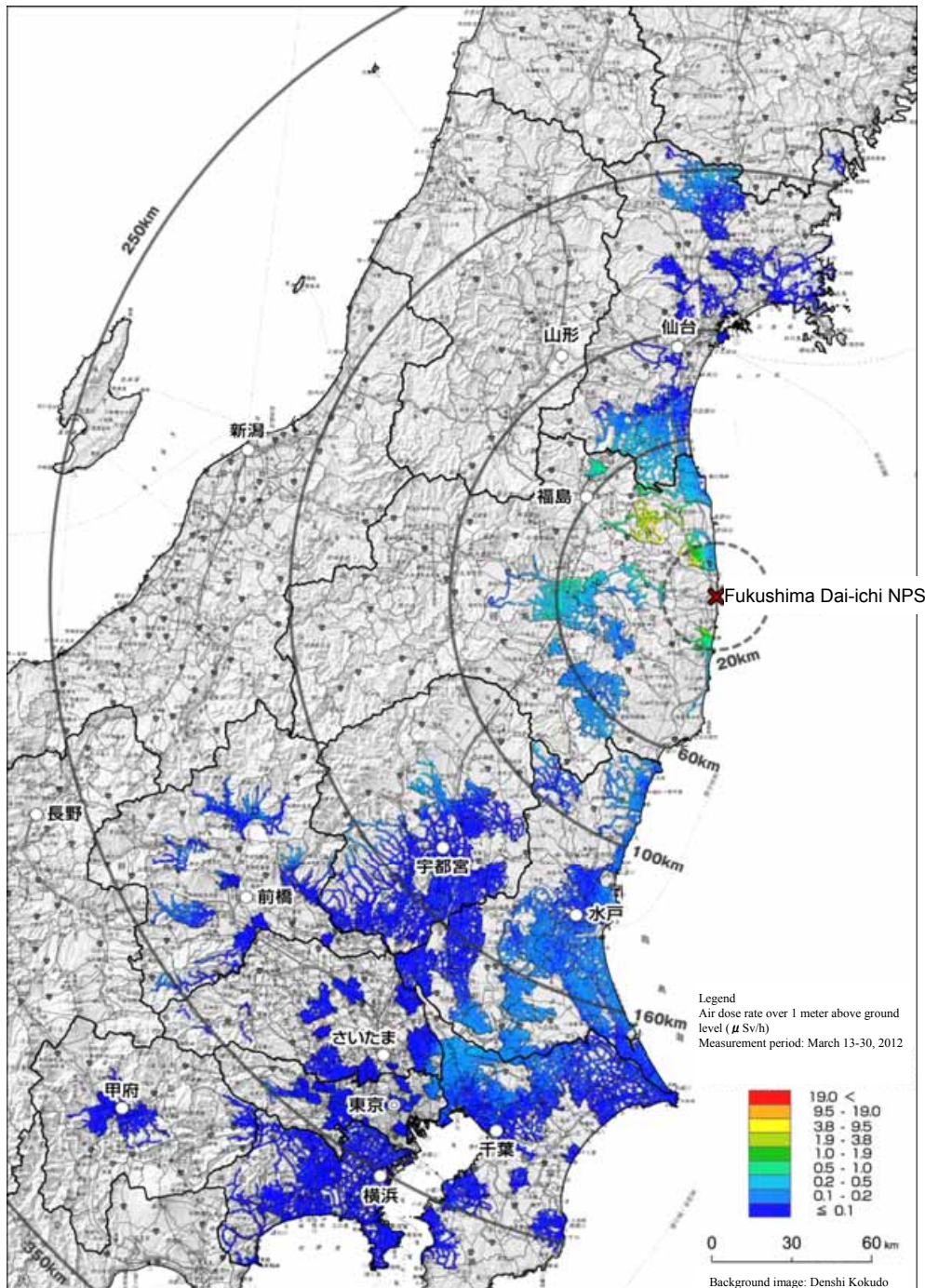
※This map includes air dose rates due to natural radionuclides.

Third Measurement by MEXT in March 2012

100 KURAMA-II Operated
in Eastern Japan

Scalability Proven

Fourth(Finished) Aug. 2012
Fifth(in progress)



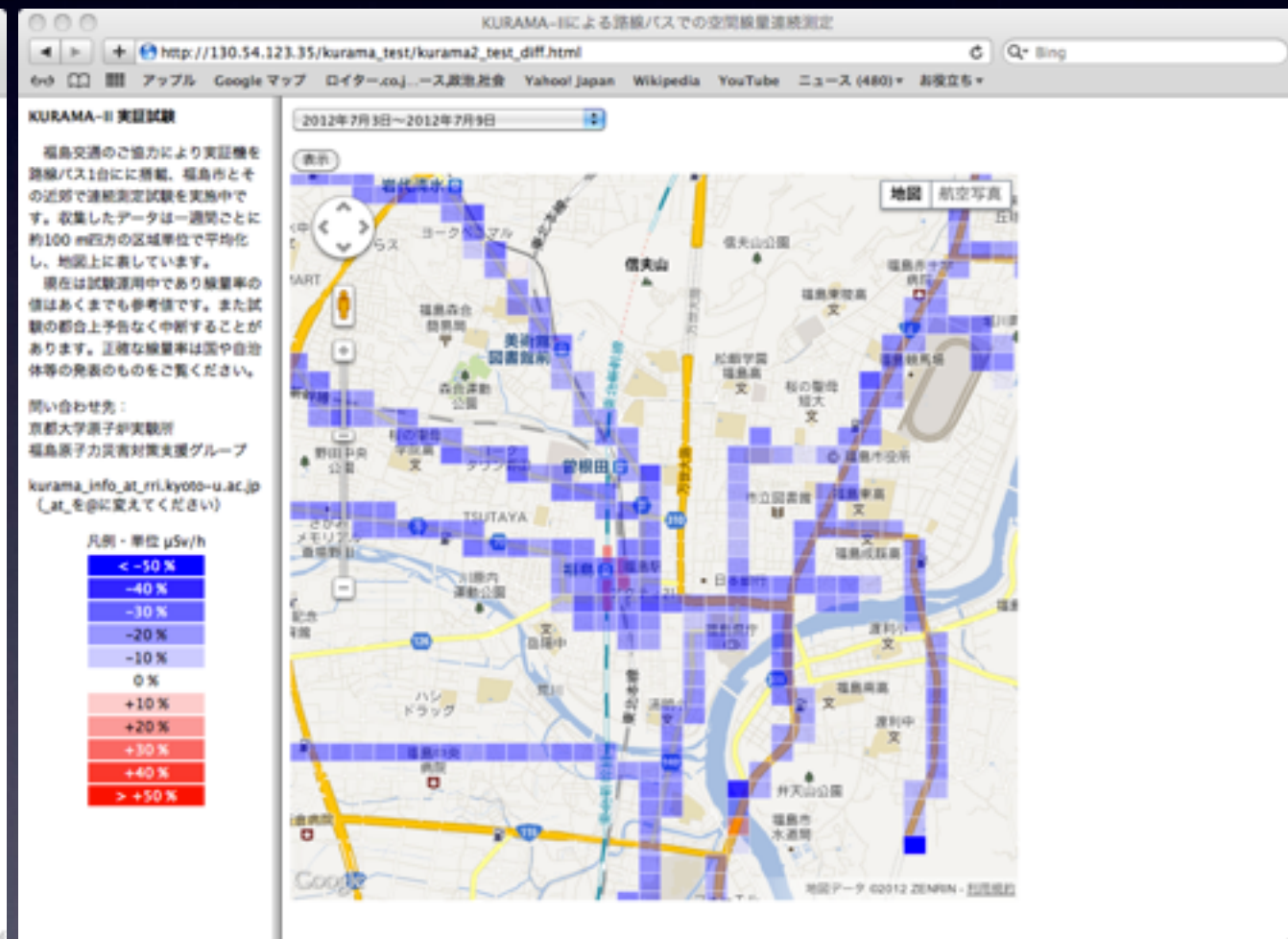
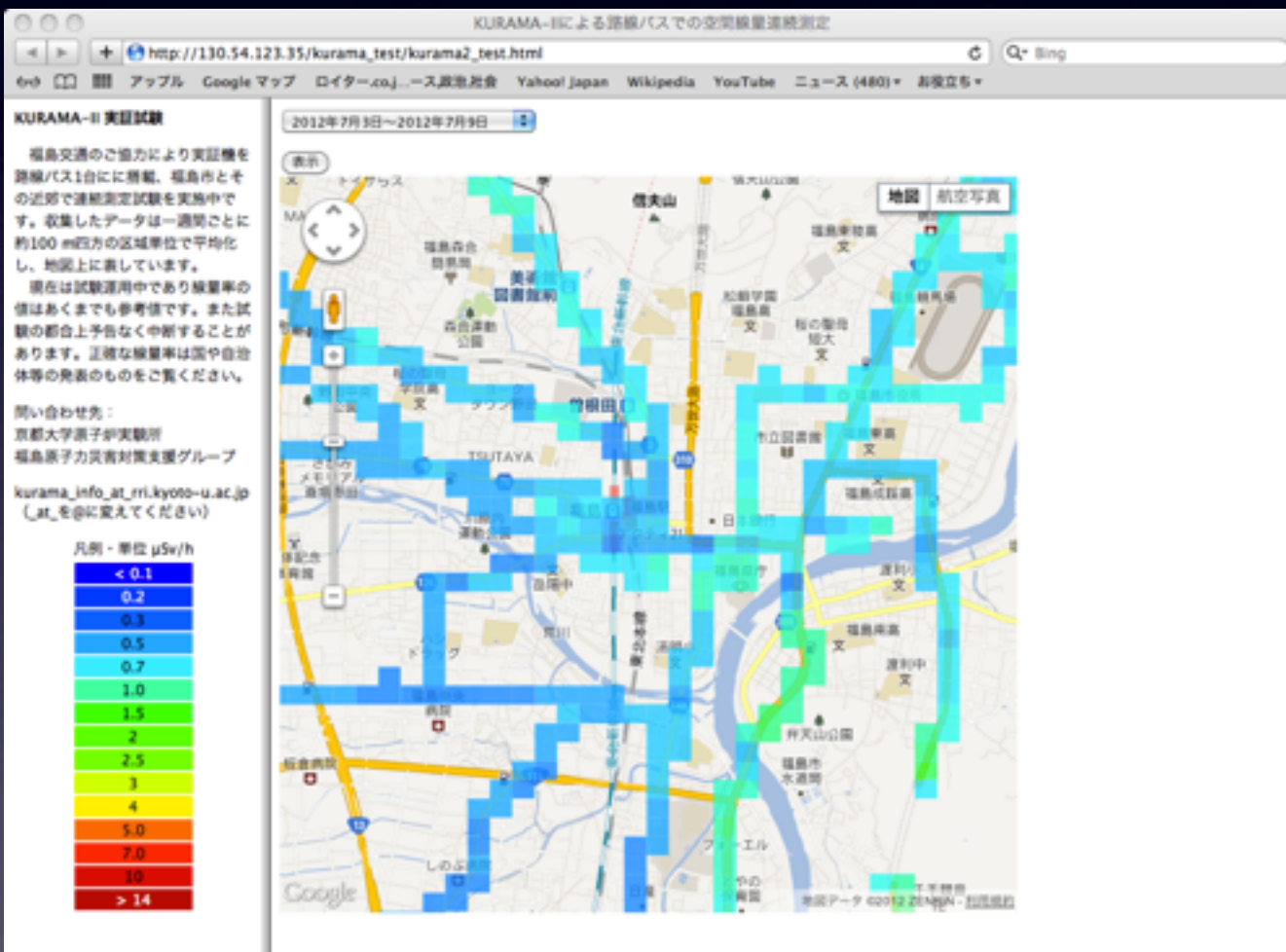
※This map includes air dose rates due to natural radionuclides.

To the Public

Ready for Smart Phone

Radiation

Attenuation Rate



Future KURAMA & KURAMA-II



Bike



on Foot

KURAMA-II on Bike

CI2I37
(Height : 1 m)



KURAMA-II on Bike

CI2I37
(Height : 1 m)



CI2I37



cRIO-9076

KURAMA on Foot

With Differential GPS

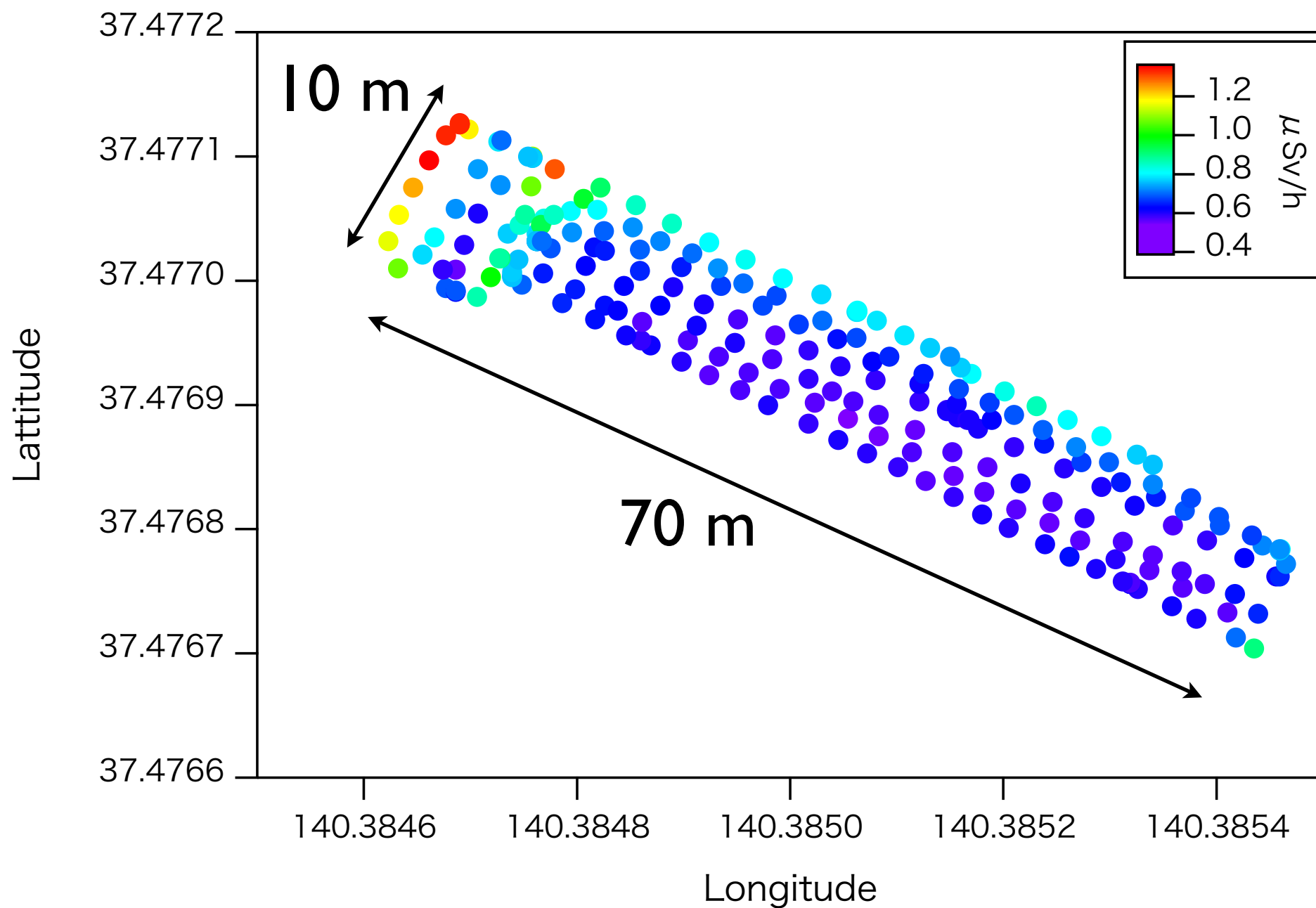
DGPS
Antenna

CsI
Detector

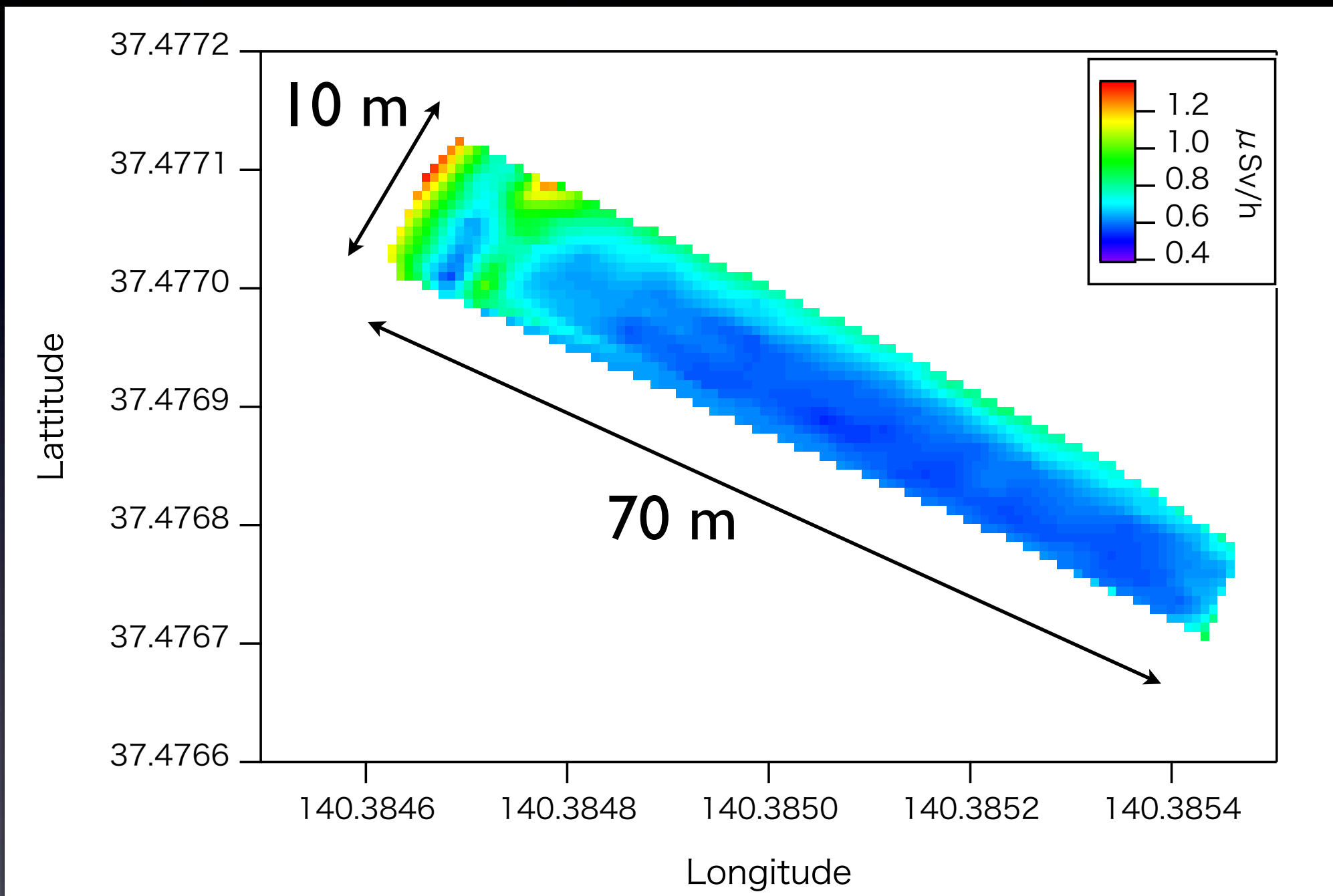
Tablet PC



Mapping in Rice Field



Mapping in Rice Field



Expected Application

Collecting Contamination Data

Internet/
Cloud

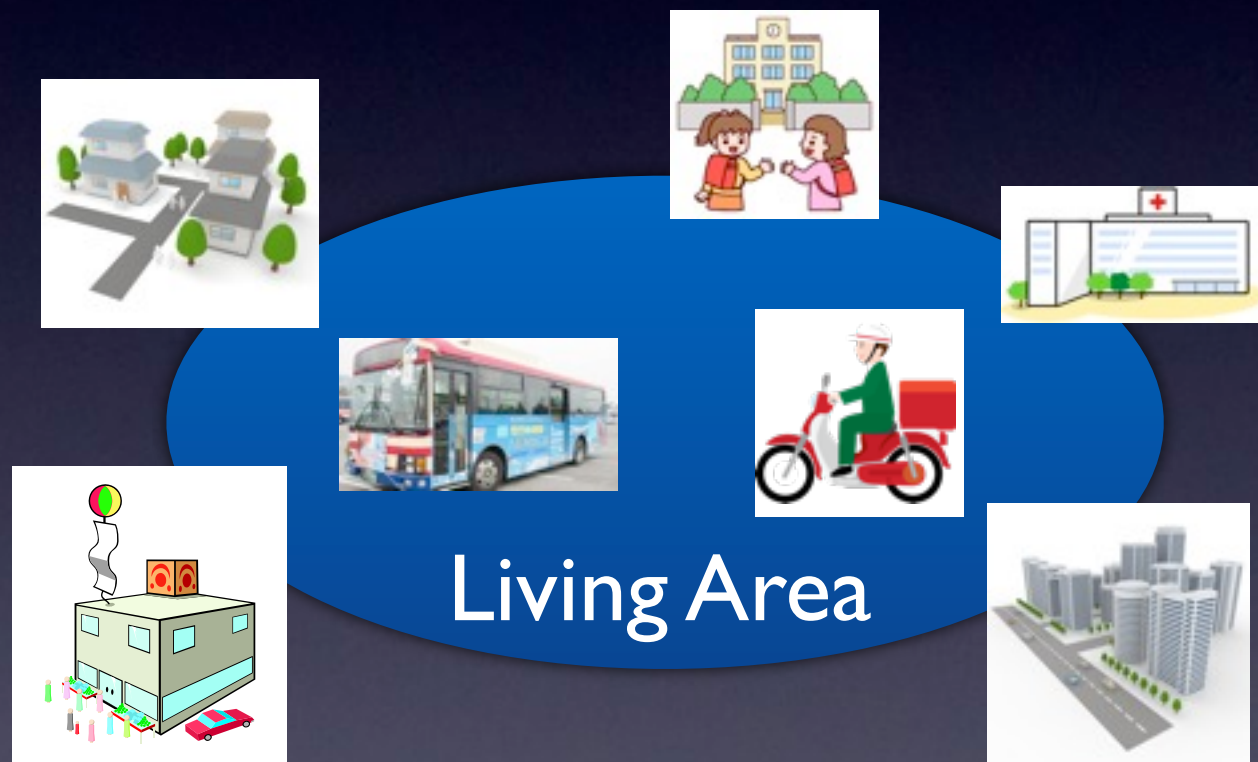
Sharing Data
with Authorities,
Laboratories



Surveys by Farmers
for Their Own

Perspective

Measuring around Living Areas on Daily-basis, with Ease



Survey Everyday

Precise Map

“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA



“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA

Contamination
in Mountains

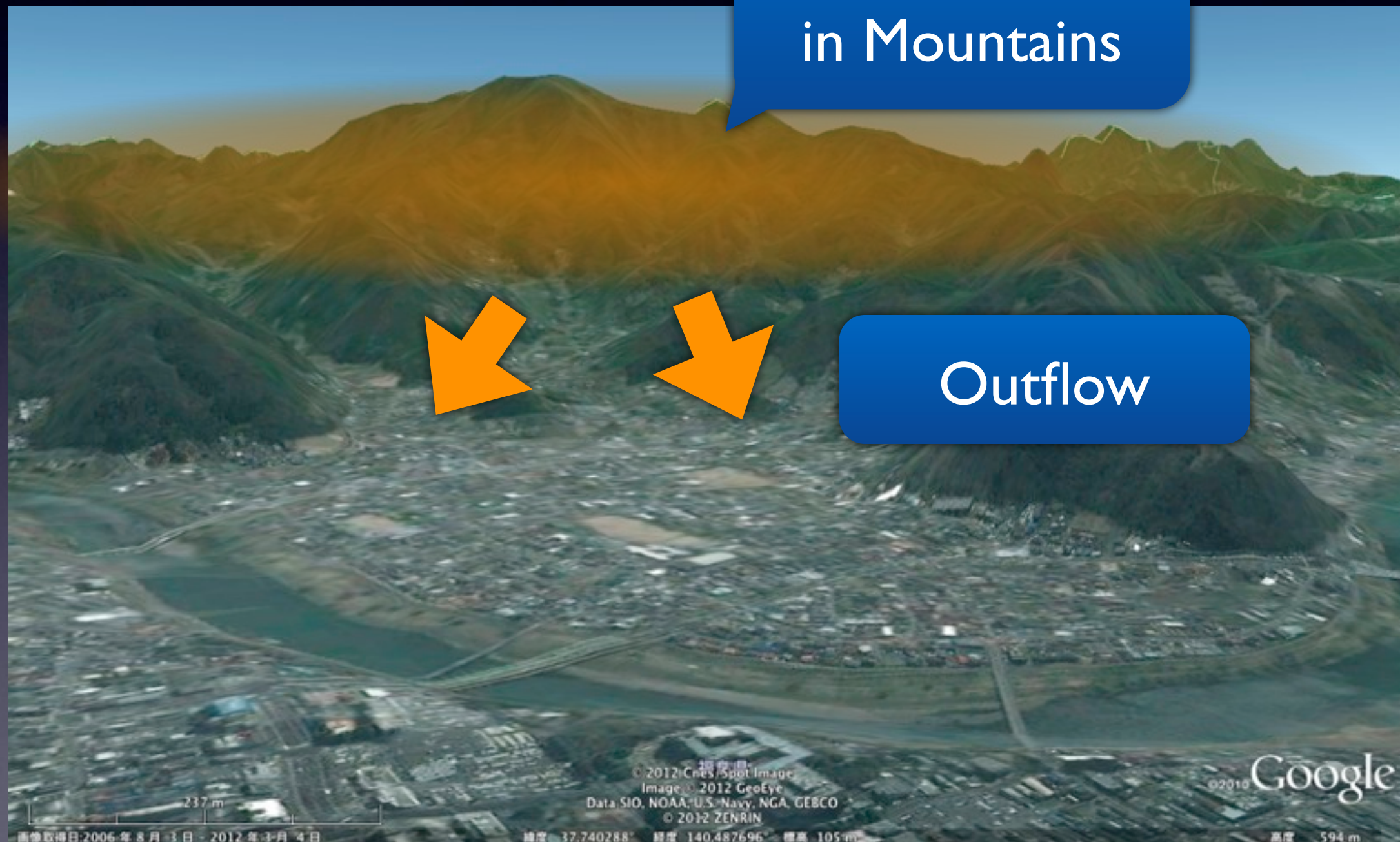


“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA

Contamination
in Mountains

Outflow



画像取得日: 2006年8月3日 - 2012年3月4日

緯度 37.740288° 経度 140.487696° 標高 105m

高度 594m

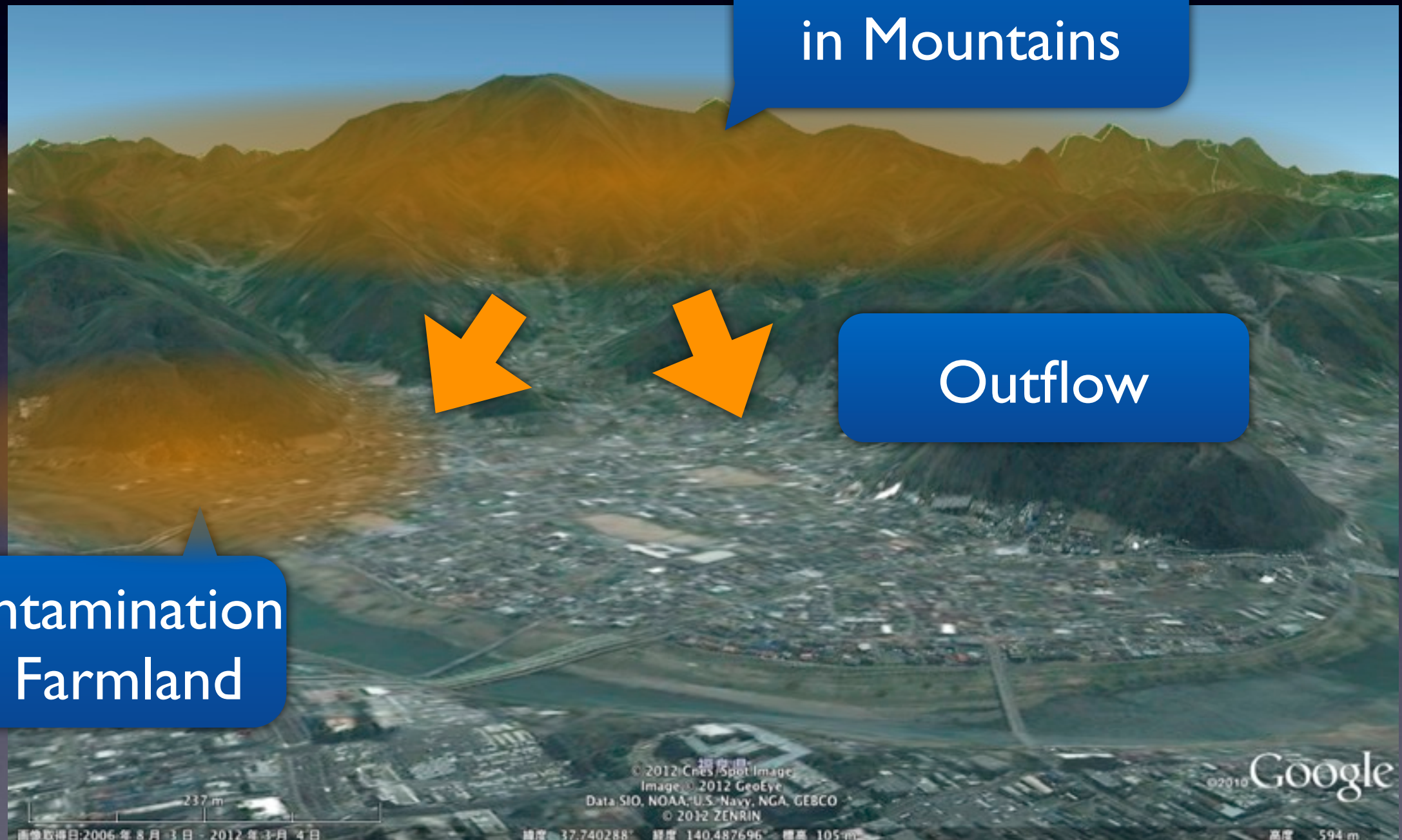
“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA

Contamination
in Mountains

Outflow

Contamination
in Farmland



“Eye” for the Area

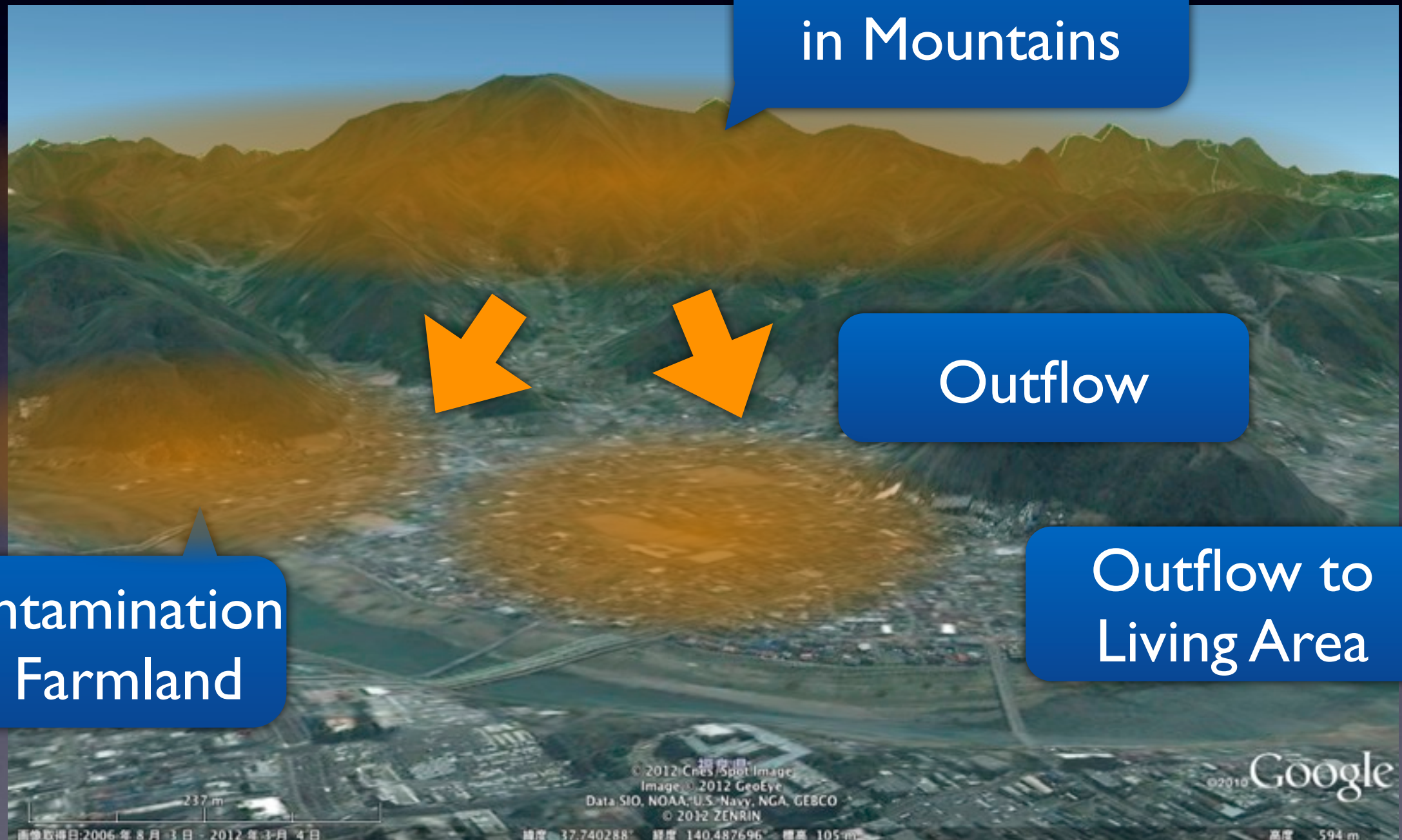
Confirm Safety and Giving Relief by KURAMA

Contamination
in Mountains

Outflow

Outflow to
Living Area

Contamination
in Farmland



“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA

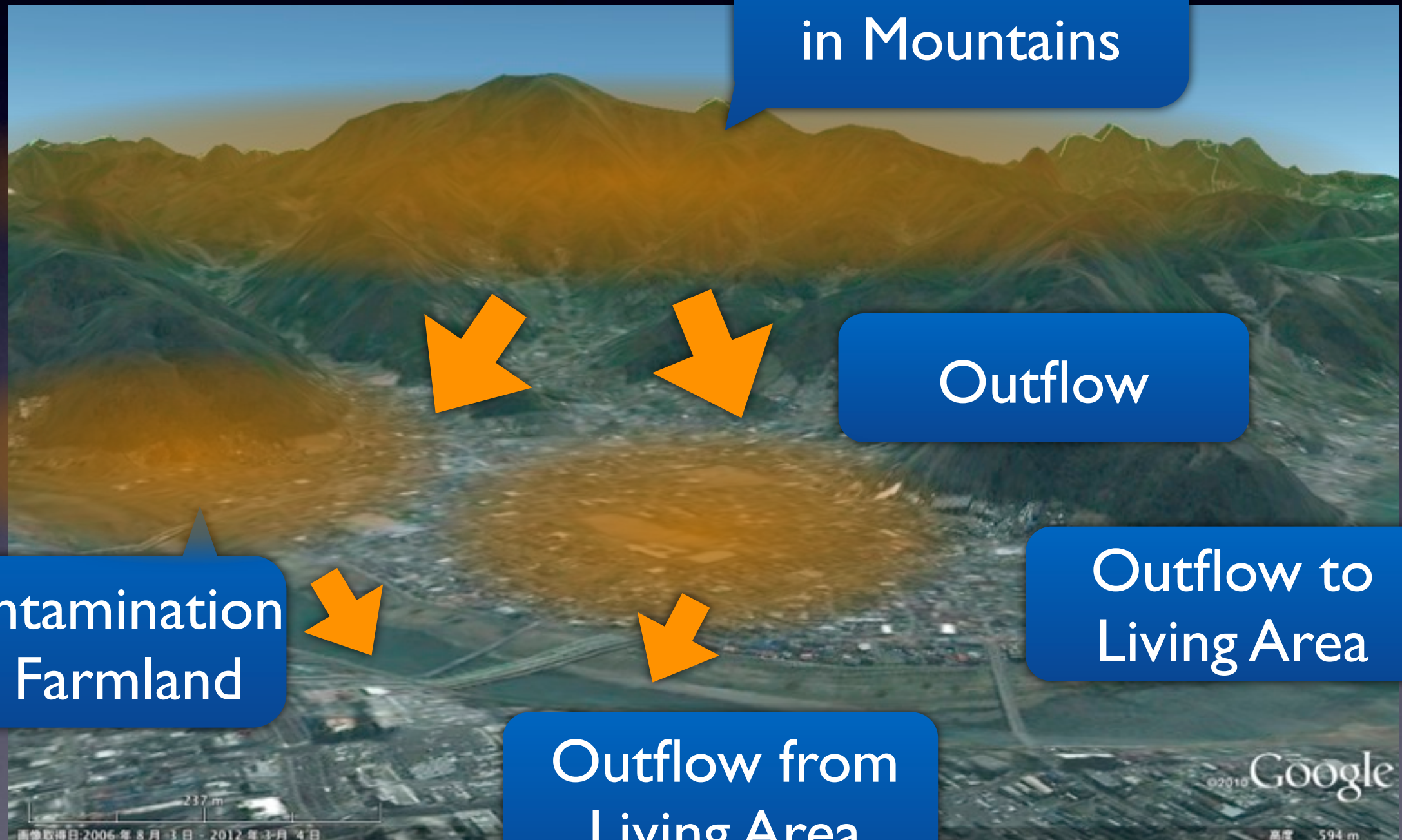
Contamination
in Mountains

Outflow

Contamination
in Farmland

Outflow to
Living Area

Outflow from
Living Area



“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA

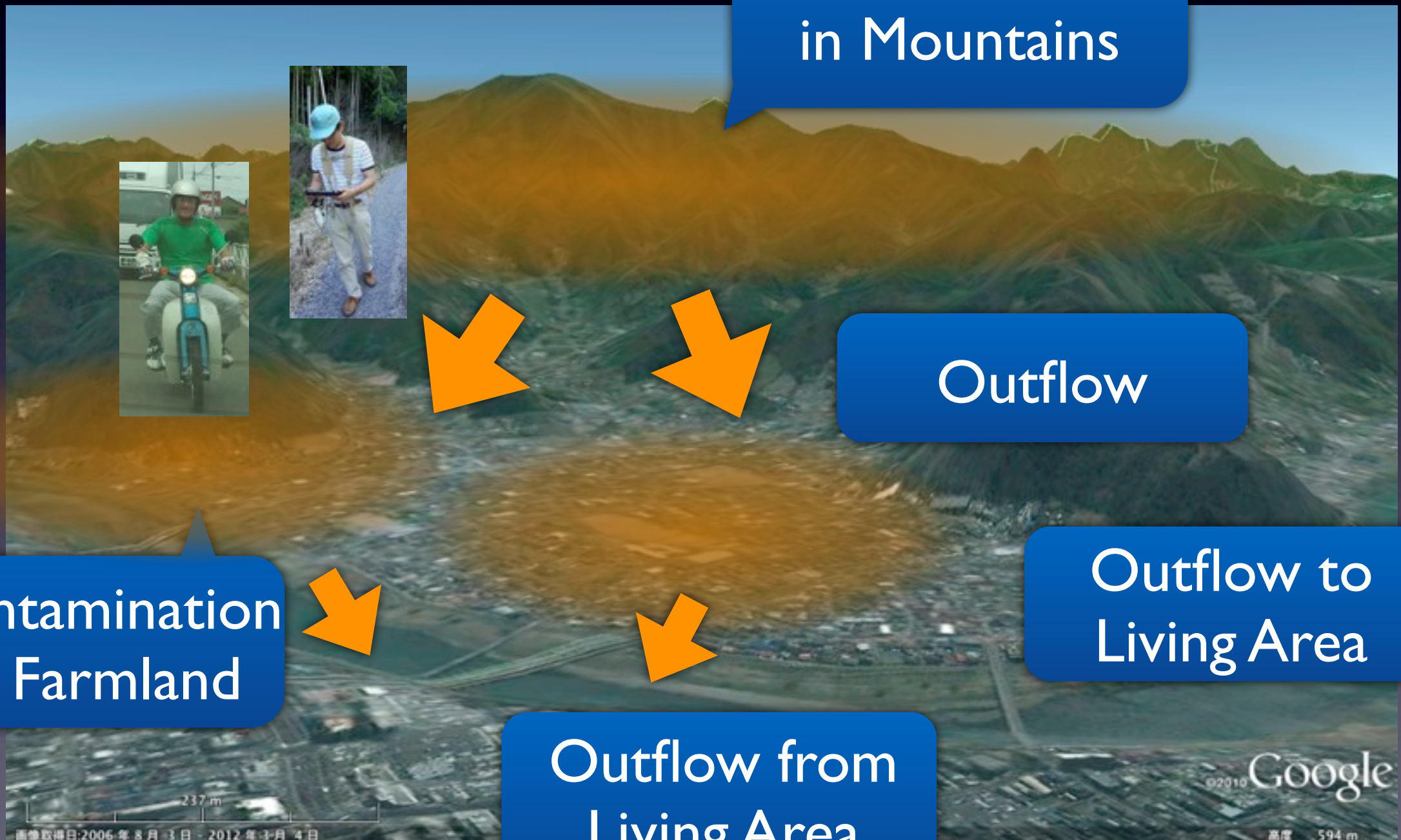
Contamination
in Mountains

Outflow

Outflow to
Living Area

Contamination
in Farmland

Outflow from
Living Area



“Eye” for the Area

Confirm Safety and Giving Relief by KURAMA

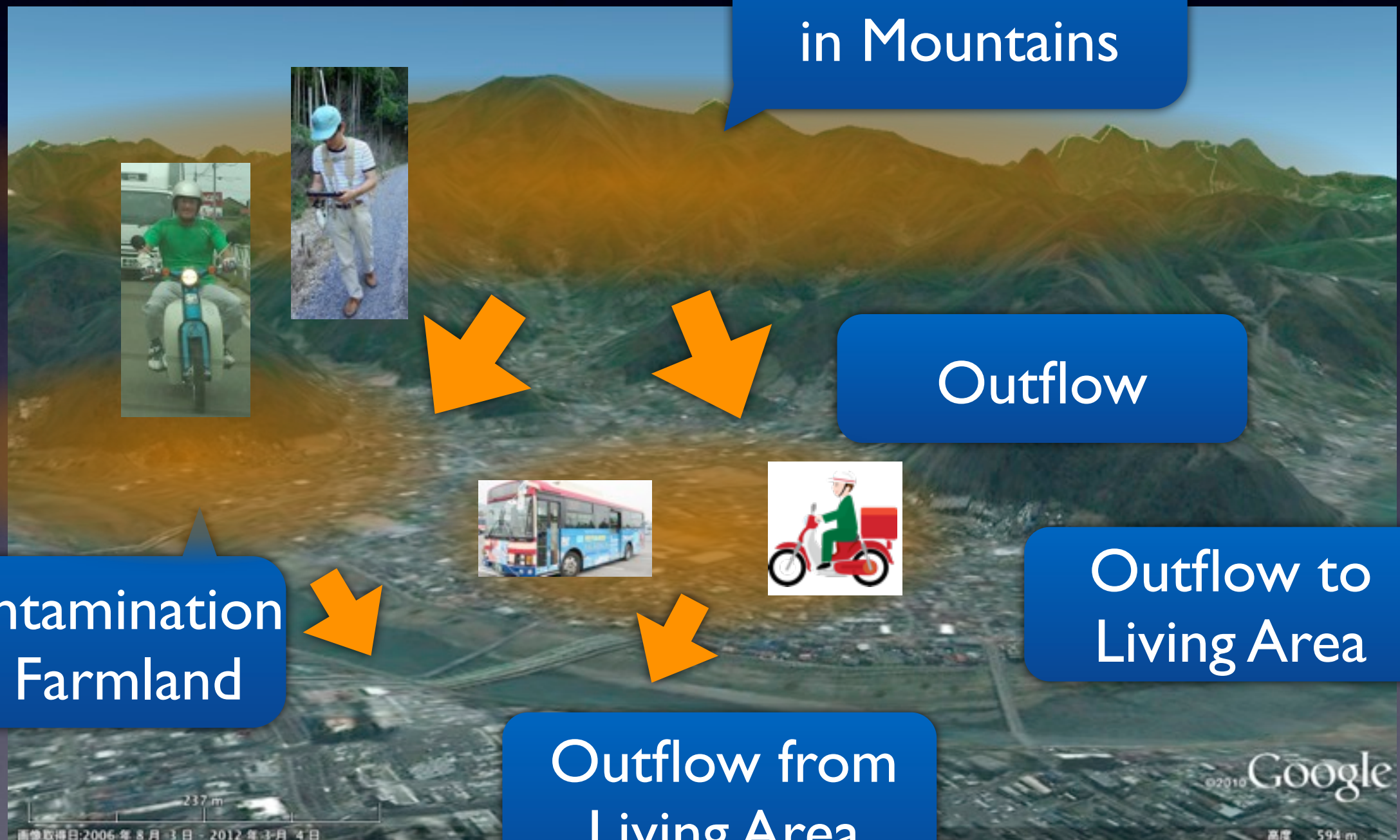
Contamination
in Mountains

Outflow

Outflow to
Living Area

Contamination
in Farmland

Outflow from
Living Area



Lessons I Learned

In a Crisis like We Experienced...

- Disaster Strikes when You Least Expect It
- Analyze Situations, then Act BEFORE Requested
- Authorities Can't Do Little Beyond Prepared
- Difficulties Exist in Organizing Measurement & Data

There Must be So Many Things
Control System Community Can Contribute

Acknowledgements

Fukushima Pref. : Mr. Koyama, Dr. Mizuno, Mr. Abe, Mr. Kojima

JAEA : Dr. Saito, Dr. Takemiya, Dr. Tsuda, Dr. Yoshida, Dr. Nakahara, Dr. Sato

NIRS : Dr. Uchibori, Dr. Shinomiya

NI Japan : Japan Recovery Grant Program

Matsuura Denkosha : Mr. Yasuoka, Mr. Matsuura

Matsushimaya Inn : Mr. & Mrs. Takahashi