Japan Indonesia Joint Research J-RAPID

Urgent Surveys for Evacuation and Measures from Unexpected Large Tsunami

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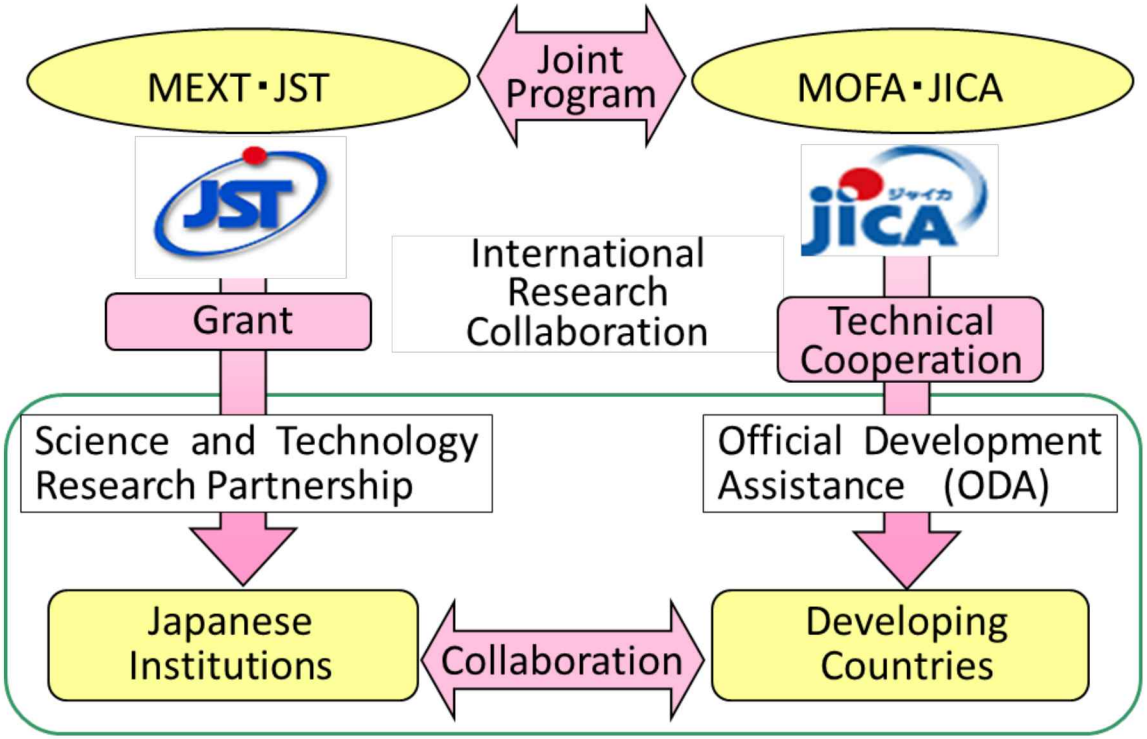
SATREPS project

A joint research project titled "Multi-disciplinary Hazard Reduction from Earthquakes and Volcanoes in Indonesia (PIs; Kenji Satake and Hery Harjono)" was executed from 2009 to 2011 as one of the first SATREPS (Science and Technology Research Partnership for Sustainable Development) projects.



Launching a J-RAPID project

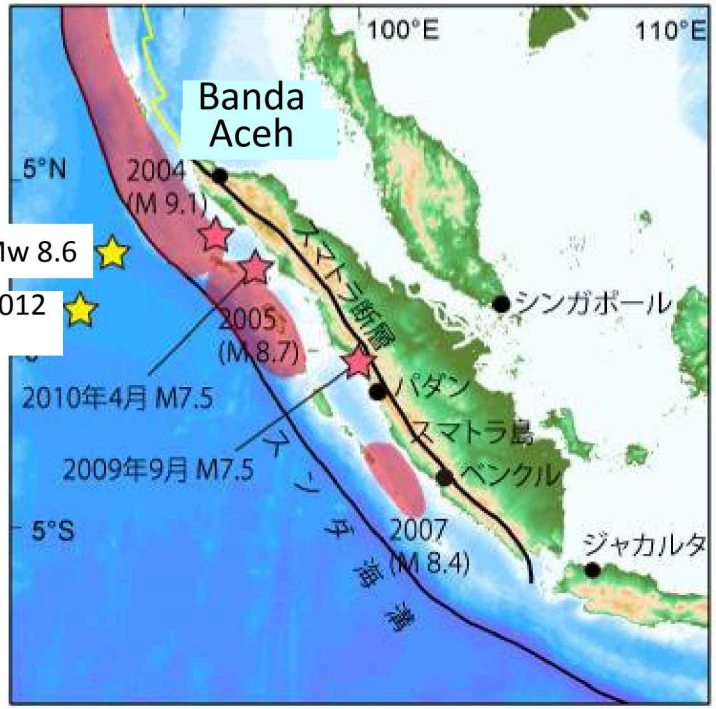
- In the last year of our SATREPS project, the Mw 9.0 Tohoku earthquake occurred, and the giant tsunami ruined nearly 20,000.
- It was clear that the key element for tsunami disaster mitigation was efficient evacuation. Then, the joint research "Urgent Surveys for Evacuation and Measures from Unexpected Large Tsunami " was launched.

At Kadonowaki of Ishinomaki

At Yuriage of Natori

Meanwhile,

- An Mw 8.6 earthquake occurred off northern Sumatra on 11 April, 2012. While this earthquake did not cause a large tsunami, the ground shook so strong that people thought a tsunami was on its way. More than 100,000 people in Banda Aceh in Sumatra evacuated the area in a hurry.



Courtesy of Serambinews Corp, Banda Aceh

Traffic jam on 11 April, 2012

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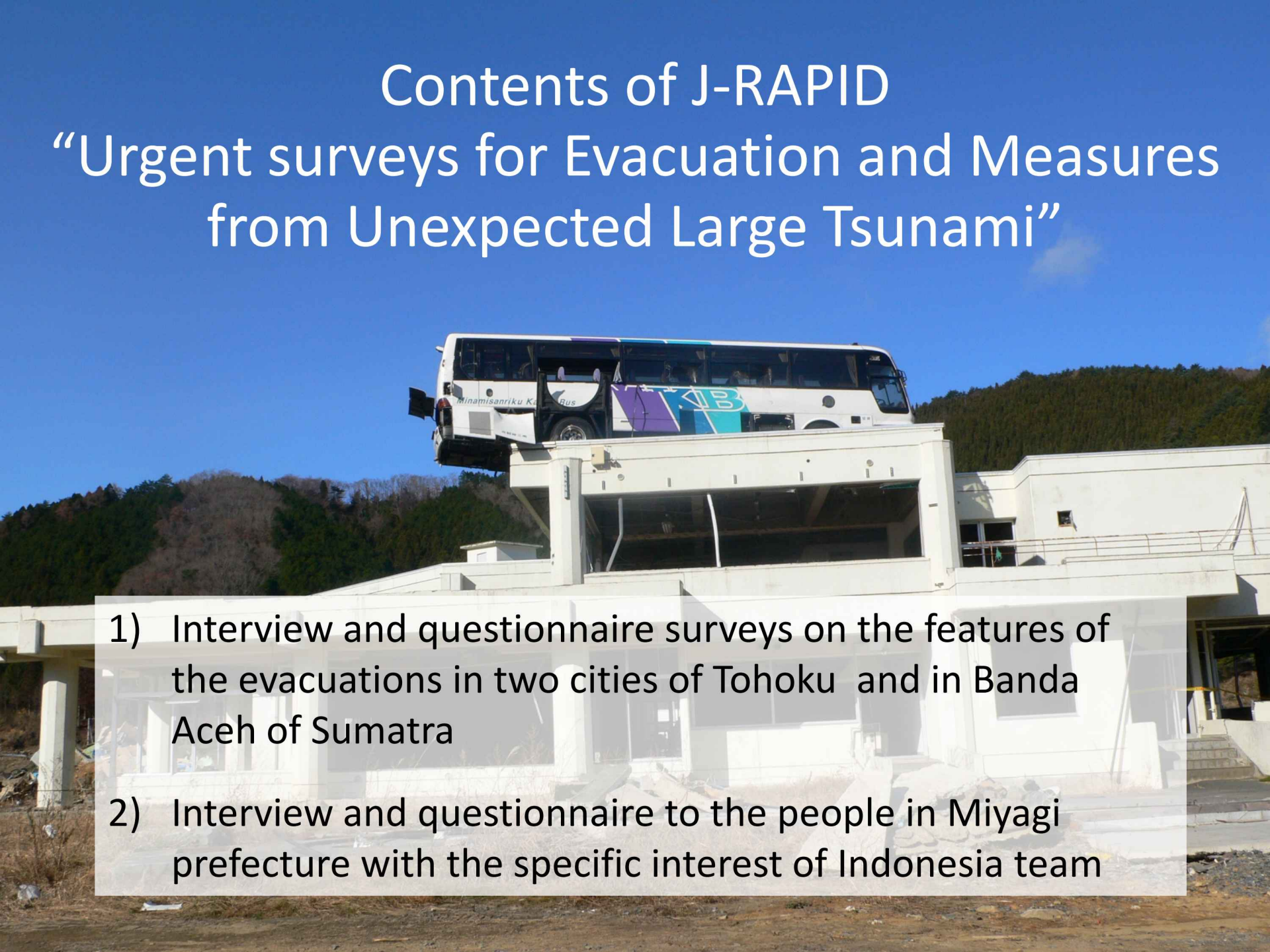


1) Interview and questionnaire surveys on the features of the evacuations in two cities of Tohoku and in Banda Aceh of Sumatra

2) Interview and questionnaire to the people in Miyagi prefecture with the specific interest of Indonesia team

The features of three mass evacuations in Tohoku and Banda Aceh were surveyed.

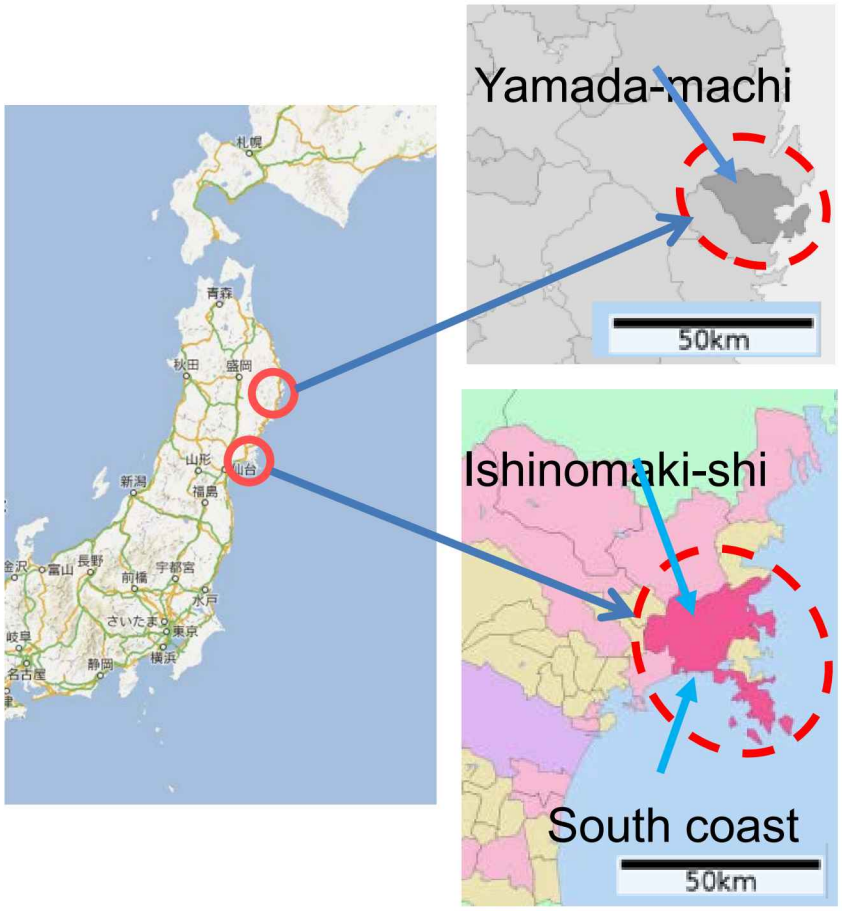
1) Interview and questionnaire to 1,350 refugees in Yamada-machi, Iwate prefecture, and in Ishinomaki-shi , Miyagi prefecture, about their evacuation at the Mw 9.0 Tohoku earthquake, 11 March, 2011.

2) Interview to 1,065 people in Banda Aceh, about their evacuation at the Mw 8.6 off northern Sumatra, 11 April, 2012.

At a community hall in Yamada

At a village in Banda Aceh

Yamada-machi and Ishinomaki-shi

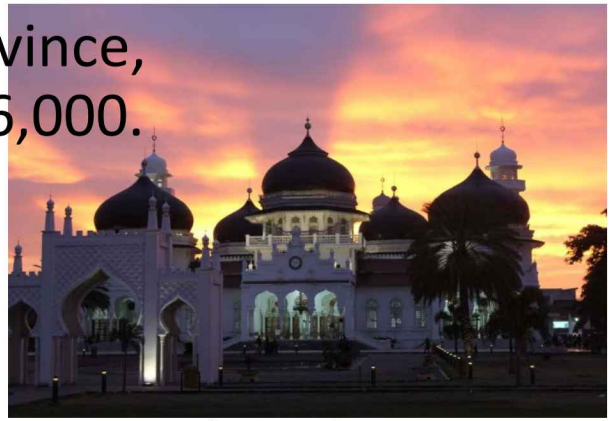


Yamada has a sawtooth coast facing to Pacific Ocean, suffered destructive tsunami three times in the past 115 years. The dead and the missing by March 11, 2011 were 743, 10.5% of the population in the tsunami area.

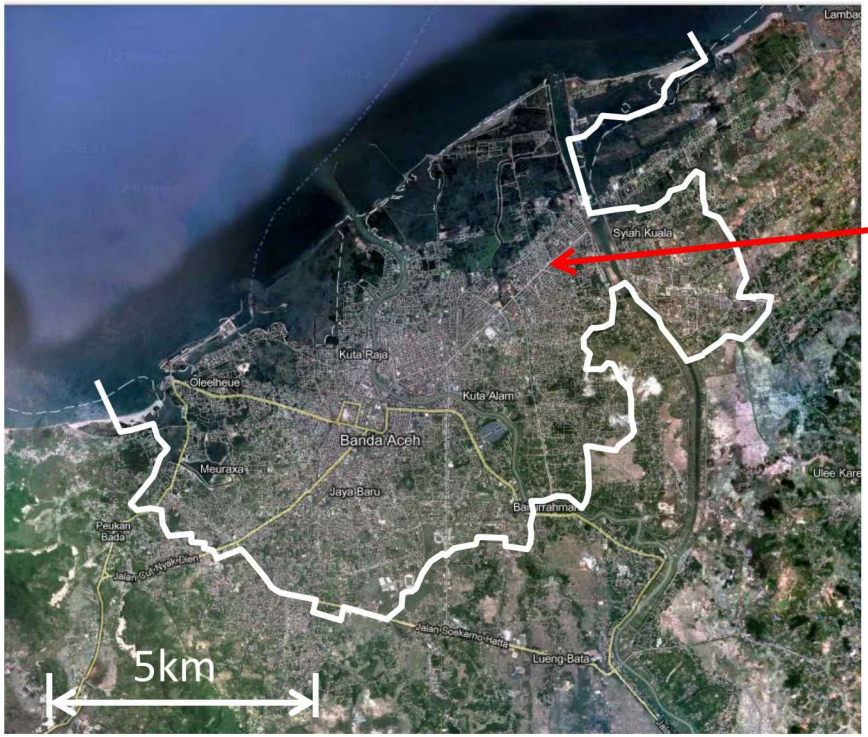
The south coast area of Ishinomaki has a flat land along Sendai Bay, where densely populated and industrialized. The dead and the missing were 3,859, 4.2% of the population in the tsunami area.

Banda Aceh

- Banda Aceh is the capital city of Aceh province, Sumatra, Indonesia. The population is 256,000.
- A quarter of the people was killed and a half of the city was ruined by the Indian Ocean Tsunami of Dec. 2004



Courtesy of Mr. Suzuki in Kesennuma



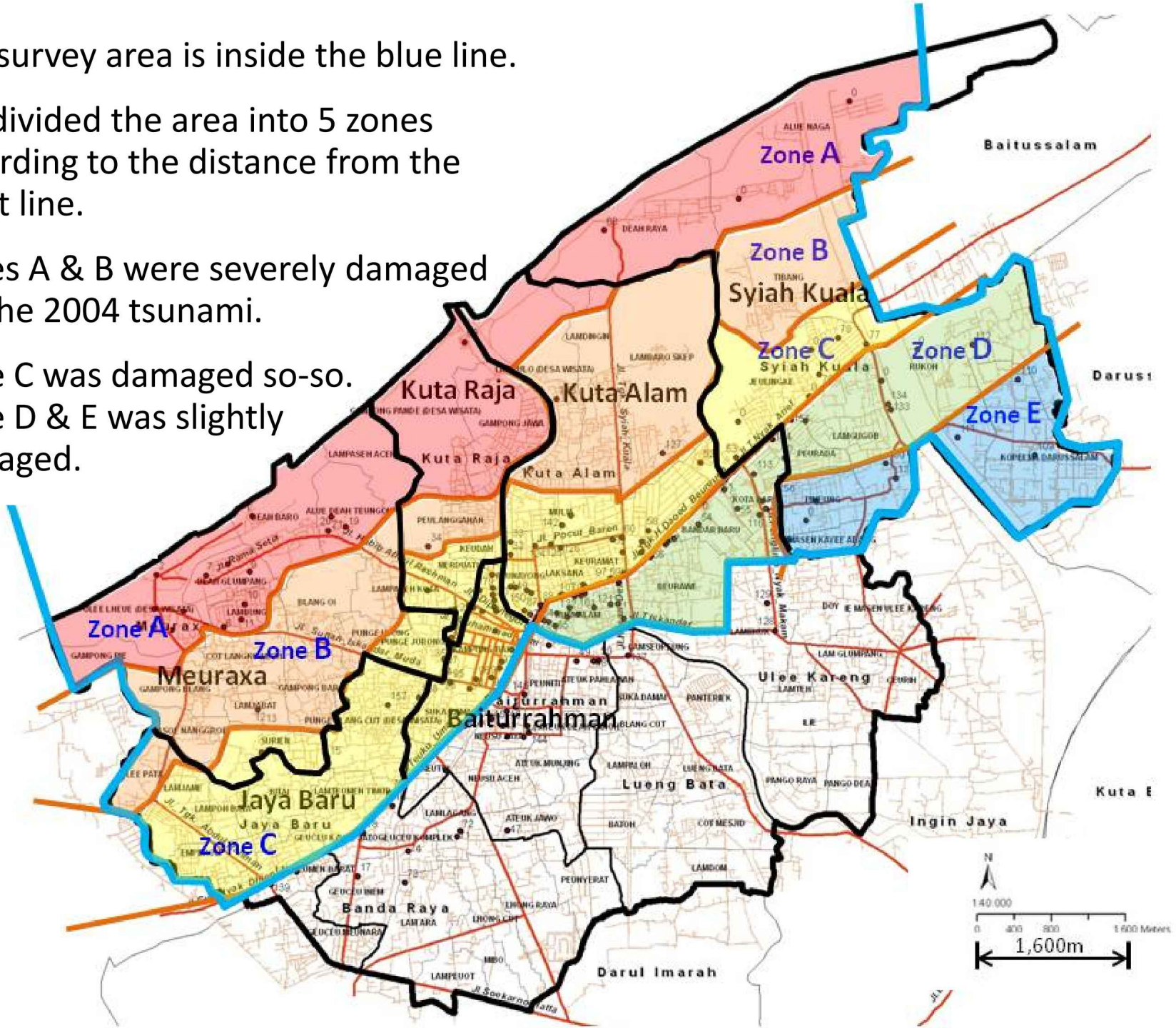
Captured from Google web page

Our survey area is inside the blue line.

We divided the area into 5 zones according to the distance from the coast line.

Zones A & B were severely damaged by the 2004 tsunami.

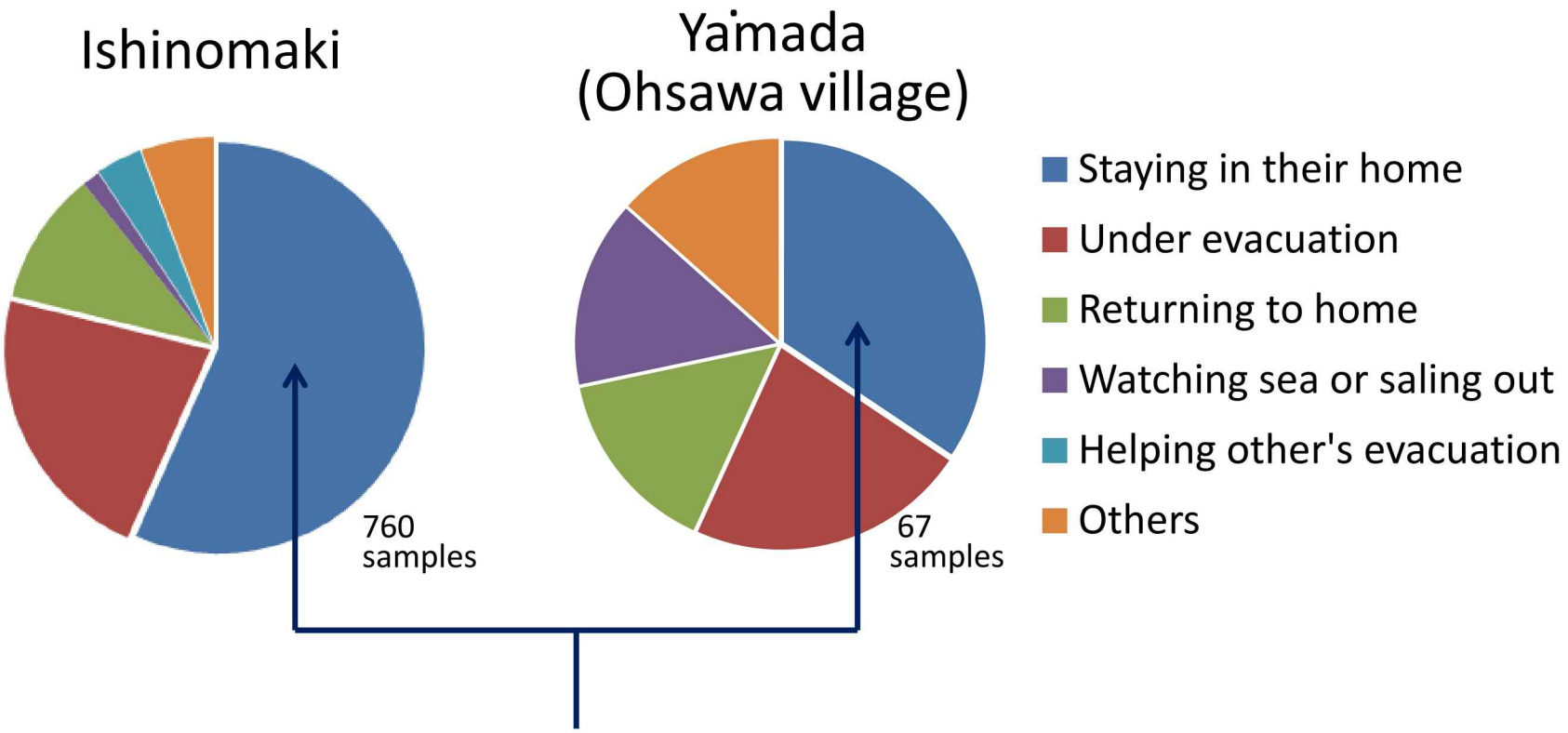
Zone C was damaged so-so.
Zone D & E was slightly damaged.



Information (2)

Places where the dead were at the time of the tsunami coming.

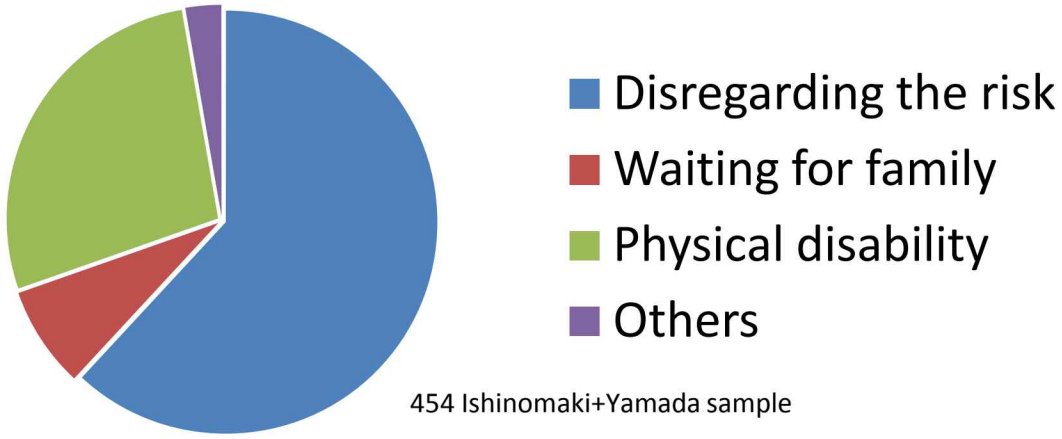
These data were collected from the witnesses of survivors by Dr. Taku Mikami of Eight-Japan Engineering Consultant Inc.



They stayed in their home!!

Why were the deads staying in their home?

These data were collected from the witnesses of survivors by Dr. Taku Mikami of Eight-Japan Engineering Consultant Inc.



"Disregarding the risk" might come from;

1) Underestimation of the risk due to the underestimated forecast in the JMA's initial tsunami warning,
2) the "cry-wolf syndrome" to the repeated tsunami alerts,
3) the experience of 1960 Chilean Earthquake Tsunami,

JMA's upgraded warning but….

- JMA issued the first warning 3 minutes after the earthquake (3m for Iwate and 6m for Miyagi), and NHK broadcast it about 4.5 minutes after the earthquake. The municipality broadcasting systems of Ishinomaki and Yamada followed. However, the announced tsunami height was underestimated.
- Twenty-eight minutes after the earthquake, JMA upgraded the estimated tsunami heights(6m for Iwate and more than 10m for Miyagi), but most people could not watch TV because of power supply outage. NHK radio did not broadcast the update. The municipality broadcasting systems did not announce the upgrade either.
- Consequently, most people did not get updated information about the tsunami height.

"Cry-wolf Syndrome" had spread!

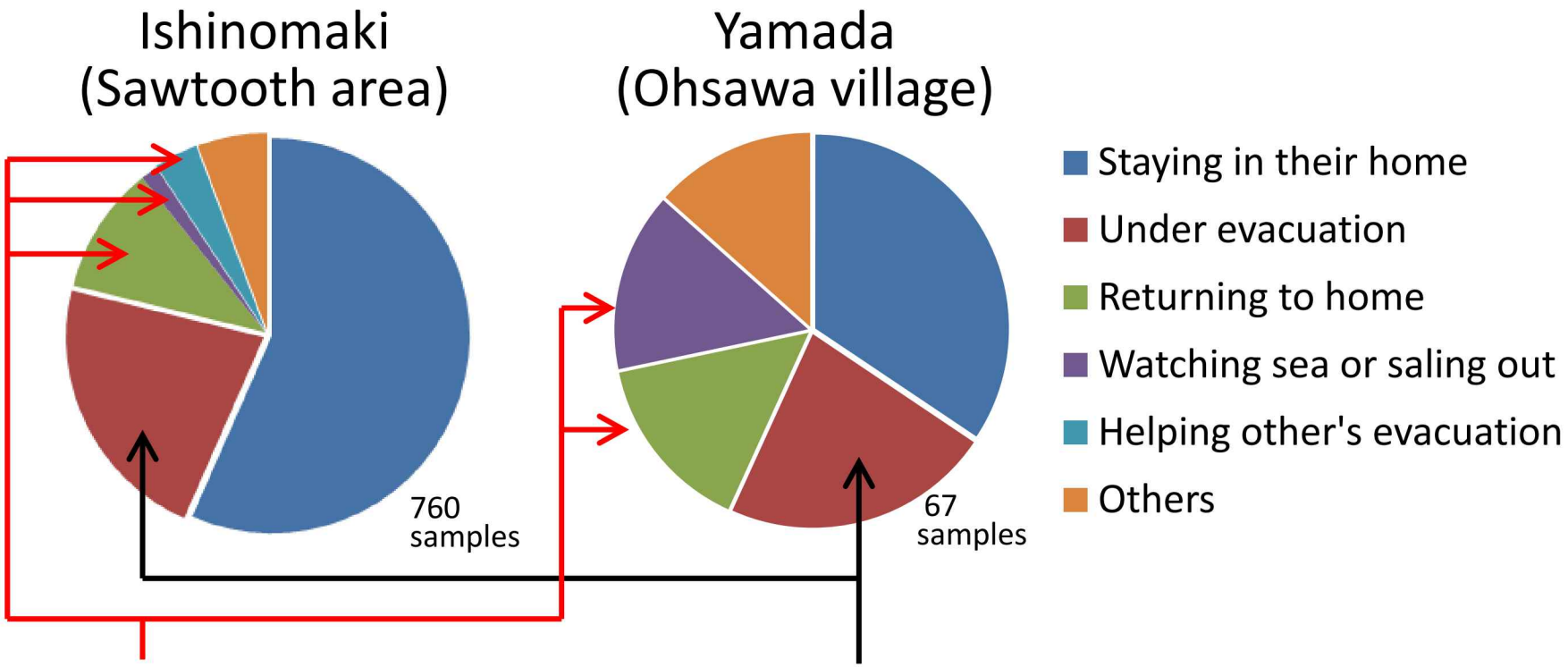
Tsunami warning vs. actually observed tsunami height along the coast of Miyagi and Iwate from 1978 to 2011

Earthquake	M	Warning level	Observed tsunami
Off Miyagi, 1978	M7.4	Tsunami warning (2 meters)	Sendai new port 49cm
Off Miyagi, 1981	M7.0	Tsunami warning	Kamaishi 22cm Miyako 20cm
Offshore Sanriku, 1994	M7.1	Tsunami warning	Miyako 56cm
Chilean Earthquake, 2010 (1 year before the 3.11)	Mw8.8	Large tsunami warning (More than 3 meters)	Hachinohe 84cm Kuji port 120cm Sendai port 106cm
Off Sanriku, 2011, March 9 (2 days before the 3.11)	M7.3	Tsunami advisory	Hachinohe 20cm Ohfunato 60cm Ayukawa 50cm

Extracted from JMA HP

Places where the dead were at the time of the tsunami coming, again.

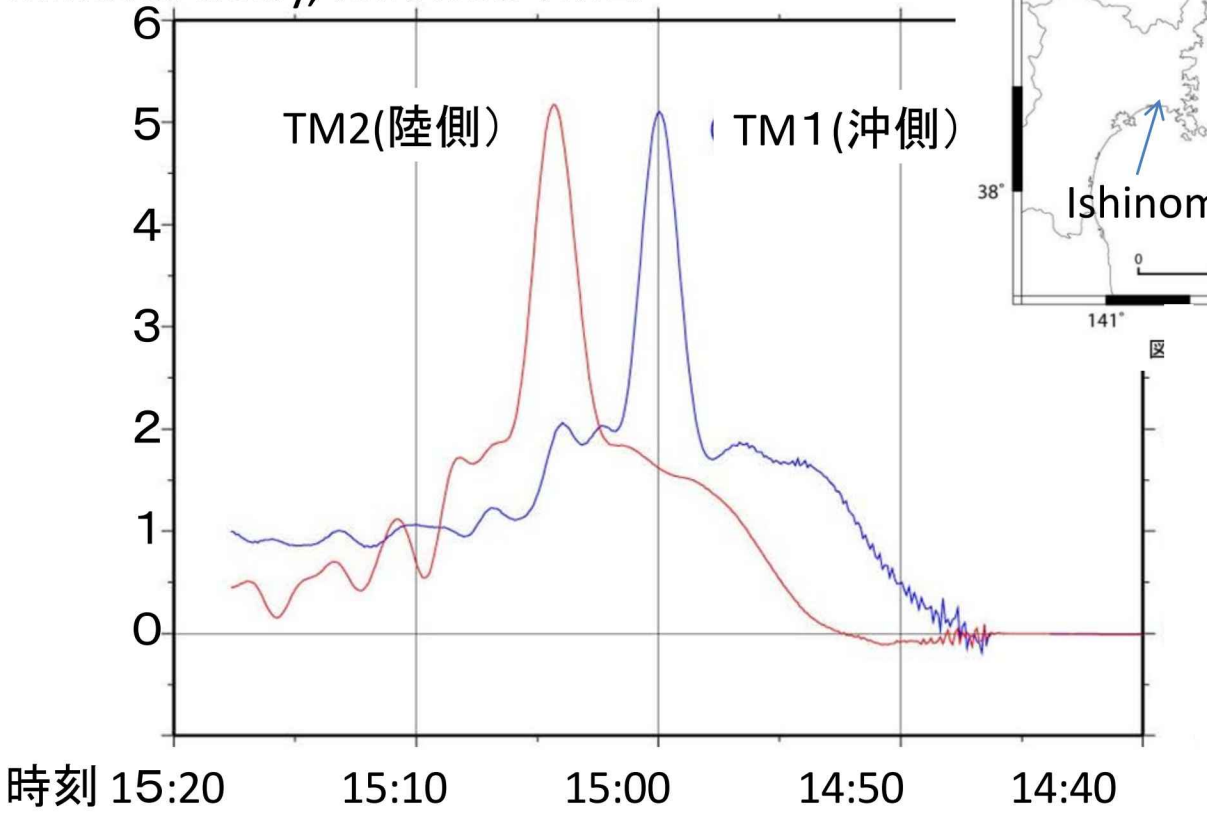
People need localized and sure tsunami forecasts for each bay or beach.



These people might survive if they could get a sure warning 10 minutes earlier.

The offshore tsunami gages recorded the rapid rise of sea level 20 minutes before the tsunami arrival.

At the beginning, TM1 recorded the earthquake vibration at 14:46, then TM1 recorded 2m rise, and 11 minutes later, recorded around 5m rise. TM2, with 4 minutes delay, followed TM1.



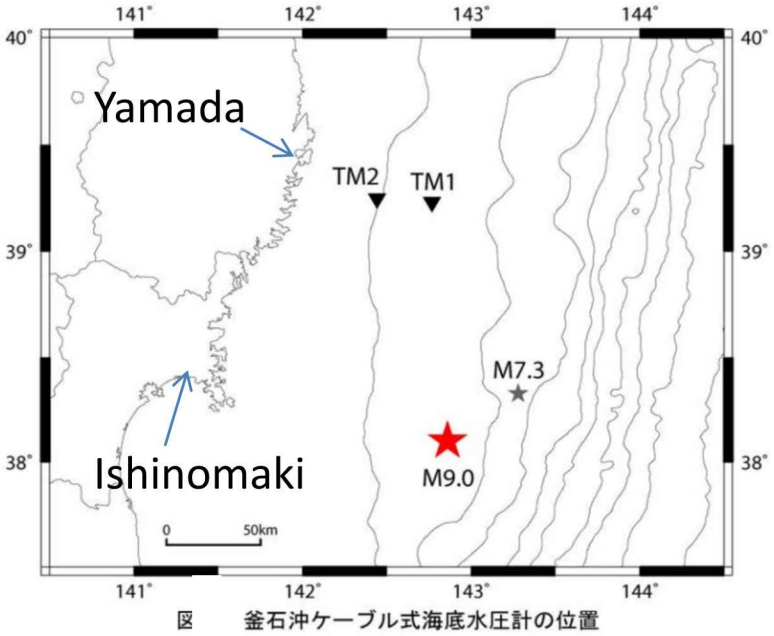


図　釜石沖ケーブル式海底水圧計の位置

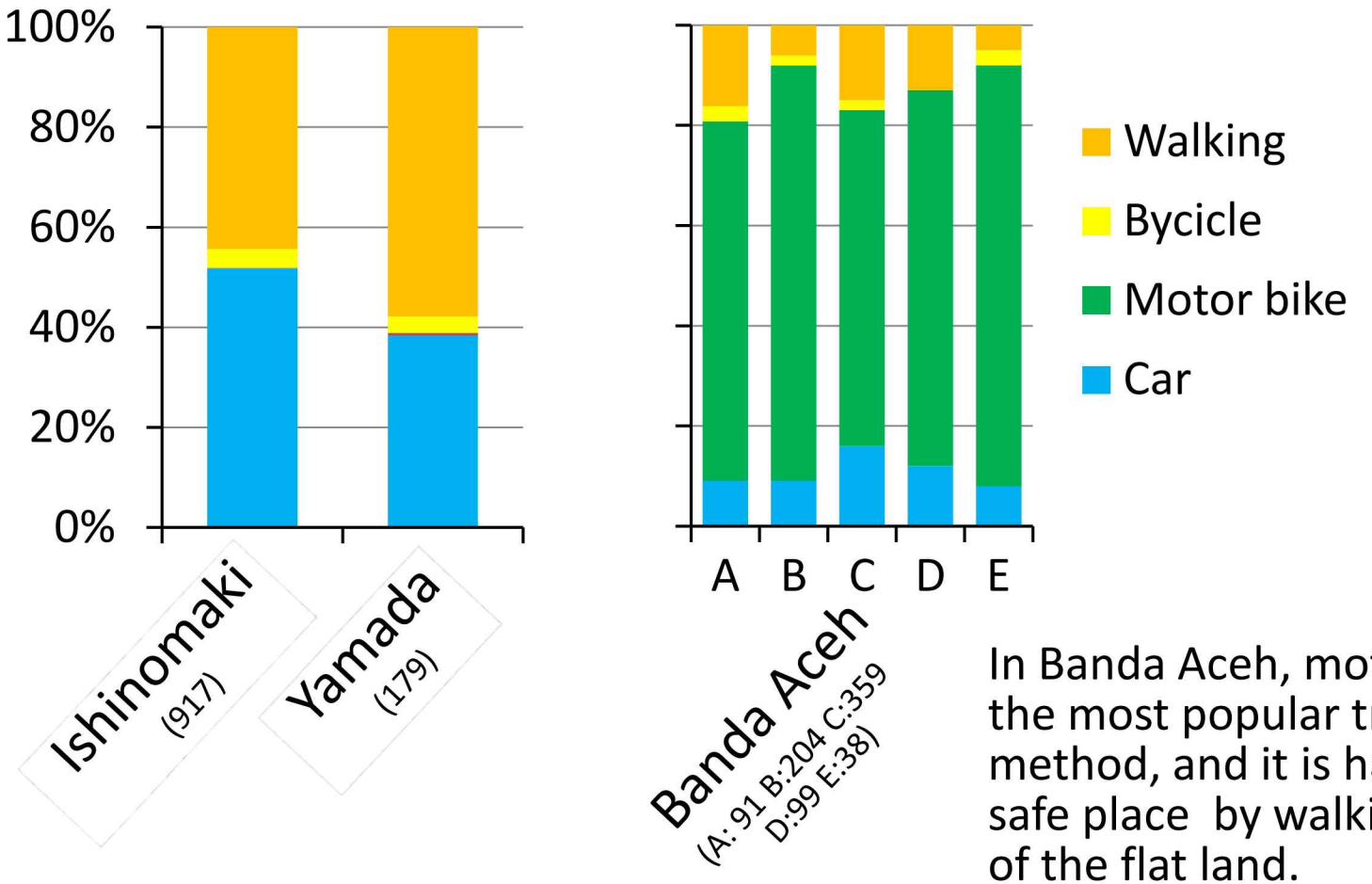
TM1 was placed on the sea bed of 1600 m depth.

TM2 was placed on the sea bed of 1000m depth.

Sea level rise recorded by the sea bed cable type tsunami gage, ERI the Univ. of Tokyo

Traffic jam (1)

Transportation methods for evacuation



In Banda Aceh, motorbike is the most popular traffic method, and it is hard to get a safe place by walking because of the flat land.

In Ishinomaki and Yamada, car is the most popular traffic tool.

You can see the features of the evacuation in this picture.

- Some ladies did not ware thier Hijab, scarf. 97% of the people in Banda Aceh is Moslem. In the normal days, we cannot see ladies without scarf. They could not mind thier scarf in a hurry for evacuation.
- Four person on one bike.
- Some families were using a side car. It must be illegal to use for human transfer.

Courtesy of Serambinews Corp, Banda Aceh

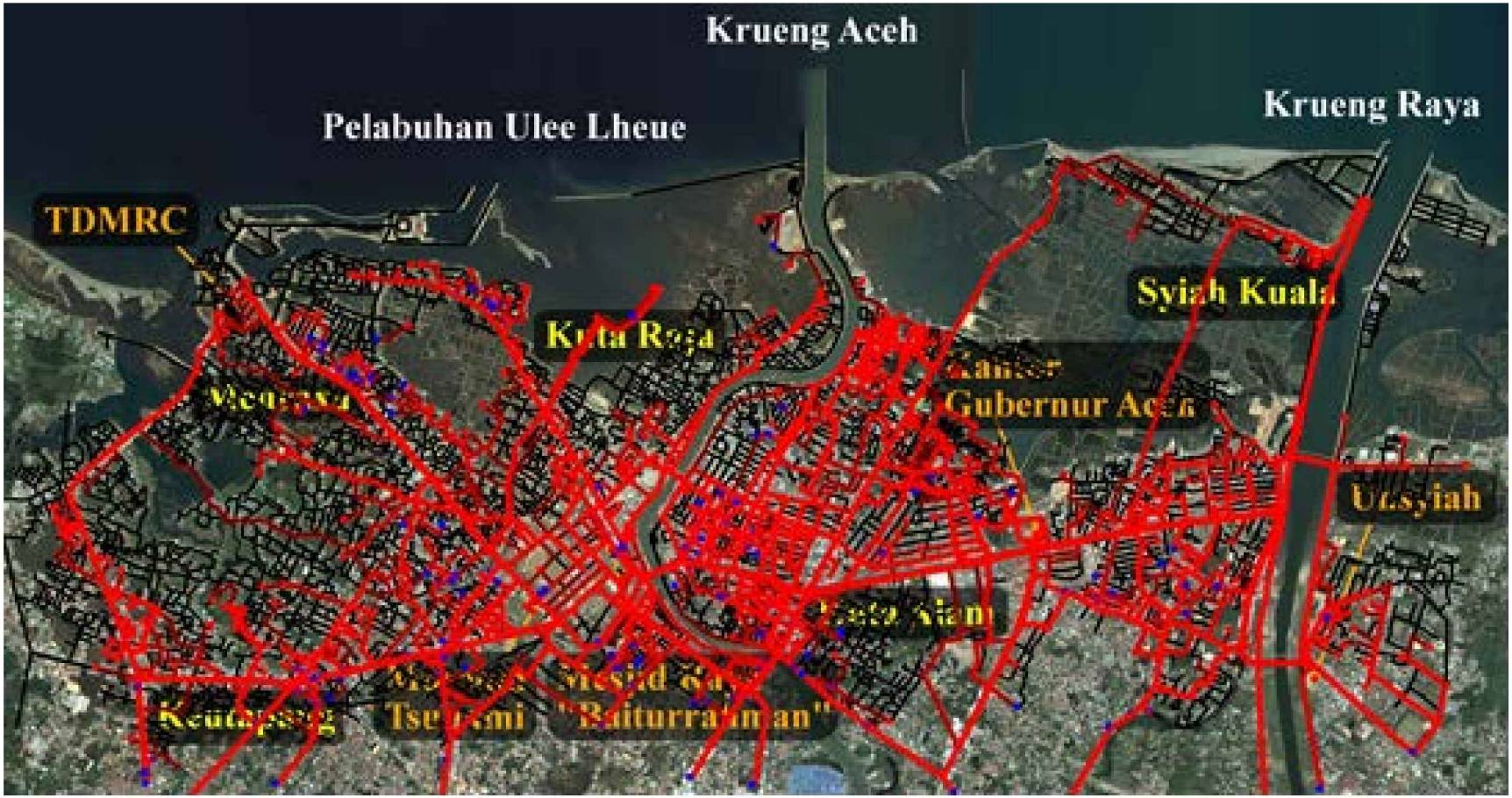
Traffic jam

	Ishinomaki	Yamada	Banda Aceh			
	Car	Car	Car	Motor-bike	Bicycle	Walk-ing
Did not see a traffic jam	26%	75%	0%	3%	20%	47%
Saw traffic jams but not trapped in	30%	14%	5%	9%	0%	38%
Trapped in traffic jams	44%	11%	95%	88%	80%	15%
Trapped in traffic jam and swept away by tsunami	7%	4%	--	--	--	--
Trapped in traffic jams, left the car and ran away	13%	3%				--
No. sample	*486*	*71*	*101*	*576*	*15*	*98*

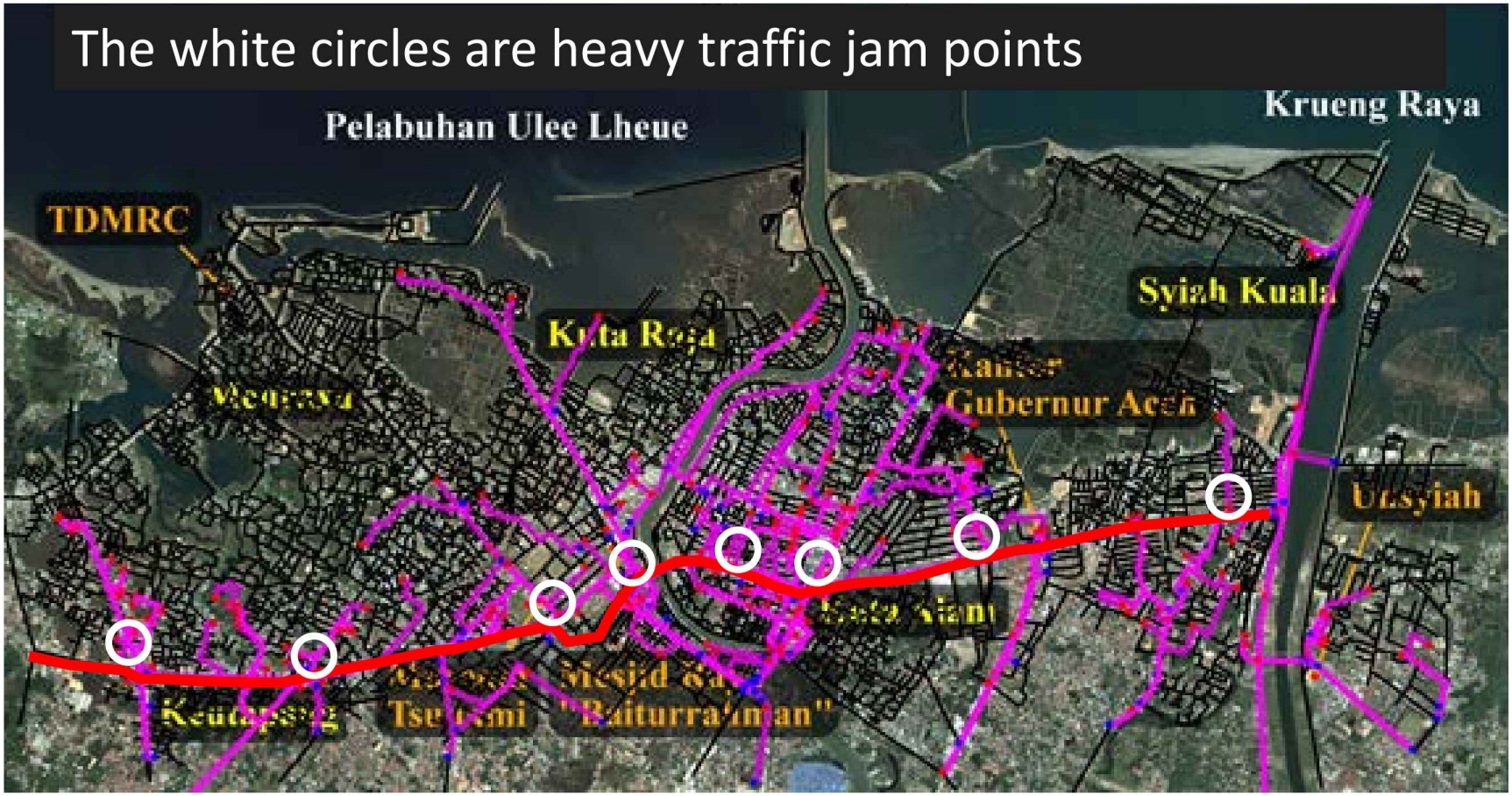
Note that these data came from only survivors

Traffic jam (3)

Evacuation routes of interviewed 785 evacuees of Banda Aceh



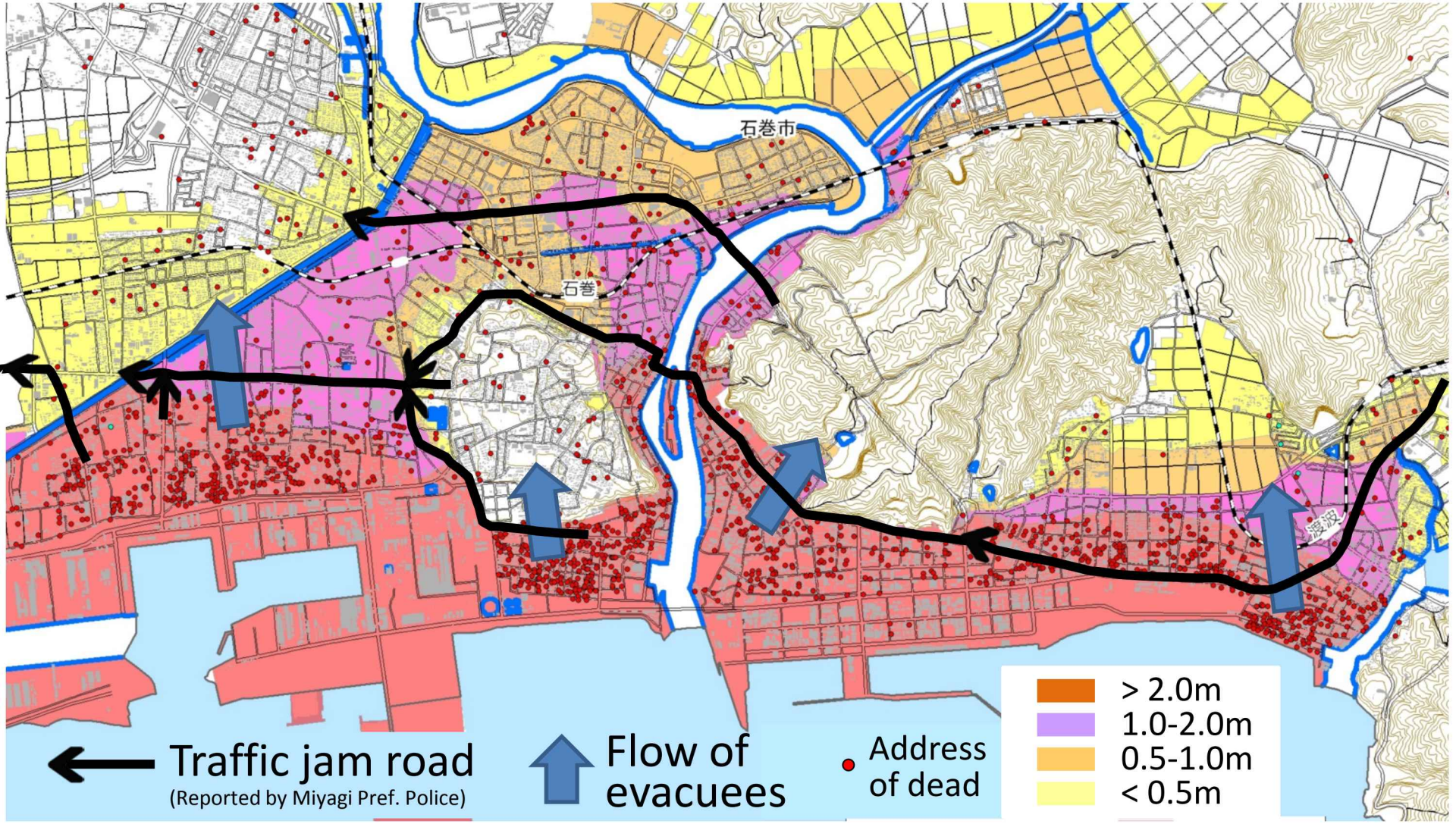
Traffic jam routes based on the evacuees' witnesses



The red line is the main road that traverses the city and blocks the evacuation routes extending toward inland.

Traffic jam (7)

The main road traversing Ishinomaki blocked the flow of evacuees



Main conclusions from the surveys about the evacuation

- Each municipality in Japan and Indonesia should have their own tsunami monitor-and-alert systems utilizing GPS buoys or offshore tsunami gauges
- Roads that extend from coastal areas inland should cross main roads by means of overpasses, both in Japan and Indonesia.

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Perception of Japanese People on the March 11, 2011 Earthquake

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Hery Harjono, Indonesia Institute of Science (LIPI)
Reported by
Triono, Hery Harjono, Irina Rafliana, LIPI

Questionnaire from an Indonesia researcher

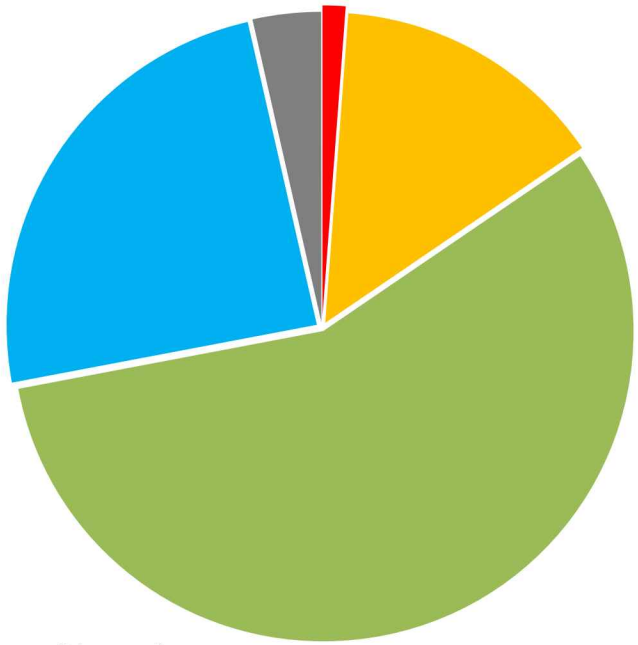
Indonesia team subjected the questionnaire of their specific concernments to 93 people in Miyagi prefecture.

Interview at a meeting room of a temporary housing complex

Lesson Learned

- Japan is a model in reducing risk of the earthquake and tsunami disaster. Some questions are:
  - How do Japanese people react when the scientist failed to predict the magnitude of the March 11 earthquake and tsunami?
  - Do they still rely on scientists?
  - East coast of Japan has experienced with destructive events. Why did they forget the history?

Q2 How do you think the fact that scientists (researchers in universities and public research institutes) failed to predict the magnitude of the 2011 March 11 earthquake and tsunami?



84 samples

- I am indignant so much. They should be on trial.
- I am indignant. They should quit the study which makes no result.
- It is inevitable that they missed. I hope they will study much more.
- There is a limit in science. Utilization of it is the responsibility of politician.
- Others

Q4 If you cannot rely on scientists, whom do you rely on?

- There is no way except to rely on scientist.
- I will rely on a predictor who is introduced by media
- I will rely on the leader of a religious group.
- I will rely on a leader in my community.
- Others

Perception to Scientists

- Most people still rely on the scientist and ask them to study more deeply
- Only a few people are indignant
- The community leader is also respected

- **Evacuation decisions depend on the risk perception that associated with**
  - knowledge or experiences,
  - influenced by others, and
  - information obtained during the decision making process such as early warning, evacuation command etc.

If the society has good enough knowledge on tsunami risk, they should be able to take the right decision when the warning comes.

However, it seem that people's knowledge on tsunami risk is inadequate, or more likely tends to rely on the past experiences.

Their experience with some tsunami heights that less than 120 cm since 1978 (JMA) has formed their perception that the March 2011 tsunami just as the past events. They did not rely on the tsunami that occured long before. As a result, the level of risk perception remains low and not enough to motivate them to evacuate.

Conclusions from Indonesia team

- Japanese people have good perception on science and scientist
- History the past events long before is also important to remember for mantain the awareness of the people