

# CHANGES IN LEVELS OF RADIOACTIVE CONTAMINATION IN ABANDONED PADDY SOIL, MINAMISOMA CITY

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## Background

The Great East Japan Earthquake of 11 March 2011 and subsequent tsunami caused severe damage to farmland in the eastern Tohoku Region.

Although Minamisoma City has published the maps of soil radioactive concentration for 2013 and 2014, they do not show the accurate areas of radioactive contamination.

Therefore, the aim of this study is to identify the actual radioactive contamination area in abandoned paddy soil and atmospheric radiation for reviving the farming industry in Minamisoma City.



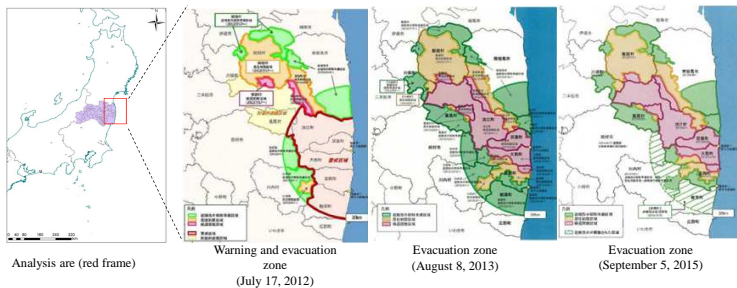
Minamisoma City, Fukushima (24 Aug. 2014)



A Spot of farmland resumed (26 August, 2014)

• This photo shows former rice paddies that were abandoned due to high levels of radiation.

## Study Area



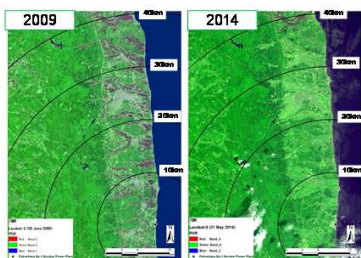
From HP of Ministry of Economy, Trade and Industry

At first, Minamisoma City, Fukushima, established the evacuation zone of 30km around the leaking sector. Currently, the evacuation zone is released with restricted residence area (orange frame), difficult-to-return zone (red frame), and zone in preparation for the lifting of the evacuation order (green frame).

## Method

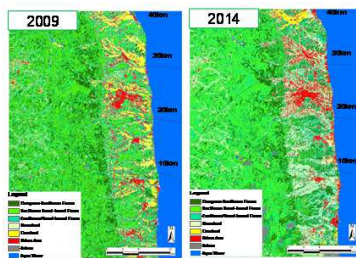
- Research period: September 1 to September 3, 2012 (28 spots), September 4 to September 6, 2013 (44 spots), August 24 to August 26, 2014 (48 spots), September 9 to September 11, 2015 (48 spots)
- Measure radioactive concentration in abandoned paddy area and atmospheric radiation by field work in Minamisoma City, Fukushima.
- The radioactive concentration of soil samples were measured with an LB-200 (Berthod Technologies) radiation meter.
- Atmospheric radiation at research areas were measured with GC-S1 (System TALKS Inc.).
- The maps of radioactive concentration measurement in abandoned paddy area were made with ArcGIS10.2 for 2012, 2013, and 2014.
- Landsat 5 data (June 2, 2009) and Landsat-8 (May 31, 2014) were downloaded from USGS (<http://www.usgs.gov/>).
- Land cover maps of the disaster area derived from Landsat data using USGS were also constructed for 2009 and 2014.
- The correlations between GIS data of 1:200,000 Seamless Land Conservation Map (topographic and geologic map) and radioactive concentration in abandoned paddy soil were examined.

## Results: Land cover classification implemented on the Landsat images for 2009 and 2014



True Color Image in the disaster region based on Landsat data for 2009 and 2014

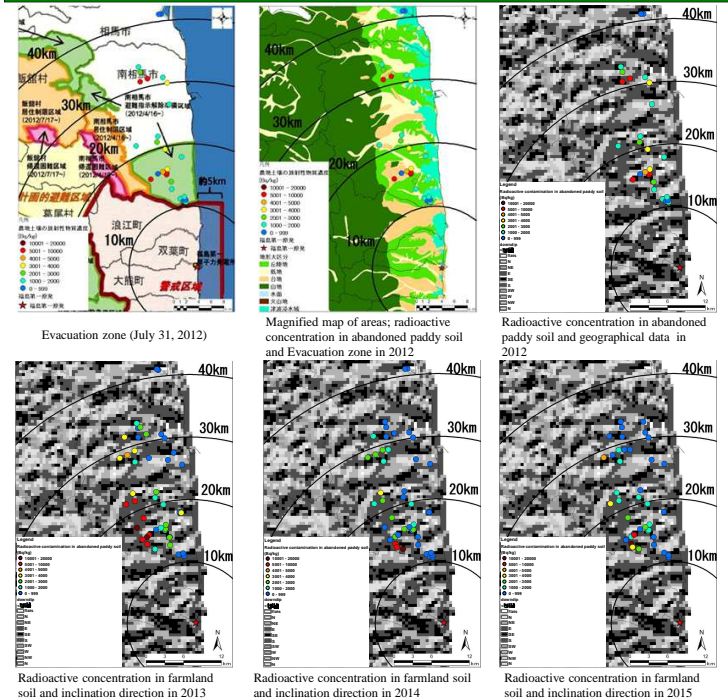
Dark color areas in the 2009 image indicate irrigated rice paddies along the coastal plain. In 2014, almost all the paddies have disappeared.



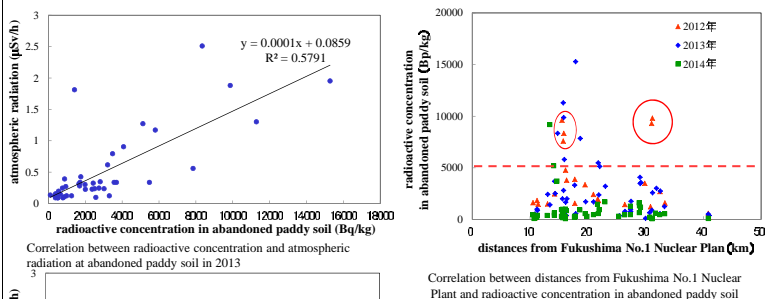
Land cover classification implemented on the Landsat images for 2009 and 2014

Rice paddies along the coastal plain remain, around 40km from the Nuclear Power Plant. The paddies closer to the station are no longer filled with water, indicating that they have been abandoned.

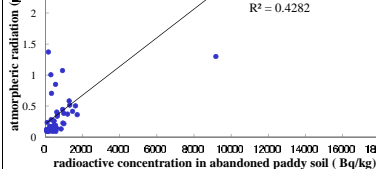
## Results: Distribution of radioactive substances in abandoned paddy soil (2012~2015)



• In 2012, concentrations of 5480 Bq/kg and 5129 Bq/kg were measured at spots on steep slopes in the east-facing hillsides, but in 2013, the levels of radiation had decreased to 3000 Bq/kg or below, at a distance of 30 km from the leaking reactor. This reduction is most likely related to projects for removal or decontamination of radioactive soil. Also, in 2013, concentrations of 15278 Bq/kg and 11289 Bq/kg were measured at spots on steep slopes in the east-to-south-facing hillsides, but in 2014, the levels of radiation had decreased to 3000 Bq/kg or below at the points of the projects in a distance of 20 km from the leaking reactor.



Correlation between radioactive concentration and atmospheric radiation at abandoned paddy soil in 2013



Correlation between radioactive concentration and atmospheric radiation at abandoned paddy soil in 2014

Correlation between distances from Fukushima No.1 Nuclear Plant and radioactive concentration in abandoned paddy soil

• In both 2013 and 2014, locations where atmospheric radiation exceeding the maximum limit, 3.8  $\mu$ Sv/h, which is evacuation reference line, were not identified. As shown in the graph, in 2013, the radiation concentration in abandoned paddy soil became higher as the atmospheric radiation was increased. However, in 2014, the radiation concentration in abandoned paddy soil became lowered as the atmospheric radiation was decreased.

• In 2012, radioactive concentration exceeding the maximum limit was detected in areas outside the evacuation zone, however, in both 2013 and 2014, it was not detected in areas outside the evacuation zone and detected within 30km from the leaking reactor, where is restricted residence area.

## Conclusions

- As a result of this research, radioactive concentrations exceeding the maximum limit were measured at spots on steep slopes in the east-facing hillsides. This is more precise result than the map of radioactive contamination that Minamisoma City has published.
- Removal or decontamination of radioactive soil were seriously started after August, 2014. GIS and satellite data present the decreasing of soil radioactive concentration at many areas, and areas where rice production was resumed.
- The reason is the extension of time for the removal or decontamination of radioactive soil and compensation for damages by the accident of Fukushima No.1 Nuclear Power Plant. Continued sampling and mapping of soil radioactivity is necessary.
- Removal or decontamination of radioactive soil can help resume farming, but other problems such as aging population and a lack of successors are remained to be resolved.

## References

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[http://www.meti.go.jp/earthquake/nuclear/pdf/130808/130808\\_01a.pdf](http://www.meti.go.jp/earthquake/nuclear/pdf/130808/130808_01a.pdf)(2013年8月8日時点);

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