

ANALYSES FOR SOIL SALINITY AT STRAWBERRY FARM BY THE TSUNAMI OF 2011 OFF THE PACIFIC COAST EARTHQUAKE OF TOHOKU USING MULTITEMPORAL TERRASAR-X DATA

**Genya SAITO*, Kuniaki UTO*, Shigeru KAKUMOTO*, Yukio KOSUGI*,
Haruyuki SEKI*, Shinya ODAGAWA* and Hideki SHIMAMURA****

*Value Added Remote Sensing, Innovative Research Initiative, Tokyo Institute of Technology
G2-16, 4259 Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8503, Japan, saito.g.aa@m.titech.ac.jp

**Research and Development center, PASCO Corporation,
2-8-11 Higashiyama, Meguro-ku, Tokyo 153-0043, Japan

KEY WORDS: Strawberry farm, TerraSar-X, Tsunami damage, Salt concentration, The 2011 off the Pacific coast of Tohoku earthquake.

Abstract: On 11 March 2011, the big tsunami of 2011 off Tohoku-Pacific Ocean Earthquake was occurred, and that caused a lot of damage against coastal zone in Iwate, Miyagi, Fukushima and Ibaraki Prefectures. Watari Town had the largest damage area in Miyagi Prefecture and the damage area was about 2,700 ha, 78% of agricultural land has been affected by the Tsunami. Strawberry production is famous in the town, and almost the fields are coastal zone. Field surveys were performed at middle July and early August in 2011 and we determined the soil salinity. The geometric corrected images of TerraSAR-X were used for this studies, and we compared with obtain the intensity of TerraSAR-X data and salinity of soil at the strawberry fields. The TerraSAR-X data are at December 3, 2010 before the earthquake, at March 12, 2011 the day after the disaster, at March 17 2011 after 6 days of it, at May 14 2011, after about two months, and on June 5 2011, after about three months. Using TerraSAR-X images, we could understand distinction between water and non-water area at observation dates. By the images, the status of seawater extraction and retention of the affected areas were able to understand. The salinity of sand soil at very closely to the coast has declined quickly because sands had no capacity to catch ions. In other farmland, salinities of soil at strawberry fields are related with retention periods of seawater by the Tsunami

INTRODUCTION

On 11 March 2011, the big tsunami of 2011 off Tohoku-Pacific Ocean Earthquake was occurred, and that caused a lot of damage against coastal zone in Iwate, Miyagi, Fukushima and Ibaraki Prefectures. Those were well reported that about 20,000 peoples were died or lost, many building were damaged and the nuclear power plants in Fukushima Prefecture were broken by the tsunami. Agricultural damages mainly agricultural infrastructure crushed and flooding at the fields were not well reported. The flooding area of farmland due the tsunami reached 23,600 ha and 64% of which are in Miyagi Prefecture (Rural Development Bureau, Department of Statistics, 2011). The flooding remained debris of trees, houses etc. and salt of sea water. Watari Town had the largest damage area in Miyagi Prefecture and the damage area was about 2,700 ha, 78% of agricultural land has been affected by the Tsunami. In the flooding field, paddy was 1,840 ha (66% of total paddy) and strawberry field was 55 ha (90% of strawberry field). In Watari town, rice paddy field was 2760 ha (80% of agricultural area) and strawberry field was 58 ha (1.7% of agricultural area) before the disaster. The ratio of strawberry area and rice area was 1:50 and the production values were almost same about 20 million USD. Strawberry production is famous in the town, and almost the fields are coastal zone. Strawberry farmers asked us to measure soil salinity at strawberry farm in Watari Town. We compared the TerraSAR-X image (the synthetic aperture radar X-band sensor) and the amount of salt at strawberry fields in the tsunami damage area.

TARGET AREA

Targets were strawberry fields at Watari Town, the salinity of the remaining amount of salt in the soil due to the earthquake tsunami affected areas in Miyagi Prefecture eastern Japan. Fig. 1 is Watari Town of the target area of the study. Fig. 2 is the aerial photos before and after the disaster at Watari Town, (a) is before the disaster at late spring, and (b) is just after the disaster. At (a), it was late spring almost paddy fields were cover with water, and greenhouse using plastic film stood at strawberry fields. In the greenhouse, there were many strawberry plans. At (b), the greenhouses were broken down and sea water is remained at the paddy and strawberry fields.

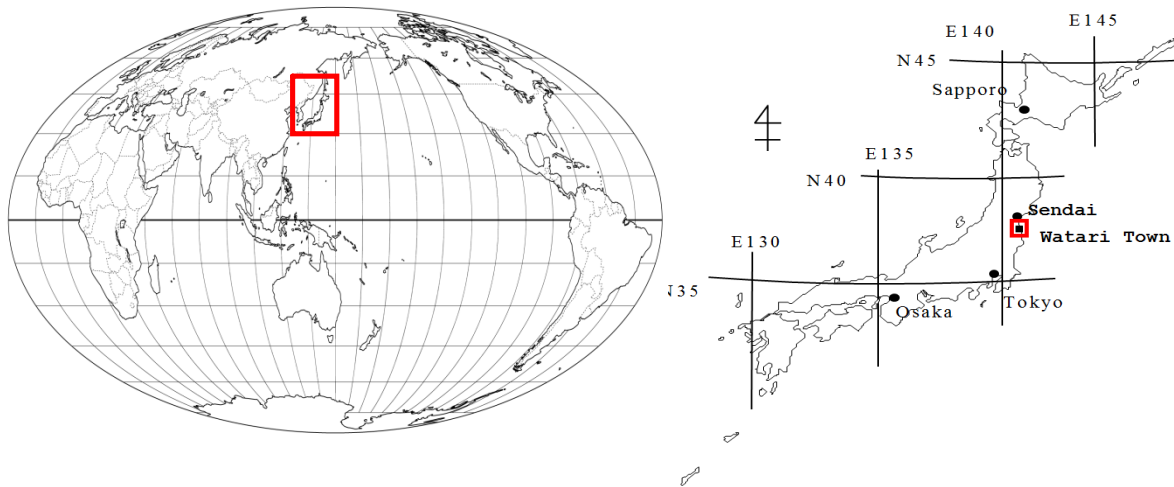


Fig. 1 Watari Town of the target area of the study



(a) Before the disaster at late spring

(b) Just after the disaster

Fig. 2 Aerial photos before and after the disaster at Watari Town (Watari Town, 2011)

FIELD SURVEY AND SALT CONCENTRATION MEASUREMENT

Field surveys were performed at middle of July and early August in 2011 and we investigated with reference to the technical guidelines of Agri-Horticultural Environment Division, Miyagi Prefecture. We measured electric conductivity (EC) and salinity of well water on site, and sampled the top soil (0 - 1 cm depth) and sub soil (9 - 11 cm depth) at 3-5 points in each strawberry field. The samples of soil were analyzed salinity at our laboratory. First, soil water contents were determined by drying the soil. Next, we added distilled water to raw soil to be 5:1 (water : dry soil) and shook for 1 hour. We measured EC, and converted to salinity of the soil. At Fig. 3, salt concentrations are average of top and sub soil and 3-5 points at middle July sampling, and units of quantity are mg salt (NaCl) / 100g dry soil

TERRASAR-X

The geometric corrected images of TerraSAR-X were used for this studies, and we compared with obtain the intensity of TerraSAR-X data and salinity of soil at the strawberry fields. The TerraSAR-X data are at 3 December 2010, before the earthquake (Fig. 4), at 12 March 2011, the day after it (Fig. 5), at 17 March 2011, 6 days after it (Fig. 6), 14 May 2011, about two months after it (Fig. 7), and at 5 June, about three months after it (Fig. 8).

ANALYSIS RESULTS

Using TerraSAR-X images, we could understand the distinction between water and non-water area at observation dates. By the images, the status of seawater extraction and retention of the affected areas were able to understand. The salinity of sand soil at very closely to the coast has declined quickly because sands had no capacity to catch ions. In other farmland, salinities of soil at strawberry fields are related with retention periods of seawater by the Tsunami.

ACKNOWLEDGMENTS

We thank for strawberry farmers of Watari Town to use their fields and the students of our laboratory, Tokyo Institute of Technology and the studies were performed by their activities.

REFERENCES

Agri-Horticultural Environment Division, Miyagi Prefecture, 2011, Technical information of agricultural crops for the Tohoku-Pacific Ocean Earthquake, 2011. (Part 1), [http://www.pref.miyagi.jp/noenkan/nousansyokuryou/gijyutu1\(H230407\).pdf](http://www.pref.miyagi.jp/noenkan/nousansyokuryou/gijyutu1(H230407).pdf), Miyagi Prefecture, Sendai

Rural Development Bureau, Department of Statistics, 2011, Estimation of agricultural land area affected by the (tsunami) Great East Japan Earthquake, <http://www.maff.go.jp/j/tokei/saigai/pdf/shinsai.pdf>, Ministry of Agriculture, Forestry and Fisheries, Tokyo

Watari Town, 2011, Reconstruction plan Watari-cho, <http://www.town.watari.miyagi.jp/index.cfm/22,0,134,282,html?20111214191926882>, Watari Town