

## Helicopter-borne EM survey over coastal areas inundated by the tsunami of March 11, 2011, in northeast Japan

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The Geological Survey of Japan, AIST conducted a helicopter-borne EM survey over inundated areas by the tsunami on March 11, 2011 in northeast Japan 15 months after the 2011 off the Pacific coast of Tohoku Earthquake. The purpose of the survey is to map the electrical resistivity of the ground intruded by seawater during the tsunami for its reutilization as farming lands and water assessment of the area.

The survey was flown in June 2012 at an altitude of 60 m above ground with a speed of 50 km/h along survey and traverse lines spaced 100 m and 1,000 m apart, respectively. The airborne EM system (Fuguro Airborne Surveys' RESOLVE system) was installed in a bird and towed 30 m below the helicopter. This is a frequency-domain system operated at five frequencies (340, 1,500, 6,900, 31,000, 140,000 Hz) in a horizontal coplanar configuration and at a frequency (3,300 Hz) in a vertical coaxial configuration.

The survey area is located at the border of Miyagi and Fukushima Prefectures along the Pacific coast in the southern part of the Sendai Plain and is divided into two sub-areas: Watari-Yamamoto-Shinchi area (area A) and Matsukawaura area (area B). The area A is known for its production of high-quality strawberries on beach ridges and much fresh groundwater has been used for irrigation of strawberries and warming of strawberry greenhouses by water curtain. However, the salinity of groundwater from shallow irrigation wells in this area increased dramatically after the tsunami (Mori et al., 2012). Since it still remains at high level, there is an urgent need to find new water resources. Whereas, the area B is characterized by a beautiful lagoon called the Matsukawaura which is preserved as one of prefectural parks of Fukushima Prefecture. Rice fields occupy the areas west of the Matsukawaura and most of them were covered by seawater during the attack of the tsunami. Desalinization of the rice fields is being conducted intensively to resume rice farming in these fields.

The observed electromagnetic data were processed and apparent resistivity maps were created for each frequencies. As for the apparent resistivity map at a frequency of 140,000Hz, very low resistivities less than 4 ohm-m are dominant over lagoons and river mouths along the coastline, indicating the existence of salt water wedge. Relatively low resistivities (8 - 22 ohm-m) range from close to the coastline up to 4km inland and are edged to the west by high resistivities (64 - 128 ohm-m), corresponding to the maximum inundated area as derived from aerial photos by the Geospatial Information Authority of Japan (2011). These low resistivities might be associated with the effect of seawater intrusions. As the frequency becomes lower, low resistivities areas (< 8 ohm-m) extend to inland, indicating the existence of deep salt water wedges and/or fossil salt water. To verify the results by airborne surveys and confirm the groundwater environment, further studies will be done with shallow drillings as well as with time-domain EM and high-density electrical surveys on ground.

Keywords: airborne EM survey, resistivity, the 2011 Off the Pacific Coast of Tohoku Earthquake, tsunami, groundwater environment, salt damage