2.1.6 Aerial SAR observation

2.1.6.1 Overview

Pi-SAR-L (Polarimetric Interferometric Synthetic Aperture Radar in L-band) is an airborne L-band synthetic aperture radar developed by JAXA and completed in 1996. It is mounted on a Gulfstream II jet airplane and observes a zone with a width of approximately 15 km to the left of the direction of travel from an altitude of around 10,000 m. With transmission power as high as 3,500 W (almost a little less than twice that for satellite-borne SAR) and closer proximity to the targets of observations, Pi-SAR-L is capable of capturing images of exceptional quality. Accordingly, this type of SAR was developed with an eye on future SAR evolution and expansion of the study area. It offers the following advantages: 1) the range resolution is twice as high as that of PALSAR, and the azimuth resolution is five times as high; 2) the noise level is -45 dB (approximately 10 dB lower than that for PALSAR), and 3) polarimetric observation can be made at any time. Pi-SAR-L was put into operation to support the identification of changes in the collapsed crater of Murakoshi Village (2004), Miyake Island's Mt. Oyama (July 2000), Mt. Usu (September 2000) and other disasters. As it is difficult for aircraft to fly as straight as satellites, high-resolution images can be obtained only with highly accurate analysis of data from an inertia navigator on board. For analysis relating to the Great East Japan Earthquake, observations were made on April 4 and April 13, 2011. On April 4, the inertia navigator failed to operate properly, but on April 13, normal images for some areas were obtained and used for analysis as shown below. Figure 2.1-65 gives an overview of an evaluation area encompassing the damaged cities of Higashimatsushima, Sendai and Natori.

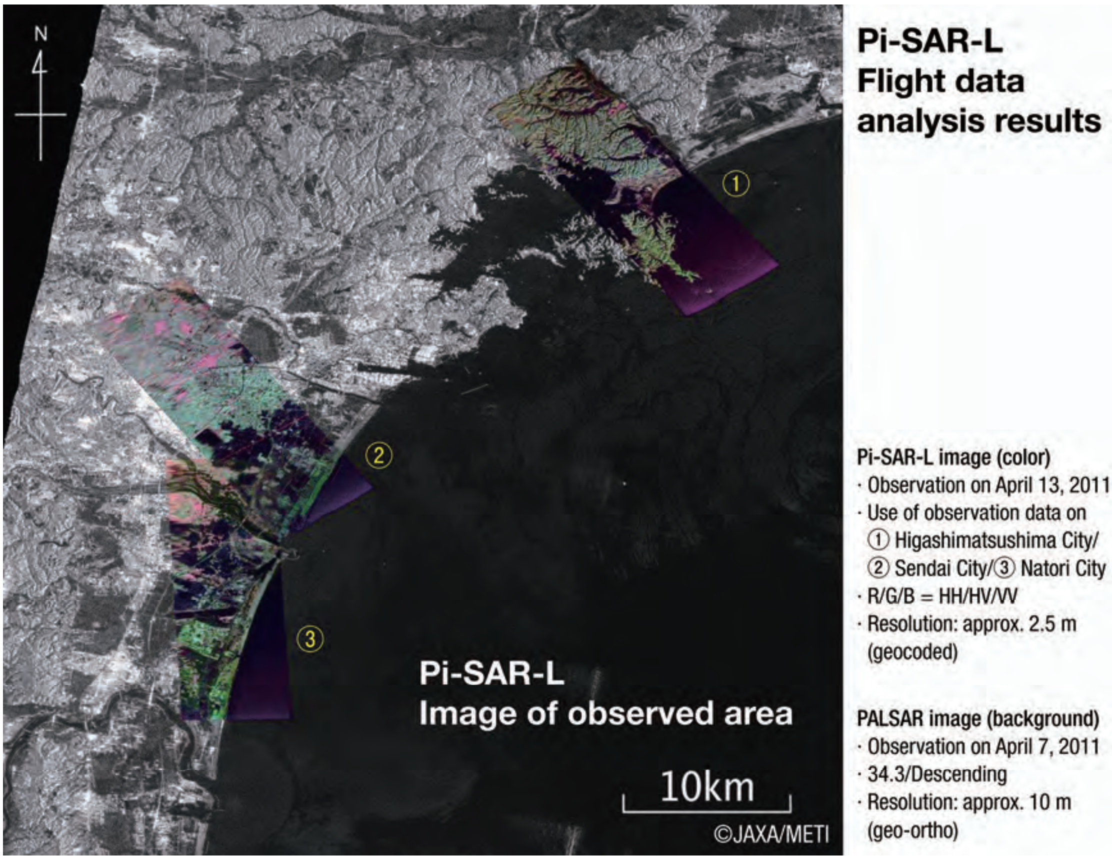

Figure 2.1-65 Pi-SAR-L observation area (PALSAR image in the background, Pi-SAR-L observation zone with a width of 15 km)

2.1.6.2 Analysis of single images

A lack of imagery for April 4 made it impossible to identify changes that had taken place over a period of eight days. Pi-SAR-L images ① and ② were taken by the satellite from a trajectory along the coastline, and image ③ was taken as it moved eastward (see Figure 2.1-65). An enlarged picture of image ③ together with WorldView-2 images is shown in Figure 2.1-66. Although the quality of these images varies greatly (as the resolution of Pi-SAR-L is approximately 3 m while that of WorldView-2 is approximately 50 cm), both satellites captured clear images showing scattered debris. Pi-SAR-L has a full-polarimetric function, and pseudo-natural color images (as shown in Figure 2.1-66 (left)) can be created by converting R-G-B to received signals HH-HV-VV (HV means that horizontally-polarized waves (H) are transmitted and vertically-polarized (V) waves are received), and visibility is improved as a result. Areas shown in green represent piled up objects (volume scattering), while those in purple are solid masses (surface scattering). The images are mostly dark-bluish purple, meaning that the majority of areas were flat. (Scattering intensity is generally higher for VV than for HH on flat surfaces.) With the resolution of Pi-SAR-L, roads, urban areas and buildings can be clearly seen, and close agreement with WorldView-2 images is confirmed. The next-generation Pi-SAR-L (Pi-SAR-L2) is currently being developed with the aim of achieving better resolution with greater stability. It is scheduled to enter full operation in April 2012, and is expected to make high-resolution observations in relation to disasters.

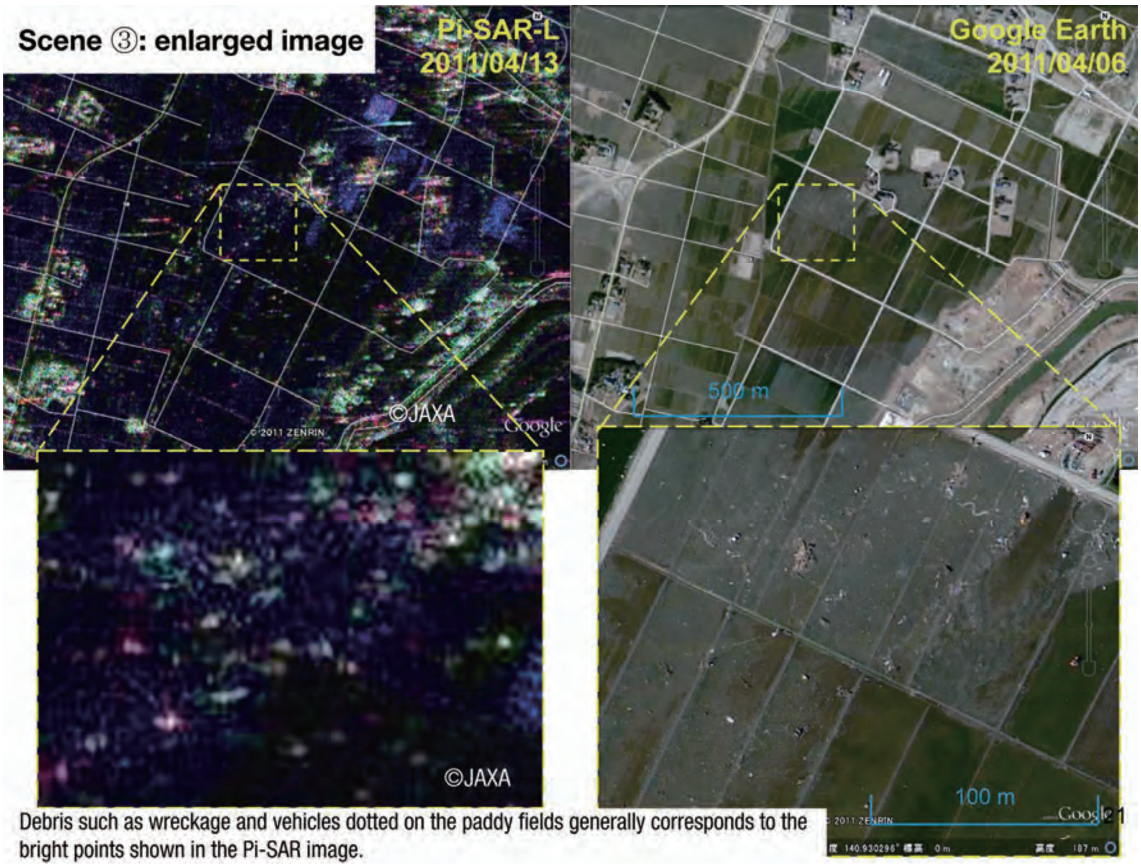

Figure 2.1-66 Comparison of Pi-SAR-L and WorldView-2 images of an affected area in Natori City
Despite a one-week difference between the observation dates, similar patterns of scattered debris are seen in both the radar and the optical images.