



## TerraSAR-X image of the month - Volcanic eruption in Chile

22 July 2011

The crater of the Chilean volcano Puyehue displays a striking, circular outline in this image from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) TerraSAR-X satellite – so this was not the culprit when a volcano in the southern Andes erupted on 4 June 2011. Instead, as the images from the German radar satellite show for the first time, the new eruption centre lies 6.7 kilometres further to the northwest, in the Cordón Caulle region. A field of lava, appearing as a uniform, light blue surface, is currently forming there. Radar images acquired by TerraSAR-X have been providing valuable information to the staff of the Chilean Volcano Hazards Program since the eruption began, helping them to assess the situation and predict its future development.

DLR's Center for Satellite Based Crisis Information (Zentrum für satellitengestützte Kriseninformation; ZKI) confirmed 40.525 degrees South, 72.142 degrees West as the coordinates of the eruption, which they reported to their Chilean colleagues when the natural disaster began. The 'International Charter on Space and Major Disasters' had asked DLR to supply satellite data about this emergency. "The TerraSAR-X images were very useful to us in confirming the location of the site of the eruption," explained geologist Luis E. Lara of the National Geology and Mining Service's (Servicio Nacional de Geología y Minería) Volcano Hazards Program (Programa de Riesgos Volcánicos) in Chile. The volcano expert coordinated the work of a team of experts and their collaboration with other national authorities and organisations in Chile. Scientists on site had already observed that the River Nilahue in the national park was at a temperature of over 45 degrees Celsius, so an eruption in the vicinity of its source was likely. Only the optical data contradicted this assumption: "optical satellite data suggested an eruption site further west." Up to this point, the experts had only been able to observe the volcano from great distances on the ground or during a few cautious overflights, but the cloud cover and large distances made it difficult to assess the situation precisely: "but the exact location of the volcanic vent was extremely important for our computer calculations of the distribution of the ash cloud."

In contrast, the cloud cover was no obstacle for the TerraSAR-X radar satellite, as the radar signals are unaffected by weather. "The ash cloud itself only slightly affected the radar signals, so that the view of the volcano complex in the TerraSAR-X images is almost undisturbed," said Robert Metzиг, from the German Remote Sensing Data Center (Deutsches Fernerkundungsdatenzentrum; DFD). "On the other hand, the effect of the ash particles is still sufficient to clearly identify the eruption column and hence the active crater." Just five days after the location of the new crater had been determined using the images obtained with TerraSAR-X, the weather conditions enabled a flight close to the eruption centre for the first time. The flight confirmed that DLR scientists had accurately calculated the location of the new crater using the radar data.

### Lava field in sight

"This TerraSAR-X image from 6 July 2011 clearly shows that, since the eruption began, a lava field has formed to the west of the new crater; it resembles a lake in the radar image," says Robert Metzиг. "The dark areas in the higher elevations of the Puyehue National Park around the crater and the new eruption site are largely due to wet snow, which only reflects a small proportion of the radar signal back to the satellite." A combination of optical satellite images and radar images enables scientists in the field to continue observing the development of the volcano. "The optical satellite images give our colleagues in Chile the opportunity to observe the

distribution of the ash cloud, and the radar images show the source of the eruption and any changes that might occur."

The Puyehue-Cordón Caulle volcanic chain, located roughly 750 kilometres south of the capital, Santiago de Chile, has been showing signs of an impending eruption since April 2011. The last time the volcano spewed out lava and ash was in 1960. Now, with the eruption of a new, smaller crater, ash was ejected up to 10 kilometres into the atmosphere, soon reaching the Argentine capital, Buenos Aires, 850 kilometres away, and the Uruguayan capital, Montevideo. The ash cloud even disrupted air traffic to Australia and New Zealand. Thousands of inhabitants in the region have had to evacuate their homes and move to emergency shelters, on the recommendation of the Programa de Riesgos Volcánicos.

### **The TerraSAR-X mission**

TerraSAR-X is the first German satellite that has been manufactured under what is known as a Public-Private Partnership between the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and Astrium GmbH in Friedrichshafen. The satellite travels around the Earth in a polar orbit and records unique, high-quality X-band radar data about the entire planet using its active antenna. TerraSAR-X works regardless of weather conditions, cloud cover or the absence of daylight and is able to provide radar data with a resolution down to one metre.

DLR is responsible for using TerraSAR-X data for scientific purposes. It is also responsible for planning and implementing the mission as well as controlling the satellite. Astrium built the satellite and shares the costs of developing and using it. Infoterra GmbH, a subsidiary company founded specifically for this purpose by Astrium, is responsible for marketing the data commercially.

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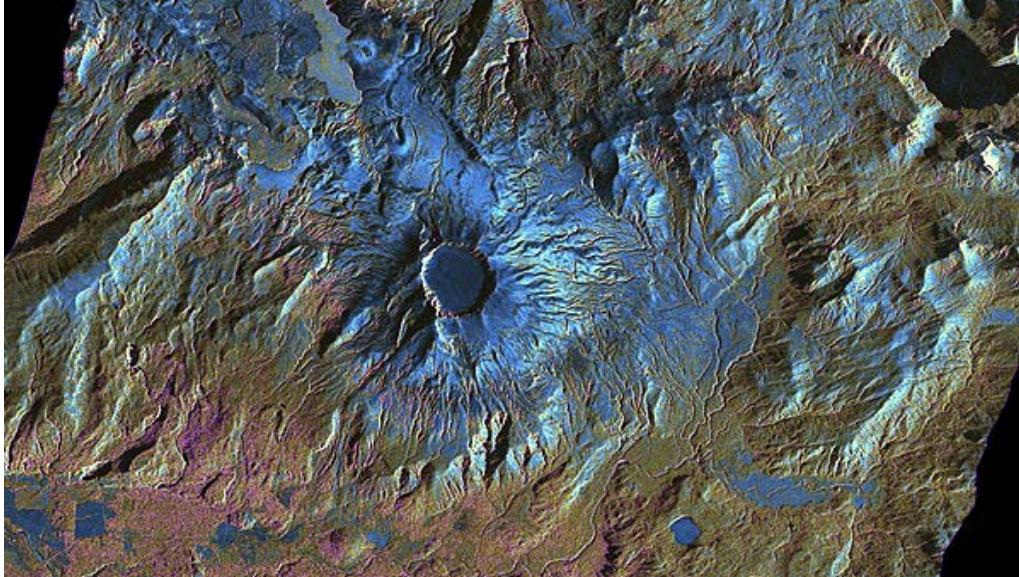
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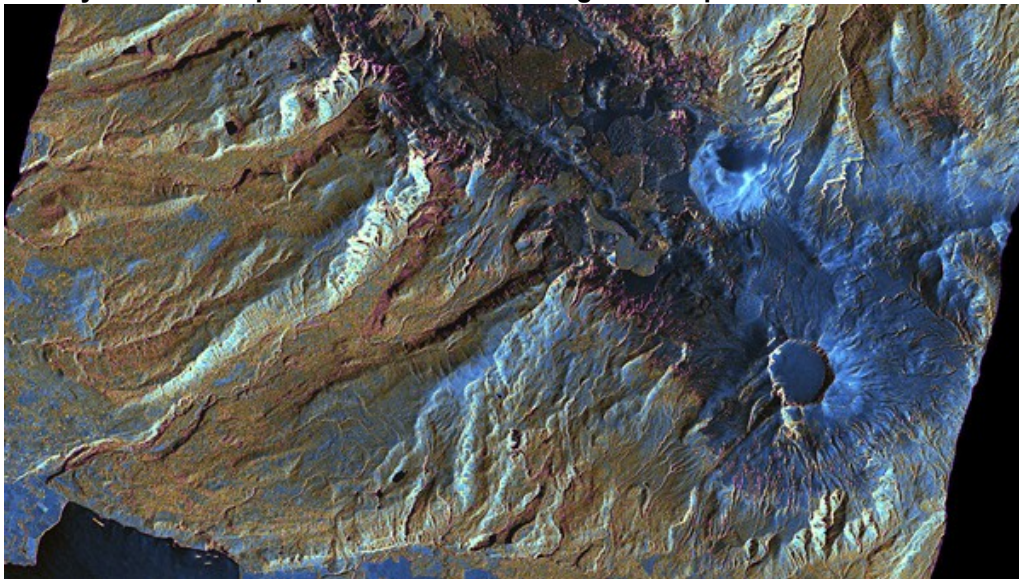
### The Puyehue-Cordón Caulle volcano region on 6 July 2011 – a month after its eruption



In this image of the Puyehue-Cordón Caulle region, acquired by TerraSAR-X on 6 July 2011, a newly formed lava field is visible northwest of the prominent Puyehue crater. The light blue coloured area is the lava field that has formed to the west of the new crater.

Credit: DLR.

### Shortly after the eruption – a radar view through the eruption column



This image, acquired by TerraSAR-X on 8 June 2011, reveals the eruption site more clearly. At the time of acquisition, shortly after the start of the eruption, no lava was being discharged from the volcano and consequently, no lava field is visible. However, the new eruption site in the Cordón Caulle area stands out clearly from its surroundings – light blue against a dark background – and the edge of the new, elliptical crater can be clearly distinguished. The ash particles in the eruption column, which at that time was enormous, are disturbing the radar signals slightly; this is revealed by the presence of a dark 'cloud' north of the new crater, optimally located in order to permit clear identification of the active crater.

Credit: DLR.

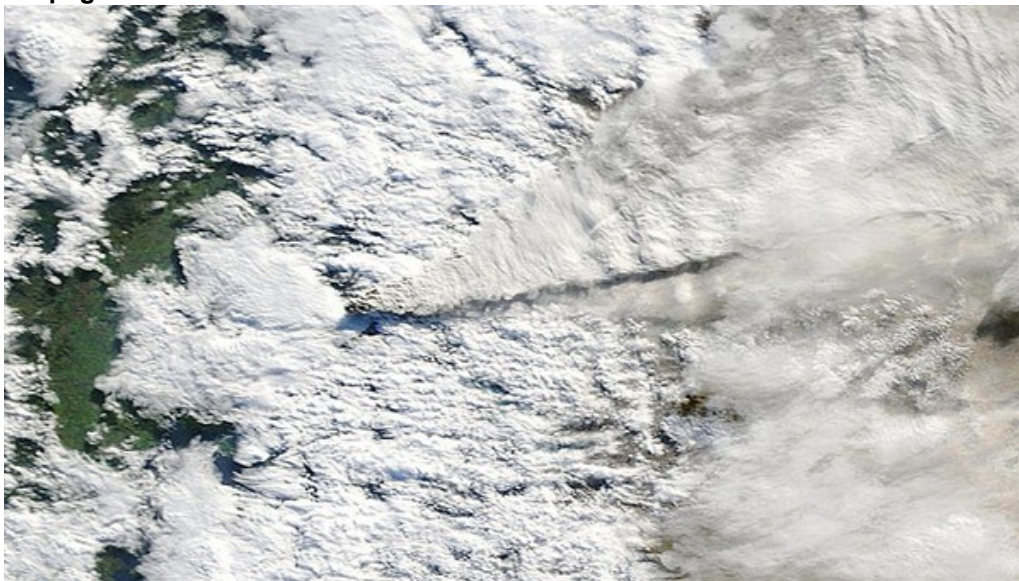
### **Aerial photograph of the Cordón Caulle area**



This aerial photo, taken on 20 June 2011 confirmed the precision of the location of the eruption site, just north of the former hot springs Los Baños, calculated using data from TerraSAR-X. Following the eruption, the lava rushed down the slope of the volcano, forming the lava field. Small mud flows, or lahars, are visible at the front of the lava flow, and are formed due to the melting snow. The volcano erupted on 4 June 2011.

Credit: J.Muñoz/Sernageomin .

### **Propagation of the ash cloud**



While the TerraSAR-X images, unaffected by the clouds, obtained on 8 June 2011, show the emerging eruption, the optical images captured with NASA's Terra satellite clearly detect the propagation of the ash cloud on the same day. Thus, optical satellite images, combined with radar images help the scientists on site to assess the further development of the situation.

Credit: NASA/GSFC, Rapid Response .

## Taking samples from the River Nilahue



A team from the Chilean Volcano Hazards Program takes samples from the River Nilahue. The new vent lies in the headwaters of the river, first confirmed with the TerraSAR-X image Obtained on 6 June 2011. The Chilean authorities had evacuated the valley due to the risk of mud slides (lahars).

Credit: Volcano Hazards Program/Sernageomin.

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