



Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

Volcano Monitoring Updates Saba and St. Eustatius 2017-2018

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Updates sent by email to local governments
2017 -2018

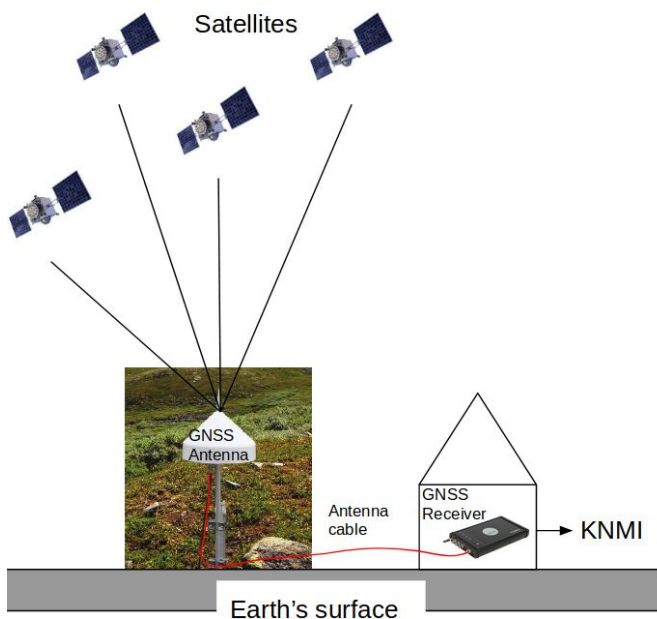
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A. UPDATE 1 – GNSS instruments, 6 June 2017, Saba and St. Eustatius.

Currently KNMI monitors the geological activity at the islands of Saba and St Eustatius with broadband seismometers. These register the *shaking* of the Earth. KNMI plans to expand this network with so called “Global Navigation Satellite System” observations (GNSS). GNSS instruments monitor the *movement* of the Earth.

Multiple satellites orbit our planet. Signals from these satellites can be picked up at the surface using an antenna. From the antenna data are transmitted to the receiver. When the signal of several satellites is received at the same time, the precise location (latitude, longitude and altitude) of the antenna can be identified with centimeter precision. By installing a continuously operating antenna/receiver, the precise location of this point can be monitored through time.



To install the antenna at a permanent location, a so-called “monument” will be created. This basically means that the pole on which the antenna will be mounted is securely cemented into a hole drilled into rock. Data from these GNSS instruments will be sent automatically to KNMI for analysis. They can be used, on a regional scale, to study how the islands move due to plate tectonics (movements of the Earth’s crust), but also more locally to identify if the surface of the volcano remains stable. Together with the seismic data this will allow improved monitoring of the state of the volcano.

Aim is to install the first GNSS instruments (one at each island) in the last quarter of 2017.

B. UPDATE 2 – GNSS instruments, 6 November 2017, St. Eustatius.

In the past months, KNMI purchased two Global Navigation Satellite System (GNSS) instruments, which will be dedicated to the observation of geophysical processes at Saba and St. Eustatius. The instruments are currently deployed and tested at KNMI. The data will be used, on a regional scale, to study how the islands move due to plate tectonics (movements of the Earth's crust), but also more locally to identify if the surface of the volcano remains stable. Together with the seismic data this will allow improved monitoring of the state of the volcano.

Due to the passing of Hurricanes Irma and Maria, the installation of the instruments is postponed till early 2018, when we will visit the island with a team of 3-5 people.

Attached is a letter asking permission from the local government to create the monument on which the antenna will be permanently installed (close to the EUTEL building just North of Kay Bay). We have also asked EUTEL for their support in establishing facilities for data transmission.

C. UPDATE 2 – GNSS instruments and temperature logging of the hot spring, 6 November 2017, Saba.

In the past months, KNMI purchased two Global Navigation Satellite System (GNSS) instruments, which will be dedicated to the observation of geophysical processes at Saba and St. Eustatius. The instruments are currently deployed and tested at KNMI. The data will be used, on a regional scale, to study how the islands move due to plate tectonics (movements of the Earth's crust), but also more locally to identify if the surface of the volcano remains stable. Together with the seismic data this will allow improved monitoring of the state of the volcano.

Due to the passing of Hurricanes Irma and Maria, the installation of the instruments is postponed till early 2018, when we will visit the island with a team of 3-5 people.

Attached is a letter asking permission from the local government to create the monument on which the antenna will be permanently installed (at St. Johns). We have also asked SATEL for their support in establishing facilities for data transmission.

KNMI plans to install a temperature logger at the hot spring opposite Green Island. This logger will measure and store the temperature of the hot spring several times per day for a period of at least 2 years. Monitoring of the temperature through time will give insight into the seasonal variations of the temperature as well as increases due to a change in volcanic activity.

D. UPDATE 3 – Two operating GNSS instruments, 12 March 2018, St. Eustatius.

In January 2018 KNMI installed the first GNSS instrument at the White Hook EUTEL facility, followed by a second installation in January 2019 at the airport (Fig. 1). Both instruments are operating as expected and data are sent to KNMI automatically every hour. Data transmission is facilitated by continued support from EUTEL.



Fig. 1 GNSS installation by White Hook (left) and at the airport (right). The white part at the top is the antenna which receives the signals from satellites orbiting the Earth.

The instruments are subject to the harsh environmental conditions on the island and will have to be maintained every year to ensure their continued operation. KNMI will take charge of this task. The primary cause of marine corrosion in coastal areas is the chloride ions in the air from the evaporated sea salt in ocean spray, this is made worse by the high temperatures, which speed up the reaction time, even corroding stainless steel (Fig. 2).



Fig 2. Corroded stainless steel leveller after 1 year of exposure to the elements at White Hook (left). After maintenance the leveller looks as good as new (right).

During every visit each seismometer is visited and inspected for proper operations. The 3 current seismometers, at White Hook, the airport and at a private property, operate as expected. A further expansion of the monitoring network is planned for 2020, in the Miriam C Schmidt botanical gardens. This setup would consist of a seismometer and a GNSS instrument which operate autonomously using solar panels and a satellite connection to transmit the data. The GNSS antenna would be placed on top of the boulder (Fig. 3), the GNSS receiver and seismometer would be placed in a vault which would be constructed and designed especially for this purpose and placed on the already existing concrete slab (Fig. 3). We are working with STENAPA to make this installation possible.



Fig. 3 Photos of the boulder on which the GNSS antenna, similar to the one at Wite Hook, would be placed (left) and the concrete slab which would house the vault for the GNSS receiver and seismometer (right).

E. UPDATE 3 – Two operating GNSS instruments and temperature logging of the hot spring, 12 March 2018, Saba.

In January 2018 KNMI installed the first GNSS instrument at St Johns, followed by a second installation in February 2019 at the airport (Fig. 1). Both instruments are operating as expected and data are sent to KNMI automatically every hour. Data transmission is facilitated by SATEL.

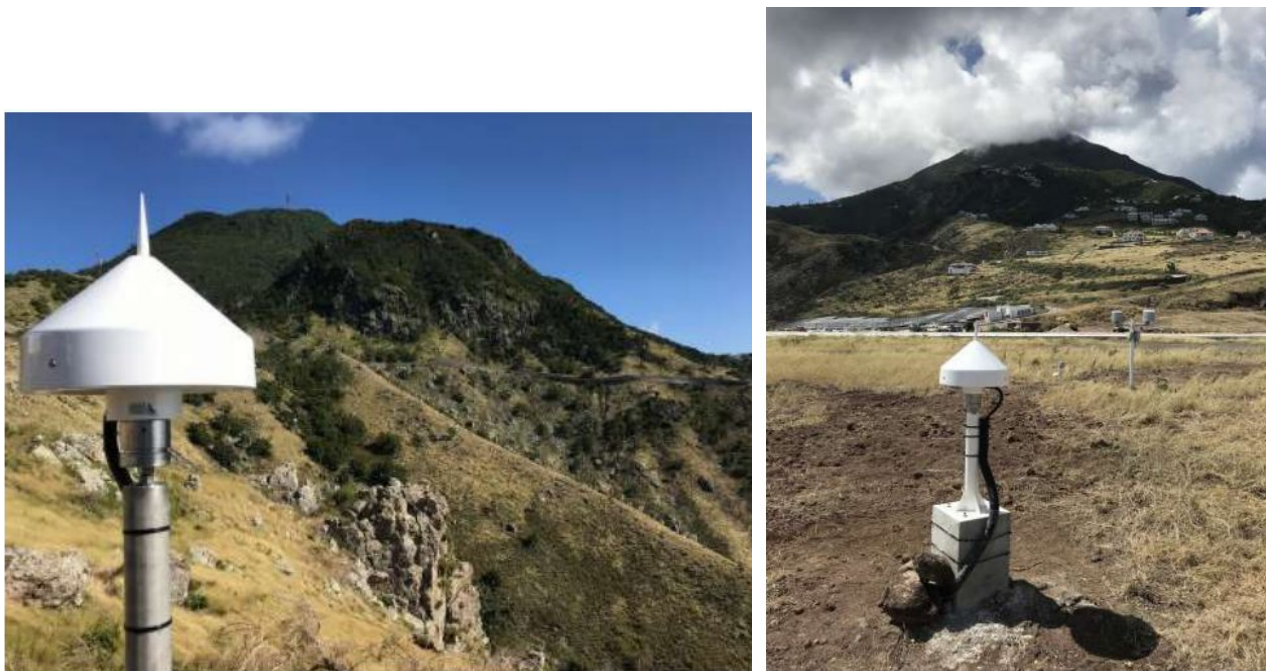


Fig. 1 GNSS installation by St. Johns (left) and at the airport (right). The white part at the top is the antenna which receives the signals from satellites orbiting the Earth.

The instruments are subject to the harsh environmental conditions on the island and will have to be maintained every year to ensure their continued operation. KNMI will take charge of this task. The primary cause of marine corrosion in coastal areas is the chloride ions in the air from the evaporated sea salt in ocean spray, this is made worse by the high temperatures, which speed up the reaction time, corroding even stainless steel (Fig. 2).



Fig 2. Corroded stainless steel leveller after 1 year of exposure to the elements at St. Johns (left). After maintenance the leveller looks almost new (right).

In January 2018 a temperature sensor was installed at the hot spring opposite Green Island. This sensor takes one measurement every 20 minutes and stores the data locally. The measurements will form a time series, which will give more detailed information about temperature changes of the hot spring, compared to the single temperature measurements taken so far. The site was revisited in November 2018, when data were collected and new temperature probes were installed. In February 2019 we collected data once again and improved the installation.



Fig. 3 Temperature measurements of the hot spring opposite Green Island, in January 2018 (left), November 2018 (middle) and February 2019 (right). Temperature probes are buried in the ocean bed and covered with rocks to keep them in place. The data loggers are the small yellow cases mounted on the rock above the spring and housed in a black pelican case for additional protection from the elements in the most recent setup.



During every visit each seismometer is also visited and inspected for proper operations. Due to damage of one of the seismic dataloggers currently 3 seismometers are in operation at The Bottom, St. Johns, and Windwardside. The fourth seismometer will be reinstalled at the airport after repair (Fig. 4) as discussed with Maegan Hassell.

Fig. 4 The foreseen location for the fourth seismometer, underneath the stairs to the airport tower.

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