



# Environmental Research with GNSS

by Agnes Zeiner

**On three closely linked interdisciplinary projects, two of which are within the remit of the Competence Center Environment and Sustainability of the ETH Domain (CCES), the Institute of Geodesy and Photogrammetry (IGP) at the Swiss Federal Institute of Technology Zurich (ETH) opted for the Leica GRX1200 reference station receiver. The scope of the projects extends from research into tectonics, the movements of block glaciers right up to the determination of atmospheric water vapour content. The common denominators are sustainable studies in the fields of energy and environmental catastrophes as well as the Leica ATHENA Program for Higher-Education and Non-profit Organizations.**

“The three projects demonstrate how GNSS can be used in a wide range of research. We see GNSS as a valuable multifunctional tool in geodetic seismology and tectonics, in hazard monitoring and last but not least in atmospheric research,” explains Professor Alain Geiger from the Geodesy and Geodynamics Lab (GGL) at the Institute of Geodesy and Photogrammetry. The aim is to make new discoveries and gain better knowledge of particular processes so that natural

catastrophes can be predicted and even more importantly, averted.

## **Earthquake Research**

In COGEAR (COupled seismogenic GEohazard in Alpine Regions), an ETH Domain project in the canton of Valais, high-precision Leica GRX1200 reference stations are used to study tectonics, in particular the long-term movements of the earth’s crust and to detect the displacements arising from earthquakes. “This task requires a whole network of stations,” explains Geiger. The project studies earth crust movements and the team around Geiger hopes to highlight zones under high and increasing strains. “We also wish to research earthquake risks in the Alpine area and the associated displacements that could lead to soil slips and rock falls,” says Geiger.

## **Water Vapour**

APUNCH (Advanced Process UNderstanding and prediction of hydrological extremes and Complex Hazards), another ETH Domain project, uses Leica GRX1200 reference stations to determine the distribution of water vapour in the atmosphere. “If a network has enough receivers, the high-precision measurements can be processed to reveal a three-dimensional image of the distribution of atmospheric

water vapour,” explains Geiger: “Water vapour and rain are at the start of the chain that can lead to flooding, soil slips and build-ups of water. We wish to work out when and how much rain will fall by studying the whole chain.”

### Block Glaciers

In the third project X-Sense, part of the Swiss federal programme Nano-Tera, research is taking place on block glaciers, among them the Dirru in the Mattertal valley. “In this study we are looking into the detailed movements of block glaciers and trying to assess the potential risk of slips, because thawing block glaciers pose a danger for whole valley communities,” says Geiger, who along with Dr. Philippe Limpach and doctorate students is supporting this project from the GNSS side. Low-cost receivers from a third-party supplier are used as local references on the glacier, with the Leica GRX1200 GNSS receiver acting as the regional reference instruments. The Computer Engineering and Networks Laboratory from ETH Zurich, the Department of Geography from the University of Zurich, the Swiss Federal Office for the Environment and the company GAMMA Remote Sensing are working alongside Geiger’s team on the X-Sense project.

The three projects are spread over a period of time and overlap one another and will take up to six years to complete. “The GNSS stations, which are used for all three projects and form our ‘backbone network’, will be maintained afterwards. To augment the information from the reference stations, we are working very closely with the Federal Office of Topography (swisstopo), we can use its AGNES network as a higher-order reference network and therefore also include its data, for example, in our atmospheric research,” explains Alain Geiger.

### The Leica ATHENA Program

The use of the high-precision GRX1200 reference stations falls within the framework of the Leica Geosystems ATHENA Program. ATHENA stands for “Advanced Technology for Higher-Education and Nonprofit Associations”. The objective is to support academic and research bodies with the latest GNSS and monitoring technology. ■

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■ Reference station on a swisstopo trig point above the Randa avalanche zone (Wallis Canton, CH). The Dirru block glacier can be seen on the opposite side of the valley.

## ETH Domain and the CCES

In addition to the two universities of applied sciences, ETH Zurich and EPF Lausanne, ETH Domain also includes four federal research establishments:

- Paul Scherrer Institute (PSI),
- Swiss Federal Institute for Forest, Snow and Landscape Research (WSL)
- Swiss Federal Laboratories for Materials Testing and Research (Empa)
- Swiss Federal Institute of Aquatic Science and Technology (Eawag)

The ETH Board has supported four theme-oriented competence centres for interdisciplinary research in which the relevant areas of each institute work closely together. They form a platform that interlinks basic research and applied research to produce innovations with economic or social benefits and provides a point of contact for external enquiries. One of these is the Competence Center Environment and Sustainability of the ETH Domain (CCES).