

## Modernisation of the Swiss Vertical Reference System

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The concept of altitude is not solely based on geometry, as a typical user of altimetric data might initially perceive. Instead, it is also based on physical definitions. A GNSS (Global Navigation Satellite System) measurement results in an ellipsoidal altitude, which is purely geometric. However, only physical heights which take into account the Earth's gravitational field, meet practical requirements, and allow measurements from different techniques to be combined, such as levelling with GNSS measurements. For several years, the quantity and utilisation of 3D geodata are surging, heavily driven by the rapid technological advancements in satellite-based GNSS, which allow a centimeter-level accuracy. This evolution underscores the constraints of the current swiss vertical reference system LN02, a century-old legacy built upon leveling measurements, which struggles to meet the contemporary requirements for absolute altimetric determination. The differences between LN02 and a rigorous height system is currently from 30 up to 40 centimetres (Schlatter, 2007).

In this context, the School of Engineering and Management HEIG-VD, in close collaboration with the Federal Office of Topography swisstopo, has launched a study on the modernisation of the height reference system and frame in Switzerland.

This study covers the technical and normative aspects to be defined to allow a system change, including international comparison. An initial report has been published on this matter (Willi and al., 2022).

Part of this study consists of establishing the main characteristics of existing altimetric information (analog and digital) by drawing up a technical questionnaire targetting all users of altimetric data in Switzerland. The results show that over 90% of altimetric data is managed in the official swiss reference frame LN02, but that around 40% of data is first acquired by GNSS before being transformed into LN02, leading to a deterioration in data accuracy.

The study should also raise awareness among professionals and users of altimetric data, so that they can better anticipate any transition. Several videos were produced for this purpose, and the questionnaire helped identify the kind of problem expected by data managers. The main concern related to the risk of confusion between the old and new height references. The second main concern is the lack of communication between the various professions and understanding the new height system.

Investigations related to an altimetric system change will continue. This includes defining the new height system, creating and evaluating transformation tools. For the definition, the current choice is to use normal heights. The new altimetric system will be compatible with higher-level systems, such as global

measurement systems like GNSS, and will have a kinematic component, allowing to take into account movements of the Earth's crust.

#### REFERENCES

Schlatter A. 2007. Das neue Landeshöhenetz der Schweiz LHN95, Schweizerische Geodätische Kommission, 328.

Willi D. and al. 2022. Studie zur Modernisierung des Schweizer Höhenbezugssystems und -rahmens (Teil I – Grundlagen, Stand der Technik und internationaler Vergleich), Geodäsie und Eidgenössische Vermessungsdirektion, Report 22-07.