

Soil Survey in Switzerland

L-F Bonnard

Eglantine 12, CH-1006 Lausanne, SWITZERLAND

[formerly of: Swiss Federal Research Station for AgroEcology and Agriculture
CH-8046 Zurich–Reckenholz, SWITZERLAND]

History and Development

The specific interest in soil survey in Switzerland began in the early 1950s in connection with academic training and teaching in agricultural chemistry at the Department of Agriculture of the Federal Institute of Technology, Zurich. It also originated from the agronomic research performed in various Experimental Stations and Schools of Agriculture. No soil survey as such had previously been carried out in Switzerland.

Various studies relating to nutritional elements, soil water, mineral and organic fractions were ongoing, and the need to study the soil as an entity *per se*, and no longer only as the existing physical framework supporting and feeding plants, came to be recognised. As part of this new interest, studies of the morphological, chemical and physical properties of soil profiles developed along with those on the spatial variability of soils within the landscape. Thus soil cartography in Switzerland was born (Frei and Juhasz, 1963).

The promotion of soil cartography as a basis for agricultural planning (Frei, 1959; Frei *et al.*, 1969; Bonnard, 1972; Bonnard *et al.*, 1988) was mainly by the Swiss Federal Research Station for Agronomy (FAP), along with other institutions (Alther, 1976; BGS/SSP, 1985a). Initially interest was local (Bonnard, 1982) but this gradually extended to regional (Frei and Juhasz, 1965, 1967); Frei and Guyer, 1968; Dietl and Jäggli, 1972), and national levels by demand.

The nomenclature and classification of soils became an important issue. The taxonomic system developed by Pallmann (1947) was adopted. In it water regime and the physical soil composition were rated as primary factors (Peyer and Frei, 1992).

Soil surveys have been undertaken since the beginning of the 1960s to evaluate the quality and potential of agricultural soils, mainly at the time of ongoing land improvement such as the

redistribution of real estate, land drainage or irrigation works (Peyer *et al.*, 1976).

It was considered important to establish and develop a rating system (Frei, 1961) which could be applied to the various topo-climatic regions of Switzerland (FAL, 1997). Other issues that currently require a knowledge of soils and their distribution include among many: the storage of sewage sludges and the safeguarding of cultivable land for food security.

In 1977 a long-term project to survey the soils of the whole of the country at a scale of 1:25,000 was initiated, with priority being given to the agricultural Midlands.

Soil Maps

Numerous soil maps have been prepared over the last 30 years, most of which were by staff of FAP. Many are in the form of unpublished manuscripts, with issues of 1 to 5 copies. Some are of several tens to hundreds of hectares, others represent whole regions. Others cover the whole country apart from the highest mountains but at a coarser scale.

The scales of the maps vary from 1:1,000 to 1:1,000,000, with the detail of the information provided varying accordingly (Frei *et al.*, 1966; Peyer, 1983) (Table 1).

Most of the maps are biased towards agriculture (Gratier, 1986), and are capable of being used to indicate the suitability of soils for drainage or irrigation, for different crop rotations, or the capacity of soils to absorb liquid manures, especially sewage sludge (Peyer *et al.*, 1977).

Thematic maps are derived from basic pedological surveys to indicate crop suitability, agricultural land values, hydrology, amongst others. Forest soils, because of their specific nature, were mapped separately and their evaluation took into account tree density (BUWAL, 1996).

Table 1 Main published soil maps of Switzerland

Maps	Date	Publisher	Scale	Area
Soil map of Switzerland (Annex to Geotechnical map of Switzerland)	1934 1st Ed 1964 2nd Ed	Geological Commission of the Swiss Academy of Sciences	1:1,000,000	35,000 km ²
Map of Soil Capacity for Agriculture in Switzerland	1973	Federal Offices for Agriculture forestry and land planning	1:300,000	35,000 km ²
Map of Soil Capacity for Agriculture in Switzerland 3 folios (Solothurn, Zurich, Geneva)	1976		1:50,000	Each 840 km ² Total: 2,520 km ²
Map of Soil Capacity of Switzerland	1980	Federal Offices for Agriculture forestry and land planning.	1:200,000	35,000 km ²
Soils Overview. (in Atlas of Switzerland)	1984	Federal Office of Topography	1:500,000	35,000 km ²
Soil maps at 1:25.000 scale	Since 1981	Swiss Federal Research for Agronomy	1:25,000	Each 210 km ² Total: 2730 km ²
Diverse soil maps	Since 1970	Various Cantons (Zurich, Basel, St-Gall, Jura, etc.)	1:5,000 to 1:10,000	Hundreds to thousands of hectares

In addition to maps made on request, the FAP undertook a systematic survey of the national territory at a scale of 1:25,000 from 1977 onwards. So far 13 folios have been published (Figure 1) covering some 2730 square kilometres.

The mapping has been carried out according to the procedures outlined in Figure 2. Field information has been obtained from soil trenches, specially dug soil profiles and through a network of manually or hydraulically excavated 1-2 metre deep boreholes, the density of which relates to the needs and scale of the survey.

Boundaries on maps were delineated by geomorphological analysis (interpretations in the field and on aerial photographs of topography, geology and position in the landscape). Additionally, soil analysis (granulometry of the fine fraction, pH, lime content and organic matter) is used to support delineations in the field.

The legend of most maps, particularly large scale ones, are set up to provide information on both pedological classification and agricultural applications. Broad categories are established which include information on 'water regime' and soil depth (suitability for plants).

Soil Monitoring

Given the political organisation of Switzerland on the basis of a strict federal system, and consequently the power of the twenty three Cantons to settle territorial issues, there is no national office in charge of the study and survey of soils. It was only in 1986 that, as a result of a federal law on environmental protection, the central state established a control network to monitor the diffusion of pollutants in the soils of Switzerland (NABO).

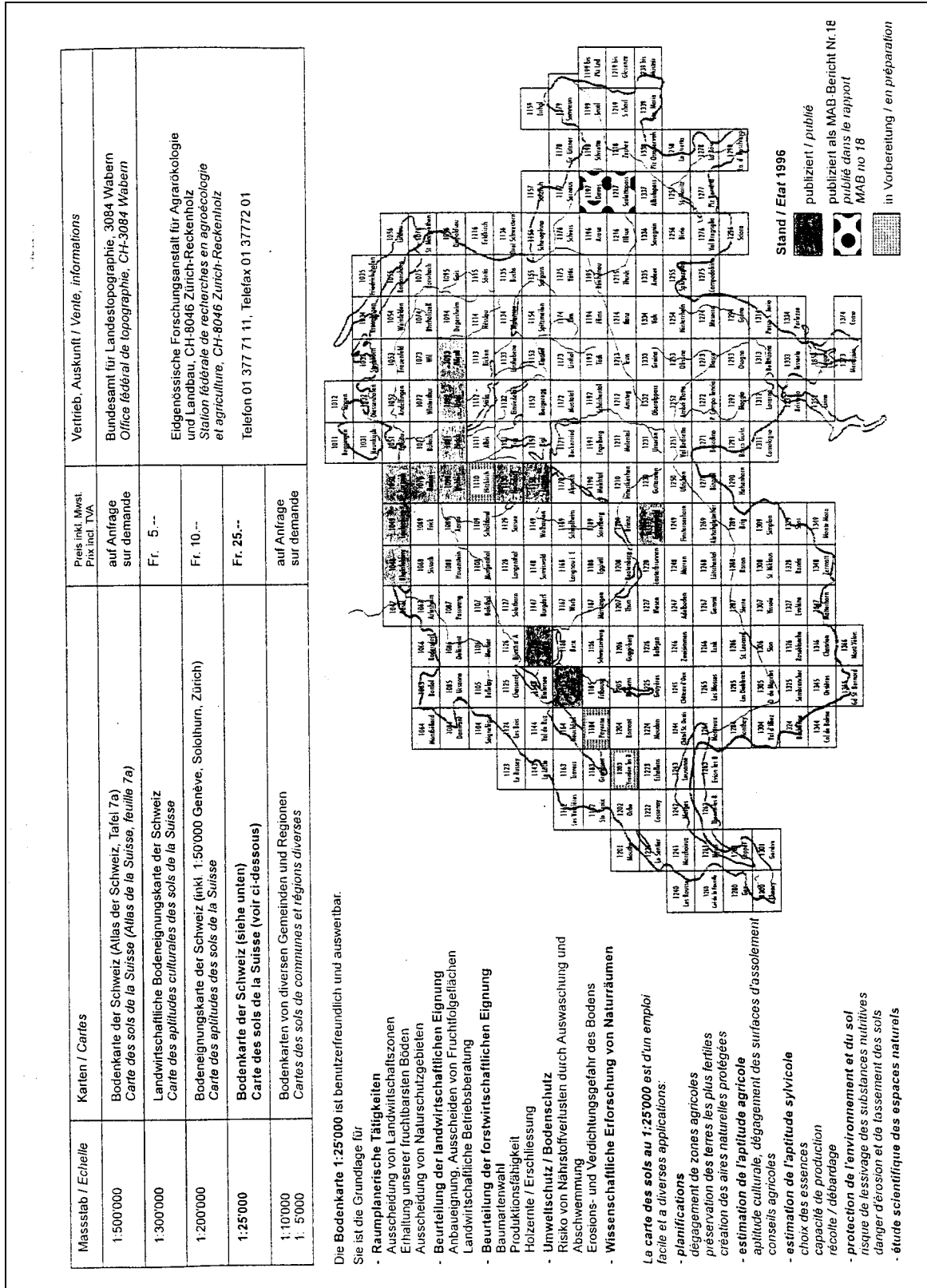


Figure 1: Overview of the maps at scale 1:25,000 published nowadays

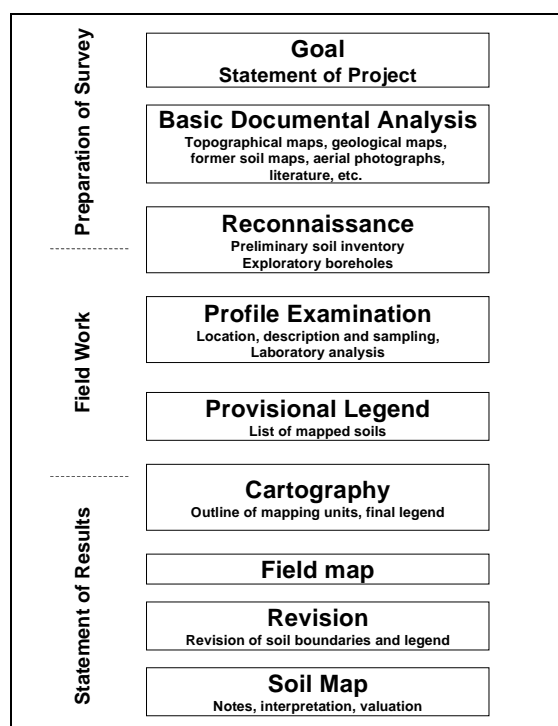


Figure 2: Scheme for Preparation of Soil Maps

This network follows an existing programme designed and run by the individual Cantons to detect chemical, biological and physical degradation in the soils. Apart from some localised problems of heavy metal contamination, the first results of the national programme gave no major cause for concern. The results are as yet incomplete with respect to organic pollutants.

The extension of the built environment in a country with limited space for agricultural production, with overpopulation and a high level of industrialisation, has become a major issue of concern over the past 20 years (BGS/SSP, 1985b).

Food autonomy is far from being achieved in spite of increased agricultural yields associated with crop selection, improved methods of cultivation and land improvement. The reduction in the size and amount of 'natural zones' and the extension of the area of built structures in the landscape have provided an incentive to survey the remaining 'green' areas as a basis for a preservation plan.

Some of the Cantons, challenged to undertake such surveys, drew up thematic soil maps indicating the possible areas for different crop rotations. In addition to these measures a national soil research programme was set up between 1985 and 1991 (Häberli, 1991) aimed at promoting a more cautious, more conservational approach to the Swiss soil resources. The intention was to reduce

losses to the construction industry, maintain soil fertility, safeguard natural sites and encourage the adoption of more sustainable ways of managing the soil resource.

Soil Databases

Thousands of profile descriptions and analyses are stored at the FAP, following numerous research studies. Further data is kept in various archives in the institutions of the Polytechnical Schools (forestry, agronomy, land engineering, earth sciences, ecology) and at the Higher Technical Schools, among others. A computerised database is foreseen to improve the organisation and availability of these data. Future soil maps, especially those at 1:25,000 scale, will be digitised.

Applications of Soil Data

As most of the large and medium scale maps were requested by official agencies to evaluate land fertility, crop rotation, capacity to retain liquid fertilisers, among many applications, use has generally been made of the maps. Maps at a scale of 1:25,000 are intended to support agricultural planning and teaching. Their use is mainly at the level of the Canton because of their scale (Muller and Zihlmann, 1987; Peyer, 1982).

Maps at a scale of 1:200,000 are a reference for all federal officers working in agriculture, forestry and the environment. Maps, soil descriptions and analyses support investigations of environmental issues. Studies of soil erosion and compaction, both problems accentuated by modern farming techniques such as enlargement of field size and increasing weight of cultivation and harvesting machinery, benefit from soil data.

Outlook

It is expected that soil surveys will have an increasing part to play in maintaining a sound, sustainable environment. In the future, soil mapping contracts are likely to be awarded to the private sector, with the companies using methods suggested by the FAP or similar organisation. Despite this, divergent methods of soil mapping are likely to make it difficult to compare soil data from one study to another.

To try to limit these likely problems, the Swiss Pedological Society, founded in 1975, has set up a Working Group, the aim of which is to maintain a level of consistency in cartographic methods, terminology used and interpretation of results.

In the past, soil maps have proved their usefulness and have been widely accepted as important references. The increasing care for the study, control and maintenance of the environment, as

well as the requirements of food production that is more respectful of land and water supplies, confirm the need for future extensive use of soil surveys and the information they generate.

References

- Alther, E.W. (1976). Die Anwendung von Bodenkarten bei der Schaffung von Landwirtschaftszonen. Mitt. f.d. Schweiz. Landwirtschaft, Jahrg. 24, Nr. 9, 182-188.
- Bodenkundliche Gesellschaft der Schweiz (BGS)/Société suisse de pédologie (SSP). (1985a). Estimation et protection des sols. BGS Dokument /Document SSP 2, 52 pp.
- Bodenkundliche Gesellschaft der Schweiz (BGS) / Société suisse de pédologie (SSP). (1985b). Boden bedrohte Lebensgrundlage ? / Sol bien vital menacé ? Verlag Sauerländer Aarau, Frankfurt.a.M., Salzburg. 84pp.
- Bonnard, L.-F. (1972). La cartographie des sols au service de l'aménagement du territoire. Mensurations, Photogrammétrie, Genie rural LVX, 3-72, 25-27.
- Bonnard, L.-F. (1982). La carte des sols du domaine de Changins. Bull. BGS/SSP 6, 159-165.
- Bonnard, L.-F., Müller, M. and Zihlmann, H. (1988). Bodenkarten Im Dienste von Planung, Land- und Forstwirtschaft / Les cartes des sols au service de planification, de l'agriculture et de sylviculture. Bull. BGS/SSP 12, 221-226.
- Bundesamt f. Umwelt, Wald und Landschaft (BUWAL) / Office fédéral de l'environnement, des forêts et du paysage (OFEPF). (1996). Handbuch Waldbodenkartierung / Manuel Cartographie des sols forestiers. 125 pp.
- Dietl, W. and Jäggli, F. (1972). Die kartierung von Vegetation und Boden als Planungsgrundlage für eine umfassende Alpverbesserung. Schweiz. landw. Forschung, 11/4, 475-520.
- Eidg. Forsch.anstalt f. Agrarökologie und Landbau (FAL) (Ed.). (1997). Kartieren und Beurteilen von Landwirtschaftsböden. Schriftenreihe der FAL, 24.
- Frei, E. (1959). Anwendung und Nutzen von Bodenkarten in der Landwirtschaft. Schweiz. Landw. Monatshefte 37, 156-162.
- Frei, E. (1961). Probleme der Fruchtbarkeitsbeurteilung bei der Bodenbewertung und Kartierung. Die Grüne 21, 632-642.
- Frei, E. and Guyer, H. (1968). Die landbauliche Beurteilung der Sauren Braunerde im Voralpengebiet unter besonderer Berücksichtigung der Nutzung als Intensivweide. Schweiz. landw. Forschung, VII, 3/4, 352-370.
- Frei, E., Jäggli, F., Peyer, K., Juhasz, P. and Bonnard, L.-F. (1969). Bodenkarten unterstützen Meliorationen, Bonitierungen und Planungsarbeiten. Mitt. f.d. Schweiz. Landwirtschaft. Jahrg. 17, Nr. 12, 197-208.
- Frei, E. and Juhasz, P. (1963). Beitrag zur Methodik der Bodenkartierung und der Auswertung von Bodenkarten unter schweizerischen Verhältnissen. Schweiz. landw. Forschung, II, 3, 249-307.
- Frei, E. and Juhasz, P. (1965). Geographische Verbreitung und Nutzungen der Braunerden und Gleyböden in der Gemeinde Hüntwangen ZH. Schweiz. landw. Forschung Nr. 3, 215-250.
- Frei, E. and Juhasz, P. (1967). Eigenschaften und Vorkommen der sauren Braunerde in der Schweiz. Die Bodenkarte Landiswil-Rüderswil, Emmental BE. Schweiz. landw. Forschung VI, 3/4, 371-393.
- Frei, E., Juhasz, P., and Bach, R. (1966). Bodenkarte der Schweiz 1:1,000,000. Erläuterungen zur Karte und zur Systematik der Böden der Schweiz. Schweiz. landw. Forschung V, 3/4, 537-551.
- Gratier, M. (1986). Aptitude à la mise en valeur agricole des sols du canton de Genève. Bull. BGS / SSP 10, 4-10.
- Häberli, R. (1991). L'affaire sol. Pour une politique raisonnée de l'utilisation du sol (PRN 22). Georg Editeur S.A. Genève. 192 pp.
- Müller, M. and Zihlmann, U. (1987). 10 Jahre Bodenkartierung 1:25,000. Bull. BGS / SSP 11, 25-31.
- Pallmann, H. (1947). Pédologie et phytosociologie. Congrès intern.de pédol.méditer. Montpellier. 1-36.
- Peyer, K. (1982). Systematische Auswertung der Bodenprofilaten der Bodenkarte M 1:25,000 Blatt Uster. Bull. BGS / SSP 6, 165-170.

- Peyer, K. (1983). Aussagewert von Bodenkarten mit verschiedenen Massstäben der Region Uster ZH. Schweiz. Landw. Forschung 22, 1/2, 43-59.
- Peyer, K and Frei, E. (1992). Klassifikation der Böden der Schweiz. BGS and FAL. 84 pp.
- Peyer, K., Frei, E., Jäggli, F. and Juhasz, P. (1976). Bewässerungsplanung im Val Müstair (GR) aufgrund von Bodenkarten. Schweiz. Landw. Forschung 15, 3/4, 361-369.
- Peyer, K., Frei, E., Jäggli, F., Juhasz, P and Petrasek, M. (1977). Belastbarkeit des Bodens für Flüssigdünger. Mitt. f.d. Schweiz. Landwirtschaft Jahrg. 24, Nr. 5, 105-120.