2.7 External Data Sources

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2.7.1 Introduction

Starting with the preparation, and leading up to the analysis of the second NFI, several different spatially related pieces of information were used. A large part of the data was already recorded by other institutions, so that they were directly taken over by the NFI. By utilizing these "external" data, a great deal of time and costs were saved in the NFI.

2.7.2 Analog Data

Aerial Photographs

Aerial photographs belong to the most important external data source of the NFI. They were analyzed with analog remote sensing methods. The aerial photographs were produced by the Federal Office of Topography to periodically update the Swiss national maps, and were made available free of charge to the NFI.

The film material used was a panchromatic black-and-white slide film (Agfa Aviphot-Pan and Kodak Panatomic). The aerial photographs from the years 1987 until 1991 were taken with an aerial mapping camera (type Wild RC-10) at a scale of approximately 1:25,000. In 1992 and 1993, the Federal Office of Topography used a high-performance aircraft, which was equipped with an aerial mapping camera (type Leica RC-20). The aerial photographs taken at that time had a scale of approximately 1:30,000 to 1:33,000. All aerial photographs were taken with an endlap of 60% to 70%, so that many interpretation areas were analyzed in several different stereo models (see Chapter 2.2).

The attributes measured in the aerial photographs are described in detail in Chapter 2.2.

National Maps

As in the first NFI, the second NFI was based on the kilometer grid of the Swiss national map (Federal Office of Topography).

For the assignment planning of the field survey teams, the national map with a scale of 1:100,000, as well as the national map with a scale of 1:25,000, were used (Bundesamt für Landestopographie 1987–1992).

The maps with a scale of 1:25,000 additionally served in determining ground control points (see Chapter 2.2) for the orientation of the aerial photographs. They were also used for the inquiries, which the field survey team conducted with the individual district forester. At that time the access roads were delineated on the map by the district forester (Chapter 2.6).

2.7.3 Digital Data Files

Digital Map (Pixel Map)

The Swiss Federal Office of Topography offers digital maps as well as the printed maps (Bundesamt für Landestopographie 1986–1991).

Pixel maps are simple copies of a print in a digital format without establishing any direct reference to the individual map elements. The map information is separated into different color levels and not into thematic groups[1].

The access roads were directly recorded on the computer screen, while the pixel map was displayed in the background (Chapter 2.6).

[1] Source of the statement: *http://www.swisstopo.ch/de/digital/pixel.htm* as of 1997

Since the road survey was a census, all necessary auxiliary data that were used to calculate the derived attributes had to be on hand for the entire area. In order to calculate the road density (Chapter 2.6), the forest area was determined from the continuous green tone of the pixel map that represented the closed forest.

Digital Map (Vector 25)
This data set (Vector 25) is a digital national map with a scale of 1:25,000 (Bundesamt für Landestopographie 1996). In contrast to the pixel maps, digital maps are not separated by different levels of color, but according to thematic groups. The basic element is the individual object (e.g., individual roads), which is stored in vector format. Until the end of 1996, the Federal Office of Topography was able to finish 43 of the 249 map sheets. From these, 18 were used for the survey of the roads. Thanks to these 18 map sheets, the roads in these regions did not have to be digitized, which meant that a considerable amount of time was saved (Chapter 2.6).

Digital Elevation Model
A Digital Elevation Model (DEM) makes it possible to obtain the elevation above sea level for any arbitrary point in Switzerland. The WSL has four different DEM's at its disposal.

Table 1. Digital elevation models available at the WSL.

Name	Grid width	Reference
RIMINI	250 m	(Bundesamt für Landestopographie)
Arealstatistik	100 m	(Bundesamt für Statistik)
Tydac	50 m	Tydac AG
DHM25	25 m	(Bundesamt für Landestopographie)

Bundesamt für Statistik (BFS), 1992: Arealstatistik der Schweiz 1979/85; GEOSTAT, Bern.
Bundesamt für Landestopographie (L+T), 1994: Geländedaten DHM25, Bern.
Bundesamt für Landestopographie (L+T), 1965: Höhenmodell RIMINI, Bern .

The elevation model RIMINI was used in order to find and display the default ground elevation values of the interpretation plot center for the aerial photography interpretation (see Chapter 2.2 Aerial Photograph). On the one hand, the interpretation process was simplified by showing the default value, while on the other hand, it was possible to eliminate sample plots as non-forest sample plots without interpretation equipment, if the altitude of the plot was 2,500 m above sea level. At this elevation it is very unlikely that a plot is forested. Since the aerial photography interpretation took place between the years 1993 and 1995, the DEM25 was not used for all of Switzerland due to the lack of availability. In the course of the analysis of the recorded data, the DEM was used to obtain several different derived attributes. The DEM was used, for example, for the attributes to characterize the site quality (Chapter 3.1), for the road survey (Chapter 2.6), or for modeling the protective function of the forest (Chapter 3.6).

GEOSTAT/Area Statistics
The Swiss Federal Statistical Office determined the land use for all of Switzerland with the help of a hectare grid (BFS 1992a). The land use, which encompasses 69 basic categories, was determined for the total 4.1 million sample points. The land use was determined by a majority decision based on an area with the size of 100 m*100 m for each sample point.
Information about settlement areas was used, for example, to determine the hazard potential for the protective forest model (Chapter 3.6).

In addition, GEOSTAT provided data of the last population census (1970, 1980, and 1990). The data of the population census were primarily used to model the recreational functions (Chapter 3.7). The amount of forest area in Switzerland, given in the area statistic, was used for comparison purposes (STROBEL *et al.* 1999).

Soil Capability Map
The Soil Capability Map (EJPD, Bundesamt für Raumplanung *et al.* 1980) was ordered by the Federal Department of Justice and Police, and the Federal Office for Spatial Planning. The Swiss Federal Statistical Office holds the copyright to this map, which was produced by the Department of Geography at the University of Bern in 1980.

Switzerland was divided into physiographical units based on aerial photographs and topographic and geological maps. For each of these units, soil samples were collected and the associated soil type, along with the soil properties, were determined. The map in the scale of 1:200,000 shows these geomorphological and pedological separated units. These units were evaluated later with respects to their agricultural and forest utilization potential (BFS 1992b).

Characteristics of the Soil Capability Map were used in the derivation of several attributes for the site quality assessment: the total increment, the altitudinal vegetation zones, or the potential natural forest vegetation (see Chapter 3.1).

Simplified Geotechnical Map
The geotechnical map was published by the Federal Office for Water Management (Bundesamt für Wasserwirtschaft 1990). The scale of the map is 1:200,000. The geotechnical map represents rocks primarily in relation to their importance as building ground or building material. The map contains as a secondary attribute the characterization of rocks. For example, with loose rocks, information is disclosed about the grain size or the sorting. The 60 classes of the original map were combined into 30 classes (BFS 1992b). The geotechnical map was utilized in the NFI for calculating the rockfall hazard. This map showed where rockfall could occur and where, due to the prevalent type of rock, rockfall was less likely or impossible. In addition, the acidity of the bedrock was used to assess the site quality (Chapter 3.1).

Forest Statistic
The Swiss Federal Statistical Office, in cooperation with the Swiss Agency for the Environment, Forests, and Landscape publishes a forest statistic every year, which especially focuses on the economical aspects of forestry (BFS 1995).

Among other things, this data set also shows the border of the different forest regions of Switzerland. The production regions, the economic regions, and the forest district were the most important areas for the NFI. In addition to this, measures about the forest area in Switzerland were taken from this statistic and compared with the amount of forest calculated by the NFI (STROBEL *et al.* 1999).

Administration Units
From the Swiss Federal Office of Topography, a national map with a scale of 1:25,000 was used by the Federal Land Surveying Directorate to digitize several administration unit boundaries. They are periodically updated in cooperation with the Swiss Federal Statistical Office.

The national border, as well as the municipal and cantonal borders, belong to the data set that was employed (Vermessungsdirektion *et al.* 1996).

2.7.4 Employed Models

In the following section the external models used in the NFI are briefly introduced. They are described in detail in Chapter 3.1 and 3.6.

Potential Vegetation
With these models it was possible to calculate the plant communities' potential vegetation within Switzerland. The model developed by BRZEZIECKI, KIENAST and WILDI (BRZEZIECKI *et al.* 1993; 1995; KIENAST *et al.* 1994; 1996) requires several parameters to calculate the potential vegetation which include: information about soil property (pH value, soil depth, etc.), annual precipitation, average annual temperature, exposition, and slope.

Protective Functions

The model developed by the land survey company GEO7 was used to assess the protective function that the forests provided (Chapter 2.6). With the help of the GIS (Arc/Info, ESRI 1992), the model calculated the potentially endangered areas where a protective forest could help to reduce the hazard potential (GEO7 1996).

As input parameters, the slope gradient or the type of rock was used.

2.7.5 Literature

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