Excursion Guide

Soil Management on site

14/10/2019
Field work, profiles description, laboratory analysis and guide editing:

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Geitner Clemens (UIBK)

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References:

- Waldwirtschaftsplan Agrargemeinschaft Waldinteressentschaft Igls und Lans;
- Geologische Karte der Republik Österreich 1:50000 (148, Brenner), Geologische Bundesanstalt, Wien 2009;
- Land Tirol, TIRISmaps;
- Walböden erkennen und verstehen, 2017. BFW, Institut für Waldökologie und Boden;
- Guidelines for Soil Description, Fourth edition, Food and Agriculture Organization of the United Nations, Rome, 2006;
- Munsell Soil Color Charts, revised 2009.
### Legend

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<th>Properties</th>
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<th>pH</th>
<th>Ca [kg/ha]</th>
<th>Mg [kg/ha]</th>
<th>K [kg/ha]</th>
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<th>P [kg/ha]</th>
<th>Color</th>
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<td>&gt;20</td>
<td>&gt;7500</td>
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* According to forest site evaluation (see ref.)

<table>
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<tr>
<th>Characteristics</th>
<th>Abbr.</th>
<th>Definition</th>
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<td>Shape and size of rock fragments</td>
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<tr>
<td>R</td>
<td>Rounded</td>
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</tr>
<tr>
<td>A</td>
<td>Angular</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Fine (2-6.3 mm)</td>
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</tr>
<tr>
<td>M</td>
<td>Medium (6.3-20 mm)</td>
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</tr>
<tr>
<td>C</td>
<td>Coarse (20-63 mm)</td>
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</tr>
<tr>
<td>S</td>
<td>Stones (63-200 mm)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Boulders (&gt;200 mm)</td>
<td></td>
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</table>

| Soil structure type |        |            |
| SB                | Subangular Blocky | |
| AB                | Angular Blocky | |
| GR                | Granular | |
| SG                | Single Grain | |
| MA                | Massive | |

| Mottling - contrast, abundance |        |            |
| d                 | Distinct contrast | |
| f                 | Faint contrast | |
| F                 | Few (<5%) | |
| C                 | Common (5-20%) | |
| M                 | Many (>20%) | |

| Carbonates content | ST | Strongly calcareous |
| Horizon boundaries (Humus) | D | Distinct (<2 mm) |
**Details on measurements and classification system in use:**

Soil horizon designation and textural classes: Austrian Soil Classification [ö]

Color: Munsell Soil Color Charts 2009

Soil types: World Reference Base for Soil Resources, 2014

Abbreviations for coarse fragments, shape and size of coarse fraction, soil structure type, mottles, roots and carbonates: Guidelines for Soil Description, 2006

pH values: ÖNORM L 1083
Total Organic Carbon: ÖNORM L 1080
Total Nitrogen: ÖNORM L 1082
Exchangeable cations: Al, Ca, Fe, K, Mg, Na, Mn und H+ concentrations ÖNORM L 1086-1 (0.1 M BaCl2-Extract)
Extraction of Ca, Mg, K, P, S, Mn, Fe, Al in nitrohydrochloric acid (ÖNORM 1085)

Texture: fine soil < 2 mm (sand, silt, clay percent), at depths 10 - 20 cm and 40 - 80 cm.

Stock values calculated from fine soil bulk density, determined with volumetric sampling.
Fig. 1: Areal view of excursion points

**Location and organizational aspects:** the excursion sites are located south from the city of Innsbruck and they are under the jurisdiction of the municipality of Innsbruck and Lans. The closest village is Igls. The village geographically separates the two groups of excursion points (groups 1 and 2 in Fig.1) that will be visited in two consecutive steps and are located at a distance of approx. 3 km from each other.

Within group 1 in the *Paschbergwald* there will be two adjacent forest soil profiles to be observed and compared: one of them is to be found directly under the track of a harvester machine, which operated at the beginning of 2019 and presumably caused soil compaction. Together with compaction effects on soils and its prevention, we will discuss aspects of biomass removal in the forest. The second site within group 1 is at a peat bog at 10 minutes bus distance: inside the same pit our excursion guides will describe two different soil profiles: a Cambisol and a Histosol.

The second group of points is located at foot of the mountain *Patscherkofel* at few minutes walking distance between each other. They are located at a low mountain range terrace, at heights between 980 and 1,040 m a.s.l. The point 2-1 is to be found inside the skiing area of *Patscherkofel*, right above the valley station of the ropeway which brings to the mountain station at 1951 m a.s.l. The relatively recent transformation of this area, in addition to
adjustment operations to the drainage system, had some consequences on the soil development and functions, which we will discuss during the excursion and compare to an adjacent forest site (2-2). Site 2-3 is located on the opposite side of the Römerstraße, at approximately 140 m distance from the road and at the border with the golf course “Olympia Igls”.

**Climate:** all sites are located in the inner Alps area with its typical subcontinental climate, characterized by high summer precipitation and strong foehn storms, which can reach velocities up to 200 km/h on the top of the Patscherkofel. The average measured precipitation range between 873 and 902 mm/year in the different locations and the average yearly temperature is between 6.8 and 7.9 °C.

**Geology:** the points of interest of our excursion are located on a Moraine deposit (ground, lateral and end Moraine) (see Fig.2, Nr.30). The bedrock material is called “Innsbrucker Quarzphyllit”, which is mostly composed by quartz, albite and chlorite phyllite (93). Also outcrops of dolomitic marble (90), greenschist and chloriteschist (92) can be found in the surrounding.

![Fig. 2: Geological map extract (148 Brenner)](image)
1.1 Peat bog

Fig. 3: Overview of the site (photo: E. Cocuzza)

Fig. 4: Areal view of the site (TIRIS, 2016)

Site description
Two adjacent profiles to be observed inside the same excavation, at the border of a peat bog.

Coordinates (GK West M28): 81408.42/233854.12
Elevation: 836 m
Exposition: 165 gon
Inclination: 0-22%
Land use: Meadow, arable field.

Site infos: At this site the peat bog (Viller Moor) occupies a surface of 13ha and it extends to the village of Vill in the west and to the Lanser lake in the east. The grassland is mowed up to 3 times per year and it’s partially pastured by sheeps. Crop rotation for strawberries, vegetables and legumes.

Historical information: The area covered by a peat bog was originally occupied by a lake: the oldest documented reference to it dates back to 1270. In that period until recent times, the lake has been intensively exploited for fishing activities, which were particularly appreciated by the nobles. The Viller Lake was under the jurisdiction of the Wilten Monastery for over 480 years and after being occupied by the Bavarians at the beginning of the 19th century, it was bought by the inhabitants of Vill, who wreaked the dam and transformed the lake to the peat bog we can recognize today. Since then the area has been mowed and exploited for agricultural purposes.

Cambisol texture
### Profile description: Cambisol

<table>
<thead>
<tr>
<th>Horizon [a]</th>
<th>Depth [cm]</th>
<th>Textural Class [o]</th>
<th>Color</th>
<th>Coarse fragments [%]</th>
<th>Shape and size CF</th>
<th>Estimated bulk density [g/cm³]</th>
<th>Soil Structure type</th>
<th>Mottles</th>
<th>Roots [n/dm³]</th>
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<tbody>
<tr>
<td>Ah1</td>
<td>0-10</td>
<td>Sandy Silt</td>
<td>10YR 2/2</td>
<td>5</td>
<td>A MF</td>
<td>1.2 - 1.4</td>
<td>GR</td>
<td></td>
<td>21-50</td>
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<tr>
<td>Ah2</td>
<td>10-35</td>
<td>Loamy Sand</td>
<td>7.5Y 3/1</td>
<td>20</td>
<td>A MF</td>
<td>1.6 - 1.8</td>
<td>SB,GR</td>
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<td>6-10</td>
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<td>Bvg1</td>
<td>35-60</td>
<td>Loamy Sand</td>
<td>2.5Y 4/2</td>
<td>25</td>
<td>A MC</td>
<td>1.4 - 1.6</td>
<td>MA</td>
<td>M,d</td>
<td>1-5</td>
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<td>Bvg2</td>
<td>60-90</td>
<td>Loamy Sand</td>
<td>2.5Y 4/2</td>
<td>25</td>
<td>A MC</td>
<td>1.2 - 1.4</td>
<td>MA</td>
<td>C,d</td>
<td>1-5</td>
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<tr>
<td>HT</td>
<td>90-100</td>
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<td>100-110</td>
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<td>HT</td>
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**Soil type:** Eutric Stagnic Cambisol

### Chemical properties

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<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
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<th>Mg+Ca/CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
<th>pHCaCl₂</th>
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<td>0-5</td>
<td>294.4</td>
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<td>0.99</td>
<td>0.61</td>
<td>6.43</td>
<td>10.54</td>
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<td>10-20</td>
<td>265.5</td>
<td>99.92</td>
<td>0.99</td>
<td>0.44</td>
<td>4.54</td>
<td>10.32</td>
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<tr>
<td>20-40</td>
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<td>99.95</td>
<td>0.99</td>
<td>0.25</td>
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<td>8.72</td>
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<td>40-80</td>
<td>136</td>
<td>99.93</td>
<td>0.99</td>
<td>0.13</td>
<td>1.15</td>
<td>8.85</td>
<td>6.94</td>
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<td>80-100</td>
<td>623.6</td>
<td>99.98</td>
<td>0.99</td>
<td>0.77</td>
<td>9.88</td>
<td>12.83</td>
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<td>t/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
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Stock values of mineral layers (0-100cm) are short term available, except for phosphorus, which has long term availability.

![Fig. 5: profile (photo: E. Cocuzza)](image-url)
Profile description: Histosol

<table>
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<tr>
<th>Horizon</th>
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<th>Color</th>
<th>Coarse fragments [%]</th>
<th>Shape and size CF</th>
<th>Estimated Bulk Density [g/cm³]</th>
<th>Soil Structure type [%]</th>
<th>Mottles</th>
<th>Roots [n/dm²]</th>
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<td>Ah</td>
<td>0-15</td>
<td>Sandy Loam 10YR 2/2</td>
<td>5</td>
<td>A MF</td>
<td>1.2 - 1.4</td>
<td>MA,GR</td>
<td>21-50</td>
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<td>Go</td>
<td>15-30</td>
<td>Sandy Loam 10YR 2/1</td>
<td>5</td>
<td>A MF</td>
<td>1.4 - 1.6</td>
<td>MA</td>
<td>M,d</td>
<td>11-20</td>
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<tr>
<td>Gr</td>
<td>30-40</td>
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<td>A MF</td>
<td>1.2 - 1.4</td>
<td>MA</td>
<td>F,f</td>
<td>1-5</td>
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<td>II T</td>
<td>40-90</td>
<td>10YR 2/1</td>
<td>2</td>
<td>A S</td>
<td>1.4 - 1.6</td>
<td>MA</td>
<td>F,f</td>
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Soil type: Rheic Eutric Sapric Histosol

Chemical properties

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
<th>Base Saturation [%]</th>
<th>Mg+Ca/CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
<th>pHCaCl₂</th>
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<td>0-5</td>
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<td>80-100</td>
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<td>1</td>
<td>1.88</td>
<td>42.6</td>
<td>22.66</td>
<td>6.08</td>
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</table>

Stock values of mineral layers (0-100cm) are short term available, except for phosphorus, which has long term availability.

Fig. 6: profile (photo: C. Geitner)
1.2 Forest, harvester track

Fig. 7: Overview of the site (photo: E. Cocuzza)

Fig. 8: Areal view of the site (TIRIS, 2016)

Site description
Two adjacent soil profiles: one directly under the harvester track, the second under undisturbed conditions in the forest.

Coordinates (GK West M28): 81765.61/234819.85
Elevation: 819 m
Exposition: 373 gon
Inclination: 25%
Land use: Natural forest and woodland.


Historical information: In February and March 2019 a thinning activity took place on the site, on a forest area of 3.5 ha. In total 512 fm of wood was harvested, 60 percent of it was firewood. Before this period, no previous collection or forest management activities took place. The cost for the operation was 25 euro/m³ excl. Tax.

Management guidelines

Biomass use
Effects of whole tree harvesting

Intermittent negative effects

Compaction risk
Effects of heavy machines transit on the soil

Occasionally critical

Texture

- Depth - site
  - 0-30 cm
  - 30-100 cm
  - Undisturbed
  - Track
Profile description: undisturbed profile

<table>
<thead>
<tr>
<th>Horizon (humus)</th>
<th>Depth [cm]</th>
<th>Material/packing</th>
<th>Roots [n/dm²]</th>
<th>Horizon boundaries</th>
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<tbody>
<tr>
<td>L</td>
<td>9-7</td>
<td>Needle, wood, loose</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>F</td>
<td>7-4</td>
<td>Stratified</td>
<td>11-20</td>
<td>D</td>
</tr>
<tr>
<td>H</td>
<td>4-0</td>
<td>Compact</td>
<td>11-20</td>
<td>D</td>
</tr>
</tbody>
</table>

Horizon [0] Depth [cm] Textural Class [0] Color Coarse fragments [%] Shape and size CF Estimated Bulk Density [g/cm³] Soil Structure type [%] Carb. Roots [n/dm²]

Ahe 0-1.5 Sandy Loam 10YR 3/1 10 R MC 1.2 - 1.4 SB 21-50
Bh 1.5-3 Sandy Loam 7.5YR 3/3 10 R MC 1.4 - 1.6 SB 6-10
By 3-60 Sandy Loam 7.5Y 4/6 20 R MC 1.4 - 1.6 SB 6-10
II Bv 60-85 Loamy Sand 7.5Y 5/6 50 R FC 1.2 - 1.4 SG - SB 6-10
II Bv-Cv 85-115 Silty Sand 5YR 5/4 50 R FC 1.2 - 1.4 SG 1-5
II ICv 115-160 Sand 10YR 4/3 75 R FC 0.9 - 1.2 SG ST 0
III ICv 160-170+ Sandy Silt 10YR 6/2 5 R C 1.6 - 1.8 MA ST 1-5

Soil type: Distric Cambisol
Humus form: Dysmoder

Chemical properties

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
<th>Base Saturation [%]</th>
<th>Mg+Ca/CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
<th>pHCaCl₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-4(F)</td>
<td>493.5</td>
<td>94.16</td>
<td>0.91</td>
<td>1.55</td>
<td>44.11</td>
<td>28.46</td>
<td>5</td>
</tr>
<tr>
<td>4-0(H)</td>
<td>423.3</td>
<td>92.65</td>
<td>0.91</td>
<td>1.68</td>
<td>41.1</td>
<td>24.46</td>
<td>4.02</td>
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<td>108.4</td>
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<td>0.3</td>
<td>5.75</td>
<td>19.17</td>
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<td>5-10</td>
<td>41.9</td>
<td>39.62</td>
<td>0.37</td>
<td>0.14</td>
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</tr>
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<td>10-20</td>
<td>28.7</td>
<td>41.46</td>
<td>0.37</td>
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<td>1.29</td>
<td>12.9</td>
<td>4.31</td>
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<td>20-40</td>
<td>23</td>
<td>60</td>
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<td>0.07</td>
<td>0.82</td>
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<td>40-80</td>
<td>12.9</td>
<td>48.84</td>
<td>0.43</td>
<td>0.03</td>
<td>0.33</td>
<td>11</td>
<td>4.41</td>
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<td>80-100</td>
<td>19.9</td>
<td>96.48</td>
<td>0.93</td>
<td>0.02</td>
<td>0.12</td>
<td>6</td>
<td>5.35</td>
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<table>
<thead>
<tr>
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<th>Ca</th>
<th>Mg</th>
<th>K</th>
<th>P</th>
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<tbody>
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<td>t/ha</td>
<td>t/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
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<tr>
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<td>mineral</td>
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<td>4.35</td>
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</table>

All stock values, for humus (H,F) and mineral (0-100cm) layers, are short term available, except for phosphorus, which has long term availability.

Fig. 9: profile (photo: C. Geitner)
Profile description: Harvester profile

<table>
<thead>
<tr>
<th>Horizon (humus)</th>
<th>Depth [cm]</th>
<th>Material/packing</th>
<th>Roots [n/dm²]</th>
<th>Horizon boundaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>7.5-5.5</td>
<td>Needle, wood: loose</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>F</td>
<td>5.5-0.5</td>
<td>Stratified</td>
<td>11-20</td>
<td>D</td>
</tr>
<tr>
<td>H</td>
<td>0.5-0</td>
<td>Compact</td>
<td></td>
<td>D</td>
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<table>
<thead>
<tr>
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<th>Depth [cm]</th>
<th>Textural Class [o]</th>
<th>Color</th>
<th>Coarse fragments [%]</th>
<th>Shape and size CF</th>
<th>Estimated Bulk Density [g/cm³]</th>
<th>Soil Structure type [%]</th>
<th>Carb.</th>
<th>Roots [n/dm²]</th>
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</thead>
<tbody>
<tr>
<td>Ahe</td>
<td>0-1</td>
<td>Sandy Loam</td>
<td>10YR 3/1</td>
<td>10</td>
<td>R MC</td>
<td>1.2 - 1.4</td>
<td>SB</td>
<td>21-50</td>
<td></td>
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<tr>
<td>Bh</td>
<td>1-2.5</td>
<td>Sandy Loam</td>
<td>7.5YR 3/3</td>
<td>10</td>
<td>R MC</td>
<td>1.4 - 1.6</td>
<td>SB</td>
<td>6-10</td>
<td></td>
</tr>
<tr>
<td>Bv</td>
<td>2.5-38</td>
<td>Sandy Loam</td>
<td>7.5Y 4/6</td>
<td>10</td>
<td>R MC</td>
<td>1.4 - 1.6</td>
<td>SB</td>
<td>6-10</td>
<td></td>
</tr>
<tr>
<td>II Bv</td>
<td>38-58</td>
<td>Loamy Sand</td>
<td>5YR 4/6</td>
<td>50</td>
<td>R FC</td>
<td>1.2 - 1.4</td>
<td>SG - SB</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>II Bv-Cv</td>
<td>58-83</td>
<td>Silty Sand</td>
<td>7.5YR 5/6</td>
<td>50</td>
<td>R FC</td>
<td>1.2 - 1.4</td>
<td>SG</td>
<td>1-5</td>
<td></td>
</tr>
<tr>
<td>II ICv</td>
<td>83-121</td>
<td>Sand</td>
<td>10YR 4/3</td>
<td>75</td>
<td>R FC</td>
<td>0.9 - 1.2</td>
<td>SG</td>
<td>ST</td>
<td>0</td>
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<tr>
<td>III ICv</td>
<td>121-140+</td>
<td>Sandy Silt</td>
<td>10YR 6/2</td>
<td>5</td>
<td>R C</td>
<td>1.8 - 1.9</td>
<td>MA</td>
<td>ST</td>
<td>1-5</td>
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</table>

**Soil type:** Eutric Cambisol

**Humus form:** Eumoder

### Chemical properties

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
<th>Base Saturation [%]</th>
<th>Mg+Ca/CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
<th>pHCaCl₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5-0.5(F)</td>
<td>450.9</td>
<td>93.41</td>
<td>0.9</td>
<td>1.6</td>
<td>52.8</td>
<td>33</td>
<td>4.84</td>
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<tr>
<td>0.5-0(H)</td>
<td>436.5</td>
<td>91.68</td>
<td>0.88</td>
<td>1.65</td>
<td>45.2</td>
<td>27.39</td>
<td>4.44</td>
</tr>
<tr>
<td>0-5</td>
<td>93.5</td>
<td>13.9</td>
<td>0.13</td>
<td>0.22</td>
<td>4.2</td>
<td>19.09</td>
<td>3.66</td>
</tr>
<tr>
<td>5-10</td>
<td>25.2</td>
<td>32.94</td>
<td>0.3</td>
<td>0.1</td>
<td>1.23</td>
<td>12.3</td>
<td>4.3</td>
</tr>
<tr>
<td>10-20</td>
<td>21.4</td>
<td>40.65</td>
<td>0.36</td>
<td>0.08</td>
<td>1.49</td>
<td>18.62</td>
<td>4.38</td>
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<tr>
<td>20-40</td>
<td>15.5</td>
<td>25.81</td>
<td>0.21</td>
<td>0.05</td>
<td>0.91</td>
<td>18.2</td>
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<td>80.29</td>
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<td>0.52</td>
<td>26</td>
<td>5.17</td>
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<tr>
<td>80-100</td>
<td>44.9</td>
<td>90.33</td>
<td>0.98</td>
<td>0.02</td>
<td>0.25</td>
<td>12.5</td>
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<table>
<thead>
<tr>
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<th>Ntot t/ha</th>
<th>Ca kg/ha</th>
<th>Mg kg/ha</th>
<th>K kg/ha</th>
<th>P kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>humus</td>
<td>28.59</td>
<td>0.92</td>
<td>373.94</td>
<td>47.96</td>
<td>34.47</td>
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<tr>
<td>mineral</td>
<td>62.64</td>
<td>3.47</td>
<td>1062.31</td>
<td>254.72</td>
<td>102.28</td>
</tr>
</tbody>
</table>

All stock values, for humus (H,F) and mineral (0-100cm) layers, are short term available, except for phosphorus, which has long term availability.

---

![Fig. 10: profile (photo: C. Geitner)](image-url)
Group 2
2.1 Ski slope, pasture

![Fig. 11: Overview of the site (photo: E. Cocuzza)](image)

**Site description**
**Coordinates (GK West M28):** 82866.28/231827.41
**Elevation:** 1055 m
**Exposition:** 360 gon
**Inclination:** 28%
**Land use:** Pasture.

**Historical information:** The Patscherkofel skiing and recreational area attracts every year during both winter and summer seasons many hikers, skiers and mountain bikers. The ropeway dates back to 1928 and until 2017 it was connecting directly the town of Igls at 904 m.a.s.l. to the top of the mountain Patscherkofel. In 2015 it was decided to modify the starting point of the ropeway to the valley station at 1,009 m that is at walking distance from the soil profile’s site.

![Fig. 12: Areal view of the site (TIRIS, 2016)](image)

![Fig. 13: Soil profile representation](image)

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth [cm]</th>
<th>Textural Class</th>
<th>Color</th>
<th>Coarse fragments [%]</th>
<th>Shape and size CF</th>
<th>Estimated Bulk Density [g/cm³]</th>
<th>Soil Structure type [%]</th>
<th>Mottles</th>
<th>Roots [n/dm²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ah</td>
<td>0-3</td>
<td>Sandy Loam</td>
<td>10YR 3/2</td>
<td>20</td>
<td>A MS</td>
<td>1.2 - 1.4 GR</td>
<td></td>
<td></td>
<td>21-50</td>
</tr>
<tr>
<td>Bgd</td>
<td>3-18</td>
<td>Sandy Loam</td>
<td>2.5Y 4/3</td>
<td>40</td>
<td>A MS</td>
<td>1.6 - 1.8 SB</td>
<td></td>
<td>C,d</td>
<td>11-20</td>
</tr>
<tr>
<td>ICgd</td>
<td>18-120</td>
<td>Silty Sand</td>
<td>2.5Y 4/2</td>
<td>60</td>
<td>A MB</td>
<td>1.6 - 1.8 MA</td>
<td></td>
<td>C,f</td>
<td>1-5</td>
</tr>
</tbody>
</table>

**Soil type:** Stagnic Skeletic Anthrosol
**Chemical properties**

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
<th>Base Saturation [%]</th>
<th>Mg+Ca/CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
<th>pHCaCl₂</th>
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</thead>
<tbody>
<tr>
<td>0-5</td>
<td>94</td>
<td>99.47</td>
<td>0.98</td>
<td>0.16</td>
<td>2.32</td>
<td>14.5</td>
<td>5.78</td>
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<tr>
<td>5-10</td>
<td>78.5</td>
<td>99.62</td>
<td>0.98</td>
<td>0.09</td>
<td>1.39</td>
<td>15.44</td>
<td>6.11</td>
</tr>
<tr>
<td>10-20</td>
<td>90.5</td>
<td>99.89</td>
<td>0.98</td>
<td>0.08</td>
<td>1.14</td>
<td>14.25</td>
<td>6.59</td>
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<tr>
<td>20-40</td>
<td>78.7</td>
<td>99.87</td>
<td>0.98</td>
<td>0.05</td>
<td>0.57</td>
<td>11.4</td>
<td>7.03</td>
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<tr>
<td>40-80</td>
<td>92.6</td>
<td>98</td>
<td>0.98</td>
<td>0.05</td>
<td>0.52</td>
<td>10.4</td>
<td>7.13</td>
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<td>80-100</td>
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<td>0.97</td>
<td>0.04</td>
<td>0.34</td>
<td>8.5</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Stock values of mineral layers (0-100cm) are short term available, except for phosphorus, which has long term availability.

**Texture**

- Depth
  - 0-30cm
  - 30-100cm
2.2 Forest beside ski slope

Fig. 15: Overview of the site (photo: E. Cocuzzza)

Fig. 16: Areal view of the site (TIRIS, 2016)

Site description
Coordinates (GK West M28): 82805.43/231814.18
Elevation: 1047 m
Exposition: 362 gon
Inclination: 28%
Land use: Natural forest - pasture.
Forest info: Public interest functions: low protection, intermediate welfare and recreation. Leading production function: it is of high public interest (according to forest law:§ 6 Abs. 2 ForstG). Bioclimatic growth region: subcontinental inner Alps - west. Trees species mixture: spruce, larch and pines (mature forest). 90-97 years old and 18-31 m tall. Forest type: Fi3 - Montane warm silicate forest with larch and spruce trees, *(Luzulo luzuloidis-Piceetum typicum)*.

Profile description

<table>
<thead>
<tr>
<th>Horizon (humus)</th>
<th>Depth [cm]</th>
<th>Material/packing</th>
<th>Roots [n/dm²]</th>
<th>Horizon boundaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>7-6</td>
<td>Needle,wood</td>
<td>0</td>
<td>D</td>
</tr>
<tr>
<td>F</td>
<td>6-3</td>
<td>Refrangible, stratified</td>
<td>1-5</td>
<td>D</td>
</tr>
<tr>
<td>H</td>
<td>3-0</td>
<td>Compact</td>
<td>11-20</td>
<td>D</td>
</tr>
</tbody>
</table>

<table>
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<th>Depth [cm]</th>
<th>Textural Class [0]</th>
<th>Color</th>
<th>Coarse fragments [%]</th>
<th>Shape and size</th>
<th>Estimated Bulk Density [g/cm³]</th>
<th>Soil Structure type [%]</th>
<th>Mottles</th>
<th>Roots [n/dm²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ai</td>
<td>0-1</td>
<td>Loamy Sand</td>
<td>10YR 4/2</td>
<td>10</td>
<td>R C</td>
<td>1.2 - 1.4</td>
<td>SG - GR</td>
<td>11-20</td>
<td></td>
</tr>
<tr>
<td>Bv</td>
<td>1-40</td>
<td>Loamy Sand</td>
<td>10YR 5/4</td>
<td>10</td>
<td>R CS</td>
<td>1.4 - 1.6</td>
<td>AB - GR</td>
<td>6-10</td>
<td></td>
</tr>
<tr>
<td>Bv/Cv</td>
<td>40-55</td>
<td>Loamy Sand</td>
<td>2.5Y 5/3</td>
<td>40</td>
<td>R CS</td>
<td>1.6 - 1.8</td>
<td>MA - SB</td>
<td>C,d</td>
<td>1-5</td>
</tr>
<tr>
<td>mC</td>
<td>55-90+</td>
<td>Silty Sand</td>
<td>3Y 5/2</td>
<td>70</td>
<td>R CB</td>
<td>1.8 - 1.9</td>
<td>MA</td>
<td>C,d</td>
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</tbody>
</table>

Soil type: Eutric Skeletic Cambisol
Humus form: Dysmoder
### Chemical properties

<table>
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<tr>
<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
<th>Base Saturation [%]</th>
<th>Mg+Ca/ CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
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<td>6-3(F)</td>
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<td>49.51</td>
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<td>3-0(H)</td>
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<td>0.5</td>
<td>0.26</td>
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<td>30.12</td>
<td>3.65</td>
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<tr>
<td>5-10</td>
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<td>50.99</td>
<td>0.48</td>
<td>0.14</td>
<td>2.74</td>
<td>19.57</td>
<td>4.14</td>
</tr>
<tr>
<td>10-20</td>
<td>49</td>
<td>59.59</td>
<td>0.54</td>
<td>0.1</td>
<td>1.71</td>
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<tr>
<td>20-40</td>
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<td>83.77</td>
<td>0.76</td>
<td>0.07</td>
<td>0.99</td>
<td>14.14</td>
<td>4.62</td>
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<td>40-80</td>
<td>41.7</td>
<td>94.96</td>
<td>0.88</td>
<td>0.04</td>
<td>0.46</td>
<td>11.5</td>
<td>5.09</td>
</tr>
<tr>
<td>80-100</td>
<td>24.8</td>
<td>93.55</td>
<td>0.87</td>
<td>0.04</td>
<td>0.46</td>
<td>11.5</td>
<td>5.06</td>
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<th>Mg</th>
<th>K</th>
<th>P</th>
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<td>t/ha</td>
<td>t/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
<td>kg/ha</td>
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<td>2961.25</td>
<td>589.17</td>
<td>473.61</td>
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</table>

All stock values, for humus (H,F) and mineral (0-100cm) layers, are short term available, except for phosphorus, which has long term availability.

---

**Fig. 17: profile (photo: C. Geitner)**

---

**Texture**

**Management guidelines**

**Biomass use**
- Effects of whole tree harvesting
  - Intermediate negative effects

**Compaction risk**
- Effects of heavy machines transit on the soil
  - Occasionally critical
2.3 Golf course, meadow

Fig. 18: Overview of the site (photo: E. Cocuzza)

Site description
Coordinates (GK West M28): 82673.13/232181.95
Elevation: 984 m
Exposition: 15 gon
Inclination: 10%
Land use: Meadow.

Profile description

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth [cm]</th>
<th>Textural Class</th>
<th>Color</th>
<th>Coarse fragments [%]</th>
<th>Shape and size CF</th>
<th>Estimated Bulk Density [g/cm³]</th>
<th>Soil Structure type [%]</th>
<th>Mottles</th>
<th>Roots [n/dm²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ah1</td>
<td>0-5</td>
<td>Sandy Silt</td>
<td>10YR 3/2</td>
<td>5</td>
<td>A MC</td>
<td>1.2 - 1.4</td>
<td>GR,SB</td>
<td></td>
<td>21-50</td>
</tr>
<tr>
<td>Ah2</td>
<td>5-15</td>
<td>Sandy Silt</td>
<td>10YR 4/3</td>
<td>10</td>
<td>A MC</td>
<td>1.4 - 1.6</td>
<td>GR,SB</td>
<td></td>
<td>11-20</td>
</tr>
<tr>
<td>Bv1</td>
<td>15-40</td>
<td>Sandy Loam</td>
<td>2.5Y 3/3</td>
<td>10</td>
<td>A CM</td>
<td>1.6 - 1.8</td>
<td>MA</td>
<td></td>
<td>1-5</td>
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<tr>
<td>Bv2</td>
<td>40-75</td>
<td>Sandy Loam</td>
<td>2.5Y 4/2</td>
<td>50</td>
<td>A FC</td>
<td>1.4 - 1.6</td>
<td>MA</td>
<td></td>
<td>1-5</td>
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<tr>
<td>Bv/Cv1</td>
<td>75-90</td>
<td>Silty Sand</td>
<td>2.5Y 4/3</td>
<td>80</td>
<td>A FM</td>
<td>1.2 - 1.4</td>
<td>SG</td>
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<td>1-5</td>
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<tr>
<td>Bv/Cv2</td>
<td>90-105</td>
<td>Sandy Silt</td>
<td>2.5Y 5/6</td>
<td>10</td>
<td>A FC</td>
<td>1.4 - 1.6</td>
<td>MA</td>
<td>F,d</td>
<td>1-5</td>
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<tr>
<td>Cv</td>
<td>105-125</td>
<td>Loamy Sand</td>
<td>2.5Y 5/3</td>
<td>70</td>
<td>A SF</td>
<td>1.4 - 1.6</td>
<td>SG</td>
<td></td>
<td>1-5</td>
</tr>
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</table>

Soil type: Eutric Cambisol
### Chemical properties

<table>
<thead>
<tr>
<th>Depth [cm]</th>
<th>CEC [mmol/kg]</th>
<th>Base Saturation [%]</th>
<th>Mg+Ca/CEC</th>
<th>Ntot [%]</th>
<th>TOC [%]</th>
<th>C/N</th>
<th>pHCaCl₂</th>
</tr>
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<tbody>
<tr>
<td>0-5</td>
<td>163</td>
<td>98.9</td>
<td>0.95</td>
<td>0.5</td>
<td>5.63</td>
<td>11.26</td>
<td>5.26</td>
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<tr>
<td>5-10</td>
<td>132.1</td>
<td>99.09</td>
<td>0.95</td>
<td>0.4</td>
<td>4.03</td>
<td>10.07</td>
<td>5.3</td>
</tr>
<tr>
<td>10-20</td>
<td>94.7</td>
<td>99.47</td>
<td>0.98</td>
<td>0.21</td>
<td>2</td>
<td>9.52</td>
<td>5.41</td>
</tr>
<tr>
<td>20-40</td>
<td>57.4</td>
<td>99.13</td>
<td>0.97</td>
<td>0.1</td>
<td>0.96</td>
<td>9.6</td>
<td>5.39</td>
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<tr>
<td>40-80</td>
<td>40.7</td>
<td>98.28</td>
<td>0.96</td>
<td>0.06</td>
<td>0.6</td>
<td>10</td>
<td>5.28</td>
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<tr>
<td>80-100</td>
<td>35.8</td>
<td>98.32</td>
<td>0.95</td>
<td>0.05</td>
<td>0.4</td>
<td>8</td>
<td>5.29</td>
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</tbody>
</table>

Stock values of mineral layers (0-100cm) are short term available, except for phosphorus, which has long term availability.

### Texture

![Texture Diagram](image-url)

- **Depth**
  - 0-30cm
  - 30-100cm
### Key site characteristics

<table>
<thead>
<tr>
<th></th>
<th>elevation</th>
<th>slope</th>
<th>aspect</th>
<th>relief position</th>
<th>morphodynamics</th>
<th>geology</th>
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</table>

### Climatic characteristics

<table>
<thead>
<tr>
<th></th>
<th>mean annual temperature</th>
<th>mean annual precipitation</th>
</tr>
</thead>
</table>

### Additional remarks

- disturbance, degradation, melioration

### Ecosystem and management type

<table>
<thead>
<tr>
<th></th>
<th>original</th>
<th>current</th>
<th>past</th>
<th>planned</th>
</tr>
</thead>
</table>

### Key soil properties

<table>
<thead>
<tr>
<th></th>
<th>current</th>
<th>planned</th>
<th>...</th>
<th>comments</th>
</tr>
</thead>
</table>

- **Inherent**
  - total soil depth
  - stone content
  - clay content
  - sand content

- **Manageable**
  - soil organic matter content* in mineral soil
  - bulk density
  - pH
  - nutrient level
  - biological activity

* in mineral soil

**Type and thickness of organic layers:**

### Estimating the provision of Soil Ecosystem Services for different ecosystem and management types

**Level:** 0 (low) - 5 (high)

<table>
<thead>
<tr>
<th>Ecosystem and management type</th>
<th>current</th>
<th>planned</th>
<th>...</th>
<th>...</th>
<th>comments</th>
</tr>
</thead>
</table>

**Category**

- **Provisioning**
  - Agricultural biomass production
  - Forest biomass production

- **Regulating**
  - Water filtration and purification
  - Surface runoff regulation
  - Local climate regulation (cooling factor)
  - Global climate regulation (carbon cycle)

- **Supporting**
  - Habitat provision (biodiversity)
  - Nutrient cycle regulation
  - Water storage

- **Cultural**
  - Cultural and natural archives
  - Recreation

**Ecosystem service categories as defined in the Millennium Ecosystem Assessment**

---

**17**
current ecosystem and management type

planned ecosystem and management type

ecosystem and management type: ...

ecosystem and management type: ...
Figure 1: Orientation scheme for estimating the original ecosystem type and subsequent ecosystem and management types

<table>
<thead>
<tr>
<th>Key soil properties</th>
<th>total soil depth</th>
<th>stone content</th>
<th>clay content</th>
<th>sand content</th>
<th>soil organic content</th>
<th>bulk density</th>
<th>pH</th>
<th>nutrient level</th>
<th>biological activity</th>
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<tbody>
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<td>Regulating</td>
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<tr>
<td>Global climate regulation</td>
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<td>Supporting</td>
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<tr>
<td>Habitat provision (biodiversity)</td>
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<td>Nutrient cycle regulation</td>
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<td>Cultural and natural archives</td>
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</tbody>
</table>

- the higher the soil property value, the better the service provision
- the lower the soil property value, the better the service provision
- optimum range of the soil property regarding the service provision
- no relevant influence of the soil property on the service provision

Background: dark green: high importance of soil property; green: medium importance of soil property; light green: low importance of soil property regarding the service provision; yellow: depends on a special aspect of service, e.g. touristic activity.

Figure 2: Supporting matrix to link key soil properties with selected Soil Ecosystem Services
A short user's guide

Purpose: This 'Soil Ecosystem Service Estimation Sheet' can be used in the field at a soil profile to estimate the contribution of soils to eleven selected Ecosystem Services depending on key soil properties.

Structure and explanation

Page 1

Location and Reviser should be named in order to document where and by whom the estimation sheet was filled out.

Key site characteristics are important as some information, e.g. slope, will directly influence the service provision, whereas others are also important to understand the respective pedogenesis.

Climatic characteristics are also relevant for some Soil Ecosystem Services. For example, the mean annual temperature can influence the demand (e.g. local climate regulation) and the provision (e.g. agricultural biomass production) of the services.

Ecosystem and management type serves to collect information about the man-made history and development of the site. Thereby, 'ecosystem and management type' contains not only information on land use, but it also allows differentiating within one land use according to specific management practices. 'Original' refers to the natural ecosystem type, 'past' (if applicable) to the traditional ecosystem and management type that was maintained for a considerable time (often since the medieval settlement expansion) before the current one, 'current' describes what we see right now and 'planned' (if applicable) refers to the most likely next ecosystem and management type. Figure 1 serves as a support to differentiate ecosystem and management types.

Key soil properties are the most important information that we need in order to estimate Soil Ecosystem Services. They can be subdivided into 'inherent' (white) and 'manageable' (grey) soil properties. The latter can be influenced by humans depending on land use and management practices. The properties are either estimated or measured and directly classified on a scale from 0 (low) to 5 (high). The classification should be made at least for the current ecosystem type and management. It is also helpful to estimate the soil properties if the ecosystem and management type would be changed, e.g. for a former (original, traditional) or several planned ecosystem types of managements.

In the block Estimating the provision of Soil Ecosystem Services for ecosystem and management types the levels of service provision - from 0 (low) to 5 (high) - can be filled in. According to the classified key soil properties, the Soil Ecosystem Service can be estimated for several scenarios. Figure 2 serves as a support.
The purpose of this page is to support the decision in estimating the levels of service provision.

*Figure 1* illustrates how ecosystems can be managed. It helps to take into account, what the original ecosystem probably looked like and which factors must be considered in order to understand some site characteristics and their influence on the current or a potential future ecosystem and management type.

*Figure 2* is a support for the transformation of estimated or measured key soil properties into a level of service provision. The cross-table provides two sorts of information per 'soil property'-Soil Ecosystem Service'-pair. Firstly, mini graph symbols show in which way the soil property is determining the service. There are three options for the maximal service provision: a) max. property value, b) min. property value, c) optimum property value. Secondly, the background colour shows how much influence the soil property has on the service provision. The darker the green, the higher the influence. A yellow background stands for the ambiguous cases, where it depends strongly on the specific aspect of a service, which soil property value would be the optimum. The cross-table serves as an orientation for the majority of cases but some special cases might show other relationships.

The diagrams allow depicting the estimated levels of service provision from *Estimating the provision of Soil Ecosystem Services for different potential ecosystem and management types* as rays. The length of the ray should be directly proportional to the level of service provision. All Soil Ecosystem Services are arranged clockwise but there is no special relationship between two neighbouring services.