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Surveillance of soils and site types in the Oskarshamn area

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Abstract

Investigations to give prerequisite information for long-term storage of nuclear waste are made by the Swedish Nuclear Fuel and Waste Management Company (SKB). Ecosystem functions are crucial in this management. The range of the scope is wide including bedrock, regolith, hydrosphere and biosphere. The interface between deep geological formations and surface systems is then considered very important. This would be the top of the regolith, where soils are developed. Special attention has been paid these layers with fairly comprehensive investigations. The Department of Forest Soils, Swedish University of Agricultural Sciences, carried out Field investigations for the Oskarshamn candidate area in 2003.

The investigations in the upper regolith enclosed soil hydrology, soil parent material, pedology with soil sampling for physical and chemical analysis and on top of the soil also vegetation determinations. Methods followed the instructions for the Swedish Forest Soil Inventory. This would then provide possibilities to compare the conditions in the Oskarshamn investigation area with those of Sweden as a whole and also to relevant regions. However, there are basic differences with respect to spatial coverage. In the Swedish soil inventory, the distribution of plots provide spatial estimations for large areas but this would not be possible in the rather small Oskarshamn area. In this area, the investigation instead focused on thorough determination in relevant selected soil types. Determinations and sampling furnishes possibilities for statistical comparisons.

Geographical location of the Oskarshamn area is on the west Baltic Sea coast (N 57°25'; E 16°33') in the Kalmar county in the landscape Småland. Altitudes in the area (Figure 2-1) are up to the highest places on 53 m but mainly the area is found below 20 m. The climate is characterized by an annual precipitation of c 600 mm, fairly high evapotranspiration (> 400 mm) and an annual average temperature on c +6.5°C.

Based on a first surveillance, ten soil types were selected and surveyed in two replicates. The plots had a size of 15 m × 15 m, where site conditions were determined and eight soil profiles investigated and sampled.

Results reveal conditions similar to large parts of Sweden, however, with more frequently existing thin soils and rather often occurring small peatlands. Peat soils and Histosols dominated investigated sites. Other frequently occurring soils are Gleysols, Podzols, Umbrisols and Regosols. The small scale broken topography provided considerable variations in hydrological conditions varying from the upslope bare bedrock and thin soils where fresh and dry conditions prevailed to lowlying moist and wet sorted sediment soils and peat.

Sammanfattning

Undersökningar genomförs för att klargöra förutsättningar och fastställa förhållanden inför långtidslagring av utbränt kärnbränsle. Svensk Kärnbränslehantering AB (SKB) undersöker ekosystemförhållanden i de två områdena Forsmark och Oskarshamn. Särskilda platsundersökningar har stor omfattning, alltifrån det djupa berget upp till de lösa avlagringarna ovan berg samt vatten- och biosfärssystemen. Känsliga delar i hela systemet är övergången från geosfär till biosfär, där de övre marklagren och jordmånsskiktet är avgörande för de ytliga ekosystemen. Fältundersökningar av Oskarshamnsområdets jordar genomfördes 2003 av Institutionen för skoglig marklära, SLU.

De särskilda jordmånsundersökningar, som har genomförts omfattade vegetationsförhållanden, markhydrologi, jordartsgeologi, pedologi och inbegrep också markprovtagning för laboratorieanalyser av fysikaliska och kemiska förhållanden. Inkluderat i dessa var främst skrymdensitet, pH, total C och N.

Undersökningarna följde gängse metoder för Riksinventeringen av Skogs markinventering. Detta medför att de egenskaper som bestämts för Oskarshamnsområdet kan jämföras med förhållanden i hela Sverige eller delar därav. En avvikelse från markinventeringen, som är spatiellt täckande för lite större områden, är att sådan täckning inte eftersträvades för Oskarshamnsområdet. Istället var avsikten att söka nå statistisk spridning för egenskaper inom utvalda enhetliga marktyper. För att kunna applicera dessa över hela området så användes GIS i en areell skattning av marktyper över området. Denna kartläggning baserades på vegetations-, jordarts- och hydrologiska digitala kartor. Från detta material kan den spatiella utbredningen av marktyper bestämmas och jämföras med markinventeringens uppgifter. Detta ingår inte i föreliggande rapport, som främst är en lägesbeskrivning av genomförda insatser.

De undersökta marktyperna fastställdes till tio varianter och varje sådan inventerades i två upprepningar. Varje lokal utgjordes av en 15 m × 15 m yta, där ståndortegenskaper fastställdes och åtta markprofiler undersöktes avseende fältbestämning av jordmån, jordart, textur, humusform och för torv nedbrytningsgrad. Markprover för laboratorieanalyser togs från humuslagret, de övre 0,2 m av mineraljorden och från modermaterialet på 0,6 m djup.

Det geografiska läget för Oskarshamnsområdet (N 57°25'; E 16°33') är vid Östersjökusten i östra Småland. Området ligger strax ovan havsytenivån med högsta höjder upp till c 53 m men med större delen av området under 20 m höjd. Detta medför att jordarna är relativt unga och att jordmånsutvecklingen pågått endast relativt kort tid. Klimatet karaktäriseras av c 600 mm årsnederbörd, en årsmedeltemperatur av c +6,5 °C och ofta relativt torra och varma vegetationsperioder.

Undersökningarna visar i stort på relativt stora likheter mellan Oskarshamnsområdet och stora delar av Sverige såsom varande ett skogklätt område på tämligen vanliga jordarter.

Markfuktigheten kan ofta hänföras till frisk mark men fuktig och blöt torvmark förekommer också. De relativt unga jordarna utgörs till stor del av sorterade sediment såsom lera och sand men flerstädes också torv. Moräner förekommer endast ställvis. Bearbetning och omlagring genom havsvattnets försorg medför att de mer moränliknande jordarterna finns i de högre belägna delarna där också renspolade hällar förekommer frekvent. I lägre liggande

lägen har jordmaterialet bearbetats mer och där förekommer också de vattensorterade sedimenten. I den småskaligt varierade topografin har bidragit till dominerande humusformer främst av typerna torv, mull och mår.

Under strandförskjutningen (landhöjningen) har havsvikar blivit avsnörda från havet varvid grunda sjöar uppstått som senare omförts till våtmarker med torvbildande miljöer. Inslaget av fuktiga och blöta jordmåner såsom histosoler och gleysoler förekommer frekvent.
I övrigt finns podsoler, umbrisoler och regolsoler.

Contents

1 Introduction

The Swedish Nuclear Fuel and Waste Management Company (SKB) carries out comprehensive investigations related to management for long-term storage of nuclear waste. These investigations concern ecosystem properties and functions in tentative areas of bedrock storage. In this work, the soil and site type survey is one important part. One of the candidate areas is the Oskarshamn area where soil and site conditions were investigated in 2003. Information of regolith properties is necessary to provide possibilities to model transport of possible released nuclides from the repository, as well as determine impacts of the preparatory work for the storage compartment building.

The Department of Forest Soils, Swedish University of Agricultural Sciences in Uppsala using mainly similar methods as for ”The Swedish Forest Soil Inventory”, 2003, made the survey. This combination provides possibilities to compare the conditions in the Oskarshamn area with national and regional conditions. The variables included in the investigation are mainly the same as in the soil inventory. In this state report, comparisons are not included.

The upper part of the soil is one of the more crucial components for ecosystem functions. Clarification of the conditions in the uppermost metre of the soil was the main focus in this investigation. The general approach in the work has been to classify the land into the typical soil types of the area based on spatial information on vegetation, Quaternary deposits and a topographical index of soil wetness. This work will be carried out in a GIS environment. Variables determined will include vegetation, hydrology, soil parent material and textural composition, soil profile type and physical and chemical properties of the relevant soil layers.

The project results are preliminary reported in this written document presenting the determinations that were carried out. Mainly, this report includes an overview of the investigated sites with common descriptions. Later a more comprehensive report based on a GIS of a soil map of the Oskarshamn area will include detailed presentation of site conditions. The results from the field investigation form the basis for the soil classes suitable to characterise the Oskarshamn area. A further development included will be to extrapolate this information and give the geographical distribution of the defined soil classes in the area.

Soil here refers to the upper part of the regolith, which is characterised by horizons with certain physical and chemical properties. The soil is developed as a result of the interaction of many different factors, such as typically influences of *soil parent material, climate, hydrology* and *organisms*, being integrated over *time*. The aim of soil classification is to define soils of similar characteristics, i.e. soil types. By mapping soil types it is possible to assign properties collected in well-described soil profiles to other locations with the same soil type. Since soils are the result of many different processes, they are a sensitive component of the ecosystem and may serve as indicators for changes induced by disturbances. In the Oskarshamn area, it is of interest to be able to trace any short- or long-term changes induced by the actions taken in relation to the possible long-term bedrock storage of nuclear waste material. Short-term changes may involve changes induced by e.g. a changing ground water surface, whereas the long-term changes that might occur are unknown.

2 Investigation area

The Oskarshamn area is located on the west Baltic Sea coastline in the south-east part of Sweden. The area is c 20 km^2 and located approx. N 57°25’ and E 16°33’, west of the Oskarshamn nuclear fuel plant (Figure 2-1). The altitudes of the area ranges from coastal sea level up to c 53 m a s l but with most of the area below 20 m. The main land cover is forest on different soil types, together with partly open land on wet soils and bedrock outcrops.

The climate of the region is characterised by a snow covered winter period during three months in 80% of the years, ranging approximately from first of December to March, c 100 days. The vegetation period extends over 220 days, mainly April to October. Hydrology is characterised by fairly dry summers, autumn rains with increasing runoff as well as with snowmelt periods during winter. Annual precipitation amounts to c 600 mm and evapotranspiration reaches over 400 mm resulting in a runoff of less than 200 mm. The mean annual temperature is c +6.5°C.

The soils of the Oskarshamn area are fairly young. The soil material is of till origin, which has been influenced by the sea during the transgressions of the Baltic Sea. By these redistribution of soil material occurred and left course water washed tills in higher locations, also with thin soils and bare bedrock. Elsewhere, in depressions the redistributed fine material has been deposited as sorted sediment soils. During the overall transgression, sea bays have been cut off and now forms wet soils and peatlands.

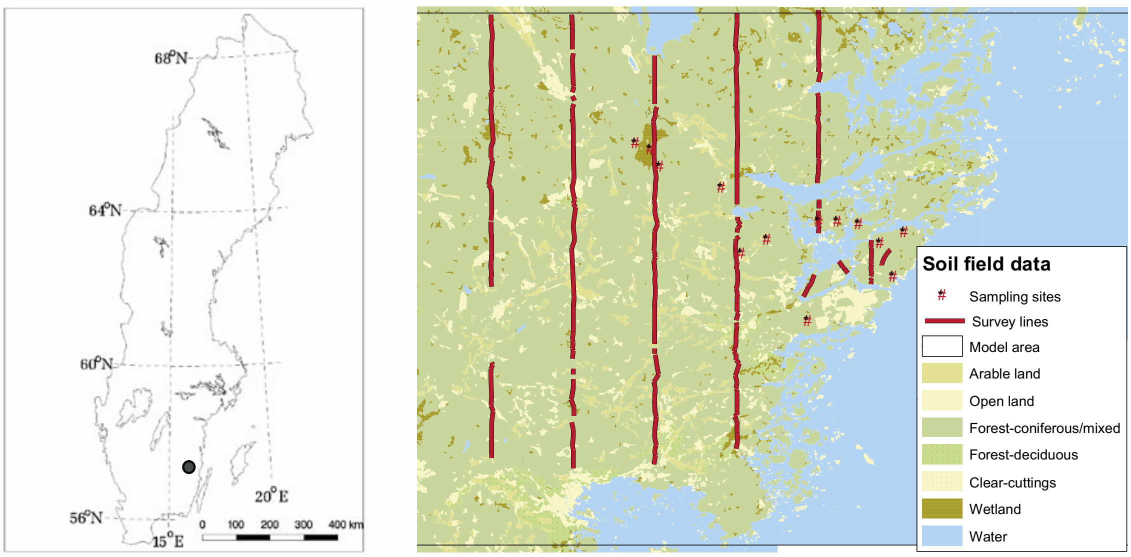


Figure 2-1. *Geographical location of the Osharshamn investigation area and presentation of land use types, inventory transects and sites.*

3 Methods

3.1 Investigation design

The investigations on site and soil conditions are linked, by mainly using similar methods, to the Swedish Forest Soil Inventory /RT, 2002/. Conditions and properties of the Oskarshamn area was classified from the plots investigated with the intention to compare with other parts of Sweden.

The primary interest in the soil inventory is to identify characteristic land types and for each of these determine statistically based values on a number of properties, especially chemical elements. These values would in a later repeated investigation provide possibilities to detect changes over time. Another interest is the possibility to compare the Oskarshamn area conditions with the national and regional conditions, surveyed in the "Swedish Soil Inventory", to show distributions of properties for the Oskarshamn area in comparison with all of Sweden and also a few other relevant regions.

In the initial inventory stage, studies were made to get an overview of the area. Two methods were used;

1) available maps were studied,

2) a site land surface survey along 11 transects over the area was made. However, this was not sufficient to achieve a total coverage of the survey area. Related comprehensive work would have been too time consuming.

From these preparatory stages ten site types were selected and representative plots thoroughly investigated. The plots were selected based on five criteria:

- The plots should be representative for typical sites in the area, primarily with respect to hydrology and vegetation.
- The sites should have representative soil material and humus forms.
- The plots should be fairly homogeneous with respect to topography, soil moisture class, vegetation, humus form and soil patent material composition.
- Elevation differences inside the plot should not exceed one metre.
- There should inside the Oskarshamn area exist a similar site, not belonging to the same biotope, to be used as replicate.

Each of the ten types had two replicates, which makes up 20 investigated plots. On each plot, being 15×15 m, a 5×5 m grid was established and used to select the exact soil profile locations. These were selected based on a systematic approach, where the first location was intended for a deep profile, second used as a reserve and third for a profile for upper horizons (0–0.5 m) and then a reserve for this and after this the same consecutive four locations repeated. Reasons for not using pre-set locations could be trees, boulders or deviating water levels. A deep profile could be changed to an upper layer pit if there would be problems to go deeper and then the reserve or next location was chosen as next deep pit.

The investigations were carried out according to Activity Plan SKB AP PS 400-03-026 (SKB internal control document). The data have been incorporated in the SICADA database under field note no Simpevarp 204.

3.2 Site survey methods

At each of the plots a site description was made including type of field- and bottom layer vegetation, hydrology, subsurface water flow, drainage activities, frequency of stones and boulders and the thickness of the humus layer.

Vegetation

Vegetation types and dominating species within the list of species used in the "Forest Soil Inventory" and percentage of coverage were determined.

Vegetation types included in the bottom layer:
1 lichen type
2 lichen-moss type
3 lichen rich type
4 *sphagnum* type
5 wet moss type
6 mesic moss type

Field layer:
01 tall herbs without shrubs
02 tall herbs with shrubs/bilberry
03 tall herb type with shrubs/vitis idea
04 low herbs without shrubs
05 low herbs with shrubs/bilberry
06 low herbs with shrubs/vitis idea
07 without field layer
08 broad leaved grass
09 narrow leaved grass
10 tall sedge
11 low sedge
12 horse tail type
13 bilberry type
14 vitis idea/whortleberry, marsh rosemary type
15 crowberry/heather type
16 poor shrubs type

The species identified relates to the number of types in the "Soil and Vegetation Survey Manual" /Lundin et al. 2002/.

Site hydrology – Soil moisture class

This variable reflects the average distance from the ground surface to the groundwater table during the vegetation period. Estimations are made from geophysiographical conditions.

1 dry
2 fresh
3 fresh/moist
4 moist
5 wet

Probability of subsurface water flow

This variable mainly refers to the slope and length of this uphill from the plot studied. Estimations are made from topography and slope length.

1 Missing/rare
2 Shorter periods
3 Longer periods

Drainage

Estimations reflect effect of ditches on the plot where 20 m considers to be the largest distance of influence.

0 not drained
1 drained

Stones and boulders

Statement shows the possibility to perform the stoniness inventory /Viro, 1958/. The special determination means pushing a 10 mm steel rod into the soil until a stone or boulder is hit within max. depth 30 cm. This was made in 36 points over the 30×30 m plot. At the same locations also the thickness of the humus layer was measured. The average stoniness depth is used in a function to estimate the volumetric content of stones and boulders in the soil.

0 measurements not possible to make
1 measurement made

Aspect

Indicates the plot facing direction.

1 north	12 northeast
2 east	14 northwest
3 south	32 southeast
4 west	34 southwest

3.3 Methods for soil inventory on profile level

Soil profile

Thickness of the genetic horizons was estimated. This refers to common designations of the horizons /Lundin et al. 2002/. Values are given as depth from the soil surface. When depth values is followed by a plus-sign (+), this means that the horizon continuous deeper then the value given.

Humus layer, deepest border
A-horizon, deepest border
AB-horizon, deepest border
E-horizon, deepest border
B-horizon, deepest border

Soil parent material in the profile

Soil material composition is determined at 20 cm depth in the mineral soil and as peat if the organic surface layer is thicker than 30 cm.

1 Well sorted sediments
2 Poorly sorted sediments
3 Till
4 Bedrock
5 Peat

Soil material texture

Textural conditions were determined in the field using common methods by working the material /Lundin et al. 2002/. Determinations were made on a sample from a depth of 20 cm in the mineral soil.

0 Boulders in the profile
1 Stone/Boulder/Bedrock
2 Gravel/Gravely till
3 Coarse sand/Sandy till
4 Sand/Sandy silty till
5 Fine sand/Silty sandy till
6 Coarse silt/Coarse silty till
7 Fine silt/Fine silty till
8 Clay/Clayish till/Gyttja
9 Peat

Despite the careful preparations and consecutive analysis, the importance of sampling may not be neglected. The fixed sampling depths mixed in some cases genetical horizons giving a less distinct result.

Soil type

Classification on soil types refers to the international World References Base system (WRB) /WRB, 1998/. The system used is a simplified version including the appropriate types for Sweden and with field determinations, which actually is not totally correct while a thorough classification needs chemical analysis. However, the simplified determination would reflect an almost correct classification.

1 Histosol
2 Leptosol
3 Gleysol
4 Podzol
5 Umbrisol
6 Cambisol
7 Arenosol
8 Regosol
9 Unclassified (could be caused by too much water, etc)

Additional features in the soil profile

There are a number of specific features that are of decisive interest in the soil profile and some of these have been determined. These are related to anthropogenic influences and chemical properties.

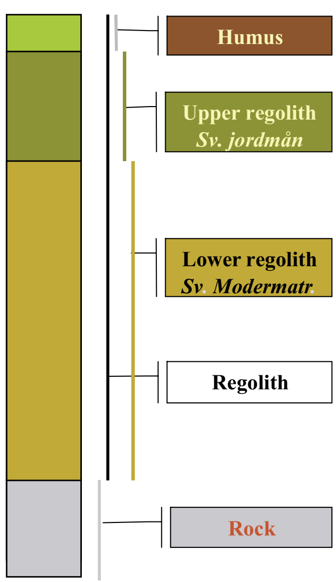
0 None
1 Culture influence (especially ploughing)
2 Disturbances (soil scarification, wind thrown trees, etc)
3 Spodic B horizon (determining the Podzol soil type)
4 Calcium carbonate (frequently found in Forsmark area)
14 Combination of 1 and 4
34 Combination of 3 and 4

Soil sampling

Soil was sampled from the profiles and the system was adopted both to international conditions and the traditional Swedish system to give the possibility to compare with the ongoing Swedish "Forest Soil Inventory". The horizon from which soil was sampled was recorded and the soil parent material and texture determined on the deepest sample, belonging to the C-horizon. This determination used the classes given above for soil parent material and texture in the soil parent material. Sampling of the soils was made according to the soil type with the basic sampling related to:

Humus layer was sampled separately and mineral soils mainly in three layers (Figure 3-1).
Mineral soil layers: 0–10 (H10 sample in mull and mull like moder), 10–20 and 55–65 cm.
In Podzols: additional 0–5 cm in the B-horizon.
In Histosols: 0–30 and 40–60 cm.

Rock, Regolith and Soil Sampling



Sampling depths, cm

Main types	Podzols	Peat
0-30	0-30	0-30
0-10	0-5	
10-20	5-20	40-60
55-65	55-65	

Figure 3-1. *The regolih over the bedrock with soil sampling depths in three categories of soils.*

Sampling for bulk density

Volumetric mineral soil samples were taken to determine dry bulk density. Two profiles on each plot were sampled, if possible, in the depths: 0–10, 10–20, 20–30, 30–40, 40–50 and 50–60 cm. The steel cylinder size used in mineral soils had the height 5 cm and radius 3.6 cm. In peat soils the larger humus sampler were used with radius 5 cm and sampled thicknes of c 10 cm.

Mineral soil material underlying peatlands

The composition of the parent material underlying peat deposits were determined according to:

1 Clay
2 Silt
3 Sand
4 Gravel
5 Stone
6 Non-sorted material
7 Boulder or bedrock

Peat humification degree

The degree of peat humification, according to the von Post scale /von Post and Granlund, 1926/ was determined in two depths in the peat, i.e. 10 cm and 50 cm.
Decomposition degree:

1 Undecomposed or very weakly, von Post H1–2
2 Weakly, von Post H3–4
3 Moderately well, von Post H5–6
4 Strongly, von Post H7–8
5 Almost completely, von Post H9–10

4 Results

4.1 Short summary on results

The overall impression of the Oskarshamn area displays a broken topography with variations from wet downslope soils with peatland Histosols and moist mineral Gleysols to drier upslope soils where Leptosols and bare bedrock are frequently occurring. However, these Leptosols were not sampled while sampling of deep soil horizons requested a substantially thick soil cover. In locations inbetween wet and dry, especially fresh soils, Umbrisols, Podzols and Regosols occurred.

4.2 Properties and spatial coverage

Variables identifying properties of the soil were determined on a representative plot scale with ten site types in two replicates. The plots were chosen in a stratified selection to cover the major occurring land types and to achieve good statistically based information from these types. The spatial coverage of land types will later be provided from the GIS mapping of the area. There, a combination of the plot determinations and the spatial coverage will be made in the comparisons of spatial distributions of properties in the Oskarshamn area with relevant areas of Sweden to reflect similarities and deviations of the Oskarshamn area land types in relation to Swedish land area conditions.

4.3 Properties of the Oskarshamn area land types

The Oskarshamn area is presented by the ten land and soil type classes selected for the inventory to represent the majority of the area. However, these rather few plots (20) did not give possibilities to reach a representative spatial coverage. This will be better presented in the GIS map. Based on this, the distributions of the soil types will be compared with prevailing conditions for the total Sweden, the relevant region of Sweden and with the Kalmar County. Forest land and peatland seems rather well represented as compared with the region and also Sweden as a country.

Site types and investigated plots

Ten site types with two replicates were investigated. These types were selected on basis of the most frequent site types in the area determined from map studies and field transect observations. The ten types were designated ÅS, ÅKER, STRAND, VÅT, GRAN, LÖV, HÄLL, ÄNG, VH and SUMP (Table 4-1). In this section a brief description is made of the plots. The two replicates had sampling identities (ID; both related to soil type class and the SKB Id-codes) and these plots will later be related to the map classification soil types (Table 4-1).

Table 4-1. Sample plots, prevailing soil type and SKB Id-codes.

Sample plot name	Site code	Soil type
GRAN	ASM 001440, ASM001441	Histosol
HÄLL	ASM001428, ASM001429	Podzol/Regosol
LÖV	ASM001426, ASM001427	Umbrisol/Regosol
STRAND	ASM001436, ASM001437	Histosol, Regosol
SUMP	ASM001434, ASM001435	Histosol
VH	ASM001432, ASM001433	Histosol
VÅT	ASM001442, ASM001443	Histosol
ÅKER	ASM001438, ASM001439	Umbrisol/Gleysol
ÅS	ASM001424, ASM001425	Podzol
ÄNG	ASM001430, ASM001431	Umbrisol/Gleysol

Gran – Peat soils in downslope locations – " ASM 001440, ASM001441"

These are drained peatlands with spruce on fresh and fresh moist soils. The combination of ditches and forest evapotranspiration, provides a vegetation type of blueberry and low herbs. The drainage has provided fresh mosses in the bottom layer. However, there is still more than 0.4 m organic layer resulting in a Histosol soil. In this case the humus form is peat and sampling made of the two pre-set peat layers. The humification degree was dominated by strongly decomposed peat in both layers. Under the peat there is mainly coarse mineral soils such as stones and boulders, perhaps also the bedrock surface.

Häll – Upslope soils representing thin soils – " ASM001428, ASM001429"

This site type was found close to bedrock outcrops and then with rather thin soil covers. Land cover is forest on mainly fresh soil moisture type with a vegetation of fresh mosses in the bottom layer and with a field layer of blueberry type. On top of the fairly coarse sandy and sandy silty till soils, a humus layer of mor type dominate. The developed soil types are in most cases Regosols but also Podzols exists. These types refer to slightly deeper soil cover where sampling of deeper horizons was possible. However, on some locations the thin soil cover furnished Leptosols. These should probably be more frequent but the soil sampling possibilities made the other soils to seem more frequent.

Löv – Forested relatively nutrient rich site types – "ASM001426, ASM001427"

Deciduous trees such as oak, birch and mountain maple mainly dominated the forest land cover. Ground vegetation was fresh mosses, grass and low herbs on a well-drained soil of fresh soil moisture type. Fairly coarse till soils of sandy and sandy-silty texture occurred with one site being fine grained (silty sandy). Developed soil types varied between Regosols and Umbrisols with the mull humus form dominating and probably with time turning more frequently into better developed Umbrisols.

Strand – Young soils in the shoreline – "ASM001436, ASM001437"

The two sites differed due to soil parent material with one being peat and the other a well-sorted soil of sandy texture. Moisture condition at the first site was wet while the sand was well drained and differed between fresh and fresh-moist. No good bottom layer vegetation had developed and the field layer was dominated by broad leaved grasses. On the wet site peat soils with Histosol type existed while the sandy soil often was without humus layer and the soil types there varied between Arenosols and Regosols.

Sump – Wetland forest type – " ASM001434, ASM001435"

Forested sites with rather rich peat soils covered by more rich mosses compared to Sphagnum and field layers of broad leaved grasses. The humus form is peat and the soil type Histosol. The mineral soil under the peat varied from clay and sand to peat on the bedrock and the humification degree was moderately well decomposed in the upper layer and strongly decomposed in the deeper one.

VH –Small wetlands in berock depressions – " ASM001432, ASM001433"

This site type represents small peatlands inbetween bedrock outcrops and is characterised as a moist dwarf shrub type with bog bilberry, lingonberry and marsh rosmary over a Sphagnum bottom carpet. In the peat soil, Histosols have developed and the humification degree is weekly or moderatly well decomposed in the upper layers and strongly in the deeper layer. Underneath the peat mainly bedrock is found but on top of this occasionally also sand.

Våt – Open fen areas " ASM001442, ASM001443"

This is a water rich type with Sphagnum mosses in the bottom layer and broad leaved grass and sedges in the field layer. The parent material is peat and the soil is a Histosol. Humification degree in the upper layers is weak and in the deep layer up to strong. The underlying mineral soils are fine sand and sand on top of the bedrock.

Åker – Arable land " ASM001438, ASM001439"

Well-drained soils of fresh and fresh moist type used for crops such as oats. No bottom vegetation and mainly cereals as field vegetation. The typical location of such land in this region is in small valleys in-between surrounding coarser soil formations and bedrocks. The parent materials were well-sorted clay or gyttja soils furnishing fairly rich conditions with mainly Umbrisols but occasionally, where water influence, Gleysols.

Ås – Glaciofluvial ridge deposit "ASM001424, ASM001425"

The glaciofluvial deposit forms an esker where out-washed fine soil material is lacking. This provides poorly sorted sediments of coarse sand, sand and partly fine sand but low content of boulders and clay. The soils have developed to mainly well-drained Podzols. Vegetation is characterised by fresh mosses and blueberry.

Äng – Meadow "ASM001430, ASM001431"

Open land for grazing as constituting meadows. Mainly well drained soils but partly with small bedrock outcrops but on some parts also moist soils. The parent material was dominated by sorted sediments mainly being clay but on one site exposed to wave-washing that resulted in slightly less well-sorted clay with content of silt and fine sand. The land has been used in agriculture and Umbrisol dominates the soils developed. Broad-leaved grasses were found in the field layer and fresh mosses occurred on one site.

4.4 Dry bulk density

In the investigation sites, sampling plots, the dry bulk densities were determined. In peat soils the densities were comparably low, ranging from 0.03 g/cm^3 to 0.36 g/cm^3. The lowest values existed at a very wet fen (Våt 1), while higher values were found at sites with tree cover (Gran and Sump). In the peat of the shoreline (Strand) reed bed values were between 0.1 g/cm^3 and 0.2 g/cm^3. Densities at ordinary Sphagnum moss and sedge peat (VH) were found in the ordinary range of natural peatland soils, i.e. 0.1 g/cm^3–0.2 g/cm^3 (Table 4-2).

In the mineral soils the ordinary stratification with depth was observed. In the upper soil layers, the densities were often below 1.0 g/cm^3 but increased up to 1.8 g/cm^3 at 0.5–0.6 m depth. Variations occurred between single layers (Table 4-2).

Table 4-2. Dry bulk densities at depths to 0.6 m at the 20 sampling plots together with parent material. Number of determinations, N.

Dry bulk density at Oskarshamn, g/cm^3								
Plot	**Material**	**Depth, cm**						**N**
		0–10	**10–20**	**20–30**	**30–40**	**40–50**	**50–60**	
Gran 1	peat	0.17	0.24	0.36	0.29	0.30	0.27	2
Gran 2	peat	0.23	0.36	0.27	0.23	0.15	0.16	2
Häll 1	till	0.87			1.35	1.18		1
Häll 2	till	0.48	1.01	1.13	1.09		1.28	1
Löv 1	till	0.52	1.00	1.07	1.38	1.21	1.04	2
Löv 2	sandy silty till	0.71	1.23	1.28	1.13	1.31	1.38	2
Strand 1	peat	0.09	0.15	0.15	0.20	0.16	0.16	2
Strand 2	sand	1.55	1.58	1.50	1.63	1.42	1.32	2
Sump 1	peat	0.18	0.24	0.30	0.31	0.21	0.35	2
Sump 2	peat	0.17	0.18	0.20	0.15	0.21	0.20	2
VH 1	peat	0.07	0.07	0.09	0.14			4
VH 2	peat	0.14	0.17	0.18	0.19	0.16	0.18	2
Våt 1	peat	0.05	0.03	0.04	0.05	0.18	0.11	1
Våt 2	peat	0.04	0.07	0.06	0.06	0.10	0.16	2
Åker 1	gyttja (clay)	0.70	0.69	0.66	0.56	0.54	0.68	3
Åker 2	gyttja (clay)	0.45	1.00	1.18	1.82	1.81	1.63	2
Ås 1	coarse to fine sand	1.16	1.35	1.58	1.48	1.66	1.57	
Ås 2	coarse to fine sand	0.45	1.00	1.18	1.82	1.93	1.63	2
Äng 1	fine sand	1.22	1.22	1.43	1.22	1.46	1.74	2
Äng 2	clay	0.29	0.48	0.35	0.36	0.50	0.57	2

4.5 Concluding characteristics of the site types

Properties related to the site types in the Oskarshamn area varied concerning soil types mainly between six classes, with Histosols being most common. Other frequently occurring soils are Gleysols, Podzols, Umbrisols and Regosols. Soils had developed partly on sorted sediments and peat but also on till with site hydrology variations on investigated plots being fresh to wet while the class dry mainly occurred on local small hills and where bedrock outcrops existed.

4.6 Soil chemistry

Soils of the Oskarshamn area were sampled on ten locations in the 20 plots constituting two replicates of ten plots. Determinations included pH, total C and total N.
(Values are found in the Sicada database.)

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