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*Semi-detailed Soil Survey and Landscape Ecological Risk Evaluation in the South-Western and Central-Western Parts of the Etosha National Park/N-Namibia*

Part 2

# SEMI-DETAILED SOIL SURVEY AND LANDSCAPE ECOLOGICAL RISK EVALUATION IN THE SOUTH-WESTERN (SHEET 1915 BB OKAUKUEJO; 1916 AA ONDONGAB) AND CENTRAL-WESTERN PARTS (SHEET 1815 CB NGANDJELA) OF THE ETOSHA NATIONAL PARK/N-NAMIBIA

by

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## PRELIMINARY REMARKS

The second part of the Etosha final report deals with the remaining three study areas Ngandjela (South West Africa 1:50000 sheet 1815 CB), Okaukuejo (South West Africa 1:50000 sheet 1915 BB) and Ondongab (South West Africa 1:50000 sheet 1916 AA). The physical and chemical properties of the occurring soils in these regions are described and characterized. Due to these soil properties the soil types were divided into different groups and units. In Appendix A a complete classification of all soil groups and soil units occurring in the study areas is given. From these informations soil associations were defined and mapped as soil units. In a second step the individual eco-pedological risks of each soil unit resp. variation within a specific soil unit were evaluated by LERIS (BUCH & LINDEQUE 1993), and transferred into maps. These maps show the integrated landscape-ecological risks of a specific region in the study areas, where the main risks of a mapping unit/variation is indicated by particular letters. An assessment and discussion of the landscape-ecological risks is given at the end of this report.

## THE STUDY AREA

Part I of this final report describes the landscape and the land units of the Sonderkop study area that is part of the so-called 'Owambo-Pans-Plain' (BUCH 1993). The south-eastern part of the Ngandjela study area (Topographical map 1815 CB) is also part of the 'Owambo-Pans-Plain' whereas the northern and north-western corner of this area and the adjacent Owambo region belongs to the land unit of the so-called 'Owambo Sandveld' (BUCH 1993). The Okaukuejo study area (Topographic map 1915 BB) principally belongs to the land unit of the "Etosha Pan in a wider sense" (BUCH 1993), only the elevated region in the south-west of this sheet is part of the so-called 'Karstveld' (BUCH 1993). Most of the area of sheet Ondongab (1916 AA) is part of the 'Karstveld' and only the areas that adjoin to the southern edge of the Etosha Pan are part of the land unit "Etosha Pan in a wider sense" (Map 1 after BUCH 1993, modified).

### 1.1. The Owambo-Pans-Plain (sheet Ngandjela 1815 CB)

The Ngandjela area, situated in the Central Western Part of the Etosha N. P., is the northern continuation of the Sonderkop area up to the game proof fence of the ENP at the northern border to the adjacent Owambo region. This area receives a mean annual precipitation of 400 mm (ENGERT 1993) and the vegetation consists of a mopane shrub land savanna (Community 21, 22, 23, LE ROUX 1980; DU PLESSIS 1992) where *C. mopane* bushes dominate the shape of the vegetation. A more detailed description of this land unit is given in the first part of this report (BUCH & LINDEQUE 1993; Part III). The north-western area of sheet Ngandjela in the area around Paradys Pan is part of the Owambo Sandveld with *C. mopane* bushes and *Terminalia spec.* (Community 17) developed as trees (>2m) as the most prominent vegetation. The geological underground is Etosha Limestone characterized by a sandy phase and/or sandstone, which belongs to the 'Andoni Formation' (BUCH 1993) sometimes mixed with Siltstone components.

The geomorphology of this area is characterized by a gently rolling to undulating relief, differentiated by distinct levels with low hills and gentle longitudinal dunes in the north-western part of this region. These levels of different altitude sometime show small circular shallow depressions.

The Ngandjela area in addition is characterized by eight smaller pans: the Sonderkop Pan, the Paradys Pan, the Onaiso Pan, the Ngandjela Pan, the Fence Pan and Owambo Pan 1, 2 and 3. All these local pans have one or two low dune ridges at their western margin. In general it can be observed, that the landscape surface is slightly terraced. The different levels are becoming gradual more extended and change over into a plain from the higher southern edge of the Ngandjela sheet to the northern end in the Owambo region (Map 7). Therefore it must be stated that the whole landscape in the Ngandjela study area is very homogeneous and -from a morphological point of view- is only slightly differentiated.

In principle the soils in the Ngandjela area are characterized by non calcareous and deep sands although some soils show a loamy to clayey texture and have a medium depth. A typical feature of all soil types and an indicator for the recent aeolian activity in the region, is a young aeolian sand cover on top of the surface, often forming micro-dunes around bushes. Due to the strong geomorphological and environmental similarity between the Sonderkop and the Ngandjela area and the fact that land units and soil associations are closely related, almost the same land units and soil associations occur in both regions.

### 1.1.1. The Marginal Pan Zone

Land unit **V** is situated at the lowest level (1063 - 1099 m a.s.l.) of the Ngandjela study area around all the local small pans and is clearly distinct from the surrounding areas by a sharp edge (Map 7). This nearly flat and even land unit covers 5.9 % of the total study area (Table 1) and is dissected by some drainage lines and marginal gully erosion. Due to the morphodynamics of backward erosion sometimes small remnants of the surrounding areas are present within land unit **V**. The soil substratum is clayey to loamy with 'high' contents of salt. Therefore the surface often is soft and powdery with salt accumulations sometimes forming salt crusts, on the top. Another phenomena are sealing crusts and polygonal shrinking and swelling cracks. Due to these extreme soil physical and chemical conditions the vegetation cover in land unit V is sparse and scattered (<10%) and only salt adapted plants can tolerate these ecological factors.

### 1.1.2. Plains

Land unit IV describes an almost flat plain with slopes <0.5° and differences in elevation less then 5 m. Some very smooth hills and some flat depressions are the only irregularities in this landscape that is dissected by a clearly marked drainage line which runs from the west to the east and ends in Onaiso Pan. The plain has an elevation between 1090-1110 m a.s.l.. With an area of 37.6 % land type IV is most widespread in the Ngandjela area. The meso-topography of mapping unit IV is slightly undulating. A thin surface crust overlain by young aeolian sands is an expression of the recent aeolian activity in this region. Like at many other places in Etosha, these aeolian sands form little dunes (10-20 cm high) around bushes and tufts of grass. The vegetation consists of mopane bushes, various grasses and *Catophractes alexandri* at the edges of the drainage line as a result of higher calcium carbonate content in the drainage line soils.

### 1.1.3. Hilly Areas

The southern half of the study area is dominated by the hilly areas of the morphological unit II that can be distinguished into several levels. One of the more extended levels is mapped between 1110 m a.s.l. to 1120 m a.s.l. and between 1120 to 1130 m a.s.l.. The marginal pan or 'lunette' dunes take a special position within land unit II because they occur as clearly visible, albeit gentle and flat ridges (Map 7), often lying on a lower levelled land unit (IV). The total area occupied by hilly areas comprise 40.7 % of the study area and of that the dunes have a share of 4.9 %. The relief is slightly rolling with some indistinct drainage lines. The surface of a single level can be described as more or less even and the meso-topography appears as slightly undulating with some flat depressions. The hilly regions also possess a sandy top layer originated from recent aeolian morphodynamics and a thin sealing crust is very common. The vegetation cover in this part of the Ngandjela area is a very dense (20-30%) bush savanna consisting of mopane bushes, acacia bushes and various grasses (e.g. *Anthephora pubescens*) including some tree species of *Acacia spec.* and *Terminalia prunioides*. Acacia and Terminalia trees (>2m) often form small 'forest'-like vegetation units on the pans edge dunes as it can be observed west of Paradys Pan.

Table 1 summarizes the Ngandjela land units and soil units with their percentage share of the study area in total.

Table 1: Soil units and soil types of the Ngandjela area (sheet 1815CB) in the Etosha N. P.

| Land unit | Soil Unit | Soil Types | Soil Profiles Nga | Area km² | Area % |
|---|---|---|---|---|---|
| IVj | A2 | Psammi-Humic Cambisol<br>Psammi-Vertic Cambisol<br>Xanthi-Cambic Arenosol<br>Haplic Arenosol<br>Cambic Arenosol | 2, 4, 5, 9, 12 | 93.9 | 28.3 |
| Various | A7 | Eutric Para-Vertisol<br>Eutric Vertisol | 8 | 6.9 | 2.1 |
| II, IIi, IIk, IIm | A9 | Cambic Arenosol<br>Rhodi-Cambic Arenosol (incl.)<br>Psammi-Vertic Cambisol (incl.) | 1, 6, 7, 10, 13, 14 | 118.9 | 35.8 |
| IId | A10 | Rhodi-Cambic Arenosol | 11 | 16.3 | 4.9 |
| IVe | A11 | no samples | --,-- | 14.3 | 4.3 |
| IVo | D2 | Mollic Fluvisol | 3 | 16.6 | 5.0 |
| V | E1(A6) | Calcic Solonchak | no samples taken see Sonderkop | 19.6 | 5.9 |
| Pan | E2 | Sodic Solonchak | no samples taken see Sonderkop | 45.5 | 13.7 |
| Total | | | | 332 | 100 |

## 1.2. Soils and Soil Associations in the Ngandjela Area

The soil map of Ngandjela (Map 8) shows the spatial distribution of the soils in this region. The dominating soils are Arenosols and Cambisols in association with Para-Vertisols and Vertisols. Table 1 shows the assoziation of the soils in a single mapping unit. Soils which cover less than 20% of the area of a soil unit are described as inclusions (FAO/UNESCO 1988). Map 2 shows the locations of the soil profile descriptions in the Ngandjela area..

### 1.2.1. Soil unit A2

This soil mapping unit, situated in the lower positions (plains) is characterized by **Psammi-Humic Cambisols and Psammi-Vertic Cambisols.** These brown (10YR 3/3-4/3) soils have an average depth of 80 cm and the content of $C_{org}$ ranges from 0.73% to 0.50%. The content of nitrogen (N) in the topsoil is 'very low' 0.03% and the phosphate (P) content (PDL) is almost zero. The fertility status is low with a cation exchange capacity of about 2.9 me/100g soil. The mean electrical conductivity of 1.0 mS/cm is medium and indicates a certain salinization risk in the subsoil, where bulk density is increasing and consequently salts (NaCl) may accumulate. Also some slight effects of impound-water, bleaching and mottling, can be observed in the subsoil. Most of the Cambisols could not be augered down to the parent bedrock of the profile due to this increased bulk density. Some of these soils are slightly calciferous, (1.6% $CaCO_3$), as the result of aeolian input of calcium carbonates. Most interesting in this context is that the soil reaction changes from pH 8.3 for carbonatic soils and to pH 4.5 for non calcareous Cambisols. As mentioned above most of the Cambisols have a thin sand layer on top of the profile and therefore the texture ranges from sandy loam in the first 20 cm to sandy clay loam in the lower profile zones. The available field capacity (AFC) of the effective rooting zone varies around 78 mm and is to classify as 'low'. The total pore space (TPS) was determined at 40 Vol.-% and therefore the water holding capacity of this soil type is rated 'low', with a sufficient internal drainage. Figure 1 presents Nga 4 showing the soil analytical data of a typical Cambisol.

In soil unit A2 the **Xanthi-Cambic Arenosols**, the **Haplic Arenosols** and the **Cambic Arenosols** occur as low ridges, which are built up by aeolian accumulation. These yellow-grey-brown soil types with a 'very low' content of organic C (approximately 0.3%) show a great variety in depth that ranges from 270 cm to 120 cm. In the topsoil the N-content of 0.03% is also 'very low' and phosphate (PDL) is almost absent with maximum 1.7 ppm. The cation exchange capacity of around 2.9 me/100g soil indicates a 'very low' fertility status. Due to the good internal drainage the $EC_5$ values of the first 90 centimetres were measured at 0.4 mS/cm (at 25°C) what is to evaluate as 'very low' with an increase at 100 cm to moderate values. All the Arenosols in the study area are free of calcium carbonates and show an average soil reaction around 5.0. The single grained sandy texture of the Arenosols results in AFC-scores of close to 125-300 mm. The total pore space was determined at 50% and the water holding capacity is very good with a satisfactorily drainage. In Figure 2 the soil analytical data of the soil profile Nga 5, a typical Arenosol of the Ngandjela study area, is given.

### 1.2.2. Soil unit A7

The **Eutric Para-Vertisols** and the **Eutric Vertisols** of soil unit A7 occur in cyclic depressions that are scattered over the whole Ngandjela mapping area. These soils show a dark brown to greyish colour (10YR 3/1-4/1 - 2.5Y 5/2-4/2) and have a medium depth of 150 cm. The content of $C_{org.}$ in the topsoil was measured at 0.8% that means slightly humic and the N-content shows 'very low' values of 0.04%. Phosphate (PDL) was quantified with 7.7 ppm a content which is to evaluate as 'very low'. These two soil types are non calcareous with a pH close to 5.0 and a CEC of 26.0 mS/cm together with a base saturation >50% indicating a medium status of fertility. The electrical conductivity is low < 0.5 mS/cm but with increased values at a depth of about 100 cm. The texture of the Para-Vertisols and the Vertisols is sandy clay in the upper (0-70 cm) profile parts and sandy clay loam in the lower profile zones. Due to the higher sand contents the structure is subangular to slightly polyhedral. The available field capacity was determined at 113 mm and together with a TPS of 48 Vol.-% a good water holding capacity is guaranteed but a share of 25% unavailable water reduces these qualities. The soil analytical features of a typical Para-Vertisol are described in Figure 3.

### 1.2.3. Soil unit A9

The most dominating soil type in the Ngandjela study area is the **Cambic Arenosol.** With a colour of 10YR 4/2 this greyish-brown soil has a mean depth of 120 cm and low $C_{org.}$ contents of 0.5% indicate a weak accumulation of organic matter. The N-(0.03%) and P-scores (0.5 ppm) range around zero indicating low biological activity and poor soil conditions. The Cambic Arenosols in the study area are non calcareous, slightly acid to neutral (pH 4.5-7.3) and the fertility status is with approximately 4.0 me/100g soil 'very low'. The average $EC_5$-content was measured at 0.5 mS/cm in the upper 50 cm with maximum values of 0.9 mS/cm in the subsoil what is to interpret as low to no salinization. In the upper profile position (0-40 cm) the Cambic Arenosols of the Ngandjela area show a single grained, sandy texture. In contrast the sandy clay loam in the deeper zone of the profile is characterized by a subangular structure. The available field capacity was determined at 173 mm and the total pore space is about 45 Vol.-% with a clear reduction in the deeper profile zones as a consequence of increased clay contents. The water holding capacity is medium with a sufficient internal drainage. The soil analytical description of Nga 13 in Figure 4 shows the typical features of Cambic Arenosols.

In soil unit A9 **Rhodi-Cambic Arenosols** occur at elevated positions in this area. They take less then 20% of this soil unit, the reason why they are described as inclusions. This soil type with a mean depth of 180 cm is typified by a red colour (5YR 4/6) in the B-horizon. 'very low' contents of organic C (0.1-0.4%), and just traces of N (0.02) and P (0.4 ppm) characterize the topsoil. The soil reaction is very acid (max. pH 3.9) and calcium carbonates are absent. The CEC is low and ranges between 2.9 and 4.0 me/100g soil. The $EC_5$-values are nearly zero so that this soil type can be called almost free of soluble salts. The texture is fine sand with a single grained to weakly subangular structure and the AFC is medium (170 mm) with a sufficient TPS of close to 40 Vol.-%. Nga 14 in Figure 5 gives a graphical impression of the analytical characteristics of this soil type in unit A9.

The **Psammi-Vertic Cambisols**, also an inclusion in soil unit A9 and occurring at deeper morphological positions, are very similar to the Cambisols in soil unit A2, where a detailed description of this soil type is given.

### 1.2.4 Soil unit A10

This soil unit describes the **Rhodi-Cambic Arenosols** that occur west of the small local pans in the study area as marginal 'lunette' dunes. The soil physical and chemical features of the Rhodi-Cambic Arenosols with their distinct red colour (5YR 4/6-2.5YR 4/8) are nearly identical to those of soil unit A9 where they are described in detail.

### 1.2.5. Soil unit D2

This mapping unit describes the **Mollic Fluvisols** of the sheet Ngandjela that show a medium depth of 80 cm, a dark brown (10YR 3/3-3/2) colour with medium high contents (1.5%) of $C_{org.}$ . The content of nitrogen (0.08) and phosphate (15 ppm) is 'very low', but nevertheless reach the highest scores in the whole Ngandjela area. The soil reaction around pH 7.5 is neutral and a cation exchange capacity of approximately 30 me/100g soil attests a good fertility status. The $EC_5$ varies around 0.6 mS/cm and is 'very low'. The single grained texture is sandy clay and the bulk density is highly increased at a depth of 50 cm. The AFC is low (118 mm), the total pore space was determined at 58 Vol.-% and with 25 Vol.-% of unavailable water (UW) the water holding capacity is sufficient. Figure 6 (Nga 3) shows a compilation of all relevant soil analytical data of a typical Mollic Fluvisol.

The soil units **E1** and **E2** were already described in Part I of this report for the Sonderkop area. Due to the high similarity of the soil units at sheet Sonderkop and Ngandjela that are situated close to the local pans, no soil samples were taken in the study area under discussion.

## 2.1. The Etosha Pan Area (sheet Okaukuejo 1915 BB)

The study area of Okaukuejo, situated west and south-west of the Etosha Pan, is in the north-eastern part mainly characterized by low levelled plains belonging to the land unit of the so called 'Etosha Pan in the wider sense' (BUCH 1993) and by the 'Karstveld' in the south-western part of this sheet. The mean annual precipitation in this area varies around 380 mm (ENGERT 1992). The vegetation of the plains is grassland savanna (Community 1: sweet grassveld on lime; LE ROUX 1980, DU PLESSIS 1992) with various grasses as the dominating species, scattered *Acacia* trees and bushes, *Catophractes* bushes and miscellaneous shrubs like e.g. *Leucosphaera bainesii*. The vegetation of the 'Karstveld' is identified by dominating *Colophospermum mopane*, *Acacia* spec. and *Catophractes* bushes (Community 8: Mopane treeveld; LE ROUX 1980, DU PLESSIS 1992). The very homogeneous geological underground consists of Etosha Limestone that sometimes, especially in the lowest parts of the landscape near the Etosha Pan, is grading into a greenish siltstone facies of the 'Andoni Formation'.

The morphology of the plains in the Okaukuejo study area can be outlined as very even and flat with shallow depressions and a system of smooth drainage lines in directed to the Etosha Pan. At the northern part of this sheet the ridges of the western marginal dunes of the Etosha Pan reach the study area (Map 5). Only from the southern edge of the map and from the mid western part of the area some larger drainage lines (omurambas) flow in direction of the Etosha Pan. As it is illustrated in Figure 8 the morphological form of the higher situated marginal 'Karstveld' is slightly hilly with a rolling and undulating meso-topography in the shape of weakly developed plateaus that are gradually more elevated from the north-east to the south-west. Figure 8 also shows the local distribution of soil associations in the Okaukuejo study area where the highest morphological positions (1140-1125 m a.s.l.) are dominated by Regosols. The next lower level extending from 1125-1100 m a.s.l. shows a soil association were Leptosols occur in combination with Fluvisols integrated in a wide spread pattern of flat and shallow drainage lines. Limestone outcrops are very common at this morphological 'terrace' level. The lowest level is reaching from 1100-1080 m a.s.l. and Solonchaks are the predominant soil type. This soil type with rooting depths of approximately 50 cm and located in the main wind direction principally is made up by airborne sediments from the Etosha Pan. This saline Etosha Pan outblow must be considered as the controlling factor for the sometimes extremely increased salt contents in these soils.

On the one hand the soils in the study area can be described as calcareous, medium deep to shallow, mostly with a high content of skeleton material and a loamy to silty texture in the plains and on the other hand as calcareous, shallow, and stony with a loamy to clayey texture at the 'Karstveld'. Only the soils developed in the substratum of the marginal western dune ridges are free skeleton (>2mm), sandy, deep and calcareous. Due to the recent aeolian dynamics and the permanent input of aeolian sediments as a result of outblow from the Etosha Pan (TRIPPNER in press), small micro-dunes have built up around bushes and tufts of grass. The existence of a sand cover on top of the surface like it has been observed in the Sonderkop and Ngandjela area could not be proved by field evidence. However, more detailed soil physical analyses in the laboratory clearly showed that most of the topsoils are influenced in the upper five centimetres by aeolian activity which lead to an increased sand content in relation to the underlying subsoil.

### 2.1.1. The Marginal Pan Zone

Land unit V, the marginal zone between the Etosha Pan and the higher situated plains is developed as a broad belt in the south-west that is getting smaller in northern direction along the Pan (Map 5). This very flat and uniform landscape is only dissected by some drainage lines and the meso-topography is slightly uneven to easy rolling. In the northern part of this land unit the surface is locally affected by gully erosion. Land unit V shows mean slopes <0.5°, is elevated from 1080-1090 m a.s.l. and includes an area of 62 km² corresponding to 8.5% of the study area in total (Table 2).

Like in the 'Marginal Pan Zones' of the Sonderkop and Ngandjela Pan the soils in this land unit are clayey to loamy with a powdery and frothy surface and often with a prismatic structure what indicates high salt contents. Sealing crusts as well as shrinking and swelling cracks are very common in this land unit. The vegetation cover is thin (5%) and only salt adapted plants are able to handle these ecological circumstances.

### 2.1.2. Plains

The 'Plains' expressed with the signature **IV** describe a land unit that is even and flat with a pattern of small and shallow drainage lines and flat depressions on the surface. The mean slope is <0.5° with differences in elevation of less than 5 m. Land unit **IV** shares 28.8 % of the Okaukuejo study area in total and occurs at an elevation between 1090-1105 m a.s.l. (Table 2). The plains at sheet Okaukuejo are divided by some larger drainage lines (omurambas) in the south-west and in the west and at some places particularly at the northern part of unit **IV** gully erosion forms up to 80-100 cm depth can be observed. The meso-topography is slightly undulating with young sand accumulations forming micro-dunes on top of the surface. Thin (1-2 mm) sealing crusts as a result of sheet wash are wide spread. These sealing crusts often have a thin alga-lichen-skin on their top a fact that reduces the water intake rate of the soils. The loamy and silty soil substratum predominantly is loose and powdery with a high bulk density. The vegetation cover is medium dense (5-15%), dominated by various grasses and small shrubs like *Leucosphaerum bainesii*.

### 2.1.3. Hilly Areas

The hilly areas with the signature **II** are located in the south-western quarter of the map sheet Okaukuejo and belong to the land unit of the 'Karstveld'. As a ramp-shaped association of individual morphological forms, it is extended over elevations between 1105-1177 m a.s.l.. The mean slopes range between 1-5° and the differences in altitude of the landscape vary between 5-40m. Land unit **II** has a share of about 40% of the whole study area and is rolling to undulating with a several ramified drainage lines in the south-western part. The meso-topography is flat to slightly rolling with some larger but shallow depressions. A thin sealed layer with an alga-lichen-skin often can be observed on top of the soils. Micro-dunes of youngest aeolian accumulation occur on top of the surface. Gravels and stones (length 10-90 cm) as well as limestone outcrops are very common in this land unit.

Consequently the loamy to clayey soil substratum comprises a high content of skeleton material (>2mm), which often results in a loose structure of the solum. In most of the cases, the soil profiles are very shallow. The vegetation cover shows densities between 10-20%. The most prominent plant species is *C. mopane* which grow as trees (> 2m) and higher bushes (> 1.5m). Vegetation variations show assoziations with *Catophractes alexandri*, dense and high grass species and as well as dense bushes of *Acacia spec.*.
Table 2 lists all the sampled soil profiles of the Okaukuejo area together with the percentage distribution of the land and soil units.

Table 2: Soil units and soil types of the Okaukuejo area (sheet 1915BB) in the Etosha National Park

| Land unit | Soil Unit | Soil Types | Soil Profiles Oka | Area km² | Area % |
|---|---|---|---|---|---|
| **IId 1a** | **A 8** | Humi-Calcaric Arenosol | 6, 40, 41, 49 | 38 | 5.2 |
| **II 1b/ IV 1b** | **C1** | Calcaric Regosol<br>Calcaric Arenosol | 44, 45, 46, 47, 48 | 40 | 5.5 |
| **IIm 1b** | **C2** | Rendzic Leptosol<br>Eutric Leptosol<br>Calcaric Fluvisol | 5, 12, 17, 20, 21, 22, 32, 34, 35, 38, 39, 65 | 180 | 24.7 |
| | **C3** | Eutric Regosol<br>Hypercalcaric Regosol<br>Calcaric Regosol<br>Calcaric Fluvisol incl.<br>Calcic Solonchak incl.<br>Rendzic Leptosol incl. | 11, 18, 23, 24, 25, 28, 29, 30, 31, 33, 36, 63, 67, 72 | 92 | 12.6 |
| **IVm 1b** | **C4** | Eutric Leptosol<br>Rendzic Leptosol<br>Mollic Leptosol<br>Hypercalcaric Regosol incl. | 1, 2, 3, 13, 14, 56, 58, 71 | 56 | 7.7 |
| | **C5** | Calcaric Regosol<br>Eutric Regosol<br>Hypercalcaric Regosol<br>Eutric Leptosol incl. | 4, 9, 43, 50, 61 | 60 | 8.2 |
| **Various** | **C6** | Eutric Vertisol (WP) | 57, 59, 68 | 7 | 1.0 |
| **IVo 1b** | **D1** | Hypersalic Fluvisol | 70 | 37 | 5.1 |
| **Vm 1b** | **E1** | Calcic Solonchak | 8, 52, 53, 54, 55, 60, 64 | 62 | 8.5 |
| **Etosha Pan** | **E2** | Sodic Solonchak | BUCH 1993 | 157 | 21.5 |
| **Total** | | | | **729** | **100** |

The locations of the soil profiles of the sheet Okaukuejo is given in Map 3.

## 2.2. Soils and Soil Associations in the Okaukuejo Area

### 2.2.1. Soil unit A8

Soil unit A8 is characterized by **Humi-Calcaric Arenosols** which are located in the northern part of the Okaukuejo study area, west of the Etosha Pan (Map 6). The mean depth of this greyish-brown (10YR 3/2) soils varies around 120 cm. These soils are slightly humic with a $C_{org.}$-content of 1.1%. With a mean content of 45% $CaCO_3$ the soils are very strongly calciferous throughout the profile. The N-content of the topsoil is 0.06% and the phosphate content is still low with 16.4 ppm. Due to the very high $CaCO_3$ content the soil reaction is alkaline with values around pH 8.5. The $EC_5$-values of the Humi-Calcaric Arenosols are low to moderate (0.1 mS/cm topsoil - 2.0 mS/cm subsoil). The fertility status is characterized by low CEC values around 9.0 me/100g soil [1]. The texture of the soil in this mapping unit is sandy loam to sandy clay loam in the deeper profile zones, with a single grained structure in the topsoil and single grained to subangular structure in the subsoil. In general the available field capacity of the Humi-Calcaric Arenosols of the soil unit A8 is high with values around 275 mm. The total pore space ranges around 55 Vol.-%. Therefore the water holding capacity of this soil type is very good, with an excellent internal drainage. Soil profile Oka 40 in Figure 7 illustrates the soil analytical properties of a Humi-Calcaric Arenosol.

### 2.2.2. Soil unit C1

Soil unit C1 includes the soil types **Calcaric Regosol** and **Humi-Calcaric Arenosol**. The **Calcaric Regosols** are characterized by a brownish grey (10YR 5/3-4/3) colour, an average depth of 70 cm and are moderately humic (1.9%). The N-contents vary close to 0.12% and the content of phosphate is 'very low' with 13 ppm. The $CaCO_3$-content of the Regosols in this soil unit reach 14.8% and the pH is about 7.9. The scores of electrical conductivity range around 0.2 mS/cm what indicates no salinization. The CEC was measured at 12.4 me/100g soil indicating low fertility. The texture is clayey loam with a single grained and loose structure, sometimes with low contents of skeleton material around 2 weight-%. The low AFC of 79 mm and the TPS about 50 Vol.-%, give values that show that the water holding capacity and the internal drainage of the Regosols in this unit is sufficient. Oka 47 in Figure 9 represents the typical features of this soil type. The other soil type in this mapping unit are the **Humi-Calcaric Arenosols** with a mean depth of 50 cm, a dark greyish-brown (10YR 3/3) colour and medium to high $C_{org.}$-scores of 2.0%. The N- (0.09%) and the P-values (16 ppm) are both 'very low' and the

[1] In most of the Okaukuejo soils it was problematic to analyse the CEC correctly because of an extreme oversaturation of the clay minerals with calcium and magnesium. The reason for this might be the collapse of dolomite minerals due to chemical preparation of the samples (personal information Dr. Rose, Staatl. Institut für Mineralogie Regensburg). This effect leads to base saturations >100% (in some cases more than 290%). Therefore the CEC-values of the single ions as well as the base saturation was recalculated to values of 100%. Recalculated CEC-values are indicated by a ' * '.

CEC* ranges around 21.9 mS/cm indicating a 'moderate' supply of nutrients. The $CaCO_3$-content of the Arenosols in this unit give moderate values of 14.6% and the soil reaction is slightly alkaline with pH-values up to 8. The skeleton free texture is sandy loam and the structure is single grained to slightly subangular. The AFC was calculated at 127 mm ('moderate') and the TPS scores around 49 Vol.-% indicating sufficiently good soil water and drainage conditions. Oka 46 a typical Arenosol of this soil unit is shown in Figure 10.

**2.2.3. Soil unit C3:**

In this soil unit **Eutric Regosols, Hypercalcaric Regosols, Calcaric Regosols, Calcaric Fluvisols, Calcic Solonchaks** and **Rendzic Leptosols** are associated. Fluvisols, Solonchaks and Leptosols occur as inclusions. The mean depth of the grey brown Regosols in this soil unit ranges around 50 cm and the content of organic C is moderate to high with values of 1-2% in average in the topsoil. The content of N varies between 0.04% and 0.13% from 'very low' to low. The P-content is 'very low' with 19 ppm. The content of calcium carbonates ranges from zero, non calcareous, to 53% hypercalcaric and consequently the soil reaction is neutral to slightly alkaline (pH 6.5-8.4). The cation exchange capacity is moderate and ranges around 20.0 me/100g soil. The $EC_5$ analyses show maximum values of 0.5 mS/cm indicating nearly salt free soil conditions for the Regosols within this soil unit. The texture of the Regosols is clayey to loamy, sometimes silty clayey, and the structure is powdery single grained to loose. The drainage and water holding conditions of the Regosols in the soil unit C3 are poor (AFC approximately 50 mm; total pore space 50 Vol.-%). Figure 11 gives a graphical description of a typical Regosol (Oka 25) of this mapping unit. Appendix A gives further information on the physical and chemical properties of the Regosols at different mapping levels ('unit'; 'group').

The **Calcaric Fluvisols** have a brown (10YR 4/2-3/2) colour and a mean depth of 90 cm. The content of $C_{org.}$ is medium with values around 1.6%. Nitrogen and phosphate are both very low. The fertility status of the Fluvisols in this soil unit is classified as moderate, with CEC-values of 32.2 me/100g soil in average. The high $CaCO_3$-content of this soil type was determined at 25% and the pH oscillates around 8.3. The electrical conductivity was measured at 0.4 mS/cm and is very low. The texture of the Fluvisols is clay with a subangular structure and traces of skeleton material (0.1%). The available field capacity was determined at 137 mm and the total pore space ranges around 53 Vol.-%, so the water holding capacity and the internal drainage is sufficiently high. Soil profile Oka 28 in Figure 12 gives an impression of the analytical features.

**The Calcic Solonchaks** of soil unit C3 are brown (10YR 4/3-3/3) with a touch of grey and show a depth of approximately 50 cm. They have a medium C-content of 1.5% and low values of nitrogen and phosphate. The CEC* is medium with values of 25 me/100g soil. The soil reaction is slightly alkaline (pH 8.1) and the electrical conductivity is moderate to high (3.5 mS/cm). Those salinity values may have serious effects on plant growth (PETERMANN 1988; THOMAS & MIDDLETON 1993), so that these sites are mainly covered by a salt adapted vegetation. The texture of the Fluvisols in this unit is clayey and loamy with a subangular to prismatic structure. The available field capacity is low (78 mm) and the TPS is around 50 Vol.-% what makes the water holding capacity and the drainage poor and insufficient. Figure 13 shows Oka 33, a typical Fluvisol of soil unit C3.

The **Rendzic Leptosols** of this soil unit are greyish-brown (10YR 5/2) and very shallow with a depth of 17 cm. Organic C contents are moderate (1.4%) and N as well as phosphate are very low in content. The cation exchange capacity of this soil type is characterized as moderate (20 me/100g soil) and a pH of 8.0 is measured. The $EC_5$ is 'very low' and ranges around 0.3 mS/cm. The CaCO3-content of the Leptosols is moderate to high with 23%. The textural and structural features are a single grained clay loam with about 28% skeleton material. The AFC of 32 mm is to evaluate as low and the TPS of 56 Vol.-% classifies the water capacity as insufficient but the drainage is satisfactorily. In Figure 14 of soil profile Oka 29 the analytical data are presented.

### 2.2.4 Soil unit C4

Soil unit C4 comprises **Eutric Leptosols**, **Rendzic Leptosols**, and **Mollic Leptosols** and furthermore **Hypercalcaric Regosols** as inclusions. The Leptosols as major soils of this mapping unit can be distinguished into different units and groups as there are Rudi-Psammi-Eutric Leptosols, Rendzic Leptosols, Rudi-Mollic Leptosols and Psammi-Mollic Leptosols (Appendix A).

The **Leptosols** in mapping unit C4 have a dark brown (10YR 3/3-3/2) colour, depths between 8-27 cm and a Corg.-content that may reach values of up to 2.1%-3.5% (= group level *Mollic*), what classifies these soils as highly humic. In contrast to the soil types described already, the Leptosols in soil unit C4 show N-contents of 0.12%-0.17% and P-contents up to 28 ppm. These values are still to be classified as low, but they are the highest values of all the Etosha soils analysed so far. The high percentage of $CaCO_3$ is approximately 25% and the soil reaction is pH 7.8-8.0 (slightly alkaline). The cation exchange capacity may reach values up to 24 me/100g soil (= group level *Eutric*) with a basic saturation of more than 50% in most of the cases, which indicates moderate fertility conditions. The $EC_5$-value of 0.3 mS/cm in average can be classified as 'very low'. The texture of the Leptosols in the mapping unit is silty loamy to clayey loamy and the structure single grained to weakly subangular. The average skeleton contents range from 14% to 60% (= group level *Rudi*) and most of the Leptosols show slightly increased sand contents in the upper 4 cm of the soil profile (= group level *Psammi*). The AFC was calculated at maximum values of 40 mm (for most of the Leptosols the values are lower) and the total pore space approximates at 50 Vol.-%, so that the water holding and the internal drainage conditions are poor. The soil analytical data of profile Oka 3 in Figure 15 presents the average properties of a Leptosol in this soil unit under discussion.

The **Regosols** in soil unit C4 are greyish-brown (10YR 3/3-3/4), roughly 40 cm deep and are highly humic with 2.3% organic matter. The N-content is low at 0.15% and the P-content is 'very low' at 13 ppm. The $CaCO_3$-content of the Regosols in this unit reaches 30% (= unit level *hypercalcaric*) and the soil reaction is slightly alkaline 8.0. As an indication of the fertility status, moderate CEC-values of around 20 me/100 g soil were measured. The average electrical conductivity is 0.4 mS/cm (at 25°C). The Hypercalcaric Regosols usually are free of skeleton material and the texture can be described as clayey loam with a loose powdery and single grained structure. The available field capacity was determined at 29 mm and the TPS is 56 Vol.-%. Therefore the water holding conditions are poor and the internal drainage is good. Figure 16 which shows soil profile Oka 56 gives a graphical impression of the soil analytical data.

### 2.2.5. Soil unit C5

The soil unit C5 is dominated by **Calcaric Regosols, Eutric Regosols, Hypercalcaric Regosols** and furthermore **Eutric Leptosols** which occur as an inclusion.

The mean depth of the Regosols in this soil unit is 60 cm and they have a greyish brown (10YR 5/3-4/3) colour. This soil type is moderately humic within the topsoil with approximately 1.4% of $C_{org.}$. The content of nitrogen varies between 0.06% and 0.13%. The content of phosphate is to classify as low and varies around 23 ppm. The calcium carbonate contents range from 7% to 56% (= unit level *hypercalcaric*) and the soil reaction is about pH 8.0. The cation exchange capacity of 14 me/100g soil indicates a low fertility status. The $EC_5$ values were measured at about 0.3 mS/cm (25°C). The texture of the Regosols is a clayey loam with a subangular structure and a skeleton percentage of about 5% or less. The AFC reaches values up to 60 mm and the TPS was calculated at approximately 50 Vol.-%. The analytical data of a Regosol (Oka 4) are given in Figure 17.

The brown to yellowish-brown (10YR 3/2-4/2) **Leptosols** of soil unit C5 have a medium depth of 11 cm. The organic C-content shows high values of 2.2% and nitrogen as well as plant available phosphate is low in content. In general the Leptosols in this soil unit are only slightly calciferous (1.8%) and the soil reaction is nearly neutral (pH 7.6). The CEC of 14 me/100g soil indicates low soil fertility and with $EC_5$-values around 0.1 mS/cm (25° C), no salinization hazards were identified. The soil texture a is silty loam with a single grained structure. The available field capacity of 24 mm is low and the total pore space gives values around 50 Vol.-%. The soil profile Oka 37 represents a typical Eutric Leptosol (Figure 18).

**2.2.6 Soil unit C6**

This soil unit is dominated by the dark grey (10YR 6/3-5/2) **Eutric Vertisols** with a mean depth of 50 cm. The content of $C_{org.}$ gives moderate values around 1.5% and the N-values are low to 'very low' (0.03-0.12%) with a wide range of the phosphate contents from 'very low' to low (12.7-37.2 ppm). The Eutric Vertisols in soil unit C6 are very highly calciferous with values up to 50%[2] and the soil reaction is slightly alkaline with pH-values close to 8.0. The fertility status is indicated by a high CEC of 40 me/100g soil. The $EC_5$ is ranging from 3.6 mS/cm to 15.1 mS/cm what is to interpreted as an extreme salinization. These extremely high electrical conductivity values might be caused by the fact that during the rainy season the Vertisol sites are filled with water over a longer period of time. Game uses these flat water filled depressions as a natural water hole crushing and destroying the topsoil with their hoofs when the water hole drys up. By this mechanism soluble salts are washed out and crystallize in the upper profile zones. The texture of the Eutric Vertisols in this soil unit is clay and the structure is polyhedral to columnar. The AFC was calculated at 37 mm with a TPS of about 45 Vol.-% and 34 Vol.-% unavailable water. Therefore this soil type (Figure 19 Oka 68) is an almost unsuitable location for most of the plants.

**2.2.7. Soil unit D1**

This soil unit is characterized by **Calcari-Hypersalic Fluvisols** that occur in broad drainage lines and in smaller channels. The colour is greyish brown (10YR 6/2-5/2) and the depth reaches up to 60 cm. The content of $C_{org.}$ was measured at moderate values of 1.3% and the N-values are 'very low' (0.04%), whereas the phosphate contents reach very high values of 78.3 ppm, probably as the result of washed in plant residuals. The average $CaCO_3$-content of the soils in this unit varies near to 55% and the pH is alkaline around 8.9. The CEC of 32.8 me/100g soil indicates moderate to high fertility, but electrical conductivity values of 16.6 mS/cm make this soil type suitable only for some very salt adapted plants. The content of skeleton material varies around 10% and stones (-35 cm length) on top of the surface are very common. The texture is classified as clay to silty clay with a polyhedral to columnar structure. The AFC of 63 mm and the TPS around 45 Vol.-% and more than 30 Vol.-% of unavailable water characterizes the Calcari-Hypersalic Fluvisols as a very problematic site for vegetation. Figure 20 gives the soil analytical data of the profile Oka 70, which represents a typical soil of this mapping unit.

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[2]Due to the usually non-calcaric Vertisols in the Etosha National Park the guideline for soil classification (BEUGLER, BUCH & TRIPPNER 1993; Part III) did not consider Vertisols with high $CaCO_3$-contents. Future soil mappings should take into account, that some Eutric Vertisols might have high calcium carbonate contents. Therefore Vertisols with $CaCO_3$-contents of more than 25% sould be classified as with the prefix *Hypercalcari* (unit level).

**2.2.8. Soil unit E1**

This soil unit is dominated by the soil type **Calcic Solonchak** that shows a mean depth of 60 cm and has a light brown colour (10YR 5/3). This soil type is moderately humic with approximately 1.4% $C_{org}$. and 'very low' N-contents (0.1%). This soil type is very highly calciferous with values of up to 65% $CaCO_3$ and the soil reaction is very alkaline (pH 9.3). The CEC* ranges around 30 me/100g soil and the electrical conductivity reaches extremely high values of 13 mS/cm. These soils are free of skeleton material and have a texture of sandy clay loam with a subangular, polyhedral structure that sometimes alters into a columnar structure. The available field capacity is very high at 209 mm and the TPS ranges close to 48 Vol.-%, but 35 Vol.-% unavailable water classifies the Calcic Solonchaks as a problematic location for plants from the view of the soil physical conditions. In Figure 21 the analytical data of the soil profile Oka 60 are illustrated.

## 3.1. The Karstveld (sheet Ondongab 1916AA)

The Ondongab study area forms the eastern continuation of sheet Okaukuejo and is situated southerly of the Etosha Pan. Most of the area belongs to the land unit of the 'Karstveld'. Only a small belt running from west to east along the Etosha Pan belongs to the 'Etosha Pan region in a wide sense' (see above; Map 1). The mean annual precipitation is measured around 380 mm and the vegetation consists in most of the areas of mopane savanna with mopane bushes, mopane trees and acacia bushes. Smaller areas belong to the vegetation community of the 'sweet grasveld on lime' (LE ROUX 1980, DU PLESSIS 1992) which is dominated by various grass species. As it is in the Okaukuejo area, the geological underground is build up by Etosha Limestone.

The land unit 'Karstveld' shows a hilly morphology with numerous limestone hilltops, shallow drainage lines and flat depressions. The lower situated Etosha Pan land unit shows a flat and even morphology also with a network of small drainage lines. Due to the recent aeolian activity the micro-topography of the Ondongab study area shows a lot of micro-dunes and a thin layer of aeolian sand on top of the surface at most of the locations. Limestone outcrops as well as stone pavements are very common at some places of the Ondongab area especially around the catchment areas of waterholes. The mean slopes range between 1-5° and the differences in elevation vary between 5-40 m. Nearly 30% of the study area Ondongab is occupied by the Etosha Pan were a greenish siltstone forms the parent sedimentary rock (Table 3).

Most of the soils in the investigation area can be described as calcareous, shallow and stony with a clayey to loamy texture. Only some soils of the land unit 'Etosha Pan in a wider sense' are medium deep, and somehow more sandy with less skeleton material compared to the soils of the 'Karstveld'.

### 3.1.1. The Marginal Pan Zone

The marginal areas running along the Etosha Pan`s edge in a west-east direction (Map 9) are indicated by the signature **V**. They are very flat and even, divided by gully erosion and include an area of 12.3%. The elevation ranges between 1085-1090 m a.s.l. with mean slopes <0.5° and at some places in land unit **V**, small remnants of the higher elevated plain area (see below) are present. The soils in this land unit are shallow with a clayey and loamy texture, sometimes with a powdery surface, sometimes with a hard sealed surface with polygonal cracks and salt impregnations on the top. The vegetation cover is thin (5%) with salt adapted plants like *Salsola etoshensis*.

### 3.1.2. The Plains

The plains **IV** occupying 9.7% of the study area (Table 3) and extending in southern direction of land unit **V** mesh with the higher elevated hilly areas in the shape of little coves (Map 9). The plains that belong to the land unit 'Etosha Pan in a wider sense' in a further sense are elevated from 1090-1100 m a.s.l. and they are divided by some larger drainage lines (**IVo**) which occupy 3.7% of the whole Ondongab area. The meso-topography is slightly rolling with some flat depressions and thin sand accumulations on the top of the surface. Fine sealing crusts and alga-lichen-skins as the result of sheet wash are wide spread in the plains area. The soils are medium deep to shallow, frequently with a powdery topsoil and a subsoil that shows high bulk densities. The texture is loamy to silty predominantly with a low skeleton content.

The surface of the drainage lines (**IVo**) is rolling with swelling and shrinking cracks and with abundant stones (-15 cm length) on top of the surface. The soils are loamy to clayey with a prismatic structure and high salt contents throughout the soil profile. The vegetation cover of the plains particularly around waterholes is sparse (5-10%) and dominated by various grasses and shrubs like *Leucosphaerum bainesii*. The omurambas (**IVo**) show a vegetation that is adapted to high salt concentrations (*Salsola etoshensis*, *Petalidium engleranum*).

### 3.1.3. The Hilly Areas

The hilly areas, elevated between 1100-1120 m a.s.l., are dominating the south-eastern part of map sheet of Ondongab and have the signature **II**. In the western part of sheet Ondongab, where the plains cut up land unit **II,** little islands have developed as small remnants of the 'Karstveld'. The hilly areas take a share of 45% of the study area in total

(Table 3). The average slopes range between 1° and 5° and the surface is rolling numerous limestone ridges (3-6 m high) alternated with depressions that are filled up with erosion material from the hills. The depressions **IIn** occupy an area of 1.9%, so that the whole area belonging to the land form unit **II** summarizes up to 46.9% of the entire study area.

A south-north directed pattern of small and shallow drainage lines characterizes the meso-topography as well as the occurrence of limestone outcrops, stones up to 100 cm length and younger aeolian $CaCO_3$-free(!) sand accumulations on top of the surface. The sand accumulations often mixed up with wide spread thin alga-lichen-skins that seal the surface. The soils are mainly calcareous, very shallow and rich of skeleton material and are often developed in small concavities of the limestone outcrops. The texture of these soils is loamy to silty often with rock fragments on top of the surface. The soils in the depressions are clayey and non calcareous nearly free of skeleton and reach a depth of 80-120 cm. They show polygonal cracks and indications of strong shrinking and swelling dynamics. The vegetation cover of land unit **II** is dense (25%) and dominated by *C. mopane* in combination with various grasses. Due to the exceptional soil dynamics in sub-land unit **IIn** the depressions are almost free of vegetation.

Table 3: Soil units and soil types in the Ondongab area (sheet 1916AA) in the Etosha National Park

| Land unit | Soil Unit | Soil Types | Soil Sample Odo | Area km² | Area % |
|---|---|---|---|---|---|
| **II m** | **C5** | Eutric Leptosol<br>Lithic Leptosol<br>Rendzic Leptosol<br>Mollic Leptosol<br>Dystric Vertisol<br>Eutric Vertisol | 2, 6, 7, 9, 10, 11, 28,30, 31, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50, 51 | 328 | 45.0 |
| **II n** | **C6** | Eutric Vertisol | 32 | 13 | 1.9 |
| **IV m** | **C4** | Mollic Leptosol<br>Lithic Leptosol<br>Rendzic Leptosol<br>Hypercalcaric Regosol<br>Calcaric Regosol | 1, 3, 4, 5, 8, 12, 13, 14, 15, 21, 22, 23, 24, 49 | 71 | 9.7 |
| **IV o** | **D2** | Hypersalic Fluvisol | 16 | 27 | 3.7 |
| **V m** | **E1** | Calcic Solonchak<br>Rendzic Leptosol<br>Hypercalcaric Regosol (incl.) | 17, 18, 19, 20, 25, 27, 29 | 90 | 12.3 |
| **Etosha** | **E2** | Sodic Solonchak | see Buch 1993 | 200 | 27.4 |
| **Total** | | | | **729** | **100** |

## 3.2 Soils and Soil Associations in the Ondongab Area

The spatial distribution of all sampled the soil profile points at the map sheet of Ondongab is given in Map 4.

### 3.2.1. Soil unit C5

This mapping unit is dominated by **Leptosols** and **Vertisols** that occur in a typical spatial distribution pattern (Map 10). The Vertisols are located in flat to medium deep depressions, where the solum mainly developed 'in situ' and some soil material is washed in from the surrounding hilltops. In contrast to the Vertisols, the Leptosols are located at the higher relief positions and on top of low limestone ridges. Due to the soil physical and chemical properties of the Leptosols, numerous variations of this soil type can be distinguished, as there are **Lithic Leptosols, Rendzic Leptosols, Eutric Leptosols**, and **Mollic Leptosols** (Table 3). Due to their base saturation the Vertisols are differentiated into **Dystric Leptosols** (base saturation < 50%) and **Eutric Leptosols** (base saturation >50%).

The mean depth of the Leptosols in soil unit C5 ranges from 6-60 cm and the soils have a greyish black (10YR 2/2-3/2) colour. The content of $C_{org.}$ is highly humic (maximum around 5%) and the N-values are 'low' to 'moderate' up to 0.32%. Most of the Leptosols have low to moderate P-contents with a maximum of up to more than 200 ppm. The $CaCO_3$-contents of the Leptosols ranges close to 30% (strongly calciferous), although the Eutric Leptosols usually are already free of calcium carbonates. The soil reaction shows pH-values between 6.3 and 8.3. The CEC of approximately 15 me/100g soil indicates a low fertility status. The electrical conductivity of this soil type is 'very low' to low with maxima of 0.6 mS/cm. The Leptosols have high contents of coarse fragments with a mean share of 35% and top values of 78%. The texture is a loam to clay loam with a powdery single grained, coherent to subangular structure. The AFC is low (about 40 mm) and the TPS varies around 50 Vol.-%, so that the water holding capacity is very low with a good internal drainage. Figure 22 (soil profile Odo 42) describes a Leptosol of the C5 soil unit.

The Vertisols of soil unit C5 show a mean depth of 60 cm and have a dark grey (10YR 3/1-2/2) colour. They have moderate contents of organic C (1.5%) and very low contents of N and phosphate. Some Vertisols in this soil unit may be free of $CaCO_3$ or show only traces of calcium carbonates and consequently the soil reaction is slightly acid with approximately pH 6.5. The CEC* varies close to 30 me/100g soil what indicates moderate to high nutrient conditions. In general the $EC_5$ values are low at about 0.3 mS/cm (25° C). The usually skeleton free texture is clay with a polyhedral structure. The topsoil of the Vertisols frequently shows increased sand contents and due to the shrinking and swelling dynamics of such soils limestone fragments are present in the solum and pedo-

# ENVIRONMENTAL CHANGE IN THE ETOSHA NATIONAL PARK NORTHERN NAMIBIA

## THE RESEARCH-COOPERATION-PROJECT BETWEEN THE 'ETOSHA ECOLOGICAL INSTITUTE, OKAUKUEJO/REPUBLIC OF NAMIBIA' AND THE 'DEPARTMENT OF GEOGRAPHY AT THE UNIVERSITY OF REGENSBURG/FEDERAL REPUBLIC OF GERMANY'

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## AIMS, ACTIVITIES AND FIRST RESULTS

## Part V

Report submitted to the 'Deutsche Forschungsgemeinschaft (DFG)' and the 'Gesellschaft für Technische Zusammenarbeit (GTZ)'

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Regensburg and Okaukuejo 1994

turbated on top of the soil surface. Deep and wide (60 cm * 10 cm) shrinking cracks, forming polygons of more than 80 cm in diameter, are also very common. Odo 46 in Figure 23 presents the soil analytical data of a typical Vertisol in this soil unit.

**3.2.2. Soil unit C6**

This soil unit is restricted to circular depressions of a diameters up to 400 m that mainly occur in the eastern part of the map sheet Ondongab. Due to the high bulk density and the high clay contents of the soils in these depressions, which makes them extremely hard when drying up, it is often not possible to auger down the whole soil profile. The **Eutric Vertisols** with a minimum depth of 60 cm and a blackish grey colour (10YR 6/1-5/1) have $C_{org.}$ contents around 0.9%. The content of nitrogen is 'very low' 0.04% and the P-contents are close to zero. The Vertisols in soil unit C6 are very highly calciferous with values around 40% and have pH-values of 8.6. The CEC ranges around 47 me/100g soil, indicating moderate to high fertility, but the extreme bulk density in combination with electrical conductivities around 15 mS/cm is responsible for the fact that the Vertisol sites are almost free of vegetation. The texture is clay with a polyhedral to columnar structure. The content of the coarse fragments ranges around 20 weight-%. The available field capacity of 59 mm together with a TPS of 58 Vol.-% and 40 Vol.-% unavailable water characterizes insufficient water availability conditions at these locations. Figure 24 of soil profile Odo 32 shows the soil analytical data of one of these Eutric Vertisols.

**3.2.3. Soil unit C4**

This soil unit is dominated by **Leptosols** (Mollic, Lithic, Rendzic) in assoziation with **Regosols** (Hypercalcaric, Calcaric).

The Leptosols have a greyish brown (10YR 3/3-4/3) colour and depths between 6 and 30 cm. The average amount of organic C is 2.2% with maxima of 4,3%. N was measured at low to very low values around 0.05-0.13%. The Leptosols in this soil unit have moderate P-contents of 40 ppm. The $CaCO_3$ contents range close to 40% and the pH was measured at approximately 8.0. Many Leptosols in this unit have moderate EC5-values of 1.1 mS/cm. The CEC of the Leptosols in this soil unit was not determined in the laboratory but probably reaches the values of other well known Leptosols and is therefore classified as 'moderate'. The structure is single grained with a loamy to clayey texture and skeleton contents of up to 72%. The AFC calculation gives values around 50 mm and the total pore space is 50-60 Vol.-%. The Leptosols therefore are characterized by good internal drainage conditions and an insufficient water holding capacity (Figure 25).

The Regosols in this mapping unit are yellow-brown (10YR 5/3-5/2) in colour and approximately 40 cm deep. They are moderately humic with 1.5% of organic C, show low N-values and only traces of phosphate (9.4 ppm). The content of $CaCO_3$ ranges between

35-60% and the soil reaction varies around pH 8.1. The average electrical conductivities reach up to 0.27 mS/cm indicating very low to no salinization hazard. The texture of the Regosols is a clayey loam with a powdery single grained to weakly subangular structure usually with no coarse fragments (<5 weight-%). The AFC varies close to 70 mm and the TPS is 56 Vol.-% so the water holding conditions are to evaluate as 'poor'. The soil analytical data of soil profile Odo 8 is given in Figure 26.

### 3.2.4. Soil unit D2

This soil unit describes **Hypersalic Fluvisols** that show a mean depth of 30 cm and a greyish-brown (10YR 3/3-4/3) colour. The $C_{org.}$ approximates at 1.8% and the N-values of 0.05% are very low. Phosphate (PDL) is detected only in traces. These soils are medium calciferous at 15% and are alkaline at pH 9.0. An electrical conductivity of 28 mS/cm indicates extreme salinization problems and the fertility status is moderate at approximately 30 me/100g soil. The texture is a silty clay loam with a subangular to polyhedral structure and about 7% stones on top of the surface as the result of fluvial geomorphodynamics. With an AFC of 14 mm and a TPS of 50 Vol.-% poor soil-water conditions are indicated. In Figure 27 the soil profile Odo 16 illustrates a typical Fluvisol.

### 3.2.5. Soil unit E1

This soil unit describes an association of **Calcic Solonchaks** and **Rendzic Leptosols** and furthermore **Hypercalcaric Regosols** as inclusions.

The greyish-brown (10YR 4/3-3/2) Solonchaks in soil unit E1 have a medium depth of 40 cm and $C_{org.}$-contents between 1.8% and 2.7%. The N-values range between 0.04 and 0.11%. Plant available phosphate (PDL) reaches low values of 22 ppm in average, which nevertheless belong to the highest values in the Etosha National Park. The $CaCO_3$-content varies around 50% and the pH is close to 8.5. The CEC of 41 me/100g soil indicates moderate to high fertility conditions. The $EC_5$-values were measured at approximately 7.1 mS/cm with maxima of 16 mS/cm attesting the typical extreme salinization hazards of Solonchaks. The texture is clayey and the structure can be described as polyhedral to subangular sometimes columnar. The skeleton content ranges around 8 weight-%. Obviously depending on the depth of the soil profile, the AFC varies from medium 134 mm to low 20 mm with about 60 Vol.-% TPS. The Figure 28 describes a typical profile of the soil unit E1 (Odo 17).

The Rudi-Rendzic Leptosols of the mapping unit E1 in the Ondongab area are characterized to be brown (10YR 4/4-4/3), shallow (-15 cm) and highly humic (2.7%) soils. Nitrogen as well as phosphate are classified as low (0.12% / 23 ppm). The mean $CaCO_3$-content was measured at 45%, what is strongly calciferous, and the pH ranges around 8.1. The electrical conductivity is very low with 0.4 mS/cm and about 43 weight-% coarse fragments are present within the solum. The texture is a loam with a

single grained to coherent structure. The AFC is very low (20 mm) and the TPS is 30 Vol.-%. Therefore the water holding conditions are poor. Soil profile Odo 19 in Figure 29 gives the soil analytical data of this soil type.
The shallow (in average 30cm) and highly humic (≈2.4% $C_{org.}$) Lithi-Hypercalcaric Regosols in the soil unit E1 are characterized as greyish-brown (10YR 4/3-5/3). The N-values are very low and only traces of phosphate were measured. The $CaCO_3$-content varies around 50% and the pH is alkaline at 8.2. The $EC_5$ was measured at low values of 0.6 mS/cm. The texture is clayey with a coherent structure and about 6.8 weight-% of skeleton material. The AFC was calculated at 66 mm and the TPS reach 63 Vol.-% so the soil-water conditions can be described as poor. Figure 30 (soil profile Odo 25) gives an impression of the soil analytical properties of the Regosols in this soil unit.

No samples were taken from the profiles of the soil unit **E2**, where Sodic Solonchaks dominate the soil mapping unit (see BUCH 1993).

# THE LANDSCAPE ECOLOGICAL RISK EVALUATION

## 1. The Ngandjela Area

The landscape ecological risk for the 'Ngandjela' area was evaluated only for the southern part, which is situated inside the Etosha National Park, Only here, soil analytical data are available up to now. For this report assessments were only made concerning the **integrated** landscape ecological risks, because this information is of a higher evidence than the single risk evaluation (BUCH & LINDEQUE 1993; Part I). The classified average integrated landscape ecological risks is illustrated in Map 11, where the main limiting factors are indicated by letters (e.g. P, C, Z means serious soil physical risks, severe soil chemical risks and heavy risks by game pressure for this mapping unit). A detailed listing of the individual integrated landscape ecological risks in the Ngandjela study area is given in Table 4.

### 1.1. The Soil Physical Degradation Risk

In general, the soil physical degradation risk in this study area range from low to high, with the lowest values in the south-eastern corner of the Ngandjela map with soil unit A9 soils and the Eutric Para-Vertisols/Eutric Vertisols of unit A7. The highest scores in mapping unit A10, where Rhodi-Cambic Arenosols are present, are caused by the high erodibility by wind erosion, the low available field capacity and the low basic infiltration rates (Table 4). The Cambic Arenosols and the Psammi-Vertic Cambisols in soil unit A2 and A9 as well as the Mollic Fluvisols in unit D2 show moderate soil physical degradation risks. In these soil units the wind erosion risk (as a consequence of the finer-grained texture) is moderate, the AFC is better and the basic infiltration rate is higher for most of the soil profiles.

Table 4: The Landscape Ecological Risk Evaluation for the Ngandjela Study Area

| Mapping unit | Var | SoilPhys + | SoilChem + | Erosion | ErosRelief + | Rain + | Water + | Vegetat + | GamePr + | Mean + | Main Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A2** | 1 | 0,40 | 0,51 | 0,25 | **1,00** | 0,30 | **1,00** | 0,20 | 0,00 | 0,49 | E, W |
| **A7** | 1 | 0,29 | 0,53 | 0,45 | **1,00** | 0,30 | **1,00** | 0,20 | 0,00 | 0,47 | E, W |
| **A9** | 1 | 0,40 | 0,51 | 0,25 | **1,00** | 0,30 | **1,00** | 0,20 | 0,00 | 0,49 | E, W |
| | 2 | 0,26 | 0,51 | 0,00 | 0,00 | 0,30 | **1,00** | 0,20 | 0,00 | 0,32 | W |
| **A 10** | 1 | 0,51 | 0,51 | 0,25 | **1,00** | 0,30 | **1,00** | 0,20 | 0,00 | 0,50 | E, W |
| **D2** | 1 | 0,43 | **1,00** | 0,40 | **1,00** | 0,30 | **1,00** | 0,20 | 0,00 | 0,56 | E, W |

**1.2. The Soil Chemical Degradation Risk**

Due to the low nutrient status, especially the very low contents of N and P, the low content of $C_{org.}$, the absence of $CaCO_3$ and the low CEC values the soil chemical risk give moderate to high ratings from 0.42 to 0.53. The electrical conductivity values as well as the exchangeable sodium percentage are very low in all of the soils and must be considered as a secondary factor. Thus, salinization and alkalinization hazards are not to be expected for the soils in the Ngandjela mapping area (Table 4).

**1.3. The Erosion/Flood Risk**

The erosion and/or flooding risks (topographical risk) of a mapping unit mainly is controlled by its topographic position in the field, the texture, structure and organic content of the soil substratum/sediment and the vegetation cover. As a consequence of a very high wind erosion hazard or a certain degree of sheet wash hazard (unit A7, D2) for nearly all the mapping units (exept A9 in the south-eastern corner of the soil Map 8; Ngandjela), the erosion risk was rated very high (1.0). Due to the very uniform landscape with very low inclination gradients, erosion by sheet wash and/or gully erosion plays a minor role in this study area.

**1.4. The Climatic Risk**

The climatic risk was calculated as a combination of long-term seasonal amount of rainfall and the rainfall variability. Due to the relatively high amount of rainfall (about 400 mm), the long-term seasonal amount of precipitation was rated 2 and the variability of 20-30% was rated 1. Both ratings give a low to moderate climatic risk of 0.30 which is valid for the whole of the Ngandjela study area (Table 5).

Table 5: The Landscape Ecological Risk Ratings for the Soil Samples of the Ngandjela Study Area

| SU | Profile Nga | Weff | Sk | F | WEG | AFC | BIR | AC | Phys | ECt | ECs | ESP top | ESP sub | Ca | CEC | C | N | P | Chem | SOIL | S | G | W | ERO | FLO | ERO/FL | Raif | Raiv | Rain | Water | | STA | STP | Bca | Bcp | For | Fue | Deg | Veg | Zoo | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A2 | 2 | 1 | 0 | 1 | 5 | 0 | 5 | 1 | 0,37 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,51 | 0,44 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,38 |
| A2 | 4 | 2 | 0 | 1 | 0 | 3 | 5 | 1 | 0,34 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 5 | 5 | 0,56 | 0,45 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 5 | 1,00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 0,31 |
| A2 | 5 | 1 | 0 | 0 | 5 | 1 | 5 | 1 | 0,37 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,51 | 0,44 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,38 |
| A2 | 12 | 1 | 0 | 1 | 5 | 1 | 5 | 1 | 0,40 | 0 | 1 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,53 | 0,47 | 0 | 0 | 4 | 0,27 | 0 | 0,20 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,38 |
| A2 | 9 | 4 | 0 | 1 | 1 | 5 | 3 | 1 | 0,43 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,51 | 0,47 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,38 |
| A7 | 8 | 1 | 0 | 3 | 2 | 0 | 3 | 1 | 0,29 | 0 | 1 | 1 | 1 | 3 | 3 | 3 | 5 | 5 | 0,49 | 0,39 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,39 |
| A9 | 1 | 1 | 0 | 1 | 5 | 0 | 3 | 1 | 0,31 | 0 | 1 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,53 | 0,42 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 0,34 |
| A9 | 6 | 1 | 0 | 1 | 5 | 1 | 5 | 1 | 0,40 | 0 | 1 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,53 | 0,47 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,38 |
| A9 | 7 | 3 | 0 | 1 | 5 | 5 | 5 | 1 | 0,57 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,51 | 0,54 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,40 |
| A9 | 13 | 2 | 0 | 1 | 5 | 5 | 5 | 1 | 0,54 | 0 | 0 | 0 | 0 | 3 | 5 | 5 | 5 | 5 | 0,51 | 0,53 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,40 |
| A9 | 14 | 1 | 0 | 1 | 5 | 1 | 3 | 1 | 0,34 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,51 | 0,43 | 0 | 0 | 4 | 0,27 | 0 | 0,20 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,36 |
| A9 | 10 | 1 | 0 | 1 | 0 | 3 | 3 | 1 | 0,26 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 0,51 | 0,38 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,32 |
| A10 | 11 | 1 | 0 | 1 | 5 | 5 | 5 | 1 | 0,51 | 0 | 0 | 0 | 0 | 3 | 5 | 5 | 5 | 5 | 0,51 | 0,51 | 0 | 0 | 5 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,40 |
| D2 | 3 | 2 | 0 | 2 | 0 | 5 | 3 | 3 | 0,43 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 5 | 5 | 0,42 | 0,43 | 5 | 0 | 0 | 0,33 | 3 | 0,40 | 2 | 1 | 0,30 | 5 | 1,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,39 |

### 1.5. The Water Availability and Quality Risk

In the Ngandjela study area inside the Etosha National Park only the Onaiso spring seasonally supplies water. However this groundwater is of very bad chemical quality (electrical conductivity class E = >900 mS/cm). Thus the availability and chemical quality risk for water in the study area has to be rated as 'very high' (1.0).

### 1.6. The Vegetation Risk

Due to the excellent vegetation status (standing crop annuals/perennials, basal cover annuals/perennials, forage factor, fuel factor and vegetation degradation status) in all mapping units of the Ngandjela study area with scores between 0 and 1, the vegetation risk is rated very low 0.2 (Table 5).

### 1.7. The Zoological Risk

The game pressure in a certain region is controlled by the availability, quality and palatability of the forage plants, but is -at least for most of the game- much more determined by the quality and the availability of water. Despite the high tolerance of game towards poor water quality, the water at the Onaiso spring is so unsuitable and uncertain that the game pressure for this area is rated zero. In the Ngandjela area larger populations of game are missing or just migrating through, as long as the animals have the opportunity to find alternatives at other water holes in the surrounding areas of the Etosha N. P..

### 1.8. The Mean Integrated Landscape Ecological Risk

The soil units A9 and A11 in the eastern part of Map 11 show the lowest total rating for the landscape ecological risks as a consequence of low soil physical risk, soil erosion hazard and vegetation risks. The soil units A2, A7 and the rest of A9 -that make up most of the study area- are rated 'moderate' due to a high soil risk rating (0.41-0.46) and very high erosion hazard respectively water quality/quantity risk ratings (1.0). High integrated risks are indicated for the soil units A10 and D2 with scores of 0.50 and 0.56. The reason for this is found in the high to very high soil risks, very high erosion hazard risks (A10 'wind erosion', D2 'sheet wash' and 'flooding') and very high water quality/availability risks. Due to the experiences with soil profiles from the Sonderkop Pan (Part I of this report; TRIPPNER 1993) and the Etosha Pan (BUCH 1993) the risk values of soil unit E1 were rated very high (>0.75).

### 1.9. Implications

In general, the integrated landscape ecological risk of the Ngandjela study area is moderate with sufficiently good soil conditions, an excellent vegetation status and very low game pressure although the nutrient status is low and the erodibility risk is high at most of the locations. However the water quality and availability is extremely poor. Thus pos-

sible plannings for irrigation schemes in future (for agricultural use) or for extended farming activities, must be considered very critical. According to the experience so far, it must be expected that irrigation water of such a high electrical conductivity, as it is known from the Ngandjela area, will lead to soil salinization hazards within some years. An increased utilization pressure by farming activities with high cattle stockings, together with the expected salinization hazards by irrigation would increase erosion and vegetation degradation risks to a great extent.
At the moment the Ngandjela area is not in the area of tourism and/or farming activities, thus future development planning should be carried out carefully with the background of an environmentally sound management.

## 2. The Okaukuejo Area

The integrated landscape ecological risk in the Okaukuejo area in general, is rated low to moderate (Map 12). However it must be mentioned here that in the south-eastern corner of this map, where the map sheet Ondongab is adjoining, the mean integrated risks is underestimated because the assessment of the soil risks is based on only one sampled soil profile (Oka 71) with a comparatively low risk rating (indicated by question marks). When compared with the very high mean integrated risk ratings in the Ondongab area (Map 13) it is clear that the mean landscape ecological risks in the south-eastern corner of the Okaukuejo map should be upgraded to a final risk rating of moderate to high.

### 2.1. The Soil Physical Degradation Risk

In general the soil physical degradation risk in the Okaukuejo area is considered to be low to moderate (Table 6), with high values in mapping unit A8 at the westernmost dune ridge (Oka 40). Here a high water erosion rating (F-index), a high wind erosion rating (4) and very high (5) AFC and BIR scores are combined. Due to the shallowness of the soil profiles and the low available field conditions as a consequence of high clay contents in the soil unit C3 (profiles Oka 23, 24, 25), the soil physical degradation risk is rated 1.00 (Table 6). Mapping unit C4 around the Okaukuejo tourist camp, where most of the soils are shallow and stony, shows very high soil depth (5) and high (4) skeleton scores, which give a final rating of 1.00. On account of the high water erodibility and AFC scores (5) in the soil unit D1, the soil physical risk here is also rated 1.00.

Table 6: The Landscape Ecological Risk Evaluation for the Okaukuejo Study Area

| Mapping Unit | Var. | SoilPhys + | SoilChem + | Erosion | ErosRelief + | Rain + | Water + | Veg+ | GamePr + | Mean + | Main Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **A8** | 1 | 0,66 | 0,44 | 0,45 | **1,00** | 0,70 | 0,00 | 0,17 | **1,00** | 0,57 | **E, Z** |
| | 2 | 0,06 | 0,40 | 0,00 | 0,00 | 0,70 | 0,00 | 0,77 | 0,00 | 0,28 | |
| **C1** | 1 | 0,23 | 0,24 | 0,00 | 0,00 | 0,70 | 0,00 | 0,17 | 0,00 | 0,20 | |
| **C2** | 1 | 0,26 | 0,18 | 0,00 | 0,00 | 0,60 | 0,20 | 0,69 | 0,60 | 0,36 | |
| | 2 | 0,34 | 0,24 | 0,00 | 0,00 | 0,40 | 0,00 | 0,89 | 0,00 | 0,27 | |
| | 3 | 0,31 | 0,18 | 0,00 | 0,00 | 0,70 | 0,00 | 0,20 | 0,00 | 0,20 | |
| **C3** | 1 | 0,14 | 0,24 | 0,00 | 0,00 | 0,70 | 0,00 | 0,49 | 0,00 | 0,22 | |
| | 2 | **1,00** | 0,33 | 0,25 | **1,00** | 0,50 | 0,20 | 0,26 | **1,00** | 0,61 | **P, E, Z** |
| | 3 | 0,31 | 0,22 | 0,00 | 0,00 | 0,50 | 0,00 | 0,49 | 0,00 | 0,22 | |
| | 4 | 0,23 | 0,24 | 0,00 | 0,00 | 0,70 | 0,00 | 0,03 | 0,00 | 0,17 | |
| **C4** | 1 | **1,00** | 0,30 | 0,15 | **1,00** | 0,30 | 0,00 | 0,89 | **1,00** | 0,54 | **P, E, Z** |
| | 2 | 0,26 | 0,11 | 0,00 | 0,00 | 0,30 | 0,00 | 0,49 | 0,00 | 0,16 | |
| **C5** | 1 | 0,23 | 0,31 | 0,00 | 0,00 | 0,70 | 0,00 | 0,17 | 0,00 | 0,20 | |
| | 2 | 0,37 | 0,33 | 0,45 | **1,00** | 0,70 | 0,00 | **1,00** | **1,00** | 0,63 | **E, V, Z** |
| | 3 | 0,23 | 0,20 | 0,00 | 0,00 | 0,50 | 0,00 | 0,20 | 0,00 | 0,16 | |
| **C6** | 1 | 0,37 | 0,60 | 0,00 | 0,00 | 0,30 | 0,00 | 0,66 | 0,00 | 0,28 | |
| **D1** | 1 | **1,00** | **1,00** | 0,25 | 0,25 | 0,30 | 0,00 | 0,69 | 0,60 | 0,55 | **P, C** |
| **E1** | 1 | 0,14 | **1,00** | 0,00 | 0,00 | 0,70 | 0,00 | **1,00** | 0,00 | 0,41 | **C, V** |
| | 2 | 0,20 | **1,00** | 0,00 | 0,00 | 0,30 | 0,00 | 0,20 | 0,00 | 0,24 | **C** |

## 2.2. The Soil Chemical Degradation Risk

The soil chemical degradation risk in the Okaukuejo area ranges from low to moderate with increased ratings in soil units C6, D1 and E1. Due to the high salinization scores (4-5) in the topsoils of soil units C6, D1, E1, the additional high alcalinization scores in soil unit E1 (5) and the low N-contents (score 5), these mapping units are rated 1.00. All the other soil units on the Okaukuejo map show reasonable chemical risk ratings (0-3), although the N-content is high at most sites (Table 7).

Table 7: The Landscape Ecological Risk Ratings for the Soil Profiles of the Okaukuejo Area

| SU | Profile Oka | Weff | Sk | F | WEG | NFK | BIR | LK | Phys | ECt | ECs | ESPt | ESPs | Ca | CEC | C | N | P | Chem | Soil | S | G | W | ERO | Flo | ERO/FLO | Ralf | Raiv | Rain | Water | | STA | STP | Bca | Bcp | For | Fue | Deg | Veg | GamePr | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AB | 40 | 1 | 2 | 5 | 4 | 5 | 5 | 1 | 0,66 | 0 | 1 | 0 | 0 | 1 | 5 | 3 | 5 | 5 | 0,44 | 0,55 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 5 | 1,00 | 0,49 |
| AB | 41 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0,06 | 0 | 2 | 0 | 0 | 0 | 3 | 1 | 5 | 5 | 0,36 | 0,21 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,18 |
| AB | 49 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0,17 | 0 | 4 | 0 | 0 | 0 | 3 | 3 | 5 | 5 | 0,44 | 0,31 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 5 | 5 | 1 | 1 | 5 | 5 | 5 | 0,77 | 0 | 0,00 | 0,30 |
| AB | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0,06 | 0 | 2 | 0 | 0 | 3 | 3 | 3 | 5 | 5 | 0,47 | 0,26 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 0 | 0,00 | 0,32 |
| C1 | 45 | 3 | 0 | 0 | 3 | 0 | 0 | 1 | 0,20 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 5 | 0,24 | 0,22 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,19 |
| C1 | 46 | 3 | 1 | 0 | 4 | 0 | 0 | 1 | 0,26 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 5 | 5 | 0,29 | 0,27 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,20 |
| C1 | 47 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0,11 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 5 | 0,22 | 0,17 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,17 |
| C1 | 48 | 2 | 1 | 0 | 4 | 0 | 0 | 1 | 0,23 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 3 | 5 | 0,29 | 0,26 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,20 |
| C2 | 12 | 2 | 1 | 0 | 3 | 0 | 0 | 1 | 0,20 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 1 | 0,16 | 0,18 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,19 |
| C2 | 17 | 5 | 3 | 0 | 0 | 0 | 0 | 1 | 0,26 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 1 | 1 | 0,16 | 0,21 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 1 | 0,20 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,46 |
| C2 | 20 | 5 | 5 | 0 | 3 | 0 | 0 | 5 | 0,51 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 3 | 0,20 | 0,36 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,30 |
| C2 | 21 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0,11 | 0 | 1 | 0 | 0 | 0 | 5 | 1 | 5 | 1 | 0,29 | 0,20 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,26 |
| C2 | 22 | 5 | 4 | 0 | 3 | 0 | 0 | 5 | 0,49 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 5 | 3 | 0,31 | 0,40 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 1 | 0,20 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 0,60 | 5 | 1,00 | 0,44 |
| C2 | 65 | 5 | 3 | 0 | 3 | 0 | 0 | 1 | 0,34 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 1 | 0,18 | 0,26 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,24 |
| C2 | 66 | 5 | 3 | 0 | 3 | 0 | 0 | 1 | 0,34 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0,22 | 0,28 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,28 |
| C2 | 67 | 3 | 2 | 0 | 3 | 0 | 0 | 1 | 0,26 | 0 | 1 | 0 | 0 | 3 | 1 | 0 | 5 | 5 | 0,33 | 0,30 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,25 |
| C2 | 32 | 5 | 2 | 0 | 3 | 0 | 0 | 1 | 0,31 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 3 | 0,18 | 0,25 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 0 | 0,00 | 0,17 |
| C2 | 34 | 5 | 1 | 0 | 3 | 0 | 0 | 1 | 0,29 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 3 | 3 | 0,27 | 0,28 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 0 | 0,00 | 0,18 |
| C2 | 35 | 5 | 2 | 4 | 3 | 3 | 3 | 1 | 0,60 | 0 | 0 | 0 | 0 | 1 | 5 | 0 | 3 | 3 | 0,27 | 0,43 | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 5 | 1,00 | 0,41 |
| C2 | 38 | 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0,20 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 3 | 0,18 | 0,19 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,18 |
| C2 | 39 | 5 | 1 | 5 | 3 | 5 | 3 | 1 | 0,66 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 5 | 1 | 0,18 | 0,42 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 5 | 1,00 | 0,45 |
| C2 | 69 | 5 | 2 | 0 | 0 | 0 | 0 | 1 | 0,23 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 1 | 0,18 | 0,20 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,17 |
| C2 | 72 | 3 | 3 | 0 | 3 | 0 | 0 | 1 | 0,29 | 0 | 2 | 0 | 0 | 3 | 1 | 0 | 5 | 5 | 0,36 | 0,32 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,20 |
| C3 | 18 | 1 | 0 | 0 | 3 | 0 | 0 | 1 | 0,14 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 5 | 3 | 0,24 | 0,19 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,22 |
| C3 | 23 | 4 | 1 | 0 | 3 | 0 | 0 | 1 | 0,26 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 5 | 3 | 0,24 | 0,25 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 1 | 0,20 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 5 | 1,00 | 0,38 |
| C3 | 24 | 4 | 2 | 5 | 3 | 5 | 5 | 1 | 0,71 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 5 | 3 | 0,33 | 0,52 | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 1 | 0,20 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 0,26 | 5 | 1,00 | 0,46 |
| C3 | 25 | 3 | 2 | 3 | 3 | 5 | 1 | 1 | 0,51 | 0 | 1 | 0 | 0 | 3 | 3 | 1 | 5 | 5 | 0,40 | 0,46 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 1 | 0,20 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 0,26 | 5 | 1,00 | 0,47 |
| C3 | 11 | 5 | 2 | 0 | 3 | 0 | 0 | 1 | 0,31 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 5 | 0,22 | 0,27 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,22 |
| C3 | 31 | 5 | 1 | 0 | 2 | 0 | 0 | 1 | 0,26 | 1 | 0 | 0 | 0 | 1 | 1 | 3 | 3 | 5 | 0,31 | 0,28 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0,14 | 0 | 0,00 | 0,20 |
| C3 | 33 | 3 | 3 | 5 | 3 | 5 | 1 | 3 | 0,66 | 1 | 4 | 5 | 5 | 0 | 5 | 0 | 5 | 0 | 0,56 | 0,61 | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 5 | 1,00 | 0,48 |
| C3 | 36 | 4 | 3 | 0 | 3 | 0 | 0 | 1 | 0,31 | 1 | 2 | 0 | 0 | 1 | 5 | 0 | 3 | 3 | 0,33 | 0,32 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 0 | 0,00 | 0,20 |
| C3 | 27 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0,17 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 5 | 3 | 0,24 | 0,21 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 0 | 0,00 | 0,16 |
| C3 | 28 | 1 | 1 | 4 | 0 | 5 | 5 | 3 | 0,54 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 1 | 0,18 | 0,36 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 5 | 0,70 | 1 | 0,20 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 5 | 1,00 | 0,44 |
| C3 | 29 | 5 | 3 | 0 | 3 | 0 | 0 | 1 | 0,34 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 1 | 0,18 | 0,26 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 0 | 0,00 | 0,18 |
| C3 | 44 | 4 | 1 | 0 | 2 | 0 | 0 | 1 | 0,23 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 5 | 5 | 0,33 | 0,28 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,20 |
| C4 | 1 | 5 | 4 | 3 | 0 | 5 | 0 | 3 | 0,57 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0,22 | 0,40 | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 0,94 | 5 | 1,00 | 0,47 |
| C4 | 3 | 4 | 4 | 0 | 0 | 0 | 0 | 1 | 0,26 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 0,16 | 0,21 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 0,54 | 5 | 1,00 | 0,32 |
| C4 | 62 | 5 | 3 | 0 | 0 | 0 | 0 | 1 | 0,26 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 3 | 0,11 | 0,18 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,22 |
| C4 | 63 | 3 | 1 | 5 | 3 | 5 | 1 | 1 | 0,54 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 5 | 0,31 | 0,43 | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,47 |
| C4 | 56 | 4 | 1 | 0 | 3 | 0 | 0 | 1 | 0,26 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 5 | 0,27 | 0,26 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,19 |
| C4 | 58 | 4 | 1 | 0 | 4 | 0 | 0 | 1 | 0,29 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 0,11 | 0,20 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 5 | 5 | 3 | 3 | 5 | 0,77 | 0 | 0,00 | 0,21 |
| C4 | 71 | 4 | 2 | 0 | 0 | 0 | 0 | 1 | 0,20 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 0,11 | 0,16 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,16 |
| C5 | 42 | 1 | 1 | 5 | 3 | 5 | 3 | 1 | 0,54 | 1 | 0 | 0 | 0 | 0 | 3 | 3 | 5 | 5 | 0,38 | 0,46 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 5 | 1,00 | 0,46 |
| C5 | 43 | 4 | 2 | 0 | 3 | 0 | 0 | 1 | 0,29 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 5 | 5 | 0,31 | 0,30 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0,17 | 0 | 0,00 | 0,21 |
| C5 | 50 | 3 | 1 | 0 | 3 | 0 | 0 | 1 | 0,23 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 5 | 0,22 | 0,23 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,16 |
| C5 | 51 | 0 | 0 | 4 | 0 | 5 | 3 | 1 | 0,37 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 3 | 5 | 0,33 | 0,35 | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 5 | 0,70 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 5 | 1,00 | 0,48 |
| C5 | 30 | 3 | 1 | 0 | 3 | 0 | 0 | 1 | 0,23 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 5 | 5 | 0,27 | 0,25 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,03 | 0 | 0,00 | 0,17 |
| C5 | 37 | 5 | 1 | 0 | 2 | 0 | 0 | 1 | 0,26 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 3 | 3 | 0,18 | 0,22 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,19 |
| C5 | 4 | 4 | 1 | 0 | 3 | 0 | 0 | 1 | 0,26 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 0,16 | 0,21 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,13 |
| C5 | 26 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0,06 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 5 | 0,27 | 0,16 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,15 |

Table 7: continued

| SU | Profile Oka | Weff | Sk | F | WEG | NFK | BIR | LK | Phys | ECt | ECs | ESPt | ESPs | Ca | CEC | C | N | P | Chem | *Soil* | S | G | W | ERO | Flo | ERO/FLO | Ralf | Ralv | Rain | Water | | STA | STP | Bca | Bcp | For | Fue | Deg | Veg | GamsPr | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C5 | 61 | 5 | 1 | 5 | 0 | 5 | 0 | 1 | 0,49 | 0 | 0 | 0 | 0 | 5 | 1 | 3 | 5 | 1 | 0,33 | *0,41* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 1 | 0,20 | 3 | 3 | 5 | 5 | 3 | 3 | 5 | 0,77 | 0 | 0,00 | 0,36 |
| C6 | 57 | 4 | 1 | 0 | 3 | 0 | 0 | 5 | 0,37 | 2 | 0 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 0,47 | *0,42* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 0,60 | 0 | 0,00 | 0,25 |
| C6 | 59 | 5 | 1 | 4 | 3 | 5 | 1 | 3 | 0,63 | 4 | 0 | 5 | 5 | 5 | 3 | 3 | 5 | 3 | 0,73 | *0,68* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 5 | 5 | 3 | 3 | 5 | 0,77 | 0 | 0,00 | 0,38 |
| C6 | 68 | 4 | 1 | 0 | 3 | 0 | 0 | 5 | 0,37 | 4 | 4 | 0 | 0 | 3 | 1 | 3 | 5 | 5 | 0,56 | *0,46* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 0 | 0,00 | 0,30 |
| D1 | 70 | 3 | 2 | 0 | 3 | 0 | 0 | 3 | 0,31 | 5 | 5 | 0 | 0 | 5 | 1 | 1 | 5 | 1 | 0,51 | *0,41* | 0 | 0 | 0 | 0,00 | 3 | 0,15 | 2 | 1 | 0,30 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 0 | 0,00 | 0,25 |
| D1 | 64 | 3 | 1 | 5 | 3 | 5 | 0 | 5 | 0,63 | 5 | 5 | 1 | 1 | 5 | 1 | 3 | 5 | 3 | 0,64 | *0,64* | 0 | 0 | 4 | 0,27 | 3 | 0,35 | 2 | 1 | 0,30 | 0 | 0,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,54 |
| E1 | 8 | 4 | 2 | 0 | 3 | 0 | 0 | 1 | 0,29 | 4 | 5 | 0 | 0 | 3 | 3 | 1 | 3 | 3 | 0,49 | *0,39* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 0 | 0,00 | 0,35 |
| E1 | 52 | 0 | 0 | 3 | 3 | 5 | 3 | 1 | 0,43 | 1 | 4 | 3 | 5 | 5 | 3 | 1 | 5 | 3 | 0,67 | *0,55* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 5 | 0,70 | 0 | 0,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 5 | 1,00 | 0,53 |
| E1 | 60 | 1 | 0 | 0 | 4 | 0 | 0 | 3 | 0,23 | 4 | 5 | 5 | 5 | 5 | 1 | 1 | 3 | 3 | 0,71 | *0,47* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 0 | 0,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 0 | 0,00 | 0,35 |
| E1 | 53 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 0,17 | 2 | 4 | 5 | 5 | 3 | 1 | 0 | 3 | 3 | 0,58 | *0,37* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 5 | 0,70 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,24 |
| E1 | 54 | 3 | 2 | 5 | 1 | 5 | 0 | 1 | 0,49 | 5 | 5 | 3 | 3 | 3 | 1 | 1 | 5 | 3 | 0,64 | *0,57* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 1 | 0,30 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 5 | 1,00 | 0,44 |
| E1 | 55 | 4 | 0 | 0 | 3 | 0 | 0 | 1 | 0,23 | 5 | 5 | 5 | 5 | 5 | 1 | 1 | 5 | 3 | 0,78 | *0,50* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 1 | 0,30 | 0 | 0,00 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0,20 | 0 | 0,00 | 0,22 |

### 2.3. The Erosion/Flood Risk

Due to the even and flat topography in the Okaukuejo area the erosion and flood risks is rated zero (low) in most mapping units of the study area. The westernmost dune ridge in mapping unit A8 shows high sheet wash and wind erosion scores and is therefore rated 1.00. Soil unit C3 (Oka 23, 24, 25) with high sheet wash scores (5) is rated 1.00 as well. The areas around the Okaukuejo camp with sheet wash ratings of 3 in combination with low soil depths is also assessed with an erosion risk of 1.00. Soil unit C5 near the Etosha Pan (Oka 51) shows sheet wash ratings of 5 and wind erosion ratings of 4, which give also an integrated erosion/flood rating of 1.00.

### 2.4. The Climatic Risk

In the Okaukuejo area the long-term mean annual precipitation of about 380 mm gives a rainfall risk scores of 2. Together with high rainfall variability scores of 3-5 at most of the sites in this study area, the climatic risk is rated high with values between 0.50-0.70 for most of the soil mapping units.

### 2.5. The Water Availability and Quality Risk

Due to the high availability and relatively good chemical quality of the water (natural and artificial sources) in the Okaukuejo area, the water risk in general is rated low. However it must be pointed out that the nearby waterholes 'Gemsbokvlakte' and 'New Browni' (on map sheet Ondongab; see below) produce water of very poor chemical quality (-900 mS/m) and despite the high availability of this water, it is neither drinkable for humans nor acceptable for irrigation purposes.

### 2.6. The Vegetation Risk

The vegetation risk in the Okaukuejo areas in general is moderate to very high, with comparative good scores for the basal vegetation cover (annuals/perennials) in most of the units. Only during the dry season of 1993 the mapping unit E1 around 'Wolfsnes' had high risk ratings (5) for all vegetation parameters (Table 7). In general the highest risk scores occur in the vicinity of the waterholes with an increased game pressure. Thus, around Okaukuejo, the areas west and south (the direction to Ombika) of the tourist camp and in the 'Wolfsnes' area in direction to the 'Okondeka' waterhole the highest scores are reached with vegetation risk ratings between 0.69 and 1.00 (Table 6).

### 2.7. The Zoological Risk

The game pressure on map sheet Okaukuejo is mainly controlled by the distance from the waterholes and the vegetation status and palatability. Therefore the westernmost dune ridge of soil unit A8, which is influenced by the 'Okondeka' waterhole, the southern spot of C3, the area around the tourist camp of Okaukuejo and the areas around 'Wolfsnes' show high game pressure scores, hence they are rated 1.00. Mapping units C2 and D1 show medium game pressure scores (3) and are rated 0.6.

### 2.8. The Mean Integrated Landscape Ecological Risks

In general, most of the Okaukuejo area show low to medium mean integrated risk ratings as a consequence of mainly low individual landscape ecological risks. However it must be kept in mind that even in those areas some individual landscape ecological risks might be dramatically increased (Table 6). The highest risk ratings occur (as it was described in the chapters above) in the vicinity of the waterholes, in areas close to the Etosha Pan and in the animal migration areas with ratings between 0.41 and 0.61. Again, it must be pointed out that the landscape ecological risk for south-eastern corner of the Okaukuejo map is underestimated due to a single soil profile with good risk ratings. Coming from the Ondongab area with very high risk scores, the adjacent Okaukuejo areas are in the transition zone from very high (Ondongab) to low (Okaukuejo) ratings. Therefore this zone must be assessed more precisely with a moderate to high mean integrated landscape ecological risk rating. The area under discussion is marked by question marks in Map 13.

### 2.9. Implications

Although most of the mapping units in the Okaukuejo area show low to moderate landscape ecological risk ratings, special attention should be directed to certain soil units where individual landscape ecological risks may cause severe degradation hazards. For the Okaukuejo mapping area the most prominent degradation hazards are vast damages by soil erosion and soil degradation around waterholes as it can be observed around Okaukuejo. The dominating soil physical and chemical degradation risks (shallow soil depth, high skeleton content, salinization hazards) in combination with a high vegetation degradation status and high game pressure at some locations (like waterholes and game migration areas) may cause -respectively have already caused in the past- irreversible damages to the ecosystem of Etosha. An ecological and environmental sound management and planning activity therefore should take into consideration, whether some waterholes could be closed (Okaukuejo) or if it is reasonable to open new waterholes (New Browni) which may attract additional game in overutilized areas at the map sheet Okaukuejo. In order to reduce the high game pressure in the endangered areas of the Okaukuejo map, it is thought to discuss the opening of new waterholes (probably in the todays non-touristic areas of the Etosha N. P.) more intensively against the background of landscape ecological risks. The distribution of the present game populations of the Okaukuejo area over large regions of the central southern part of the Etosha National Park (directed by artificial waterholes) may help to facilitate a regeneration of the ecological stressed areas.

## 3. The Ondongab Area

The Ondongab area, which is adjoining the Okaukuejo area to the east, is characterized by the highest integrated landscape ecological risk (ratings from moderate to high to very high) for all the four study areas investigated by the author. The exceptional high scores are mainly caused by soil physical, erosion, chemical water quality, vegetation status and zoological hazards as the dominating risks (Map 13).

### 3.1. The Soil Physical Degradation Risk

Due to the shallow, skeleton rich soils that are susceptible to wind and water erosion together with a high scored (5) AFC risk, the soil physical degradation hazard in all of the soil units and especially around the waterholes Gemsbokflakte and Olifantsbad, is rated very high (1.00; Table 8).

Table 8: The Landscape Ecological Risk Evaluation for the Ondongab Study Area

| Mapping Unit | Var. | SoilPhys + | SoilChem + | Erosion | ErosRelief + | Rain + | Water + | Vegetat + | GamePr + | Mean + | Main Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **C4** | 1 | **1,00** | 0,27 | 0,45 | **1,00** | 0,50 | **1,00** | **1,00** | **1,00** | 0,82 | **P, E, W, V, Z** |
| | 2 | **1,00** | 0,22 | 0,35 | **1,00** | 0,50 | **1,00** | **1,00** | **1,00** | 0,75 | **P, E, W, V, Z** |
| **C5** | 1 | **1,00** | 0,24 | 0,35 | **1,00** | 0,50 | **1,00** | **1,00** | **1,00** | 0,82 | **P, E, W, V, Z** |
| | 2 | **1,00** | 0,24 | 0,45 | **1,00** | 0,50 | 0,60 | **1,00** | **1,00** | 0,75 | **P, E, V, Z** |
| | 3 | **1,00** | 0,38 | 0,45 | **1,00** | 0,50 | **1,00** | **1,00** | **1,00** | 0,84 | **P, E, W, V, Z** |
| **C6** | 1 | **1,00** | **1,00** | 0,45 | **1,00** | 0,50 | 0,40 | **1,00** | **1,00** | 0,84 | **P, C, E, V, Z** |
| **D2** | 1 | **1,00** | 0,42 | 0,10 | 0,10 | 0,30 | 0,60 | 0,60 | 0,60 | 0,52 | **P** |
| **E1** | 1 | **1,00** | **1,00** | 0,45 | **1,00** | 0,50 | **1,00** | **1,00** | **1,00** | 0,93 | **P, C, E, W, V, Z** |
| | 2 | **1,00** | 0,40 | 0,45 | **1,00** | 0,50 | **1,00** | **1,00** | 0,60 | 0,75 | **P, E, W, V** |

### 3.2. The Soil Chemical Degradation Risk

As a result of high calcium carbonate contents and low N-values, the soil chemical hazards in the soil units C4, C5 and D2 range from low to moderate (0.22-0.42). The salinization risk (score 1), the alkalinization hazards (1), the fertility status (1-3) as well as the content of organic matter (score 0) indicate sufficiently good chemical properties within these soil units. The high salinization and alkalinization scores (5), together with high scores of the nitrogen and plant available phosphate values cause a high risk rating (1.00) for soil units C6 and E1 (Table 8, Table 9).

### 3.3. The Erosion/Flood Risk

Due to the very high sheet and wind erosion hazards, scores between 2 and 5 in all mapping units -exept soil unit D2- the erosion risk in the Ondongab mapping area is rated 1.00. Soil unit D2 with a high wind erosion score of 4 and some flooding risk is rated 0.25.

### 3.4. The Climatic Risk

A mean long-term seasonal rainfall of about 400 mm and a high rainfall variability of 30-40% in the Ondongab area results in a climatic risk rating of 0.30-0.50 (Table 8).

### 3.5. The Water Availability and Quality Risk

In the Ondongab mapping area the water availability is very good with a strong perennial flow at most of the waterholes. However the chemical water quality is poor (-900 mS/m). Especially the waterholes at the edge of the Etosha Pan, 'Kapupuhedi' and 'Ondongab', are characterized by a seasonal flow of water with an extremely poor quality (>900 mS/m). Therefore the water availability and quality scores of 5 are rated 1.00, what means that the water is normally not suitable for animals, but due to missing alternatives this water is consumed by game.

### 3.6. The Vegetation Risk

The vegetation in the Ondongab area is highly degraded and also the total vegetation status give high risk scores of 5. Consequently, the vegetation conditions are rated 1.00.

### 3.7. The Zoological Risk (Game Pressure)

As the water availability is very high and the supply of vegetation is still sufficiently high, many animals are attracted to the Ondongab study area. This causes a high game pressure on nearly all soil units in this area. Thus, also the zoological risk is assessed to a value of 1.00.

### 3.8. The Mean Integrated Landscape Ecological Risk

The mean integrated landscape ecological risk in the Ondongab study is rated more than 0.50 for most of the mapping units and often shows scores of 1.00. Thus, the combination (integration) of the individual landscape ecological parameters attest ***heavy*** ecological hazards for the entire region. The main risks for the ecosystem are identified with the soil physical, the erosion, the water quality, the vegetation and the game pressure risks.

Table 9: The Landscape Ecological Risk Ratings of the Soil Samples in the Ondongab Area

| SU | Profile Odo | Weff | Sk | F | WEG | AFC | BIR | AC | Phys | ECt | ECs | ESPt | ESPs | Ca | CEC | C | N | P | Chem | Soil | S | G | W | ERO | FLO | ERO/FLO | Ralf | Ralv | Rain | Water | | STA | STP | Bca | Bcp | For | Fue | Deg | Veg | GamePr | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C5 | 2 | 4 | 2 | 4 | 3 | 5 | 0 | 1 | 0,54 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 5 | 1 | 0,22 | *0,38* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,61 |
| C5 | 6 | 5 | 5 | 2 | 3 | 5 | 1 | 3 | 0,69 | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 5 | 3 | 0,31 | *0,50* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,67 |
| C5 | 7 | 4 | 3 | 5 | 0 | 5 | 3 | 1 | 0,60 | 0 | 0 | 0 | 0 | 3 | 5 | 0 | 3 | 1 | 0,27 | *0,43* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,63 |
| C5 | 9 | 5 | 4 | 3 | 3 | 5 | 1 | 1 | 0,63 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0,22 | *0,43* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,65 |
| C5 | 10 | 5 | 1 | 5 | 3 | 5 | 3 | 1 | 0,66 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0,22 | *0,44* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,66 |
| C5 | 11 | 5 | 5 | 2 | 3 | 5 | 5 | 3 | 0,80 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0,24 | *0,52* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,65 |
| C5 | 28 | 4 | 4 | 2 | 3 | 5 | 5 | 3 | 0,74 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,22 | *0,48* | 2 | 0 | 4 | 0,40 | 0 | 0,30 | 2 | 3 | 0,50 | 2 | 0,40 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,58 |
| C5 | 30 | 5 | 5 | 3 | 3 | 5 | 1 | 3 | 0,71 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,24 | *0,48* | 4 | 0 | 0 | 0,27 | 0 | 0,20 | 2 | 3 | 0,50 | 2 | 0,40 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,58 |
| C5 | 31 | 5 | 5 | 3 | 0 | 5 | 3 | 3 | 0,69 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 3 | 0,29 | *0,49* | 4 | 0 | 0 | 0,27 | 0 | 0,20 | 2 | 3 | 0,50 | 2 | 0,40 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,57 |
| C5 | 50 | 5 | 2 | 5 | 3 | 5 | 3 | 1 | 0,69 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 1 | 0,18 | *0,43* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 4 | 0,80 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 0,94 | 3 | 0,60 | 0,59 |
| C5 | 33 | 5 | 3 | 5 | 3 | 5 | 3 | 1 | 0,71 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 1 | 0,20 | *0,46* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 3 | 3 | 0,60 | 2 | 0,40 | 5 | 5 | 5 | 5 | 3 | 3 | 3 | 0,83 | 5 | 1,00 | 0,60 |
| C5 | 51 | 5 | 2 | 4 | 3 | 5 | 5 | 1 | 0,71 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0,07 | *0,39* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 4 | 0,80 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 0,94 | 3 | 0,60 | 0,59 |
| C5 | 34 | 5 | 5 | 2 | 3 | 5 | 3 | 5 | 0,80 | 1 | 0 | 0 | 0 | 3 | 5 | 0 | 5 | 3 | 0,38 | *0,59* | 1 | 0 | 4 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 3 | 3 | 3 | 0,83 | 5 | 1,00 | 0,68 |
| C5 | 35 | 5 | 5 | 4 | 4 | 5 | 1 | 1 | 0,71 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,24 | *0,48* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 3 | 3 | 3 | 0,83 | 5 | 1,00 | 0,68 |
| C5 | 36 | 2 | 1 | 3 | 0 | 3 | 0 | 0 | 0,26 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 5 | 5 | 0,33 | *0,30* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,58 |
| C5 | 37 | 5 | 2 | 5 | 3 | 5 | 1 | 1 | 0,63 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 3 | 0,27 | *0,45* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,68 |
| C5 | 38 | 3 | 1 | 3 | 0 | 5 | 0 | 1 | 0,37 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 5 | 5 | 0,33 | *0,35* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,63 |
| C5 | 39 | 5 | 5 | 3 | 3 | 5 | 3 | 1 | 0,71 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 1 | 0,11 | *0,41* | 4 | 0 | 4 | 0,53 | 0 | 0,40 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,67 |
| C5 | 40 | 5 | 2 | 2 | 0 | 5 | 0 | 1 | 0,43 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 5 | 5 | 0,42 | *0,43* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,61 |
| C5 | 41 | 5 | 5 | 2 | 3 | 5 | 5 | 1 | 0,74 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 1 | 1 | 0,13 | *0,44* | 1 | 0 | 4 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,65 |
| C5 | 42 | 4 | 1 | 5 | 2 | 5 | 0 | 1 | 0,51 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 5 | 5 | 0,42 | *0,47* | 5 | 0 | 3 | 0,53 | 0 | 0,40 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 5 | 1,00 | 0,68 |
| C5 | 43 | 2 | 1 | 5 | 2 | 3 | 3 | 1 | 0,49 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 5 | 5 | 0,38 | *0,43* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 3 | 0,60 | 0,59 |
| C5 | 44 | 5 | 5 | 2 | 4 | 5 | 5 | 1 | 0,77 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 1 | 0,11 | *0,44* | 1 | 0 | 4 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 3 | 0,60 | 0,60 |
| C5 | 45 | 5 | 5 | 3 | 4 | 5 | 5 | 1 | 0,80 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 3 | 1 | 0,22 | *0,51* | 2 | 0 | 4 | 0,40 | 0 | 0,30 | 2 | 3 | 0,50 | 5 | 1,00 | 3 | 3 | 5 | 3 | 3 | 3 | 1 | 0,60 | 3 | 0,60 | 0,57 |
| C5 | 46 | 3 | 0 | 3 | 3 | 5 | 1 | 1 | 0,46 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 5 | 5 | 0,36 | *0,41* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 3 | 3 | 5 | 3 | 3 | 3 | 1 | 0,60 | 3 | 0,60 | 0,57 |
| C5 | 48 | 5 | 1 | 5 | 3 | 5 | 1 | 1 | 0,60 | 0 | 0 | 0 | 0 | 3 | 3 | 1 | 5 | 5 | 0,38 | *0,49* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 3 | 3 | 5 | 3 | 3 | 3 | 1 | 0,60 | 3 | 0,60 | 0,59 |
| C6 | 32 | 3 | 3 | 4 | 3 | 5 | 0 | 3 | 0,60 | 5 | 5 | 0 | 1 | 3 | 1 | 3 | 5 | 5 | 0,62 | *0,61* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 2 | 0,40 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,64 |
| C4 | 1 | 4 | 2 | 5 | 3 | 5 | 1 | 1 | 0,60 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 1 | 0,18 | *0,39* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,64 |
| C4 | 3 | 4 | 0 | 5 | 0 | 5 | 1 | 1 | 0,46 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,22 | *0,34* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,60 |
| C4 | 13 | 5 | 4 | 3 | 0 | 5 | 1 | 1 | 0,54 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 3 | 0,29 | *0,42* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 5 | 1,00 | 0,58 |
| C4 | 14 | 5 | 3 | 5 | 3 | 5 | 1 | 1 | 0,66 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,22 | *0,44* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 0,49 | 5 | 1,00 | 0,62 |
| C4 | 15 | 4 | 1 | 4 | 3 | 5 | 1 | 3 | 0,60 | 2 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,27 | *0,43* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 5 | 1,00 | 0,66 |
| C4 | 4 | 5 | 3 | 4 | 0 | 5 | 3 | 1 | 0,60 | 2 | 0 | 0 | 0 | 0 | 5 | 0 | 5 | 3 | 0,33 | *0,47* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,64 |
| C4 | 5 | 4 | 2 | 4 | 3 | 5 | 1 | 1 | 0,57 | 0 | 0 | 1 | 1 | 5 | 5 | 1 | 5 | 5 | 0,51 | *0,54* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,69 |
| C4 | 8 | 4 | 1 | 5 | 3 | 5 | 1 | 1 | 0,57 | 0 | 0 | 1 | 1 | 3 | 3 | 0 | 3 | 5 | 0,36 | *0,46* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,66 |
| C4 | 12 | 5 | 5 | 3 | 3 | 5 | 3 | 3 | 0,77 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 3 | 0,27 | *0,52* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 3 | 3 | 5 | 0,77 | 5 | 1,00 | 0,62 |
| C4 | 24 | 5 | 5 | 2 | 3 | 5 | 3 | 5 | 0,80 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 3 | 0,18 | *0,49* | 2 | 0 | 4 | 0,40 | 0 | 0,30 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 3 | 0,60 | 0,61 |
| C4 | 21 | 4 | 3 | 3 | 3 | 5 | 3 | 1 | 0,63 | 2 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,27 | *0,45* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 3 | 0,60 | 0,63 |
| C4 | 22 | 5 | 5 | 3 | 0 | 5 | 3 | 3 | 0,69 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 3 | 0,27 | *0,48* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 3 | 0,60 | 0,61 |
| C4 | 23 | 4 | 5 | 3 | 3 | 5 | 3 | 1 | 0,69 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 1 | 0,22 | *0,45* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 3 | 0,60 | 0,62 |
| C4 | 49 | 5 | 1 | 0 | 0 | 5 | 1 | 1 | 0,37 | 0 | 0 | 0 | 0 | 5 | 1 | 0 | 3 | 1 | 0,22 | *0,30* | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 2 | 3 | 0,50 | 4 | 0,80 | 5 | 5 | 3 | 5 | 5 | 5 | 5 | 0,94 | 3 | 0,60 | 0,49 |

Table 9: continued

| SU | Profile Odo | Weff | Sk | F | WEG | AFC | BIR | AC | Phys | ECt | ECs | ESPt | ESPs | Ca | CEC | C | N | P | Chem | *Soil* | S | G | W | ERO | FLO | ERO/FLO | Raif | Raiv | Rain | Water | | STA | STP | Bca | Bcp | For | Fue | Deg | Veg | GarmPr | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D2 | 16 | 4 | 1 | 5 | 3 | 5 | 0 | 3 | 0,60 | 5 | 0 | 1 | 1 | 3 | 1 | 1 | 5 | 1 | 0,40 | *0,50* | 0 | 0 | 4 | 0,27 | 3 | 0,35 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 5 | 1,00 | 0,69 |
| D2 | 52 | 3 | 2 | 0 | 0 | 0 | 1 | 3 | 0,26 | 1 | 0 | 0 | 0 | 5 | 3 | 1 | 5 | 3 | 0,40 | *0,33* | 0 | 0 | 0 | 0,00 | 3 | 0,15 | 0 | 0 | 0,00 | 0 | 0,00 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,00 | 0 | 0,00 | 0,12 |
| E1 | 17 | 2 | 2 | 4 | 3 | 3 | 0 | 3 | 0,49 | 2 | 5 | 5 | 5 | 3 | 1 | 1 | 3 | 5 | 0,67 | *0,58* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 1,00 | 5 | 1,00 | 0,73 |
| E1 | 18 | 3 | 1 | 4 | 3 | 5 | 1 | 1 | 0,51 | 3 | 0 | 5 | 5 | 3 | 1 | 0 | 5 | 3 | 0,56 | *0,53* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 3 | 3 | 0 | 0 | 3 | 3 | 1 | 0,37 | 5 | 1,00 | 0,63 |
| E1 | 19 | 5 | 3 | 5 | 0 | 5 | 1 | 1 | 0,57 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 3 | 3 | 0,22 | *0,40* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 3 | 0,60 | 0,58 |
| E1 | 20 | 4 | 0 | 5 | 3 | 5 | 0 | 1 | 0,51 | 4 | 0 | 0 | 0 | 5 | 1 | 0 | 5 | 3 | 0,40 | *0,46* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 0,94 | 3 | 0,60 | 0,63 |
| E1 | 25 | 4 | 2 | 4 | 3 | 5 | 0 | 1 | 0,54 | 1 | 0 | 0 | 0 | 3 | 1 | 0 | 5 | 5 | 0,33 | *0,44* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 3 | 0,60 | 0,62 |
| E1 | 27 | 5 | 1 | 5 | 0 | 5 | 0 | 1 | 0,49 | 5 | 0 | 5 | 5 | 5 | 1 | 0 | 5 | 3 | 0,64 | *0,57* | 5 | 0 | 0 | 0,33 | 0 | 0,25 | 2 | 3 | 0,50 | 5 | 1,00 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 3 | 0,60 | 0,62 |
| E1 | 29 | 4 | 1 | 5 | 3 | 5 | 0 | 3 | 0,60 | 5 | 0 | 5 | 5 | 5 | 1 | 1 | 5 | 3 | 0,67 | *0,63* | 5 | 0 | 4 | 0,60 | 0 | 0,45 | 2 | 3 | 0,50 | 2 | 0,40 | 5 | 5 | 3 | 3 | 5 | 5 | 5 | 0,89 | 5 | 1,00 | 0,64 |

### 3.9. Implications

As a consequence of the above described landscape ecological risks management and planning activities in the Ondongab area should be lead out very carefully, i.e. no new waterholes attracting more animals than today should be opened and it should be seriously thought about closing waterholes like 'Gemsbokflakte', 'Olifantsbad' and 'Aus' where the degradation process of the soils and the vegetation already reaches a maximum. These measurements are surely not very popular, especially under the aspect of expanding tourism in the Etosha National Park, but it is thought that this kind of conservation practises are necessary, in order to protect and stabilize this unique and fragile ecosystem for future generations.

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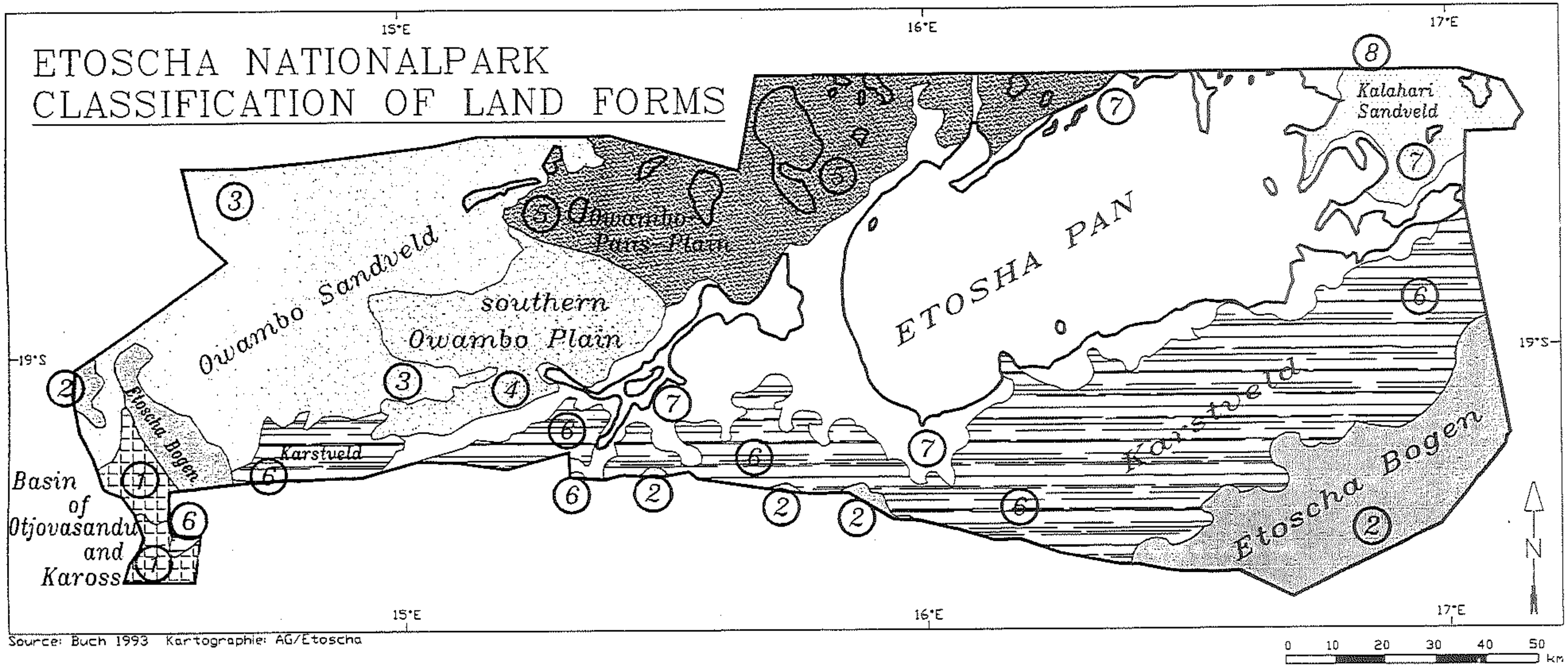



Map 1: Classification of the Land Forms in the Study Area (modified; after BUCH 1993)

(1) Basin of Otjovasandu and Kaross

(2) Etoscha Bogen

(3) Owambo Sandveld

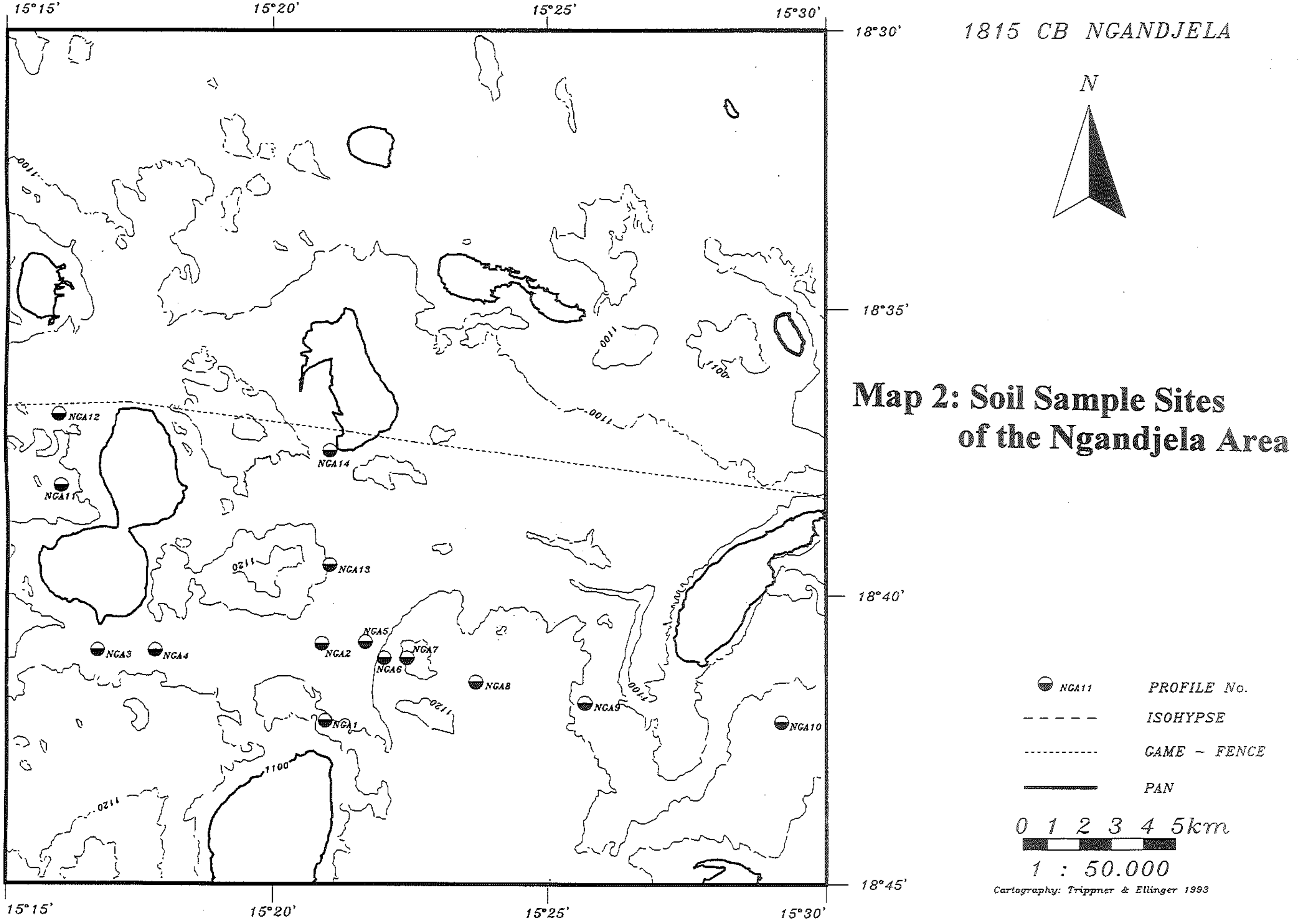
(4) southern Owambo Plain

(5) Owambo-Pans-Plain

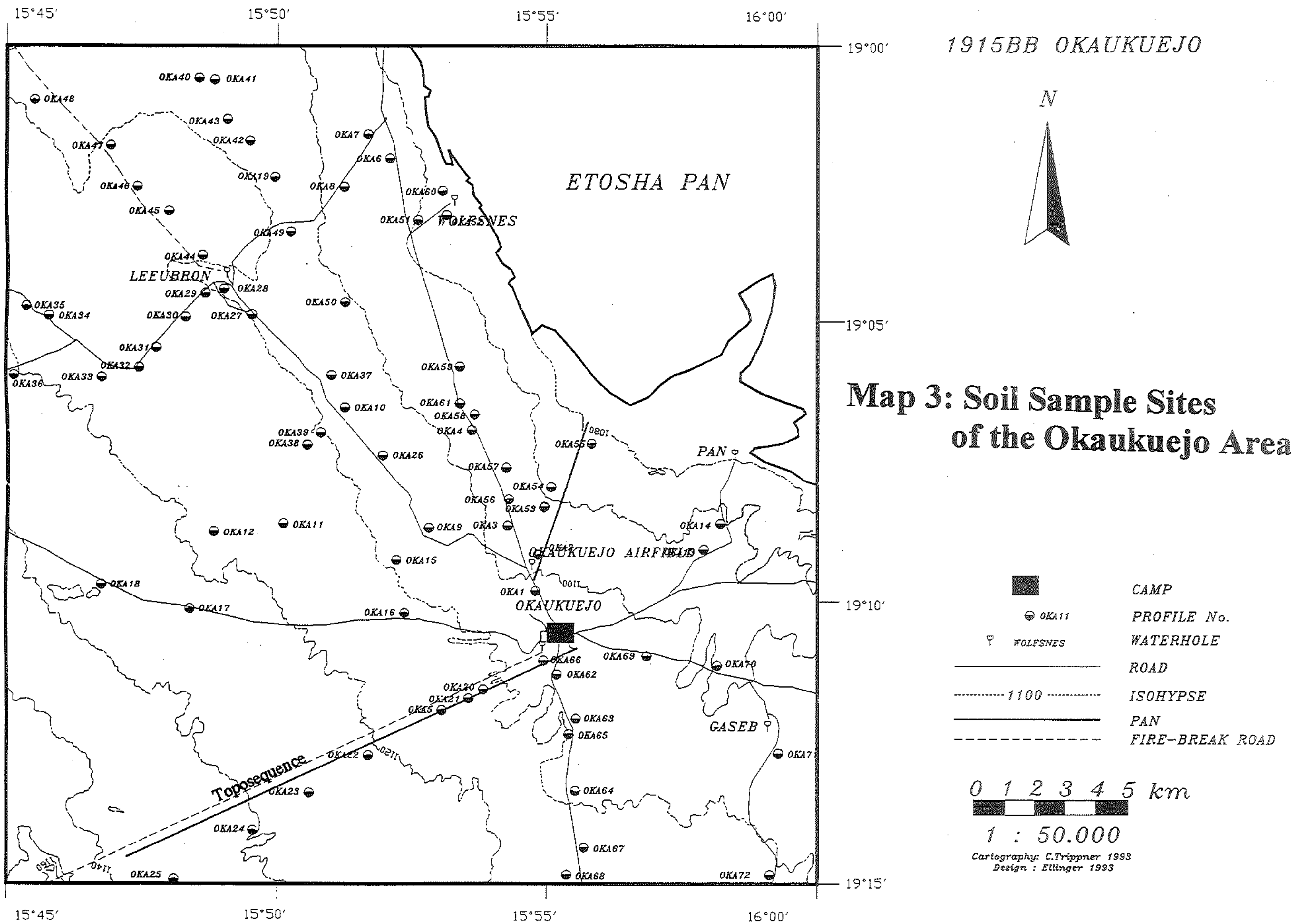
(6) Karstveld

(7) Etosha Pan i.a.w.s. with "Kalahari Sandveld"

(8) Kavango Longitudinal Duneveld

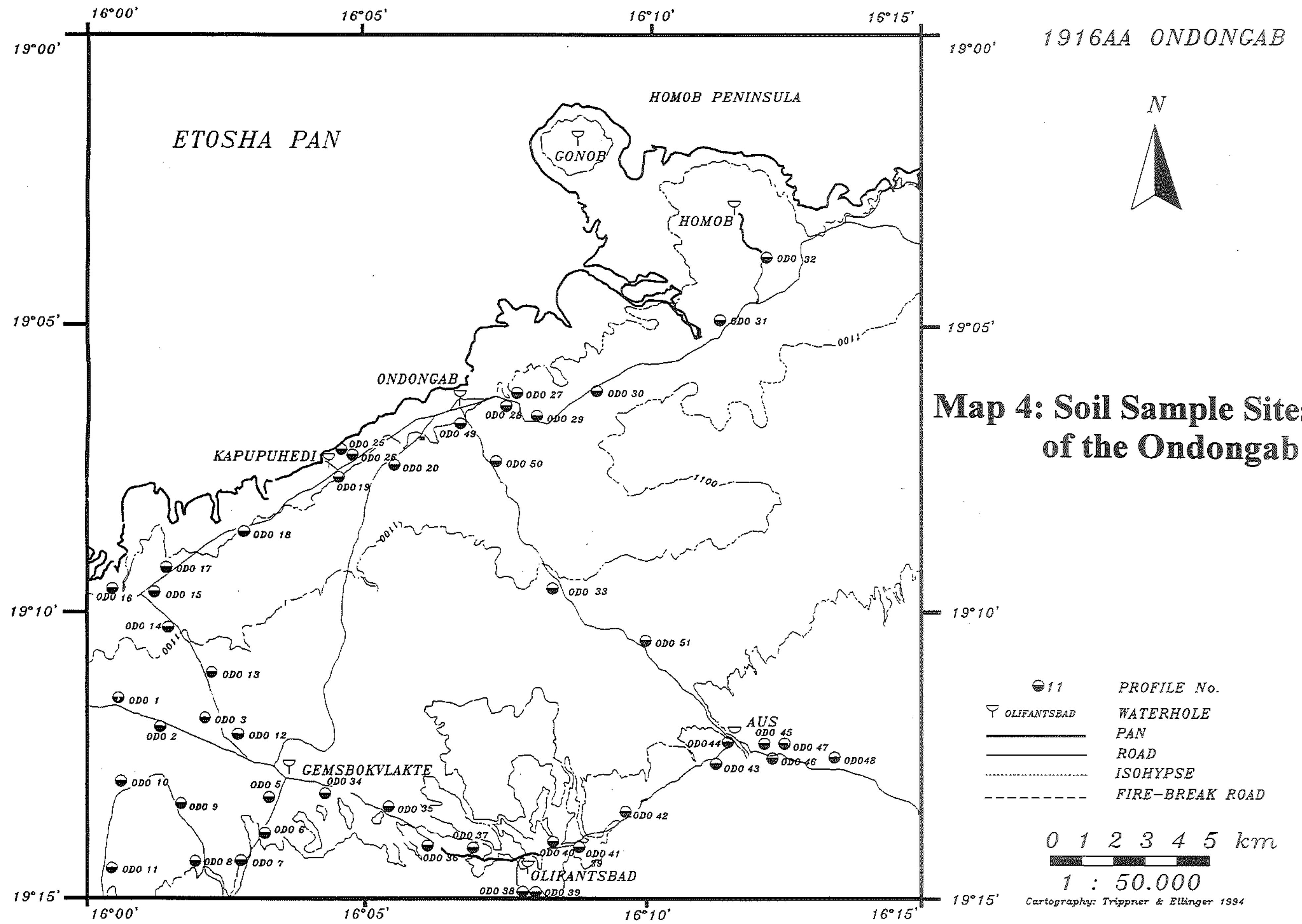



**Map 2: Soil Sample Sites of the Ngandjela Area**




# Map 3: Soil Sample Sites of the Okaukuejo Area

# Map 4: Soil Sample Sites of the Ondongab Area

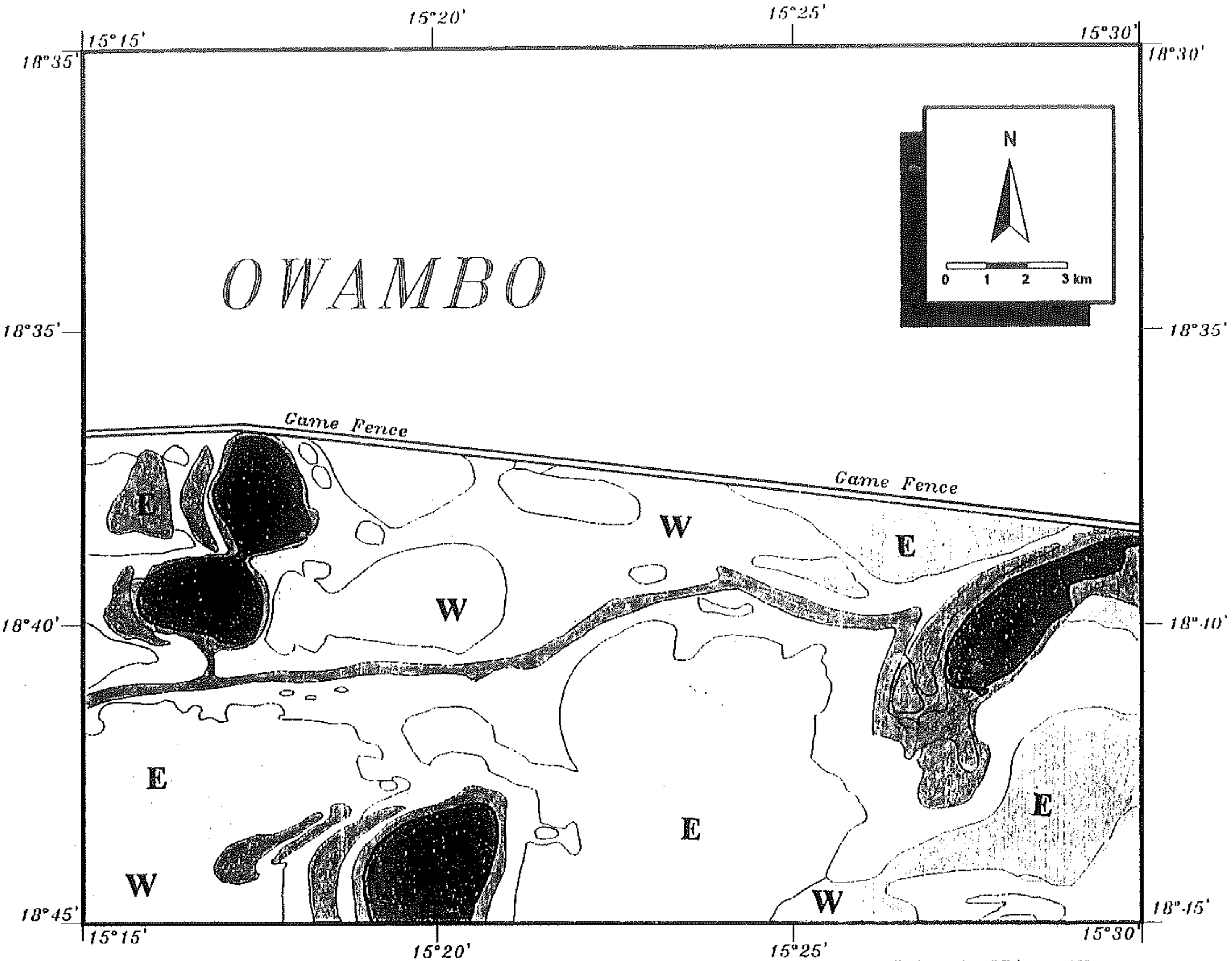


# Map 5 - 10

see plastic sac at the end of this report

# Map 11: The Ngandjela Area in the Central Western Part of the Etosha National Park

### Integrated Landscape Ecological Risks




Cartography: C.Trippner 1994
Design: L.Ellinger 1994

**Landscape Ecological Risk Rating:**

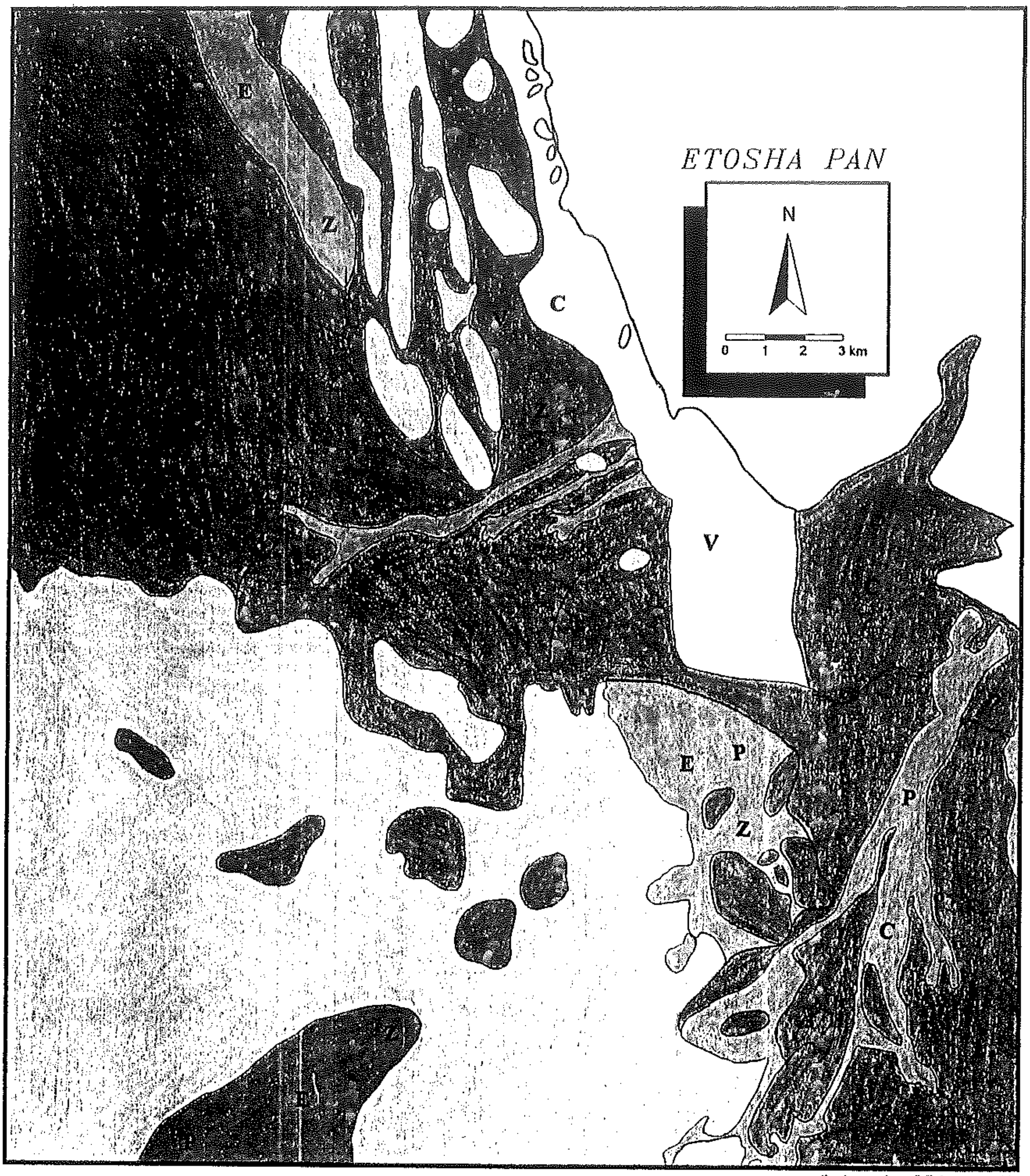
| | | |
|---|---|---|
| very high | 0.75-1.00 | |
| high | 0.60-<0.75 | |
| moderate to high | 0.50-<0.60 | |
| moderate | 0.40-<0.50 | |
| low to moderate | 0.25-<0.40 | |
| low | <0.25 | |

**Main limiting Risk:**

- **P** Soil Physical Risk
- **C** Soil Chemical Risk
- **E** Erosion/Flood Risk
- **R** Climatic Risk
- **W** Water Risk
- **V** Vegetation Risk
- **Z** Game Pressure

# Map 12: The Okaukuejo Area and the South-West of the Etosha Pan in the Etosha National Park

## Integrated Landscape Ecological Risks




*Cartography: C.Trippner 1994*

**Landscape Ecological Risk Rating:**

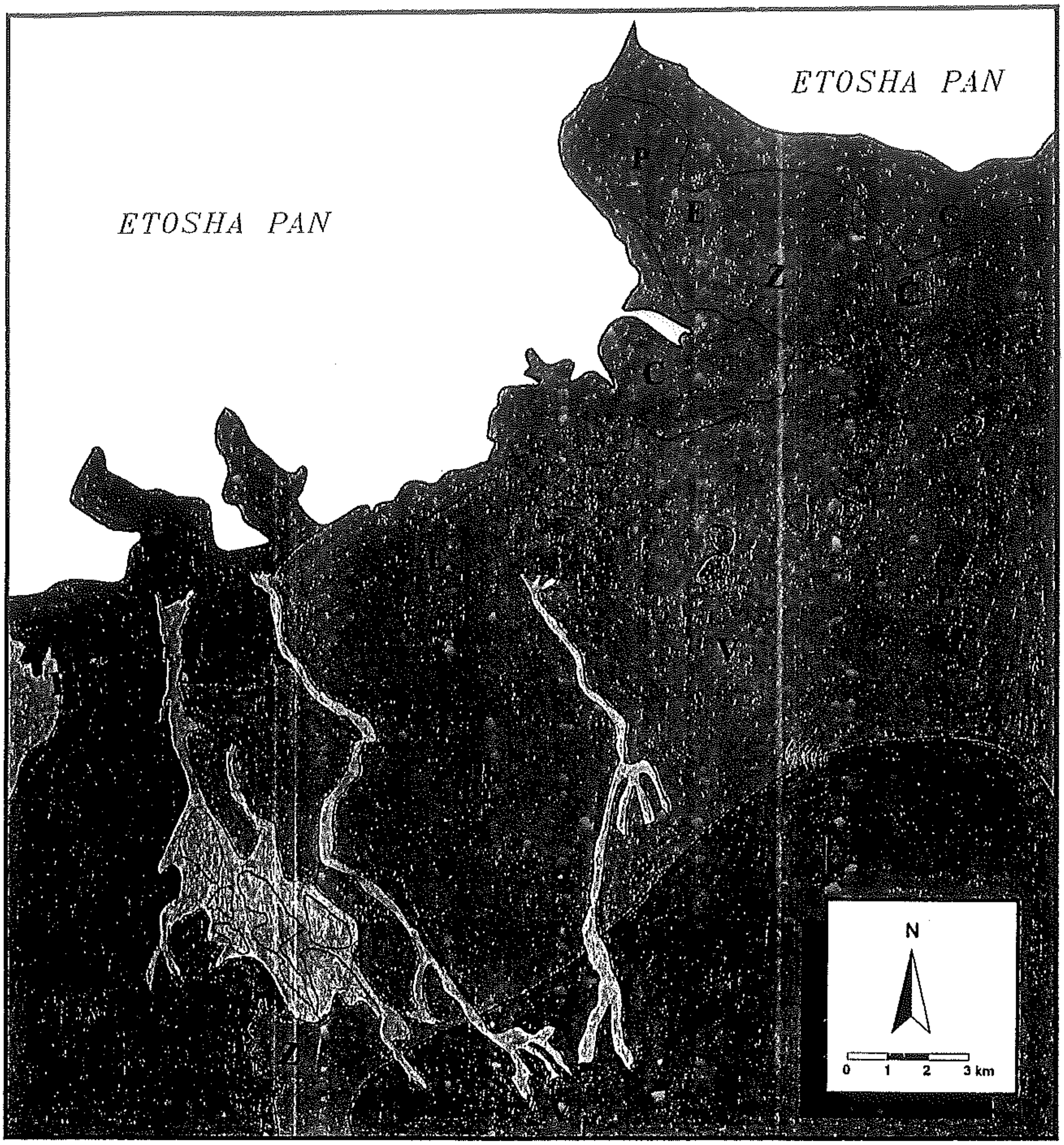
| | | |
|---|---|---|
| very high | 0.75-1.00 |
| high | 0.60-<0.75 |
| moderate to high | 0.50-<0.60 |
| moderate | 0.40-<0.50 |
| low to moderate | 0.25-<0.40 |
| low | <0.25 |

**Main limiting Risk:**

- **P** Soil Physical Risk
- **C** Soil Chemical Risk
- **E** Erosion/Flood Risk
- **R** Climatic Risk
- **W** Water Risk
- **V** Vegetation Risk
- **Z** Game Pressure

# Map 13: The Ondongab Area South-West of the Etosha Pan in the Etosha National Park

## Integrated Landscape Ecological Risks




*Cartography: Trippner & Ellinger 1994*

**Landscape Ecological Risk Rating:**

| | | |
|---|---|---|
| very high | 0.75-1.00 | |
| high | 0.60-<0.75 | |
| moderate to high | 0.50-<0.60 | |
| moderate | 0.40-<0.50 | |
| low to moderate | 0.25-<0.40 | |
| low | <0.25 | |

**Main limiting Risk:**

- **P** Soil Physical Risk
- **C** Soil Chemical Risk
- **E** Erosion/Flood Risk
- **R** Climatic Risk
- **W** Water Risk
- **V** Vegetation Risk
- **Z** Game Pressure

# Appendix A

**THE SOIL PHYSICAL AND SOIL CHEMICAL DATA OF THE SOIL SAMPLES OF THE NGANDJELA, OKAUKUEJO AND SONDERKOP STUDY AREAS**

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nga | 01 | A | 0-18 | 10YR 3/3-3/2 | 0,37 | 0,02 | 0,50 | 6,48 | 0,0 | 0,04 | 0,0 | 89,2 | 5,7 | 5,2 | LS | Cambic Arenosol |
| Nga | 01 | B | 27-33 | 10YR 3/3-4/3 | 0,31 | * | * | 5,63 | 0,0 | 0,07 | 0,0 | 89,2 | 4,8 | 6,0 | LS | |
| Nga | 01 | C | 47-55 | 10YR 4/3 | 0,22 | * | * | 6,34 | 0,0 | 0,09 | 0,0 | 88,5 | 5,9 | 5,5 | LS | |
| Nga | 01 | D | 72-84 | 10YR 4/4-3/4 | 0,31 | * | * | 6,68 | 0,0 | 0,36 | 0,0 | 83,9 | 5,1 | 11,0 | LS | |
| Nga | 01 | E | 120-127 | 10YR 4/4 | 0,16 | * | * | 7,34 | 0,0 | 1,03 | 0,0 | 79,5 | 8,5 | 12,0 | SL | |
| Nga | 01 | F | 145-151 | 10YR 5/4-4/4 | 0,16 | * | * | 7,76 | 0,0 | 0,82 | 0,0 | 79,4 | 12,9 | 7,7 | LS | |
| Nga | 01 | X | 163 | Sandstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 02 | A | 0-18 | 10YR 3/4-3/3 | 0,45 | 0,03 | 0,70 | 6,44 | 0,0 | 0,08 | 0,0 | 92,0 | 4,0 | 4,0 | FS | Xanti-Cambic Arenosol |
| Nga | 02 | B | 47-53 | 10YR 3/4-7.5YR 3/4 | 0,21 | * | * | 6,44 | 0,0 | 0,07 | 0,0 | 90,0 | 4,6 | 5,3 | MS | |
| Nga | 02 | C | 74-86 | 7.5YR 4/4-10YR 4/4 | 0,18 | * | * | 4,40 | 0,0 | 0,20 | 0,0 | 90,5 | 3,3 | 6,2 | FS | |
| Nga | 02 | D | 118-129 | 7.5YR 4/6 | 0,13 | * | * | 3,64 | 0,0 | 0,44 | 0,0 | 90,6 | 2,9 | 6,5 | FS | |
| Nga | 02 | E | 176-188 | 10YR 5/8 | 0,11 | * | * | 3,83 | 0,0 | 0,33 | 0,0 | 90,0 | 3,0 | 7,0 | FS | |
| Nga | 02 | F | 212-219 | 7.5YR 5/8-10YR 5/8 | 0,09 | * | * | 4,26 | 0,0 | 0,25 | 0,0 | 90,7 | 3,5 | 5,8 | FS | |
| Nga | 02 | G | 231-245 | 7.5YR 5/8 | 0,06 | * | * | 4,22 | 0,0 | 0,16 | 0,0 | 92,2 | 4,4 | 3,4 | FS | |
| Nga | 02 | H | 256-265 | 7.5YR 5/8 | 0,06 | * | * | 4,42 | 0,0 | 0,18 | 0,0 | 92,2 | 4,7 | 3,1 | FS | |
| Nga | 02 | K | 265-274 | 7.5YR 5/8 | 0,06 | * | * | 4,36 | 0,0 | 0,16 | 0,0 | 92,8 | 3,9 | 3,3 | FS | |
| Nga | 02 | X | ?? | Sandstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 03 | A | 0-20 | 10YR 3/3-3/2 | 1,49 | 0,08 | 15,00 | 7,03 | 0,0 | 0,58 | 0,0 | 54,6 | 7,8 | 37,6 | SC | Mollic Fluvisol |
| Nga | 03 | B | 27-38 | 10YR 3/3 | 0,98 | * | * | 7,49 | 0,7 | 0,32 | 0,0 | 53,5 | 4,0 | 42,5 | SC | |
| Nga | 03 | C | 44-51 | 10YR 3/3-3/4 | 0,82 | * | * | 7,52 | 1,0 | 0,71 | 0,0 | 53,8 | 4,0 | 42,2 | SC | |
| Nga | 03 | D | 68-76 | 10YR 4/3 | 0,60 | * | * | 8,00 | 5,5 | 0,23 | 0,0 | 54,4 | 4,5 | 41,1 | SC | |
| Nga | 03 | X | 80 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 04 | A | 0-19 | 10YR 3/3 | 0,73 | 0,02 | * | 7,26 | 0,0 | 1,17 | 0,0 | 77,6 | 5,7 | 16,7 | SL | Psammi-Humic Cambisol |
| Nga | 04 | B | 31-42 | 10YR 4/3 | 0,51 | * | * | 8,28 | 4,3 | 1,21 | 0,0 | 72,7 | 6,0 | 21,3 | SCL | |
| Nga | 04 | C | 58-66 | 10YR 5/3 | 0,38 | * | * | 8,43 | 3,6 | 1,57 | 0,0 | 72,6 | 5,4 | 22,1 | SCL | |
| Nga | 04 | D | 75-81 | 10YR 6/4 | 0,28 | * | * | 8,53 | 6,5 | 1,42 | 0,0 | 72,2 | 4,7 | 23,0 | SCL | |
| Nga | 04 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 05 | A | 0-19 | 2.5Y 4/2 | 0,37 | 0,03 | 1,00 | 6,47 | 0,0 | 0,07 | 0,0 | 91,3 | 4,5 | 4,1 | FS | Haplic Arenosol |
| Nga | 05 | B | 36-48 | 2.5Y 4/2 | 0,34 | * | * | 6,68 | 0,0 | 0,08 | 0,0 | 86,8 | 5,2 | 8,0 | LS | |
| Nga | 05 | C | 59-72 | 2.5Y 4/2 | 0,32 | * | * | 6,55 | 0,0 | 0,30 | 0,0 | 87,0 | 3,4 | 9,6 | LS | |
| Nga | 05 | D | 98-107 | 2.5Y 4/3 | 0,19 | * | * | 6,67 | 0,0 | 0,08 | 0,0 | 85,6 | 3,5 | 10,9 | LS | |
| Nga | 05 | E | 138-150 | 2.5Y 5/3 | 0,16 | * | * | 6,69 | 0,0 | 0,33 | 0,0 | 84,1 | 7,7 | 8,2 | LS | |
| Nga | 05 | F | 161-169 | 2.5Y 5/3-6/3 | 0,15 | * | * | 7,07 | 0,0 | 0,21 | 0,0 | 85,0 | 8,8 | 6,2 | LS | |
| Nga | 05 | X | 169 | Sandstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 06 | A | 0-18 | 10YR 3/3 | 0,50 | 0,03 | * | 4,58 | 0,0 | 0,13 | 0,0 | 86,7 | 7,2 | 6,1 | FS | Cambic Arenosol |

Soil Analytical Data of the Soil Samples in the Etosha NP    * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nga | 06 | B | 31-38 | 10YR 4/2 | 0,42 | * | * | 4,45 | 0,9 | 0,40 | 0,0 | 83,5 | 5,7 | 10,8 | LS | |
| Nga | 06 | C | 38-47 | 10YR 4/2 | 0,46 | * | * | 5,07 | 0,0 | 0,53 | 0,0 | 81,2 | 4,7 | 14,1 | SL/LS | |
| Nga | 06 | D | 59-76 | 10YR 5/3 | 0,28 | * | * | 7,26 | 0,0 | 0,58 | 0,0 | 76,6 | 5,1 | 18,3 | SL | |
| Nga | 06 | E | 92-101 | 10YR 5/2-4/2 | 0,22 | * | * | 7,10 | 0,0 | 0,87 | 0,0 | 72,8 | 5,6 | 21,6 | SCL | |
| Nga | 06 | F | 111-122 | 10YR 5/3 | 0,20 | * | * | 6,97 | 0,0 | 0,86 | 0,0 | 70,9 | 8,4 | 20,7 | SCL | |
| Nga | 06 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 07 | A | 0-20 | 10YR 3/3 | 0,52 | 0,03 | * | 6,21 | 0,0 | 0,06 | 0,0 | 87,6 | 6,1 | 6,3 | LS/S | Cambic Arenosol |
| Nga | 07 | B | 31-36 | 10YR 3/3-4/3 | 0,35 | * | * | 5,76 | 0,0 | 0,10 | 0,0 | 85,8 | 4,3 | 10,0 | LS | |
| Nga | 07 | C | 45-50 | 10YR 4/3-3/3 | 0,27 | * | * | 6,24 | 0,0 | 0,07 | 0,0 | 85,4 | 3,6 | 11,0 | LS | |
| Nga | 07 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 08 | A | 0-18 | 10YR 3/1-4/1 | 0,79 | 0,04 | 7,70 | 4,77 | 0,0 | 0,19 | 0,0 | 62,7 | 11,0 | 26,3 | SCL | Psammi-Eutric Para-Vertisol |
| Nga | 08 | B | 36-47 | 10YR 4/1-5/1 | 0,55 | * | * | 5,40 | 0,0 | 0,19 | 0,0 | 49,3 | 9,5 | 41,3 | SC | |
| Nga | 08 | C | 65-74 | 5Y 4/1-5/1 | 0,34 | * | * | 6,07 | 0,0 | 0,17 | 0,0 | 49,2 | 13,5 | 37,3 | SC | |
| Nga | 08 | D | 74-81 | 2.5Y 5/2-4/2 | 0,29 | * | * | 5,08 | 0,0 | 0,53 | 0,0 | 50,5 | 19,7 | 29,8 | SCL | |
| Nga | 08 | E | 114-121 | 2.5Y 5/2-6/2 | 0,14 | * | * | 6,05 | 0,0 | 0,36 | 0,0 | 57,8 | 21,1 | 21,1 | SCL | |
| Nga | 08 | F | 136-140 | 2.5Y 5/2-6/2 | 0,12 | * | * | 5,75 | 0,0 | 0,50 | 0,0 | 61,0 | 21,7 | 17,3 | SL | |
| Nga | 08 | G | 161-167 | 2.5Y 6/3-6/4 | 0,14 | * | * | 6,27 | 0,0 | 1,92 | 0,0 | 56,4 | 20,4 | 23,2 | SCL | |
| Nga | 08 | X | 180 | Sandstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 09 | A | 0-15 | 2.5Y 3/2-10YR 3/2 | 0,50 | 0,03 | * | 4,98 | 0,0 | 0,17 | 0,0 | 83,5 | 6,6 | 10,0 | LS | Psammi-Vertic Cambisol |
| Nga | 09 | B | 21-28 | 2.5Y 4/2-5/2 | 0,41 | * | * | 4,26 | 0,0 | 0,35 | 0,0 | 83,6 | 5,7 | 10,8 | LS | |
| Nga | 09 | C | 28-33 | 10YR 4/2 | 0,58 | * | * | 4,37 | 0,0 | 0,45 | 0,0 | 75,8 | 6,9 | 17,3 | SL | |
| Nga | 09 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 10 | A | 0-18 | 10YR 4/2 | 0,58 | 0,03 | 3,20 | 5,01 | 0,0 | 0,20 | 0,0 | 84,5 | 6,0 | 9,5 | LS | Psammi-Vertic Cambisol |
| Nga | 10 | B | 30-41 | 10YR 4/1-4/2 | 0,45 | * | * | 5,42 | 0,0 | 0,23 | 0,0 | 75,5 | 5,5 | 18,9 | SL | |
| Nga | 10 | C | 74-83 | 10YR 5/2 | 0,31 | * | * | 6,31 | 0,0 | 0,13 | 0,0 | 71,2 | 13,0 | 15,7 | SL | |
| Nga | 10 | D | 107-115 | 10YR 6/3 | 0,15 | * | * | 7,04 | 0,0 | 0,52 | 0,0 | 77,2 | 16,7 | 6,1 | SL | |
| Nga | 10 | E | 126-130 | 10YR 6/3-7/3 | 0,22 | * | * | 7,56 | 0,0 | 0,32 | 0,0 | 74,1 | 17,2 | 8,7 | SL | |
| Nga | 10 | X | 130 | sandstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 11 | A | 0-24 | 5YR 4/6-3/4 | 0,45 | 0,03 | * | 6,67 | 0,0 | 0,09 | 0,0 | 92,4 | 3,4 | 4,1 | FS | Rhodi-Cambic Arenosol |
| Nga | 11 | B | 51-61 | 2.5YR 4/8 | 0,14 | * | * | 6,25 | 0,0 | 0,03 | 0,0 | 92,2 | 3,3 | 4,5 | FS | |
| Nga | 11 | C | 67-80 | 2.5YR 4/8-5/8 | 0,10 | * | * | 5,20 | 0,0 | 0,07 | 0,0 | 92,0 | 3,0 | 4,9 | FS | |
| Nga | 11 | D | 101-110 | 2.5YR 4/8 | 0,09 | * | * | 5,14 | 0,0 | 0,07 | 0,0 | 92,7 | 3,4 | 3,9 | FS | |
| Nga | 11 | E | 110-117 | 2.5 YR 4/6-4/8 | 0,15 | * | * | 6,47 | 0,0 | 0,07 | 0,0 | 92,8 | 3,0 | 4,2 | FS | |
| Nga | 11 | X | 117 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 12 | A | 0-21 | 10YR 4/2 | 0,37 | 0,03 | 1,50 | 5,40 | 0,0 | 0,07 | 0,0 | 92,8 | 3,8 | 3,4 | FS | Cambic Arenosol |
| Nga | 12 | B | 48-61 | 10YR 5/3-6/3 | 0,12 | * | * | 4,89 | 0,0 | 0,11 | 0,0 | 94,9 | 3,2 | 1,9 | FS | |
| Nga | 12 | C | 64-68 | 10YR 5/3 | 0,29 | * | * | 3,92 | 0,0 | 0,45 | 0,0 | 91,7 | 4,0 | 4,4 | FS | |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nga | 12 | D | 97-106 | 2.5Y 5/3-6/3 | 0,19 | * | * | 6,99 | 0,0 | 1,68 | 0,0 | 78,8 | 9,3 | 11,9 | SL | |
| Nga | 12 | E | 115-121 | 2.5Y 6/3 | 0,15 | * | * | 7,91 | 0,0 | 0,97 | 0,0 | 78,4 | 8,2 | 13,4 | SL | |
| Nga | 12 | X | ?? | Lime-Siltstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 13 | A | 0-22 | 10YR 4/4-4/6 | 0,35 | 0,03 | 0,50 | 6,14 | 0,0 | 0,09 | 0,0 | 90,6 | 4,8 | 4,6 | FS | Cambic Arenosol |
| Nga | 13 | B | 35-43 | 10YR 3/4 | 0,30 | * | * | 6,16 | 0,0 | 0,04 | 0,0 | 89,9 | 3,9 | 6,2 | FS | |
| Nga | 13 | C | 52-60 | 10YR 3/4-7.5YR 3/4 | 0,27 | * | * | 3,96 | 0,0 | 0,24 | 0,0 | 89,0 | 4,1 | 6,9 | FS | |
| Nga | 13 | D | 60-67 | 10YR 3/4-7.5YR 3/4 | 0,27 | * | * | 3,87 | 0,0 | 0,50 | 0,0 | 88,0 | 4,3 | 7,7 | LS | |
| Nga | 13 | X | 67 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Nga | 14 | A | 0-21 | 7.5YR 3/4 | 0,35 | 0,02 | 0,40 | 6,38 | 0,0 | 0,06 | 0,0 | 94,2 | 3,7 | 2,2 | FS | Rhodi-Cambic Arenosol |
| Nga | 14 | B | 68-79 | 5YR 4/6 | 0,11 | * | * | 3,88 | 0,0 | 0,17 | 0,0 | 94,1 | 3,0 | 2,8 | FS | |
| Nga | 14 | C | 106-114 | 5YR 5/8 | 0,10 | * | * | 5,40 | 0,0 | 0,02 | 0,0 | 94,1 | 3,2 | 2,7 | FS | |
| Nga | 14 | D | 150-160 | 5YR 5/8 | 0,07 | * | * | 4,95 | 0,0 | 0,01 | 0,0 | 95,5 | 2,1 | 2,4 | FS | |
| Nga | 14 | E | 186-193 | 5YR 5/8-6/8 | 0,06 | * | * | 5,22 | 0,0 | 0,01 | 0,0 | 93,7 | 3,7 | 2,5 | FS | |
| Nga | 14 | X | ?? | loss of soil material | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Obo | 02 | A | 0-16 | 10YR 2/1-3/1 | 0,75 | 0,05 | * | 6,25 | 0,0 | 0,08 | 0,0 | 85,6 | 4,9 | 9,5 | LS | Psammi-Eutric Cambisol |
| Obo | 02 | B | 38-44 | 10YR 3/2-2/1 | 0,46 | * | * | 6,32 | 0,0 | 0,10 | 0,0 | 85,0 | 3,7 | 11,4 | LS | |
| Obo | 02 | C | 61-71 | 10YR 3/1 | 0,56 | 0,03 | * | 6,38 | 0,0 | 0,09 | 0,0 | 82,0 | 3,6 | 14,4 | SL | |
| Obo | 02 | D | 95-102 | 10YR 3/1 | 0,40 | * | * | 6,08 | 0,0 | 0,10 | 0,0 | 77,4 | 3,8 | 18,8 | SCL/SL | |
| Obo | 02 | E | 116-122 | 10YR 4/1-3/2 | 0,41 | 0,03 | * | 6,32 | 0,0 | 0,09 | 0,0 | 75,3 | 3,9 | 20,8 | SCL/SL | |
| Obo | 02 | F | 132-142 | 10YR 4/1-4/2 | 0,40 | * | * | 6,43 | 0,0 | 0,18 | 0,0 | 73,8 | 4,5 | 21,7 | SCL | |
| Obo | 02 | G | 154-161 | 10YR 5/2-4/2 | 0,30 | 0,02 | * | 7,07 | 0,0 | 0,16 | 0,0 | 71,5 | 5,0 | 23,5 | SCL | |
| Obo | 02 | H | 176-185 | 10YR 4/1 | 0,19 | * | * | 7,50 | 0,0 | 0,28 | 0,0 | 71,5 | 5,0 | 23,5 | SCL | |
| Obo | 02 | J | 200-205 | 10YR 4/1-5/2 + 2.5Y 5/2 | 0,19 | 0,02 | * | 7,60 | 0,0 | 0,37 | 0,0 | 72,5 | 4,9 | 22,6 | SCL | |
| Obo | 02 | K | 205-213 | 2.5Y 5/2 | 0,25 | * | * | 7,58 | 0,0 | 0,45 | 0,0 | 72,8 | 5,0 | 22,2 | SCL/SL | |
| Obo | 02 | X | 213 - | Sand-Siltstone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 01 | A | 0-10 | 10YR 3/3-4/3 | 2,30 | 0,13 | 41,70 | 7,97 | 38,1 | 0,19 | 0,1 | 29,1 | 48,2 | 22,8 | L | Psammi-Mollic Leptosol |
| Odo | 01 | X | 24 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 02 | A | 0-18 | 10YR 4/2-3/3 | 1,90 | 0,04 | * | 8,01 | 22,4 | 0,32 | 8,1 | 25,4 | 38,3 | 36,4 | CL | Eutric Leptosol |
| Odo | 02 | B | 18-25 | 10YR 4/3-5/3' | 1,70 | * | * | 8,16 | 22,7 | 0,31 | 30,8 | 22,0 | 30,4 | 47,6 | C | |
| Odo | 02 | X | 32 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 03 | A | 0-16 | 10YR 4/2-3/3 | 2,20 | 0,08 | * | 7,90 | 28,7 | 0,47 | 0,1 | 31,1 | 36,3 | 32,6 | CL | Mollic Leptosol |
| Odo | 03 | X | 24 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 04 | A | 0-11 | 10YR 3/2-3/4 | 3,20 | 0,08 | 30,00 | 7,92 | 23,0 | 0,83 | 31,1 | 44,9 | 40,6 | 14,5 | L | Psammi-Lithic Leptosol |
| Odo | 04 | X | 11 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 05 | A | 0-20 | 10YR 5/3-5/2 | 1,80 | 0,04 | 9,40 | 8,19 | 55,9 | 0,27 | 0,1 | 31,8 | 32,0 | 36,2 | CL | Lithi-Hypercalcaric Regosol |
| Odo | 05 | X | 38 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 06 | A | 0-6 | 10YR 2/2-3/2 | 1,80 | 0,07 | * | 7,91 | 20,2 | 0,29 | 68,9 | 48,7 | 40,2 | 11,1 | L | Rudi-Lithic Leptosol |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Odo | 06 | X | 6 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 07 | A | 0-9 | 10YR 4/3-3/3 | 2,80 | 0,10 | 36,80 | 8,11 | 33,5 | 0,32 | 19,5 | 42,9 | 42,0 | 15,2 | L | Rendzic Leptosol |
| Odo | 07 | X | 21 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 08 | A | 0-18 | 10YR 4/3-3/3 | 2,80 | 0,11 | * | 8,10 | 34,3 | 0,28 | 0,0 | 25,6 | 40,2 | 34,2 | CL | Lithi-Calcaric Regosol |
| Odo | 08 | X | 35 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 09 | A | 0-10 | 10YR 4/3-3/3 | 2,40 | 0,16 | * | 8,03 | 34,0 | 0,44 | 49,6 | 43,2 | 41,8 | 15,0 | L | Rudi-Lithic Leptosol |
| Odo | 09 | X | 10 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 10 | A | 0-8 | 2.5Y 4/4 - 10YR 4/4 | 2,60 | 0,16 | 31,80 | 7,97 | 27,3 | 0,25 | 0,1 | 47,3 | 43,6 | 9,0 | L | Psammi-Lithic Leptosol |
| Odo | 10 | X | 10 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 11 | A | 0-11 | 10YR 3/2-2/2 | 3,50 | 0,18 | * | 7,81 | 25,1 | 0,97 | 66,1 | 45,6 | 41,5 | 12,9 | L | Psammi-Rudi-Lithic Leptosol |
| Odo | 11 | X | 11 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 12 | A | 0-8 | 10YR 3/2 | 2,80 | 0,08 | * | 7,97 | 35,9 | 0,39 | 67,1 | 45,4 | 41,3 | 13,4 | L | Psammi-Rudi-Lithic Leptosol |
| Odo | 12 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 13 | A | 0-8 | 10YR 4/4-3/3 | 2,60 | 0,09 | * | 8,01 | 41,1 | 0,55 | 46,1 | 42,4 | 45,6 | 12,0 | L | Psammi-Rudi-Lithic Leptosol |
| Odo | 13 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 14 | A | 0-7 | 10YR 3/3-4/3 | 2,50 | 0,09 | * | 8,04 | 34,5 | 0,22 | 11,3 | 34,7 | 44,8 | 20,5 | L | Psammi-Rendzic Leptosol |
| Odo | 14 | X | 15 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 15 | A | 0-16 | 10YR 4/3-5/3 | 2,20 | 0,06 | * | 8,36 | 40,5 | 1,14 | 0,1 | 15,3 | 27,4 | 57,3 | C | Mollic Leptosol |
| Odo | 15 | B | 16-25 | 10YR 5/4 | 1,70 | * | * | 8,58 | 45,4 | 1,87 | 0,1 | 14,1 | 26,9 | 58,9 | C | |
| Odo | 15 | C | 25-30 | 10YR 6/4 | 1,30 | * | * | 8,80 | 49,2 | 1,57 | 8,1 | 12,7 | 26,8 | 60,5 | C | |
| Odo | 15 | X | 30 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 16 | A | 0-10 | 10 YR 3/3-4/3 | 1,80 | 0,05 | * | 9,00 | 15,7 | 28,70 | 6,6 | 13,4 | 37,8 | 48,8 | SiCL | Hypersalic Fluvisol |
| Odo | 16 | X | 30 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 17 | A | 0-9 | 10YR 4/3-3/2 | 1,80 | 0,11 | 12,80 | 8,18 | 38,8 | 0,96 | 12,8 | 8,8 | 32,7 | 58,6 | C | Calcic Solonchak |
| Odo | 17 | B | 9-24 | 10YR 5/2-4/2 | 1,50 | * | * | 8,51 | 35,9 | 1,43 | 4,3 | 9,0 | 18,6 | 72,4 | C | |
| Odo | 17 | C | 38-44 | 10YR 5/4-5/3-4/3' | 1,10 | * | * | 8,84 | 44,0 | 1,48 | 0,0 | 7,6 | 16,8 | 75,6 | C | |
| Odo | 17 | D | 61-68 | 10YR 6/4 | 0,80 | * | * | 8,87 | 46,0 | 7,09 | 0,0 | 3,9 | 28,8 | 67,4 | C | |
| Odo | 17 | E | 75-81 | 10YR 7/3 | 0,40 | * | * | 8,95 | 71,3 | 5,70 | 0,0 | 13,6 | 32,7 | 53,6 | C | |
| Odo | 17 | X | 81 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 18 | A | 0-20 | 10YR 3/3 | 2,60 | 0,09 | 20,60 | 8,30 | 41,9 | 2,22 | 8,4 | 23,4 | 26,4 | 50,2 | C | Calcic Solonchak |
| Odo | 18 | X | 42 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 19 | A | 0-15 | 10YR 4/4-4/3 | 2,70 | 0,12 | 22,60 | 8,07 | 44,6 | 0,38 | 42,7 | 49,9 | 34,4 | 15,6 | L | Rendzic Rudi Leptosol |
| Odo | 19 | X | 15 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 20 | A | 0-16 | 10YR 5/3 | 2,40 | 0,05 | * | 8,72 | 59,7 | 3,61 | 0,0 | 16,2 | 38,2 | 45,6 | C | Calcic Solonchak |
| Odo | 20 | X | 35 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 21 | A | 0-21 | 10YR 3/3-3/2 | 2,60 | 0,05 | * | 7,95 | 31,0 | 1,16 | 39,3 | 36,6 | 39,2 | 24,2 | L | Rudi-Mollic Leptosol |
| Odo | 21 | X | 21 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |

Soil Analytical Data of the Soil Samples in the Etosha NP  * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Odo | 22 | A | 0-6 | 10YR 3/2-3/3 | 4,30 | 0,08 | * | 7,82 | 38,7 | 0,43 | 69,8 | 44,7 | 45,6 | 9,7 | L | Rudi-Psammi-Lithic Leptosol |
| Odo | 22 | X | 6 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 23 | A | 0-20 | 10YR 3/3 | 2,90 | 0,05 | * | 7,86 | 38,0 | 0,41 | 61,6 | 50,3 | 39,9 | 9,7 | L | Skeletti-Mollic Leptosol |
| Odo | 23 | X | 26 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 24 | A | 0-8 | 10YR 3/3-3/4 | 3,50 | 0,12 | * | 7,72 | 20,4 | 0,98 | 72,3 | 37,8 | 42,5 | 19,7 | L | Rudi-Lithic Leptosol |
| Odo | 24 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 25 | A | 0-20 | 10YR 4/3-5/3 | 2,40 | 0,07 | * | 8,27 | 48,6 | 0,58 | 6,8 | 25,7 | 28,0 | 46,3 | C | Lithi-Hypercalcaric Regosol |
| Odo | 25 | X | 33 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 26 | 0A | 15-0 | 10YR 5/2-5/3 | 3,20 | 0,10 | * | 8,34 | 70,3 | 0,32 | 5,6 | 37,4 | 32,8 | 29,8 | CL | Kupste (rez. äol. Auflage) |
| Odo | 27 | A | 0-10 | 10YR 5/3-4/3 | 3,40 | 0,08 | * | 8,63 | 73,3 | 15,67 | 8,1 | 33,5 | 41,7 | 24,7 | L | Calcic Solonchak |
| Odo | 27 | X | 16 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 28 | A | 0-20 | 10YR 3/3-3/2 | 5,60 | 0,08 | * | 7,93 | 39,0 | 0,45 | 50,1 | 34,4 | 49,3 | 16,3 | L | Rudi-Mollic Leptosol |
| Odo | 28 | X | 26 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 29 | A | 0-16 | 10YR 6/3-5/3 | 1,30 | 0,04 | * | 9,73 | 56,9 | 6,50 | 0,1 | 10,4 | 39,5 | 50,1 | C/SiC | Calcic Solonchak |
| Odo | 29 | B | 16-24 | 10YR 6/3 | 1,30 | * | * | 9,62 | 52,6 | 6,62 | 0,0 | 9,2 | 37,7 | 53,2 | C | Calcic Solonchak |
| Odo | 29 | X | 24 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 30 | A | 0-12 | 7.5YR 3/2 - 10YR 3/3 | 3,00 | 0,08 | 45,40 | 7,91 | 33,7 | 0,93 | 68,1 | 35,3 | 49,2 | 15,4 | L | Rudi-Rendzic Leptosol |
| Odo | 30 | X | 12 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 31 | A | 0-8 | 10YR 3/3 | 3,20 | 0,08 | 21,40 | 7,91 | 43,6 | 0,99 | 73,0 | 44,4 | 45,5 | 10,1 | L | Rudi-Lithic Leptosol |
| Odo | 31 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 32 | A | 0-10 | 10YR 6/1-5/1 | 0,90 | 0,04 | * | 8,32 | 44,4 | 0,70 | 20,9 | 5,5 | 36,3 | 58,3 | C | Psammi-Eutric Vertisol |
| Odo | 32 | B | 20-26 | 10YR 5/1-6/1 | 0,90 | * | * | 8,69 | 37,2 | 14,97 | 10,9 | 6,8 | 10,5 | 82,7 | C | |
| Odo | 32 | C | 35-40 | 10YR 4/1 | 0,90 | * | * | 8,82 | 0,0 | 20,10 | 19,4 | 6,3 | 29,1 | 64,6 | C | |
| Odo | 32 | X | ?? | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | zu dicht |
| Odo | 33 | A | 0-8 | 10YR 3/2 | 3,60 | 0,10 | 52,00 | 7,74 | 25,4 | 0,53 | 33,3 | 41,7 | 48,5 | 9,8 | L | Psammi-Lithic Leptosol |
| Odo | 33 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 34 | A | 0-12 | 10YR 3/2 | 3,30 | 0,09 | 20,80 | 7,92 | 35,6 | 0,51 | 77,6 | 48,8 | 36,1 | 15,1 | L | Rudi-Rendzic Leptosol |
| Odo | 34 | X | 12 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 35 | A | 0-14 | 10YR 3/3-3/2 | 2,30 | 0,08 | 42,40 | 7,93 | 33,7 | 0,55 | 47,4 | 52,7 | 34,8 | 12,5 | L/SL | Rudi-Psammi-Rendzic Leptosol |
| Odo | 35 | X | 14 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 36 | A | 0-17 | 10YR 3/1-2/2 | 0,80 | 0,02 | 4,80 | 6,47 | 0,8 | 0,06 | 0,0 | 21,3 | 20,9 | 57,8 | C | Psammi-Dystric Vertisol |
| Odo | 36 | B | 52-62 | 10YR 3/1-4/1 | 0,80 | * | * | 6,55 | 0,8 | 0,29 | 0,0 | 15,6 | 13,8 | 70,6 | C | |
| Odo | 36 | C | 62-70 | 10YR 4/1-3/1 | 0,80 | * | * | 6,45 | 0,4 | 0,27 | 0,0 | 16,0 | 15,3 | 68,7 | C | |
| Odo | 36 | X | 78 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 37 | A | 0-14 | 10YR 4/1-3/1' | 2,10 | 0,04 | * | 7,34 | 0,0 | 0,13 | 0,0 | 19,6 | 32,9 | 47,5 | C | Eutric Leptosol |
| Odo | 37 | X | 14 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 38 | A | 0-15 | 10YR 4/1-3/1 | 1,40 | 0,06 | 7,00 | 6,87 | 0,0 | 0,09 | 0,0 | 48,4 | 12,9 | 38,7 | SC | Psammi-Eutric Vertisol |

Soil Analytical Data of the Soil Samples in the Etosha NP    * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Odo | 38 | X | 60 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 39 | A | 0-8 | 10YR 2/2 | 4,30 | 0,16 | * | 7,65 | 16,9 | 0,26 | 56,0 | 42,2 | 44,0 | 13,8 | L | Rudi-Psammi-Lithic Leptosol |
| Odo | 39 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 40 | A | 0-9 | 10YR 2/2 | 1,00 | 0,05 | 101,70 | 6,93 | 0,0 | 0,29 | 6,0 | 76,1 | 10,5 | 13,4 | SL | Psammi-Eutric Leptosol |
| Odo | 40 | X | 9 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 41 | A | 0-10 | 10YR 2/1-2/2 | 5,10 | 0,21 | * | 7,71 | 2,6 | 0,29 | 66,5 | 51,2 | 37,4 | 11,3 | L | Rudi-Psammi-Lithic Leptosol |
| Odo | 41 | X | 10 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 42 | A | 0-19 | 10YR 3/2 | 1,00 | 0,06 | 4,50 | 7,02 | 0,0 | 0,10 | 0,1 | 49,1 | 32,9 | 17,9 | L | Rudi-Psammi-Eutric Leptosol |
| Odo | 42 | B | 19-31 | 10YR 2/2 | 0,90 | * | * | 6,82 | 0,0 | 0,29 | 0,1 | 42,1 | 16,3 | 41,6 | C | |
| Odo | 42 | X | 37 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 43 | A | 0-18 | 2.5Y 3/2 - 10YR 3/2 | 1,90 | 0,08 | * | 6,46 | 0,0 | 0,39 | 0,0 | 36,8 | 44,1 | 19,1 | L | Psammi-Eutric Leptosol |
| Odo | 43 | B | 18-24 | 10YR 2/2 | 1,60 | * | * | 6,37 | 0,0 | 0,32 | 0,0 | 32,7 | 39,9 | 27,4 | L | |
| Odo | 43 | C | 55-62 | 10YR 3/2 | 0,90 | * | * | 6,81 | 0,0 | 0,32 | 0,0 | 30,6 | 17,9 | 51,5 | C | |
| Odo | 43 | X | 62 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 44 | A | 0-5 | 10YR 2/1-2/2 | 7,20 | 0,32 | 270,70 | 7,76 | 13,8 | 0,36 | 36,2 | 56,6 | 32,5 | 10,8 | SL | Psammi-Lithic Leptosol |
| Odo | 44 | X | 5 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 45 | A | 0-6 | 10YR 2/2 | 2,90 | 0,11 | * | 7,48 | 0,0 | 0,31 | 51,1 | 59,3 | 32,5 | 8,2 | SL | Psammi-Lithic Leptosol |
| Odo | 45 | X | 6 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 46 | A | 0-16 | 10YR 2/1 | 2,20 | 0,09 | 5,00 | 6,24 | 0,0 | 0,26 | 0,0 | 33,6 | 25,2 | 41,2 | C/CL | Psammi-Eutric Vertisol |
| Odo | 46 | B | 27-36 | dito | 1,60 | * | * | 6,52 | 0,0 | 0,12 | 0,0 | 28,1 | 16,2 | 55,6 | C | |
| Odo | 46 | C | 53-60 | dito | 1,10 | * | * | 6,25 | 0,0 | 0,08 | 0,0 | 26,6 | 14,2 | 59,2 | C | |
| Odo | 46 | X | 60 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 47 | 0A | 2-0 | 10YR 5/2 | 0,20 | 0,02 | * | 8,25 | 0,0 | 0,63 | 0,1 | 95,1 | 1,9 | 3,0 | MS | Quarzprobe |
| Odo | 47 | X | | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 48 | A | 0-8 | 10YR 3/2 | 1,30 | 0,06 | 15,00 | 7,04 | 0,0 | 0,09 | 0,0 | 48,9 | 20,2 | 30,9 | SCL | Psammi-Lithic Leptosol |
| Odo | 48 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 49 | A | 0-14 | 10YR 5/4-5/3 | 3,00 | 0,17 | * | 8,20 | 67,7 | 0,39 | 0,0 | 38,0 | 36,7 | 25,3 | CL | Psammi-Rendzic Leptosol |
| Odo | 49 | X | 14 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 50 | A | 0-5 | 10YR 3/3 | 2,90 | 0,10 | * | 8,08 | 33,1 | 0,20 | 0,0 | 50,2 | 40,5 | 9,3 | L | Psammi-Lithic Leptosol |
| Odo | 50 | X | 5 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 51 | A | 0-15 | 10YR 2/2 | 5,10 | 0,22 | * | 7,88 | 13,9 | 0,39 | 0,0 | 50,9 | 37,7 | 11,4 | L | Psammi-Rendzic Leptosol |
| Odo | 51 | X | 15 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Odo | 52 | 00 | 0-5 | 10YR 3/3-4/3 | 1,20 | 0,04 | * | 8,46 | 58,7 | 0,72 | 32,1 | 19,2 | 28,1 | 52,7 | C | |
| Oka | 01 | A | 0-8 | 10YR 3/3-3/2 | 3,20 | 0,16 | * | 7,75 | 26,5 | 0,15 | 59,5 | 46,7 | 44,7 | 8,6 | L | Rudi-Psammi-Eutric Leptosol |
| Oka | 01 | X | 16 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 02 | A0 | 0-12 | 10YR 3/3-3/4 | 0,99 | * | * | 0,99 | 0,0 | 0,99 | 99,0 | 0,0 | 0,0 | 0,0 | | Rendzic Leptosol |
| Oka | 02 | X | 17 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |

Soil Analytical Data of the Soil Samples in the Etosha NP  * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oka | 03 | A | 0-12 | 10YR 3/3 | 2,90 | 0,17 | 27,50 | 7,79 | 18,6 | 0,37 | 11,7 | 33,7 | 49,3 | 17,1 | SiL | Rudi-Mollic Leptosol |
| Oka | 03 | B | 12-24 | 10YR 4/3- 2.5Y 4/3' | 2,50 | * | * | 7,96 | 24,0 | 0,16 | 40,5 | 22,5 | 34,8 | 42,7 | C | |
| Oka | 03 | C | 24-30 | 10YR 4/3-3/3 | 2,10 | * | * | 8,02 | 23,4 | 0,19 | 65,3 | 20,2 | 28,9 | 50,9 | C | |
| Oka | 03 | X | 30 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 04 | A | 0-18 | 10YR 5/3-4/3 | 2,50 | 0,11 | 23,00 | 8,06 | 22,4 | 0,26 | 0,1 | 25,2 | 45,9 | 28,9 | CL | Psammi-Calcaric Regosol |
| Oka | 04 | B | 18-40 | 10YR 5/3-5/4' | 1,20 | * | * | 8,06 | 28,7 | 0,32 | 0,1 | 18,8 | 31,4 | 49,8 | C | |
| Oka | 04 | X | 40 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 05 | A0 | 0-9 | 10YR 3/2-3/3 | 0,99 | * | * | 0,99 | 0,0 | 0,99 | 99,0 | 0,0 | 0,0 | 0,0 | | Rendzic Leptosol |
| Oka | 05 | X | 20 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 06 | A | 0-20 | 10YR 5/3-4/3' | 1,00 | 0,06 | 16,40 | 8,01 | 40,8 | 0,16 | 0,0 | 79,9 | 14,8 | 5,3 | LS | Humi-Hypercalcaric Arenosol |
| Oka | 06 | B | 20-36 | 10YR 5/4-4/4 | 1,10 | * | * | 8,00 | 37,5 | 0,14 | 0,0 | 71,1 | 22,1 | 6,8 | SL | |
| Oka | 06 | C | 36-52 | dito | 1,00 | * | * | 8,02 | 41,7 | 0,23 | 0,0 | 69,7 | 22,4 | 8,0 | SL | |
| Oka | 06 | D | 52-67 | dito | 0,90 | * | * | 8,10 | 38,5 | 0,92 | 0,0 | 68,6 | 23,2 | 8,2 | SL | |
| Oka | 06 | E | 67-80 | 10YR 6/4-5/4 | 0,80 | * | * | 8,28 | 43,5 | 1,33 | 0,0 | 63,2 | 23,5 | 13,4 | SL | |
| Oka | 06 | F | 80-92 | dito | 0,70 | * | * | 8,56 | 48,7 | 1,59 | 0,0 | 47,1 | 25,9 | 27,0 | SCL | |
| Oka | 06 | G | 92-104 | dito | 0,60 | * | * | 8,78 | 48,8 | 1,92 | 0,0 | 31,3 | 31,4 | 37,3 | CL | |
| Oka | 06 | H | 104-118 | 10YR 6/4-7/4' | 0,50 | * | * | 8,95 | 44,9 | 2,01 | 0,0 | 37,0 | 27,9 | 35,0 | CL | |
| Oka | 06 | X | 132 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 08 | A | 0-22 | 10YR 5/3-4/4' | 1,70 | 0,12 | * | 8,36 | 30,7 | 3,72 | 7,8 | 36,2 | 28,0 | 35,8 | CL | Calcic Solonchak |
| Oka | 08 | B | 22-37 | 10YR 6/4 | 0,90 | * | * | 8,62 | 39,8 | 4,34 | 40,6 | 30,8 | 25,5 | 43,7 | C | |
| Oka | 08 | X | 37 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 11 | A | 0-20 | 10YR 3/3-4/3 | 2,10 | 0,13 | * | 7,83 | 6,8 | 0,25 | 10,8 | 28,9 | 48,2 | 22,9 | L | Lithi-Calcaric Regosol |
| Oka | 11 | X | 20 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 12 | A | 0-16 | 10YR 4/2-4/3 | 1,40 | 0,10 | * | 7,75 | 7,0 | 0,18 | 0,1 | 17,7 | 31,0 | 51,3 | C | Calcaric Fluvisol |
| Oka | 12 | B | 33-46 | 10YR 5/3 | 0,70 | * | * | 8,05 | 15,2 | 0,37 | 0,1 | 9,6 | 24,2 | 66,3 | C | |
| Oka | 12 | C | 46-56 | 10YR 6/3 | 0,50 | * | * | 8,21 | 16,1 | 0,32 | 0,1 | 19,3 | 23,0 | 57,7 | C | |
| Oka | 12 | X | 64 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 17 | A | 0-8 | 10YR 3/3-3/2 | 5,20 | 0,30 | 69,00 | 7,19 | 0,0 | 0,56 | 1,9 | 40,0 | 50,9 | 9,1 | SiL | Psammi-Rendzic Leptosol |
| Oka | 17 | B | 8-12 | 10YR 3/3 | 3,80 | * | * | 7,47 | 2,7 | 0,41 | 22,9 | 36,9 | 52,8 | 10,3 | SiL | |
| Oka | 17 | X | 12 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 18 | A | 0-18 | 10YR 4/2 | 1,50 | 0,04 | 18,50 | 7,79 | 2,4 | 0,23 | 1,4 | 20,5 | 29,6 | 49,8 | C | Calcaric Regosol |
| Oka | 18 | X | 100 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 20 | A | 0-13 | 10YR 2/2-3/2' | 3,60 | 0,10 | 39,70 | 7,58 | 6,3 | 0,57 | 81,8 | 40,0 | 50,7 | 9,4 | SiL | Rudi-Psammi-Rendzic Leptosol |
| Oka | 20 | X | 13 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 21 | A | 0-20 | 10YR 3/3-4/3 | 1,80 | 0,04 | * | 7,97 | 19,7 | 0,33 | 0,1 | 26,6 | 35,6 | 37,8 | CL | Calcari-Dystric Fluvisol |
| Oka | 21 | B | 20-33 | | 2,20 | * | * | 8,14 | 24,0 | 0,32 | 0,1 | 18,4 | 30,1 | 51,5 | C | |
| Oka | 21 | C | 33-45 | 10YR 4/3 + 10YR 5/3 | 0,90 | * | * | 8,10 | 23,4 | 0,60 | 0,0 | 21,2 | 28,0 | 50,8 | C | |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oka | 21 | D | 45-60 | | 1,10 | * | * | 8,23 | 19,5 | 0,61 | 0,1 | 19,0 | 26,8 | 54,2 | C | |
| Oka | 21 | X | 60 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 22 | A | 0-5 | 10YR 4/2-3/2 | 2,70 | 0,08 | 33,50 | 7,60 | 2,9 | 0,24 | 55,3 | 48,9 | 41,9 | 9,2 | L | Rudi-Psammi-Lithic Leptosol |
| Oka | 22 | X | 5 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 23 | A | 0-18 | 10YR 4/2 | 2,20 | 0,06 | * | 8,01 | 14,7 | 0,16 | 3,9 | 28,5 | 36,5 | 35,1 | CL | Psammi-Eutric Regosol |
| Oka | 23 | B | 22-30 | 10YR 5/3-4/2' | 1,50 | * | * | 8,09 | 20,9 | 0,24 | 6,0 | 20,7 | 23,2 | 56,1 | C | |
| Oka | 23 | C | 30-36 | 10YR 4/3 + 10YR 5/3 | 1,20 | * | * | 7,99 | 16,7 | 0,45 | 12,5 | 15,7 | 27,3 | 57,0 | C | |
| Oka | 23 | X | 36 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 24 | A | 0-19 | 10YR 5/2-5/3' | 1,40 | 0,07 | 19,60 | 8,05 | 16,7 | 0,19 | 2,8 | 31,2 | 38,2 | 30,6 | CL | Psammi-Eutric Regosol |
| Oka | 24 | B | 19-30 | 10YR 6/3 - 2.5Y 6/2 | 1,10 | * | * | 8,00 | 27,5 | 0,37 | 10,3 | 21,9 | 34,1 | 44,0 | C | |
| Oka | 24 | X | 30 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 25 | A | 0-20 | 10YR 4/2-3/2 | 1,40 | 0,05 | 5,10 | 6,47 | 0,0 | 0,46 | 7,2 | 29,3 | 47,7 | 23,0 | L | Eutric Regosol |
| Oka | 25 | B | 20-36 | 7.5YR 3/2 - 10YR 4/2 | 1,10 | * | * | 7,12 | 0,5 | 0,51 | 0,1 | 27,2 | 28,7 | 44,1 | C | |
| Oka | 25 | C | 36-46 | 10YR 4/2 | 0,70 | * | * | 7,55 | 4,7 | 0,28 | 0,1 | 29,1 | 34,2 | 36,7 | CL | |
| Oka | 25 | D | 46-54 | 10YR 3/3-3/2 | 0,70 | * | * | 7,65 | 5,8 | 0,26 | 3,9 | 28,7 | 37,5 | 33,8 | CL | |
| Oka | 25 | X | 54 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 26 | A | 0-19 | 10YR 5/3 | 1,20 | 0,04 | * | 8,07 | 11,2 | 0,16 | 0,1 | 25,4 | 30,4 | 44,2 | C | Calcaric Regosol |
| Oka | 26 | X | 105 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 27 | A | 0-17 | 10YR 4/2 | 1,40 | 0,06 | * | 7,93 | 5,2 | 0,34 | 0,1 | 35,9 | 42,0 | 22,0 | CL | Psammi-Eutric Regosol |
| Oka | 27 | B | 17-29 | 10YR 6/4 | 0,80 | * | * | 8,00 | 10,4 | 0,29 | 9,1 | 23,3 | 24,1 | 52,7 | C | |
| Oka | 27 | C | 29-40 | 10YR 5/3-5/4 | 0,60 | * | * | 7,97 | 11,5 | 0,39 | 0,0 | 25,3 | 17,6 | 57,1 | C | |
| Oka | 27 | X | 40 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 28 | A | 0-19 | 10YR 4/2-3/2 | 1,60 | 0,06 | * | 7,99 | 19,4 | 0,37 | 0,1 | 33,5 | 33,7 | 32,8 | CL | Calcaric Fluvisol |
| Oka | 28 | B | 31-47 | | 0,70 | * | * | 8,25 | 21,4 | 0,44 | 0,1 | 23,1 | 23,7 | 53,2 | C | |
| Oka | 28 | C | 47-54 | 10YR 6/3-5/3 | 0,80 | * | * | 8,36 | 24,7 | 0,42 | 0,1 | 22,9 | 23,7 | 53,4 | C | |
| Oka | 28 | D | 71-86 | 2.5Y 6/2 - 10YR 6/3 | 0,40 | * | * | 8,55 | 26,1 | 0,43 | 0,1 | 21,6 | 29,5 | 48,9 | C | |
| Oka | 28 | X | 86 | Limestone | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 29 | A | 0-17 | 10YR 5/2 | 1,40 | 0,07 | * | 8,02 | 22,9 | 0,32 | 28,5 | 26,2 | 36,9 | 37,0 | CL | Rendzic Leptosol |
| Oka | 29 | X | 17 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 30 | A | 0-18 | 10YR 3/3-4/2 | 2,20 | 0,08 | * | 7,89 | 11,6 | 0,28 | 0,1 | 32,9 | 38,4 | 28,7 | CL | Psammi-Eutric Regosol |
| Oka | 30 | B | 18-32 | 10YR 5/3-4/3 | 1,20 | * | * | 8,16 | 16,5 | 0,74 | 4,9 | 23,4 | 27,4 | 49,2 | C | |
| Oka | 30 | X | 44 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 31 | A | 0-19 | 10YR 3/3 | 1,00 | 0,10 | * | 7,49 | 0,5 | 0,55 | 0,0 | 34,5 | 51,5 | 14,0 | SiL | Psammi-Eutric Regosol |
| Oka | 31 | X | 19 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 32 | A | 0-12 | 10YR 3/3 | 2,10 | 0,14 | 26,60 | 7,50 | 0,6 | 0,19 | 9,2 | 44,7 | 46,7 | 8,6 | L | Psammi-Eutric Leptosol |
| Oka | 32 | X | 12 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 33 | A | 0-19 | 10YR 4/3-3/3 | 2,00 | 0,09 | * | 7,88 | 13,0 | 0,81 | 17,3 | 29,3 | 35,7 | 34,9 | CL | Calcic Solonchak |

Soil Analytical Data of the Soil Samples in the Etosha NP    * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oka | 33 | B | 19-32 | 10YR 4/3-4/4 | 1,50 | * | * | 8,11 | 16,7 | 3,12 | 10,8 | 23,2 | 23,2 | 53,5 | C | |
| Oka | 33 | C | 32-42 | 10YR 6/4-5/4 | 1,20 | * | * | 8,21 | 18,3 | 3,48 | 19,0 | 21,8 | 21,7 | 54,5 | C | |
| Oka | 33 | X | 49 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 34 | A | 0-20 | 10YR 4/3-5/3 | 2,30 | 0,14 | * | 7,72 | 6,4 | 0,36 | 6,4 | 43,4 | 47,8 | 8,7 | L | Psammi-Eutric Leptosol |
| Oka | 34 | X | 20 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 35 | A | 0-12 | 10YR 3/3 | 2,00 | 0,12 | 19,40 | 7,35 | 1,0 | 1,36 | 12,6 | 42,6 | 48,6 | 8,8 | L | Psammi-Eutric Leptosol |
| Oka | 35 | X | 12 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 36 | A | 0-18 | 10YR 3/2-3/3 | 2,10 | 0,10 | 34,60 | 7,81 | 8,1 | 0,29 | 3,8 | 34,0 | 36,6 | 29,3 | CL | Psammi-Eutric Regosol |
| Oka | 36 | B | 18-29 | 10YR 3/3 | 1,10 | * | * | 7,98 | 8,6 | 0,57 | 0,1 | 25,5 | 19,9 | 54,6 | C | |
| Oka | 36 | C | 29-36 | 10YR 4/3 | 1,10 | * | * | 8,04 | 12,7 | 1,54 | 27,2 | 24,8 | 19,4 | 55,8 | C | |
| Oka | 36 | X | 36 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 37 | A | 0-4 | 10YR 3/2-4/2 | 2,20 | 0,15 | * | 7,57 | 1,8 | 0,13 | 0,0 | 42,9 | 49,7 | 7,4 | SiL/SL | Psammi-Eutric Leptosol |
| Oka | 37 | X | 11 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 38 | A | 0-8 | 10YR 3/3-4/3 | 2,00 | 0,14 | * | 7,53 | 0,7 | 0,48 | 0,1 | 36,5 | 53,5 | 10,0 | SiL | Psammi-Eutric Leptosol |
| Oka | 38 | X | 8 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 39 | A | 0-12 | 10YR 4/3-4/4 | 2,20 | 0,08 | * | 7,78 | 6,5 | 0,23 | 0,0 | 42,0 | 48,3 | 9,6 | L | Psammi-Rendzic Leptosol |
| Oka | 39 | X | 12 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 40 | A | 0-20 | 10YR 5/4 + 10YR 5/3 | 0,90 | 0,06 | 16,30 | 7,95 | 8,9 | 0,11 | 0,1 | 79,5 | 15,5 | 5,0 | SL | Humi-Calcaric Arenosol |
| Oka | 40 | B | 35-51 | 2.5Y6/4 - 10YR 5/4-6 | 0,60 | * | * | 8,05 | 8,2 | 0,16 | 0,1 | 76,7 | 16,6 | 6,7 | LS/SL | |
| Oka | 40 | C | 51-65 | 10YR 6/4 | 0,70 | * | * | 8,04 | 12,4 | 0,22 | 0,1 | 69,0 | 21,9 | 9,0 | SL | |
| Oka | 40 | D | 91-100 | 10YR 6/4-6/3' | 0,50 | * | * | 8,42 | 11,3 | 0,98 | 12,6 | 67,4 | 24,7 | 7,9 | SL | |
| Oka | 40 | X | 100 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 41 | A | 0-21 | 10YR 5/3 | 1,80 | 0,07 | * | 7,73 | 13,1 | 0,35 | 0,1 | 55,8 | 35,6 | 8,6 | SL | Humi-Calcaric Arenosol |
| Oka | 41 | B | 21-38 | 10YR 4/3 | 1,40 | * | * | 7,84 | 10,0 | 0,28 | 0,0 | 50,0 | 39,1 | 10,9 | L | |
| Oka | 41 | C | 51-61 | 10YR 5/4-6/4 | 1,00 | * | * | 8,61 | 20,5 | 1,89 | 0,0 | 48,6 | 38,0 | 13,4 | L | |
| Oka | 41 | D | 84-92 | 10YR 6/4-5/4' | 0,50 | * | * | 9,20 | 28,4 | 1,75 | 0,1 | 29,3 | 34,4 | 36,3 | CL | |
| Oka | 41 | X | 106 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 42 | A | 0-19 | 10YR 5/3-5/4 | 1,00 | 0,05 | * | 8,20 | 16,9 | 0,52 | 0,0 | 41,9 | 20,8 | 37,3 | CL | Psammi-Calcaric Regosol |
| Oka | 42 | X | 83 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 43 | A | 0-19 | 10YR 4/3-5/2 | 1,80 | 0,07 | 13,00 | 7,89 | 11,0 | 0,39 | 5,7 | 50,9 | 31,9 | 17,3 | L | Psammi-Calcaric Regosol |
| Oka | 43 | B | 19-28 | 10YR 5/3 | 1,00 | * | * | 8,06 | 19,5 | 0,49 | 9,1 | 39,3 | 20,8 | 39,9 | CL | |
| Oka | 43 | X | 28 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 44 | A | 0-21 | 10YR 4/2 | 1,10 | 0,07 | * | 8,01 | 5,6 | 0,20 | 0,1 | 46,6 | 22,5 | 31,0 | SCL | Psammi-Calcaric Regosol |
| Oka | 44 | X | 28 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 45 | A | 0-17 | 10YR 4/2-3/3 | 1,60 | 0,10 | * | 7,90 | 8,6 | 0,29 | 0,0 | 38,1 | 21,0 | 40,9 | C/CL | Psammi-Calcaric Regosol |
| Oka | 45 | X | 58 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 46 | A | 0-19 | 10YR 3/3 | 2,00 | 0,09 | * | 7,46 | 1,3 | 0,53 | 0,0 | 49,2 | 42,7 | 8,2 | L | Humi-Calcaric Arenosol |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oka | 46 | B | 19-33 | 10YR 4/3-3/3 | 1,40 | * | * | 7,60 | 3,5 | 0,37 | 0,1 | 47,3 | 41,6 | 11,1 | L | |
| Oka | 46 | C | 33-45 | 10YR 4/3 | 1,30 | * | * | 7,86 | 10,5 | 0,56 | 0,1 | 44,0 | 43,9 | 12,2 | L | |
| Oka | 46 | D | 45-52 | 10YR 5/4 | 1,00 | * | * | 8,02 | 14,6 | 0,65 | 0,1 | 46,1 | 42,5 | 11,3 | L | |
| Oka | 46 | X | 52 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 47 | A | 0-20 | 10YR 5/3-4/3 | 1,90 | 0,12 | * | 7,92 | 14,8 | 0,21 | 2,6 | 33,3 | 30,5 | 36,3 | CL | Psammi-Calcaric Regosol |
| Oka | 47 | X | 102 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 48 | A | 0-21 | 10YR 4/3-3/3 | 1,50 | 0,11 | * | 7,70 | 9,1 | 0,22 | 0,1 | 66,3 | 26,3 | 7,4 | SL | Humi-Calcaric Arenosol |
| Oka | 48 | X | 64 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 49 | A | 0-21 | 10YR 5/3-5/4 | 0,70 | 0,05 | * | 8,42 | 13,2 | 0,48 | 0,0 | 69,4 | 11,1 | 19,5 | SL/SCL | Humi-Calcaric Arenosol |
| Oka | 49 | B | 34-49 | 10YR 5/3-4/3 | 0,40 | * | * | 8,58 | 15,0 | 2,14 | 0,0 | 63,5 | 12,2 | 24,2 | SCL | |
| Oka | 49 | C | 74-87 | 10YR 6/4 | 1,10 | * | * | 8,68 | 22,8 | 3,47 | 0,0 | 59,2 | 16,5 | 24,4 | SCL | |
| Oka | 49 | D | 114-120 | 10YR 7/3-6/4 | 0,20 | * | * | 9,07 | 22,3 | 2,54 | 0,0 | 58,7 | 15,9 | 25,4 | SCL | |
| Oka | 49 | X | 120 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 50 | A | 0-20 | 10YR 3/3 | 1,90 | 0,13 | * | 7,96 | 11,4 | 0,19 | 0,0 | 27,2 | 36,6 | 36,2 | CL | Calcaric Regosol |
| Oka | 50 | X | 54 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 51 | A | 0-20 | 10YR 4/3 | 1,70 | 0,12 | * | 8,04 | 42,4 | 0,21 | 0,0 | 30,0 | 41,6 | 28,4 | CL/L | Psammi-Hypercalcaric Regosol |
| Oka | 51 | X | 83 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 52 | A | 0-16 | 10YR 5/4-6/4 | 1,20 | 0,08 | * | 8,21 | 47,8 | 0,90 | 0,1 | 37,2 | 33,6 | 29,3 | CL | Calcic Solonchak |
| Oka | 52 | B | 24-33 | 10YR 6/4 | 0,80 | * | * | 9,06 | 50,4 | 2,80 | 0,0 | 31,4 | 29,6 | 39,0 | CL | |
| Oka | 52 | C | 49-57 | 10YR 6/3 | 0,50 | * | * | 9,44 | 49,4 | 3,97 | 0,0 | 34,2 | 28,3 | 37,5 | CL | |
| Oka | 52 | X | 64 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 53 | A | 0-17 | 10YR 3/3-3/4 | 2,70 | 0,17 | * | 8,02 | 33,3 | 0,41 | 9,2 | 33,2 | 34,3 | 32,5 | CL | Calcic Solonchak |
| Oka | 53 | B | 17-29 | 10YR 3/3 | 1,80 | * | * | 8,35 | 29,7 | 1,63 | 9,5 | 25,6 | 29,7 | 44,7 | C | |
| Oka | 53 | C | 29-41 | 10YR 4/3 | 1,20 | * | * | 8,52 | 30,8 | 3,32 | 9,3 | 24,0 | 27,4 | 48,7 | C | |
| Oka | 53 | D | 41-48 | 10YR 4/3-5/3 | 1,20 | * | * | 8,56 | 17,5 | 3,81 | 11,9 | 22,1 | 27,8 | 50,1 | C | |
| Oka | 53 | X | 48 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 54 | A | 0-16 | 10YR 5/3-5/2 | 1,60 | 0,08 | * | 8,72 | 45,3 | 11,13 | 5,6 | 9,2 | 48,5 | 42,4 | SiC | Calcic Solonchak |
| Oka | 54 | B | 23-30 | 10YR 7/4-6/4 | 0,90 | * | * | 8,94 | 35,9 | 11,49 | 0,1 | 13,9 | 44,3 | 41,8 | SiC | |
| Oka | 54 | C | 41-45 | 7.5Y 8/4 - 10YR 8/4 | 0,70 | * | * | 9,01 | 63,5 | 13,40 | 0,0 | 30,1 | 39,3 | 30,6 | CL | |
| Oka | 54 | X | 45 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 55 | A | 0-7 | 10YR 6/3 | 1,40 | 0,07 | * | 8,71 | 59,1 | 9,46 | 0,1 | 20,8 | 37,0 | 42,2 | C | Calcic Solonchak |
| Oka | 55 | B | 7-19 | 10YR 7/3 | 1,30 | * | * | 8,72 | 60,7 | 11,67 | 0,0 | 13,2 | 40,5 | 46,3 | C | |
| Oka | 55 | C | 28-33 | 10YR 8/3-8/4 | 0,70 | * | * | 8,90 | 73,0 | 11,65 | 0,0 | 19,1 | 41,0 | 39,9 | SiC/SiCL | |
| Oka | 55 | X | 38 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 56 | A | 0-15 | 10YR 3/3-3/4 | 2,30 | 0,15 | * | 8,04 | 30,5 | 0,38 | 0,0 | 27,5 | 45,4 | 27,2 | CL | Hypercalcaric Regosol |
| Oka | 56 | X | 36 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 57 | A | 0-10 | 10YR 5/3-5/2 | 1,80 | 0,12 | * | 7,86 | 46,2 | 1,07 | 11,3 | 13,8 | 39,4 | 46,7 | C | Lithi-Eutric Vertisol |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oka | 57 | B | 10-26 | 10YR 5/2 | 1,60 | * | * | 8,27 | 46,0 | 0,67 | 8,9 | 21,2 | 34,8 | 43,9 | C | |
| Oka | 57 | X | 26 | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 58 | A | 0-17 | 10YR 3/3 | 2,30 | 0,16 | * | 7,88 | 19,7 | 0,25 | 13,8 | 30,7 | 51,4 | 18,0 | SiL | Psammi-Mollic Leptosol |
| Oka | 58 | X | 27 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 59 | A | 0-10 | 10YR 6/3 | 1,00 | 0,05 | 37,20 | 8,56 | 50,5 | 3,35 | 15,1 | 37,2 | 37,2 | 25,6 | CL/L | Lithi-Eutric Verisol |
| Oka | 59 | X | 10 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 60 | A | 0-12 | 10YR 5/3 | 1,40 | 0,10 | * | 8,11 | 47,4 | 0,41 | 0,0 | 60,1 | 29,9 | 10,0 | SL | Calcic Solonchak |
| Oka | 60 | B | 12-26 | 10YR6/4-5/4 | 1,00 | * | * | 8,32 | 54,0 | 3,45 | 0,0 | 51,2 | 23,6 | 25,2 | SCL | |
| Oka | 60 | C | 38-45 | 10YR 5/3 + 10YR7/3 | 0,30 | * | * | 8,72 | 50,3 | 5,24 | 0,0 | 53,4 | 18,6 | 28,0 | SCL | |
| Oka | 60 | D | 50-58 | 10YR 6/4-5/4 | 0,80 | * | * | 9,12 | 60,8 | 5,13 | 0,0 | 52,8 | 15,0 | 32,3 | SCL | |
| Oka | 60 | E | 64-74 | 10YR 4/7 | 0,30 | * | * | 9,22 | 65,1 | 1,08 | 0,0 | 51,7 | 16,5 | 31,8 | SCL | |
| Oka | 60 | F | 78-81 | 10YR 8/3-8/2 | 0,20 | * | * | 9,32 | 49,3 | 4,04 | 0,0 | 28,4 | 24,6 | 47,1 | C | |
| Oka | 60 | X | 85 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 61 | A | 0-13 | 10YR 7/3 | 0,90 | 0,06 | * | 8,46 | 55,7 | 0,34 | 12,0 | 34,9 | 36,3 | 28,8 | CL | Lithi-Hypercalcaric Regosol |
| Oka | 61 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 62 | A | 0-4 | 10YR 3/3-3/4 | 2,90 | 0,20 | * | 7,74 | 17,6 | 0,18 | 32,2 | 46,5 | 44,5 | 9,1 | L | Psammi-Lithic Leptosol |
| Oka | 62 | X | 4 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 63 | A | 0-18 | 10YR 4/3-3/3 | 2,10 | 0,09 | * | 8,13 | 28,3 | 0,32 | 5,7 | 28,7 | 36,4 | 34,8 | CL | Hypercalcaric Regosol |
| Oka | 63 | X | 54 | Limestone | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 64 | A | 0-18 | 10YR 6/1-6/2 | 0,80 | 0,04 | 36,00 | 8,31 | 62,6 | 4,73 | 0,1 | 5,4 | 46,1 | 48,5 | SiC | Calcic Solonchak |
| Oka | 64 | B | 26-33 | 10YR 6/2 | 0,80 | * | * | 8,27 | 55,1 | 9,67 | 0,1 | 7,2 | 43,1 | 49,7 | SiC | |
| Oka | 64 | C | 41-48 | 10Yr 6/2-6/3' | 0,70 | * | * | 8,33 | 52,0 | 11,11 | 0,1 | 6,8 | 48,0 | 45,2 | SiC | |
| Oka | 64 | X | ?? | loss of soil material | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 65 | A | 0-15 | 10YR 3/3-4/3 | 2,10 | 0,09 | * | 8,09 | 22,5 | 0,72 | 31,5 | 45,6 | 36,8 | 17,7 | L | Psammi-Rendzic Leptosol |
| Oka | 65 | X | 15 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 66 | A | 0-5 | 10YR 3/2 | 2,70 | 0,11 | * | 7,85 | 27,8 | 0,24 | 30,0 | 48,0 | 43,1 | 8,9 | L | Psammi-Lithic Leptosol |
| Oka | 66 | X | 5 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 67 | A | 0-19 | 10YR 4/2-4/3' | 3,00 | 0,04 | * | 8,16 | 39,7 | 0,20 | 0,0 | 18,9 | 44,1 | 36,9 | SiCL | Hypercalcaric Regosol |
| Oka | 67 | B | 34-44 | 10YR 5/3 | 1,20 | * | * | 8,32 | 47,3 | 0,46 | 5,2 | 14,2 | 37,1 | 48,6 | C | |
| Oka | 67 | C | 53-60 | 10YR 6/3-6/2 | 0,80 | * | * | 8,39 | 53,5 | 0,35 | 8,9 | 17,0 | 39,9 | 43,1 | SiC/C | |
| Oka | 67 | X | 60 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 68 | A | 0-12 | 10YR 6/2-5/2 | 0,70 | 0,03 | 12,70 | 8,00 | 36,7 | 0,43 | 0,1 | 6,9 | 31,0 | 62,0 | C | Eutric Vertisol |
| Oka | 68 | B | 28-34 | 10YR 6/3-6/2 | 0,60 | * | * | 8,06 | 37,6 | 3,63 | 0,0 | 4,2 | 36,9 | 58,9 | C | |
| Oka | 68 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 69 | A | 0-8 | 10YR 3/2-3/3 | 3,00 | 0,08 | 43,30 | 7,84 | 17,3 | 0,52 | 13,1 | 37,0 | 52,2 | 10,8 | SiL | Psammi-Mollic Leptosol |
| Oka | 69 | X | 20 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 70 | A | 0-18 | 10YR 6/2-5/2 | 1,30 | 0,04 | 78,30 | 8,66 | 50,2 | 10,68 | 3,7 | 12,4 | 24,7 | 63,9 | C | Calcari-Hypersalic Fluvisol |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oka | 70 | B | 23-30 | 10YR 5/2 | 1,10 | * | * | 8,96 | 44,9 | 16,55 | 5,5 | 15,7 | 40,7 | 43,5 | SiC | |
| Oka | 70 | C | 36-46 | 10YR 7/1-7/2 | 0,70 | * | * | 9,10 | 65,2 | 11,68 | 13,2 | 42,9 | 15,5 | 41,6 | C | |
| Oka | 70 | X | 46 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 71 | A | 0-14 | 10YR 3/2-3/3 | 3,50 | 0,12 | * | 7,96 | 22,9 | 0,41 | 9,3 | 38,8 | 48,3 | 12,9 | L | Psammi-Mollic Leptosol |
| Oka | 71 | X | 25 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Oka | 72 | A | 0-18 | 10YR 4/2-3/3 | 2,30 | 0,06 | * | 8,09 | 33,6 | 0,40 | 19,7 | 32,5 | 37,2 | 30,3 | CL | Psammi-Hypercalcaric Regosol |
| Oka | 72 | B | 18-28 | 10YR 5/3-4/3 | 1,40 | * | * | 8,29 | 36,0 | 0,36 | 17,7 | 25,2 | 33,7 | 41,0 | C | |
| Oka | 72 | C | 40-50 | 10YR 4/3-4/4' | 1,00 | * | * | 8,41 | 40,9 | 1,03 | 18,8 | 28,4 | 31,5 | 40,1 | C/CL | |
| Oka | 72 | D | 50-60 | 10YR 5/3 | 0,90 | * | * | 8,47 | 38,9 | 1,45 | 28,4 | 27,4 | 32,1 | 40,5 | C/CL | |
| Oka | 72 | X | 60 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 01 | A | 0-19 | 10YR 3/2 | 0,90 | 0,08 | 17,10 | 6,21 | 0,0 | 0,36 | 0,0 | 65,5 | 23,7 | 10,7 | SL | Psammi-Vertic Cambisol |
| Son | 01 | B | 32-46 | 10YR 4/2 | 0,40 | * | * | 6,33 | 0,0 | 0,15 | 0,0 | 64,6 | 10,2 | 25,2 | SCL | |
| Son | 01 | C | 46-60 | 10YR 4/2 | 0,40 | * | * | 7,43 | 1,1 | 0,26 | 0,0 | 61,1 | 9,6 | 29,3 | SCL | |
| Son | 01 | D | 60-71 | 10YR 4/2-4/3 | 0,40 | * | * | 7,63 | 1,9 | 0,24 | 0,0 | 60,0 | 8,3 | 31,7 | SCL | |
| Son | 01 | E | 94-105 | 10YR 4/3 | 0,30 | * | * | 7,65 | 2,8 | 0,54 | 0,0 | 54,3 | 14,5 | 31,2 | SCL | |
| Son | 01 | X | 120 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 02 | A | 0-22 | 10YR 3/1-3/2 | 1,20 | 0,04 | * | 6,69 | 0,0 | 0,27 | 0,0 | 49,3 | 31,2 | 19,6 | L | Psammi-Vertic Cambisol |
| Son | 02 | B | 22-36 | 10YR 3/1 | 1,00 | * | * | 6,47 | 0,0 | 0,61 | 0,0 | 44,8 | 20,5 | 34,6 | CL | |
| Son | 02 | C | 47-54 | 10YR 3/1-4/1 | 0,90 | * | * | 6,90 | 0,0 | 0,59 | 0,0 | 44,7 | 17,1 | 38,2 | CL/C/SC | |
| Son | 02 | D | 61-68 | 10YR 4/2-3/2 | 0,50 | * | * | 6,46 | 0,0 | 0,43 | 0,0 | 46,0 | 11,1 | 42,9 | SC | |
| Son | 02 | X | 68 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 03 | A | 0-18 | 10YR 3/1-4/1 | 0,60 | 0,04 | 5,30 | 7,29 | 0,0 | 0,23 | 0,0 | 78,1 | 10,2 | 11,7 | SL | Psammi-Vertic Cambisol |
| Son | 03 | B | 30-40 | 10YR 4/2-3/2 | 0,40 | * | * | 7,16 | 0,0 | 0,11 | 0,0 | 75,7 | 6,3 | 18,0 | SL | |
| Son | 03 | C | 56-67 | 10YR 5/2-4/2 | 0,20 | * | * | 7,08 | 0,0 | 0,50 | 0,0 | 74,5 | 5,0 | 20,6 | SCL/SL | |
| Son | 03 | D | 83-94 | 10YR 5/2-5/3 | 0,30 | * | * | 7,89 | 0,3 | 0,77 | 0,0 | 71,9 | 5,7 | 22,4 | SCL | |
| Son | 03 | X | 94 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 04 | A | 0-20 | 10YR 4/3-3/3 | 0,30 | 0,01 | * | 6,72 | 0,0 | 0,06 | 0,0 | 93,1 | 3,1 | 3,7 | FS | Cambic Arenosol |
| Son | 04 | B | 38-51 | 10YR 4/4 | 0,10 | * | * | 4,80 | 0,0 | 0,07 | 0,0 | 92,3 | 3,4 | 4,3 | FS | |
| Son | 04 | C | 74-85 | 10YR 5/4-4/4 | 0,10 | * | * | 4,62 | 0,0 | 0,05 | 0,0 | 91,6 | 3,8 | 4,6 | FS | |
| Son | 04 | D | 98-108 | 10YR 5/4 | 0,00 | * | * | 5,74 | 0,0 | 0,02 | 0,0 | 92,2 | 3,7 | 4,1 | FS | |
| Son | 04 | E | 132-137 | 10YR 6/4-5/4 | 0,00 | * | * | 4,12 | 0,0 | 0,16 | 0,0 | 92,2 | 4,4 | 3,3 | FS | |
| Son | 04 | X | 137 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 05 | 0A | 5-0 | 10YR 6/3-5/3 | 0,00 | * | * | 7,22 | 0,0 | 0,13 | 0,0 | 97,6 | 0,6 | 1,8 | FS | |
| Son | 05 | A | 0-15 | 10YR 3/2 | 0,50 | 0,03 | 2,80 | 5,53 | 0,0 | 0,13 | 0,0 | 90,2 | 3,9 | 5,9 | FS | Cambic Arenosol |
| Son | 05 | B | 28-40 | 10YR 4/2-3/3 | 0,30 | * | * | 6,47 | 0,0 | 0,10 | 0,0 | 83,6 | 5,9 | 10,5 | LS | |
| Son | 05 | C | 53-65 | 10YR 4/3-3/3 | 0,30 | * | * | 6,98 | 0,0 | 0,11 | 0,0 | 81,2 | 5,7 | 13,1 | SL/LS | |
| Son | 05 | D | 89-103 | 10YR 5/3-4/3' | 0,20 | * | * | 6,96 | 0,0 | 0,08 | 0,0 | 80,5 | 5,3 | 14,2 | SL | |

Soil Analytical Data of the Soil Samples in the Etosha NP    * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Son | 05 | E | 130-143 | 10YR 5/3-5/4 | 0,10 | * | * | 6,95 | 0,0 | 0,33 | 0,0 | 84,7 | 11,1 | 4,2 | LS | |
| Son | 05 | F | 168-178 | 10YR 5/4-6/4 | 0,10 | * | * | 7,77 | 1,0 | 0,55 | 0,0 | 82,1 | 13,7 | 4,2 | LS | |
| Son | 05 | G | 188-196 | 10YR 6/3-6/4 | 0,20 | * | * | 7,83 | 2,3 | 0,50 | 0,0 | 82,4 | 14,3 | 3,3 | LS | |
| Son | 05 | H | 214-228 | 10YR 6/4 | 0,20 | * | * | 7,98 | 5,5 | 0,49 | 0,0 | 75,1 | 16,6 | 8,3 | SL | |
| Son | 05 | J | 239-254 | 10YR 6/4 | 0,10 | * | * | 7,99 | 2,4 | 0,85 | 0,0 | 72,5 | 14,6 | 12,8 | SL | |
| Son | 05 | K | 262-266 | 10YR 6/3-5/3 | 0,10 | * | * | 7,99 | 1,9 | 0,87 | 0,0 | 76,2 | 12,1 | 11,7 | SL | |
| Son | 05 | X | 266 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 06 | A | 0-15 | 10YR 3/1 | 0,60 | 0,02 | 9,60 | 5,32 | 0,0 | 0,23 | 0,0 | 39,8 | 12,5 | 47,7 | C | Psammi-Dystric Para-Vertisol |
| Son | 06 | B | 30-36 | 10YR 3/1 | 0,50 | * | * | 5,60 | 0,0 | 0,06 | 0,0 | 38,4 | 11,5 | 50,1 | C | |
| Son | 06 | C | 50-60 | 10YR 3/1 | 0,50 | * | * | 6,14 | 0,0 | 0,06 | 0,0 | 38,9 | 9,9 | 51,2 | C | |
| Son | 06 | D | 63-68 | 10YR 3/1-4/1' | 0,50 | * | * | 5,32 | 0,0 | 0,43 | 0,0 | 38,2 | 10,3 | 51,4 | C | |
| Son | 06 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 07 | 0A | 5-0 | 10YR 5/4 | 0,10 | * | * | 7,30 | 0,0 | 0,13 | 0,0 | 96,5 | 1,9 | 1,5 | FS | |
| Son | 07 | A | 0-20 | 10YR 3/3-4/3 | 0,40 | 0,00 | * | 5,14 | 0,0 | 0,13 | 0,0 | 91,9 | 3,9 | 4,3 | FS | Xanthi-Cambic Arenosol |
| Son | 07 | B | 20-35 | 10YR 4/3 | 0,30 | * | * | 5,23 | 0,0 | 0,01 | 0,0 | 91,6 | 4,1 | 4,4 | FS | |
| Son | 07 | C | 50-54 | 7.5YR 4/3 | 0,10 | * | * | 4,21 | 0,0 | 0,15 | 0,0 | 92,4 | 3,1 | 4,5 | FS | |
| Son | 07 | D | 67-78 | 7.5YR 4/3 | 0,10 | * | * | 6,03 | 0,0 | 0,03 | 0,0 | 92,8 | 4,0 | 3,2 | FS | |
| Son | 07 | E | 92-99 | 10YR 5/2-6/3 | 0,10 | * | * | 3,66 | 0,0 | 0,28 | 0,0 | 92,5 | 5,8 | 1,8 | FS | |
| Son | 07 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 08 | 0A | 5-0 | 7.5YR 3/2 | 0,20 | * | * | 6,84 | 0,0 | 0,15 | 0,0 | 90,5 | 2,9 | 6,7 | MS | |
| Son | 08 | A | 0-17 | 10YR 3/2 | 0,50 | 0,02 | 1,60 | 5,36 | 0,0 | 0,19 | 0,0 | 88,1 | 6,0 | 5,8 | LS | Xanthi-Cambic Arenosol |
| Son | 08 | B | 41-50 | 7.5YR 3/3 | 0,40 | * | * | 5,34 | 0,0 | 0,11 | 0,0 | 86,2 | 4,1 | 9,7 | LS | |
| Son | 08 | C | 67-77 | 7.5YR 5/3-4/3 | 0,20 | * | * | 6,30 | 0,0 | 0,03 | 0,0 | 87,1 | 3,2 | 9,6 | LS | |
| Son | 08 | D | 101-111 | 7.5YR 5/4 | 0,20 | * | * | 6,26 | 0,0 | 0,05 | 0,0 | 85,5 | 3,4 | 11,2 | LS | |
| Son | 08 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 09 | A | 0-17 | 10YR 3/1 | 1,10 | 0,07 | * | 4,24 | 0,0 | 1,17 | 0,0 | 60,8 | 11,2 | 28,0 | SCL | Psammi Para-Vertisol |
| Son | 09 | B | 17-25 | 10YR 3/1 | 1,20 | * | * | 6,20 | 0,0 | 0,48 | 0,0 | 54,7 | 7,6 | 37,7 | SC | |
| Son | 09 | C | 25-35 | 10YR 3/1 | 1,10 | * | * | 7,41 | 0,0 | 0,69 | 0,0 | 55,7 | 9,3 | 35,0 | SC | |
| Son | 09 | X | 38 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 10 | A | 0-23 | 10YR 3/1 | 1,00 | 0,08 | * | 5,82 | 0,0 | 0,60 | 0,0 | 57,3 | 11,8 | 30,9 | SC/SCL | Psammi-Vertic Cambisol |
| Son | 10 | B | 23-37 | 10YR 4/1 | 0,50 | * | * | 6,72 | 0,4 | 0,29 | 0,0 | 56,7 | 5,9 | 37,4 | SC | |
| Son | 10 | C | 37-46 | 10YR 4/1-5/2-3/1 | 0,50 | * | * | 7,47 | 0,6 | 0,62 | 0,0 | 51,7 | 7,5 | 40,8 | SC | |
| Son | 10 | X | 46 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 11 | A | 0-18 | 7.5YR 3/1 - 10YR 3/1 | 0,60 | 0,03 | 15,90 | 5,42 | 0,0 | 0,32 | 0,0 | 47,1 | 8,8 | 44,1 | SC | Psammi-Dystric Para-Vertisol |
| Son | 11 | B | 18-31 | 7.5YR 3/1 - 10YR 3/1 | 0,70 | * | * | 4,55 | 0,0 | 0,65 | 0,0 | 48,1 | 8,8 | 43,0 | SC | |
| Son | 11 | C | 31-39 | 7.5YR 3/1 - 10YR 3/1 | 0,70 | * | * | 5,32 | 0,0 | 0,23 | 0,0 | 48,7 | 45,7 | 5,6 | SL | |
| Son | 11 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Son | 12 | A | 0-23 | 7.5YR 3/0 - 2.5YR 4/0 | 0,80 | 0,05 | 12,40 | 5,67 | 0,0 | 0,25 | 0,0 | 39,0 | 9,0 | 52,0 | C | Psammi-Eutric Vertisol |
| Son | 12 | B | 35-45 | 7.5YR 3/0 - 2.5YR 4/0 | 0,60 | * | * | 5,90 | 0,0 | 0,10 | 0,0 | 37,6 | 8,0 | 54,4 | C | |
| Son | 12 | C | 55-63 | 7.5YR 3/0-4/0 | 0,80 | * | * | 5,39 | 0,0 | 0,40 | 0,0 | 36,4 | 9,5 | 54,1 | C | |
| Son | 12 | D | 74-83 | 10YR 3/1 | 0,60 | * | * | 6,68 | 0,2 | 0,32 | 0,0 | 35,5 | 9,1 | 55,3 | C | |
| Son | 12 | E | 93-104 | 2.5Y 5/2-4/0 | 0,40 | * | * | 7,22 | 0,0 | 0,36 | 0,0 | 37,8 | 9,2 | 52,9 | C | |
| Son | 12 | F | 118-130 | 2.5Y 6/3 | 0,20 | * | * | 6,77 | 0,0 | 0,21 | 0,0 | 73,2 | 21,5 | 5,2 | LS/SL | |
| Son | 12 | G | 138-154 | 2.5Y 6/3 | 0,20 | * | * | 7,07 | 0,0 | 0,19 | 0,0 | 70,1 | 19,8 | 10,1 | SL | |
| Son | 12 | H | 168-175 | 2.5Y 5/2 | 0,10 | * | * | 7,09 | 0,0 | 0,22 | 0,0 | 69,0 | 20,4 | 10,6 | SL | |
| Son | 12 | X | 178 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 13 | A | 0-19 | 10YR 3/2 | 0,62 | 0,03 | * | 5,98 | 0,0 | 0,18 | 0,0 | 81,9 | 7,8 | 10,3 | SL/LS | Cambic Arenosol |
| Son | 13 | B | 19-28 | 10YR 3/2 | 0,61 | * | * | 5,45 | 0,0 | 0,19 | 0,0 | 78,2 | 6,7 | 15,1 | SL | |
| Son | 13 | C | 28-35 | 10YR 3/2 | 0,61 | * | * | 5,47 | 0,0 | 0,17 | 0,0 | 74,1 | 6,4 | 19,5 | SCL | |
| Son | 13 | D | 45-50 | 10YR 3/2 | 0,46 | * | * | 5,62 | 0,0 | 0,17 | 0,0 | 72,3 | 7,2 | 20,5 | SCL | |
| Son | 13 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 14 | A0 | 0-15 | 10YR 3/1 | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | Eutric Vertisol |
| Son | 14 | B0 | 43-57 | 10YR 3/1 | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 14 | X | 75 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 15 | A | 0-24 | 10YR 3/1-3/2 | 0,87 | 0,06 | 13,30 | 6,16 | 0,0 | 0,28 | 0,0 | 73,0 | 7,0 | 20,0 | SL/SCL | Psammi-Vertic Cambisol |
| Son | 15 | B | 39-50 | 10YR 4/1-4/2 | 0,58 | * | * | 7,60 | 0,4 | 0,61 | 0,0 | 66,5 | 7,7 | 25,8 | SCL | |
| Son | 15 | C | 70-79 | 10YR 4/2-5/2 | 0,32 | * | * | 7,72 | 0,6 | 0,32 | 0,0 | 66,9 | 7,6 | 25,5 | SCL | |
| Son | 15 | D | 99-108 | 10YR 5/2 | 0,26 | * | * | 7,73 | 3,0 | 0,29 | 0,0 | 64,5 | 8,6 | 26,8 | SCL | |
| Son | 15 | X | 110 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 16 | A | 0-20 | 10YR 3/2 | 0,79 | 0,06 | * | 7,82 | 1,9 | 0,29 | 0,0 | 77,1 | 11,6 | 11,3 | SL | Psammi-Vertic Cambisol |
| Son | 16 | B | 37-47 | 10YR 3/2-4/2 | 0,67 | * | * | 7,88 | 3,8 | 0,22 | 0,0 | 73,7 | 7,0 | 19,3 | SL/SCL | |
| Son | 16 | C | 68-72 | 10YR 4/2 | 0,77 | * | * | 7,96 | 10,3 | 0,20 | 0,0 | 69,2 | 11,5 | 19,4 | SCL/SL | |
| Son | 16 | X | 72 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 17 | A | 0-16 | 10YR 2/1-3/1 | 1,18 | 0,04 | 2,80 | 4,89 | 0,0 | 1,12 | 0,0 | 25,8 | 15,2 | 59,0 | C | Eutric Vertisol |
| Son | 17 | B | 36-44 | 10YR 2/1 | 1,22 | * | * | 6,14 | 0,0 | 0,32 | 0,0 | 23,9 | 14,3 | 61,8 | C | |
| Son | 17 | C | 62-65 | 10YR 2/1 | 1,08 | * | * | 6,04 | 0,0 | 0,40 | 0,0 | 21,8 | 14,8 | 63,4 | C | |
| Son | 17 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 18 | A | 0-19 | 10YR 3/2 | 0,53 | 0,03 | * | 5,75 | 0,0 | 0,19 | 0,0 | 86,0 | 7,3 | 6,6 | LS | Xanthi-Cambic Arenosol |
| Son | 18 | B | 26-31 | 7.5YR 3/2 | 0,39 | * | * | 6,53 | 0,0 | 0,07 | 0,0 | 80,0 | 0,0 | 0,0 | SL | |
| Son | 18 | C | 36-40 | 7.5YR 3/2 | 0,40 | * | * | 5,20 | 0,0 | 0,12 | 0,0 | 85,6 | 5,2 | 9,2 | LS | |
| Son | 18 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 19 | A | 0-19 | 10YR 3/2 | 0,49 | 0,03 | 7,30 | 5,57 | 0,0 | 0,16 | 0,0 | 85,7 | 4,8 | 9,5 | LS | Xanthi-Cambic Arenosol |
| Son | 19 | B | 32-38 | 10YR 4/2 - 7.5YR 4/2 | 0,43 | * | * | 6,50 | 0,0 | 0,05 | 0,0 | 81,3 | 5,5 | 13,2 | SL | |
| Son | 19 | C | 47-54 | 7.5YR 4/2 | 0,31 | * | * | 6,53 | 0,0 | 0,06 | 0,0 | 81,5 | 5,4 | 13,1 | SL | |

Soil Analytical Data of the Soil Samples in the Etosha NP * = no measure

| Smpl. | | | d | Colour | C(%) | N(%) | P(ppm) | pH | Ca | EC5 | Sk | S | Si | C | Texture | Soil Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Son | 19 | D | 65-68 | 7.5Yr 4/2 | 0,29 | * | * | 5,53 | 0,0 | 0,42 | 0,0 | 79,3 | 5,4 | 15,3 | SL | |
| Son | 19 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 20 | A | 0-20 | 5Y 4/4 - 7.5YR 4/4 | 0,31 | 0,02 | 2,00 | 4,84 | 0,0 | 0,15 | 0,0 | 90,7 | 4,6 | 4,7 | FS | Rhodi-Cambic Arenosol |
| Son | 20 | B | 34-46 | 5Y 4/4 | 0,21 | * | * | 5,48 | 0,0 | 0,05 | 0,0 | 90,0 | 4,6 | 5,4 | FS | |
| Son | 20 | C | 62-69 | 5Y 4/6 | 0,20 | * | * | 5,52 | 0,0 | 0,03 | 0,0 | 88,4 | 4,6 | 7,0 | FS | |
| Son | 20 | D | 83-88 | 5 Y 4/6 | 0,17 | * | * | 6,13 | 0,0 | 0,03 | 0,0 | 88,7 | 4,0 | 7,3 | FS | |
| Son | 20 | X | 88 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 21 | 0A | 0-5 | 2.5Y 6/3-6/4 | 1,11 | 0,05 | * | 9,92 | 3,5 | 69,40 | 0,0 | 13,1 | 3,9 | 83,0 | C | |
| Son | 21 | A | 5-20 | 2.5Y 6/3-6/4 | 0,60 | 0,02 | * | 9,67 | 2,1 | 12,02 | 0,0 | 4,9 | 5,3 | 89,8 | C | Calcic Solonchak |
| Son | 21 | B | 39-47 | 5Y 7/3-6/3 | 0,29 | * | * | 8,94 | 4,5 | 6,91 | 0,0 | 6,7 | 7,5 | 85,8 | C | |
| Son | 21 | C | 57-67 | 5Y 6/3 | 0,15 | * | * | 9,03 | 9,2 | 3,79 | 0,0 | 29,4 | 10,6 | 60,0 | C | |
| Son | 21 | D | 90-100 | 5Y 6/3 | 0,07 | * | * | 8,92 | 10,2 | 2,39 | 0,0 | 42,1 | 11,8 | 46,1 | C | |
| Son | 21 | X | ?? | Siltstein | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 22 | A | 0-18 | 10YR 3/1-3/2 | 0,74 | 0,03 | * | 5,86 | 0,0 | 0,18 | 0,0 | 83,9 | 8,8 | 7,3 | LS | Psammi-Vertic Cambisol |
| Son | 22 | B | 26-30 | 10YR 3/2 | 0,53 | * | * | 3,68 | 0,0 | 0,47 | 0,0 | 83,2 | 9,3 | 7,5 | LS | |
| Son | 22 | C | 37-41 | 10YR 5/2-5/1 | 0,51 | * | * | 4,65 | 0,0 | 0,38 | 0,0 | 73,3 | 5,7 | 20,9 | SCL | |
| Son | 22 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 23 | A0 | | 10YR 3/2 | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | Psammi-Vertic Cambisol |
| Son | 23 | B0 | 26-34 | 10YR 3/2-3/3 | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 23 | C0 | 38-43 | 10YR 4/2 | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 23 | X | ?? | too dense | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 24 | 0A | 5-0 | 10YR 5/2-6/2 | 0,00 | * | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |
| Son | 24 | A | 0-18 | 10YR 2/1-3/1 | 0,66 | 0,03 | 5,70 | 6,02 | 0,0 | 0,12 | 0,0 | 79,7 | 9,6 | 10,8 | SL/LS | Psammi-Vertic Cambisol |
| Son | 24 | B | 32-38 | 10YR 4/1 | 0,56 | * | * | 6,21 | 0,0 | 0,24 | 0,0 | 74,2 | 4,9 | 20,8 | SCL | |
| Son | 24 | C | 43-49 | 10YR 4/1 | 0,52 | * | * | 5,88 | 0,0 | 0,30 | 0,0 | 72,5 | 5,5 | 22,0 | SCL | |
| Son | 24 | D | 61-68 | 10YR 4/1-5/2 | 0,35 | * | * | 6,29 | 0,0 | 0,17 | 0,0 | 70,0 | 5,7 | 24,4 | SCL | |
| Son | 24 | E | 74-84 | 10YR 5/2 | 0,38 | * | * | 6,41 | 0,0 | 0,40 | 0,0 | 71,0 | 8,3 | 20,8 | SCL/SL | |
| Son | 24 | F | 84-87 | 10YR 5/2 | 0,35 | * | * | 7,47 | 0,0 | 0,00 | 0,0 | 72,5 | 11,5 | 15,9 | SL | |
| Son | 24 | X | 87 | Limestone | 0,00 | 0,00 | * | 0,00 | 0,0 | 0,00 | 0,0 | 0,0 | 0,0 | 0,0 | | |

Soil Analytical Data of the Soil Samples in the Etosha NP    * = no measure

# Appendix B

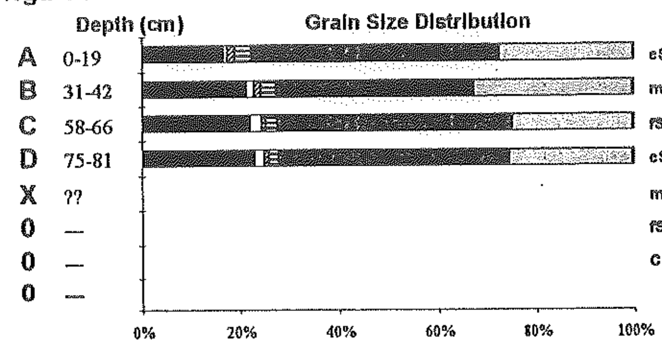
- THE FIGURES OF THE PHYSICAL AND CHEMICAL SOIL PROPERTIES OF TYPICAL SOIL PROFILES IN THE STUDY AREAS
- A TOPOSEQUENCE FROM THE 'KARSTVELD' TO THE ETOSHA PAN

Figure 1: Reference Profile Nga 4

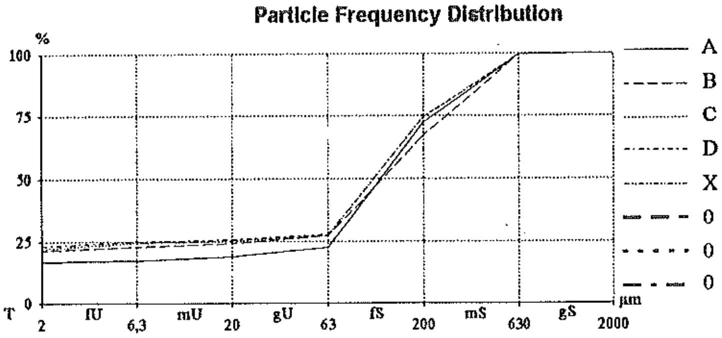
| | | | | | |
|---|---|---|---|---|---|
| **Profil:** **Nga 04** | **Site** Ovambo-Pans-Plain | **Lon.** | **Lat.** | | **Date** |
| Number of Samples: 5 | 4,8 km E Einmünd. i. Pardse FBR r. | 15°18'34" | 18°40'53" | | 1.10.92 |
| **Soil** **FAO** | **Mapping Unit** | **SA:** | | | **Risk Class.** |
| **Classification:** Psammi-Humic Cambisol | A4 | **USDA:** | | | |

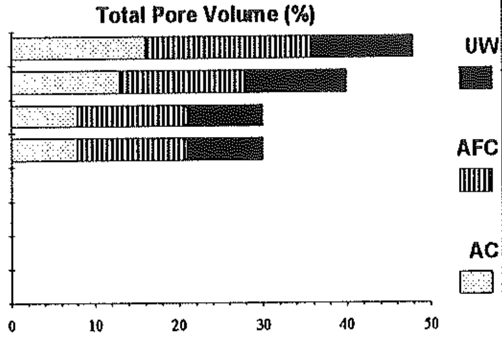
## Physical Soil Properties

**Nga 04**



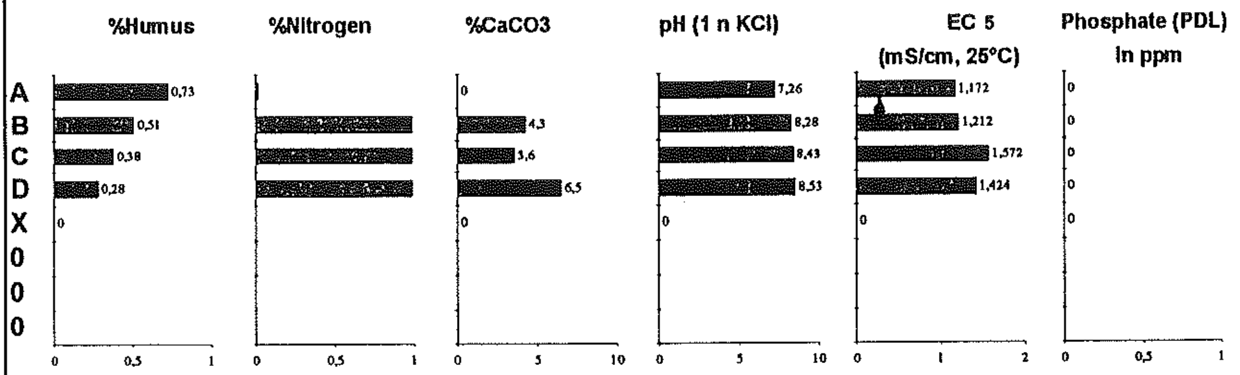

| %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|
| — | SL | 10YR 3/3 | sig |
| — | SCL | 10YR 4/3 | sig |
| — | SCL | 10YR 5/3 | sig |
| — | SCL | 10YR 6/4 | sig |
| — | — | too dense | — |
| — | — | — | — |
| — | — | — | — |
| — | — | — | — |




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 26,3 (cm/h) Erodibility: 7,5 (F-Index)

## Chemical Soil Properties



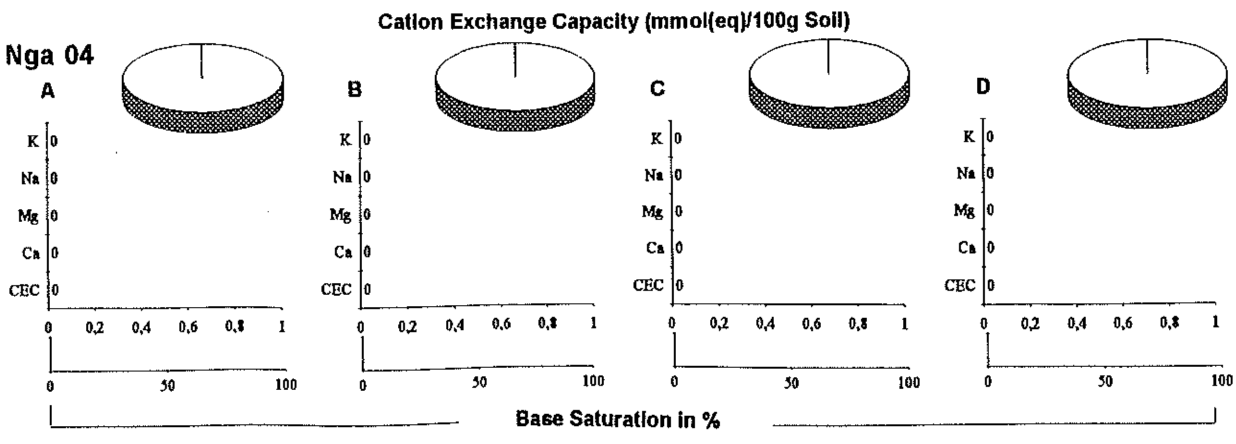



Figure 2 Reference Profile Nga 5

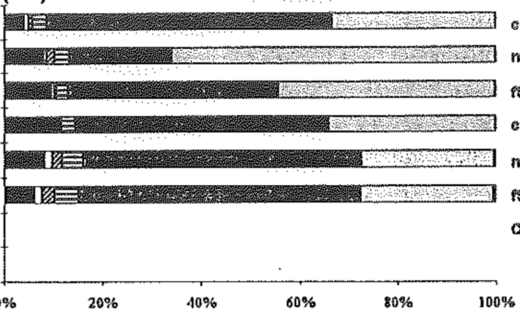
| Profil: Nga 05 | Site: Ovambo-Pans-Plain | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 7 | 1 km E Kreuz N Sokopfarme, r. | 15°21'31" | 18°40'39" | 1.10.92 |

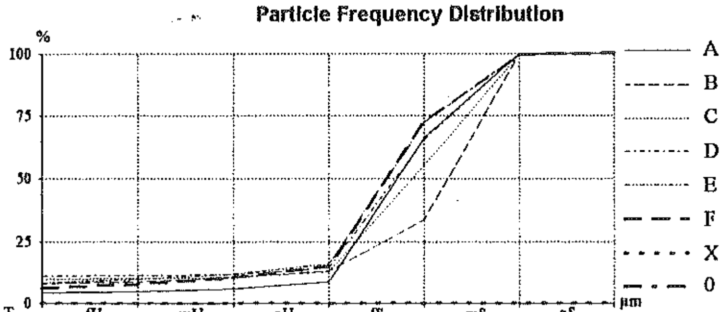
| Soil Classification: | FAO: Haplic Arenosol | Mapping Unit: A4 | SA: | USDA: | Risk Class. |
|---|---|---|---|---|---|

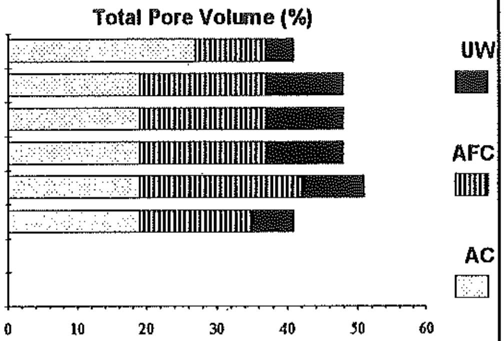
## Physical Soil Properties

Nga 05

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-19 | — | FS | 2.5Y 4/2 | sig |
| B | 36-48 | — | LS | 2.5Y 4/2 | sig |
| C | 59-72 | — | LS | 2.5Y 4/2 | sig-sub |
| D | 98-107 | — | LS | 2.5Y 4/3 | sig-sub |
| E | 138-150 | — | LS | 2.5Y 5/3 | sig |
| F | 161-169 | — | LS | 2.5Y 5/3-6/3 | sig-sub' |
| X | 169 | — | — | sandstone | — |
| 0 | — | — | — | — | — |

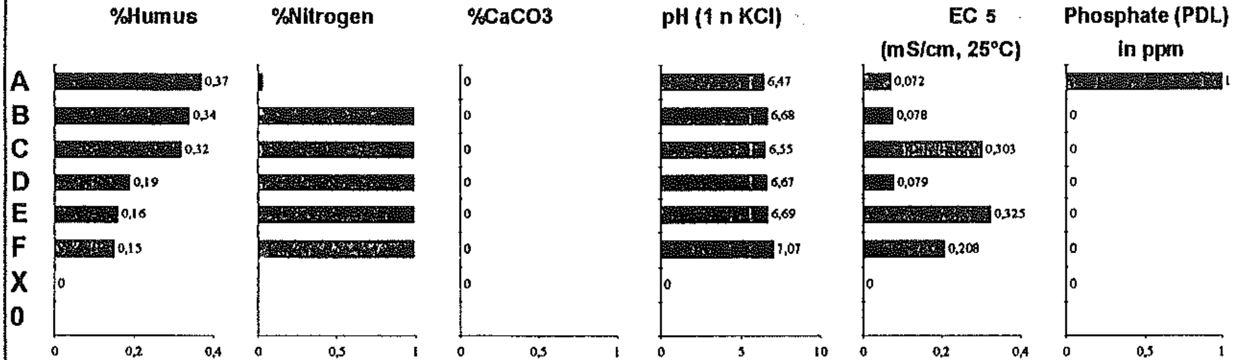



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 29,4 (cm/h) Erodibility: 7,5 (F-Index)

## Chemical Soil Properties



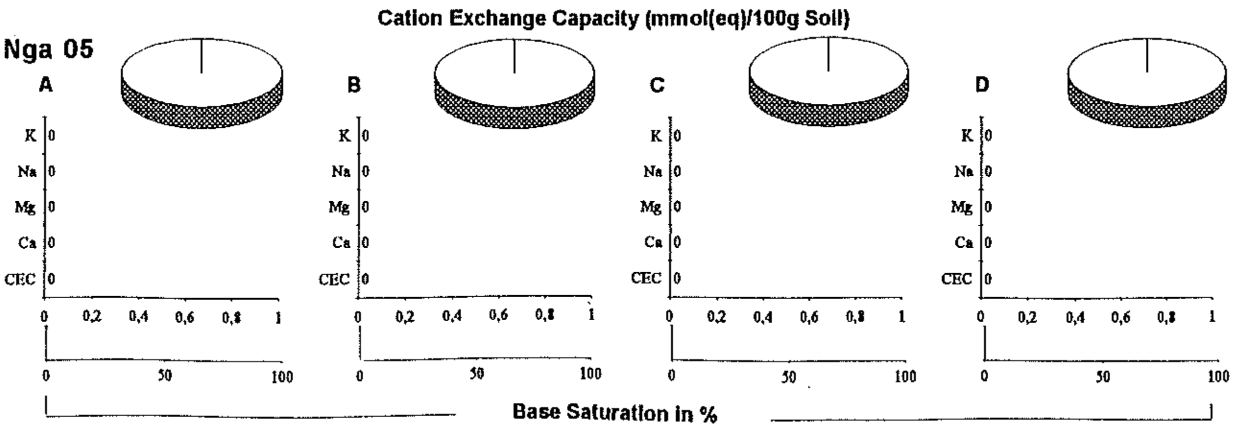



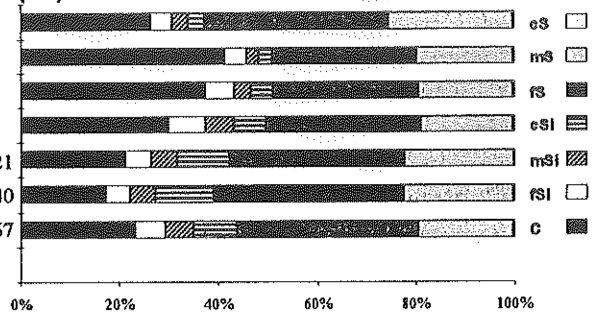
Figure 3: Reference Profile Nga 8

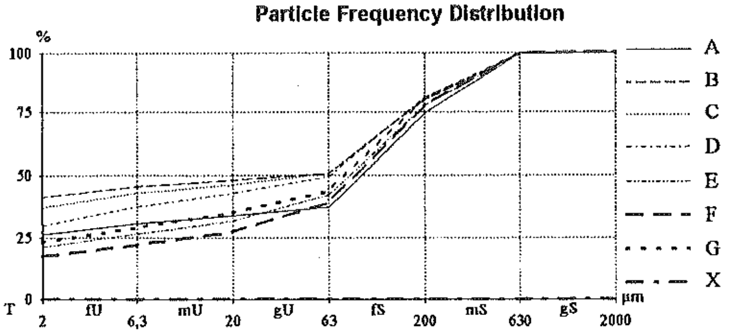
| Profil: Nga 08 | Site Ovambo-Pans-Plain | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 8 | 4,8 km E Kreuz N Sokopfanne r., Senke | 15°23'26" | 18°41'29" | 10.10.92 |
| Soil Classification: FAO Psammi-Eutric Para-Vertisol | Mapping Unit A4 | SA: USDA: | | Risk Class. |

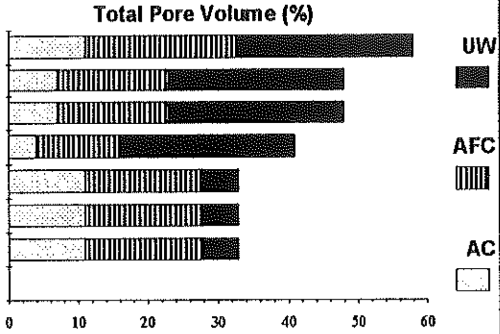
## Physical Soil Properties

Nga 08

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-18 | — | SCL | 10YR 3/1-4/1 | sig-sub |
| B | 36-47 | — | SC | 10YR 4/1-5/1 | sub |
| C | 65-74 | — | SC | 5Y 4/1-5/1 | sig-sub |
| D | 74-81 | — | SCL | 2.5Y 5/2-4/2 | sig-sub |
| E | 114-121 | — | SCL | 2.5Y 5/2-6/2 | sig-sub |
| F | 136-140 | — | SL | 2.5Y 5/2-6/2 | sig-sub |
| G | 161-167 | — | SCL | 2.5Y 6/3-6/4 | sig-sub |
| X | 180 | — | — | sandstone (calcareous) | — |

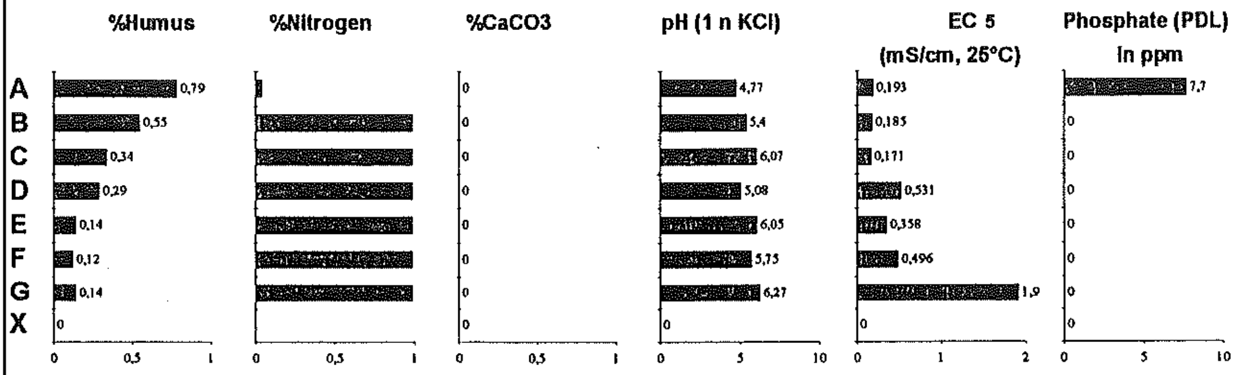



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 16,3 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



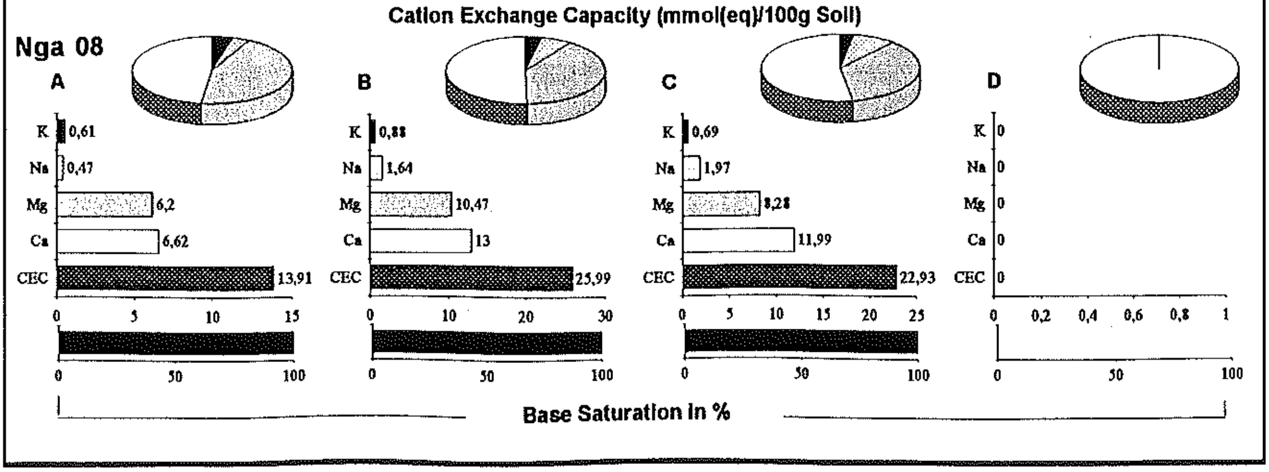



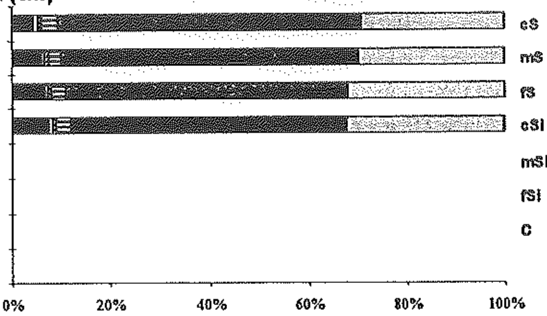
Figure 4: Reference Profile Nga 13

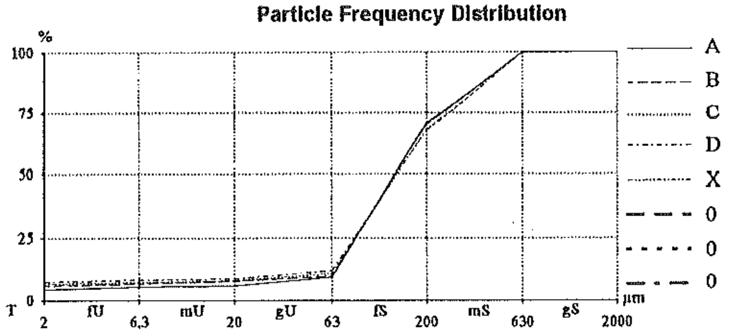
| Profil: Nga 13 | Site Ovambo Sandveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 5 | 2,3 km N Pardsekreuz l. | 15°20'56" | 18°39'23" | 20.10.92 |
| **Soil Classification:** FAO Cambic Arenosol | **Mapping Unit** A4 | **SA:** **USDA:** | | **Risk Class.** |

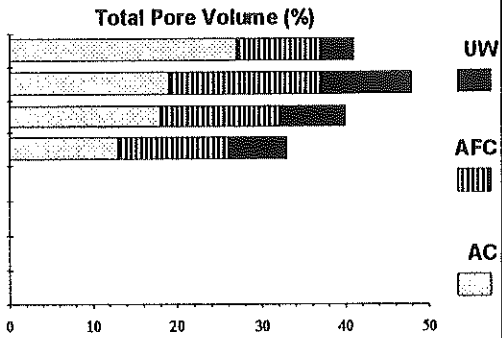
## Physical Soil Properties

**Nga 13**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-22 | — | FS | 10YR 4/4-4/6 | sig |
| B | 35-43 | — | FS | 10YR 3/4 | sig-sub |
| C | 52-60 | — | FS | 10YR 3/4-7.5YR 3/4 | sub |
| D | 60-67 | — | LS | 10YR 3/4-7.5YR 3/4 | sub |
| X | 67 | — | — | limestone (sandy) | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

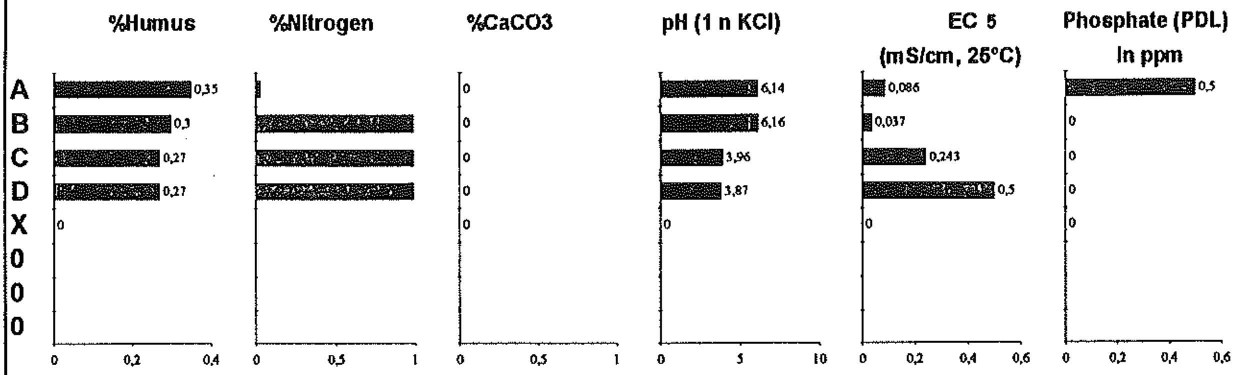



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 34,2 (cm/h) Erodibility: 8 (F-Index)

## Chemical Soil Properties



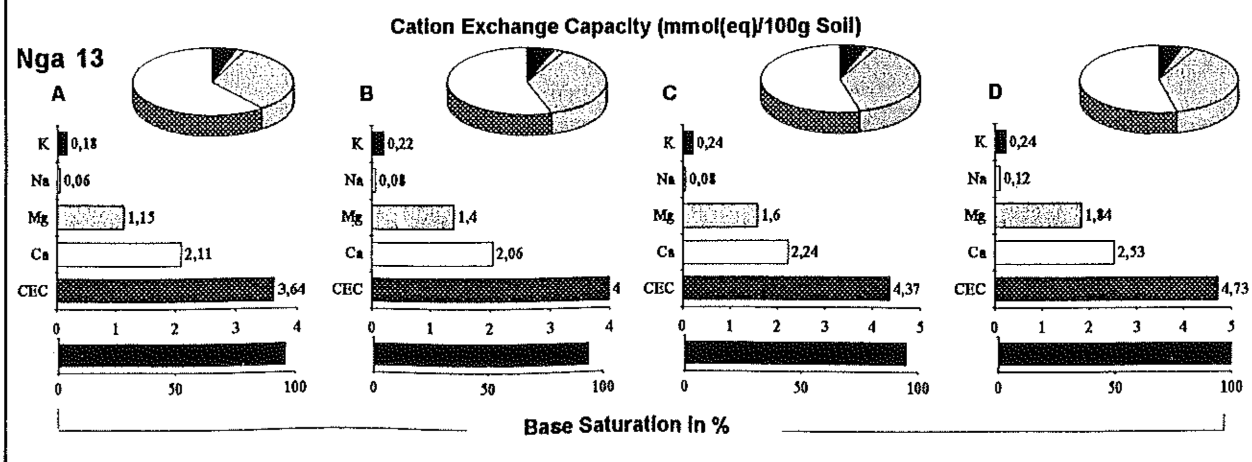



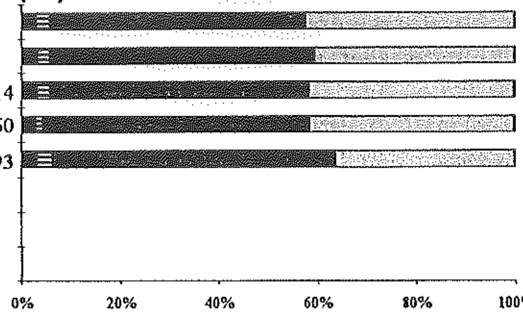
Figure 5: Reference Profile Nga 14

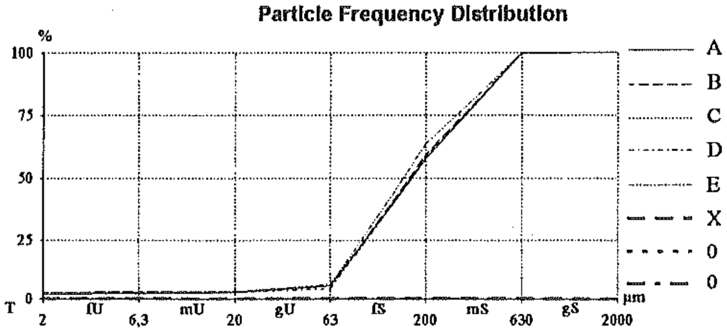
| Profil: Nga 14 | Site: Ovambo Sandveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 6 | 5,8 km N Pardsekreuz, Amhöhe | 15°21'31" | 18°37'22" | 20.10.92 |
| Soil Classification: FAO Rhodi-Cambic Arenosol | Mapping Unit: A1 | SA: | USDA: | Risk Class. |

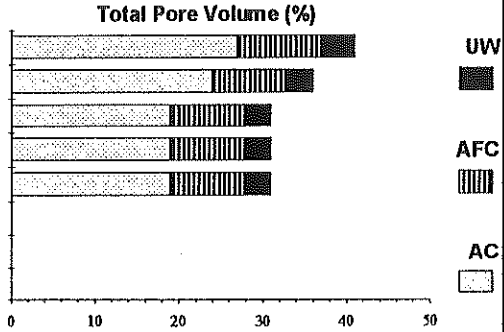
## Physical Soil Properties

Nga 14

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-21 | — | FS | 7.5YR 3/4 | sig |
| B | 68-79 | — | FS | 5YR 4/6 | sig |
| C | 106-114 | — | FS | 5YR 5/8 | sig-sub |
| D | 150-160 | — | FS | 5YR 5/8 | sub |
| E | 186-193 | — | FS | 5YR 5/8-6/8 | sub |
| X | ?? | — | — | loss of soil material | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

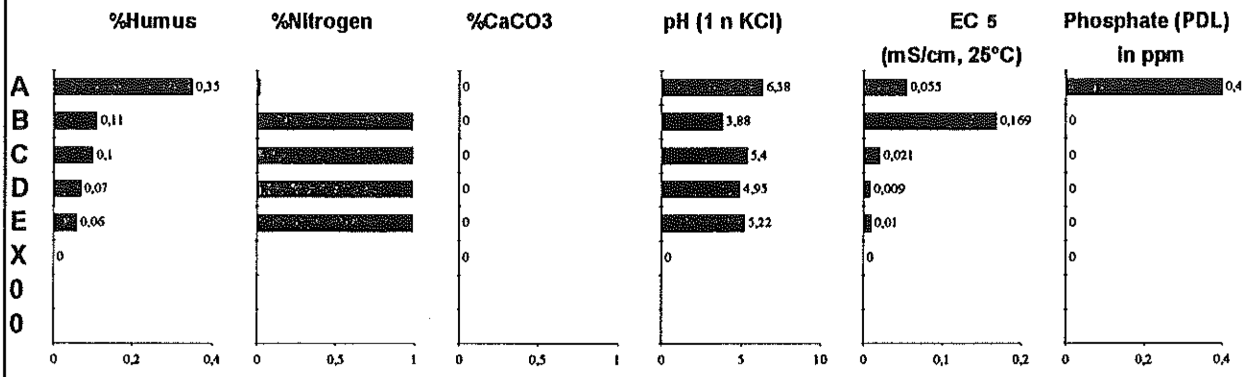



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) **Basic IR:** 20 (cm/h) **Erodibility:** 7 (F-Index)

## Chemical Soil Properties



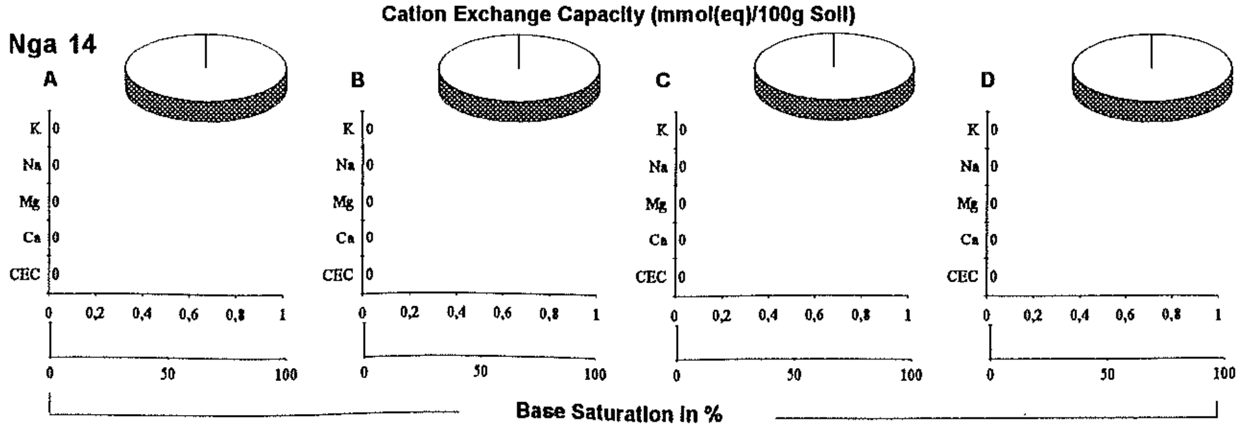
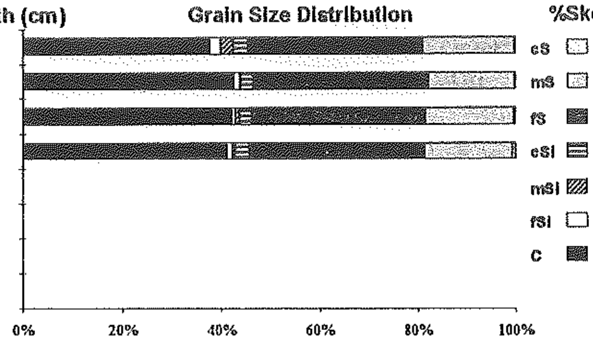



Figure 6: Reference Profile Nga 3

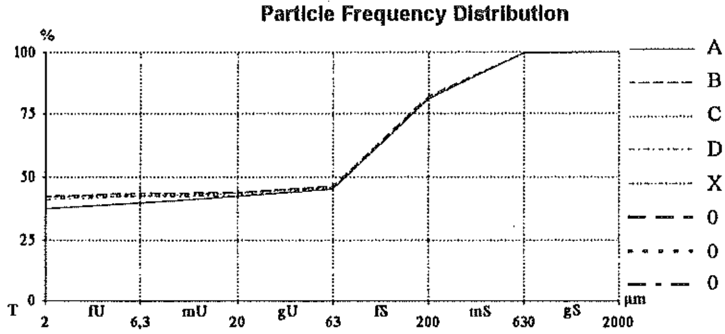
| Profil: **Nga 03** | Site: Ovambo-Pans-Plain | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 5 | 1,5 km E v.Einm. i.Pardse FBR 1., Rinne | 15°16'48" | 18°40'52" | 1.10.92 |
| Soil Classification: FAO Mollic Fluvisol | Mapping Unit D6 | SA: USDA: | | Risk Class. |

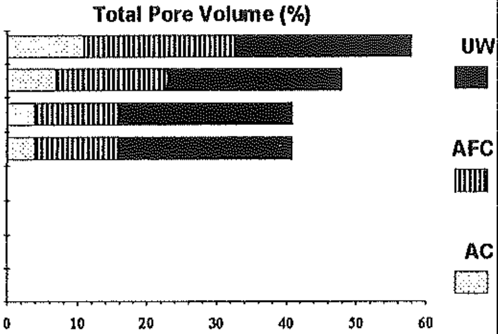
## Physical Soil Properties

**Nga 03**



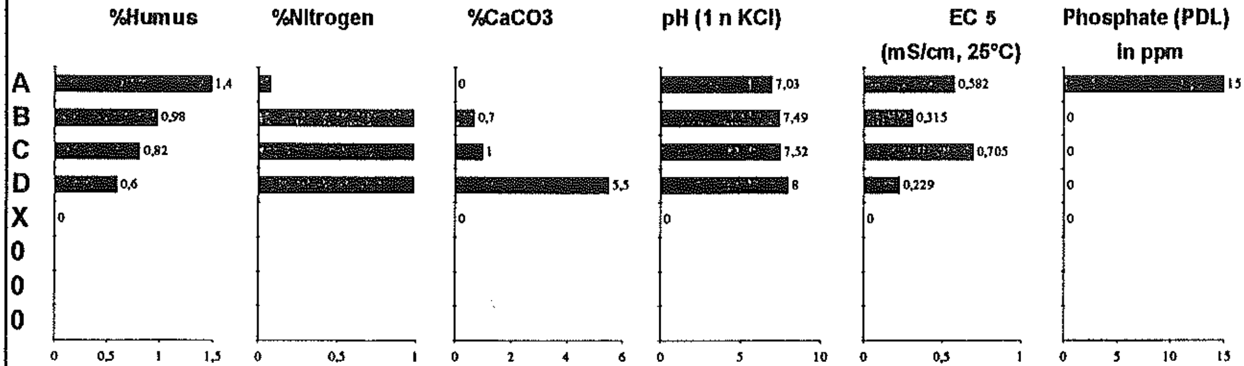

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-20 | — | SC | 10YR 3/3-3/2 | sig |
| B | 27-38 | — | SC | 10YR 3/3 | sig |
| C | 44-51 | — | SC | 10YR 3/3-3/4 | sig |
| D | 68-76 | — | SC | 10YR 4/3 | sig |
| X | 80 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) **Basic IR:** 20,6 (cm/h) **Erodibility:** 2 (F-Index)

## Chemical Soil Properties



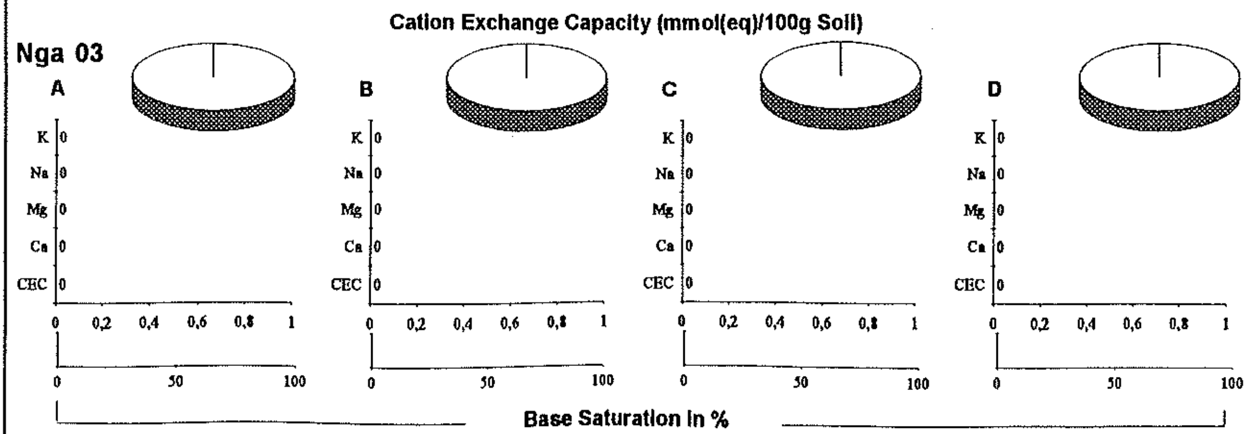



Figure 7: Reference Profile Oka 40

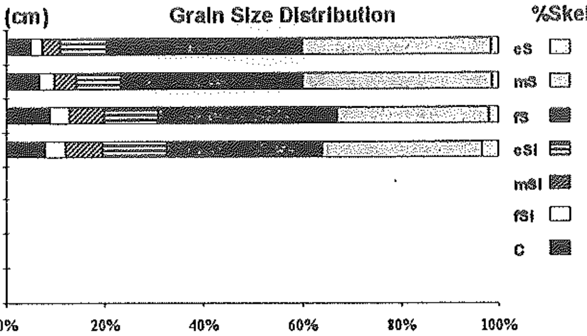
| | | | | |
|---|---|---|---|---|
| **Profil:** Oka 40 | **Site** Etosha Pan | **Lon.** | **Lat.** | **Date** |
| Number of Samples: 5 | 5,9 km n. NW-Abzw. v. Leeubr.- Okond., links | 15°48'24" | 19°00'35" | 8.6.91 |
| **Soil** FAO | **Mapping Unit** | **SA:** | | **Risk Class.** |
| **Classification:** Humi-Calcaric Arenosol | A6 | **USDA:** | | |

## Physical Soil Properties

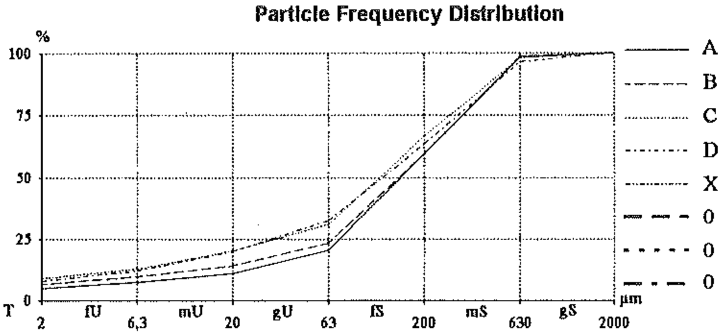
**Oka 40**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-20 | 0,1 | SL | 10YR 5/4 + 10YR 5/3- | sig |
| B | 35-51 | 0,1 | LS/SL | 2.5Y6/4 - 10YR 5/4-6 | sig |
| C | 51-65 | 0,1 | SL | 10YR 6/4 | sig |
| D | 91-100 | 12,6 | SL | 10YR 6/4-6/3' | sig |
| X | 100 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

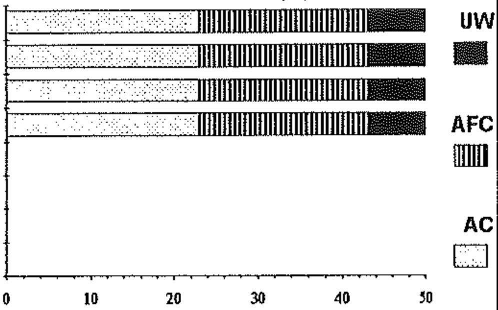
**Grain Size Distribution**




**Particle Frequency Distribution**

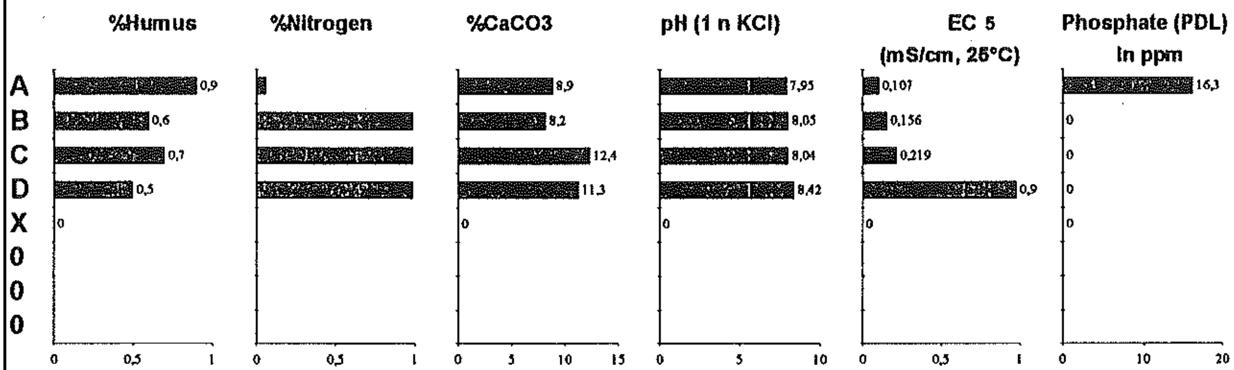



**Total Pore Volume (%)**




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) **Basic IR:** 12,3 (cm/h) **Erodibility:** 6,5 (F-Index)

## Chemical Soil Properties




**Cation Exchange Capacity (mmol(eq)/100g Soil)**

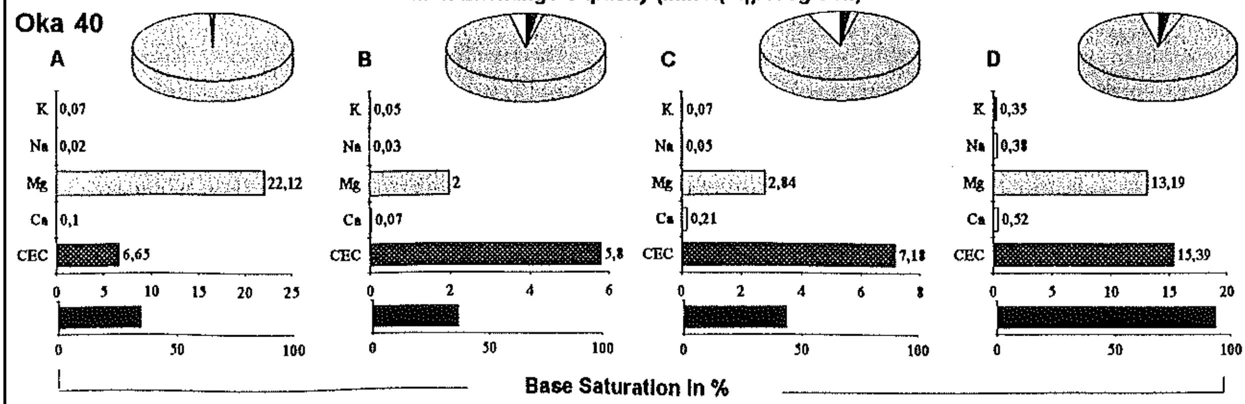


Figure 9: Reference Profile Oka 47

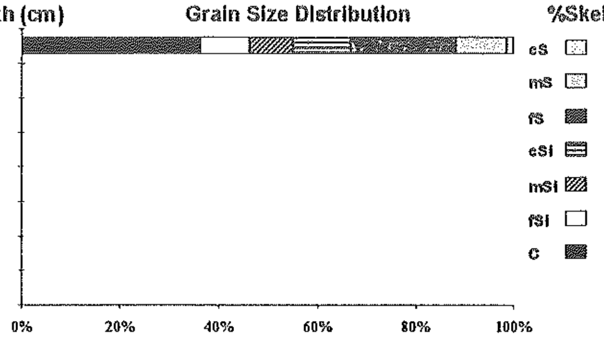
| Profil: Oka 47 | Site | | Lon. | Lat. | Date |
|---|---|---|---|---|---|
| Number of Samples: 2 | 5,5 km n.Leeubr.a.Adam.FBR, 300m rechts | | 15°01'49" | 19°01'51" | 10.6.91 |
| Soil | FAO | Mapping Unit | SA: | | Risk Class. |
| Classification: | Psammi-Calcaric Regosol | C5 | USDA: | | |

## Physical Soil Properties

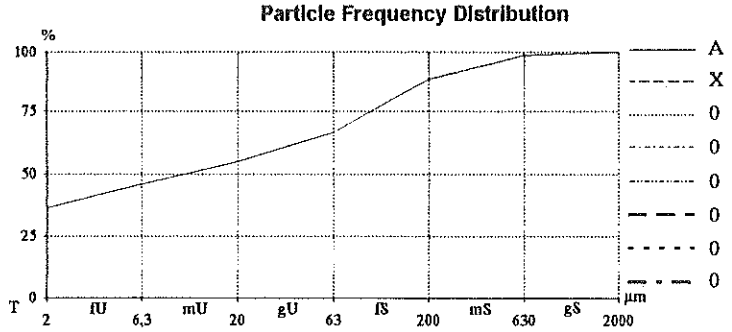
Oka 47

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-20 | 2,6 | CL | 10YR 5/3-4/3 | sig-koh |
| X | 102 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

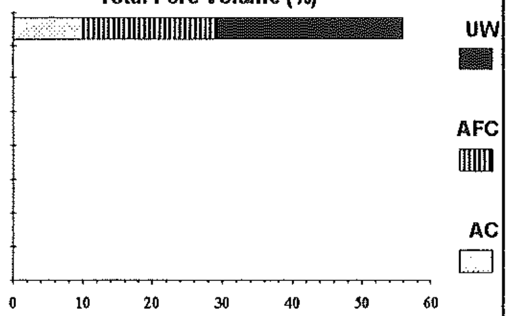
Grain Size Distribution




Particle Frequency Distribution

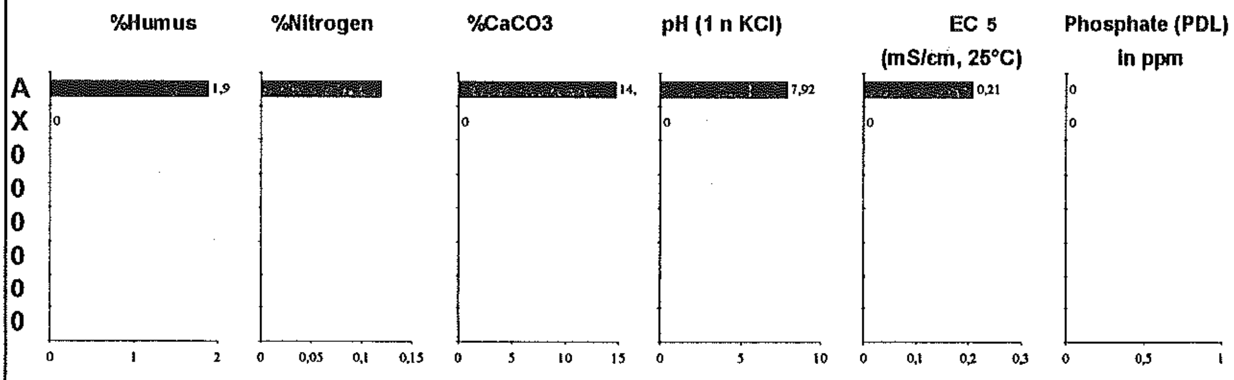



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 15,7 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

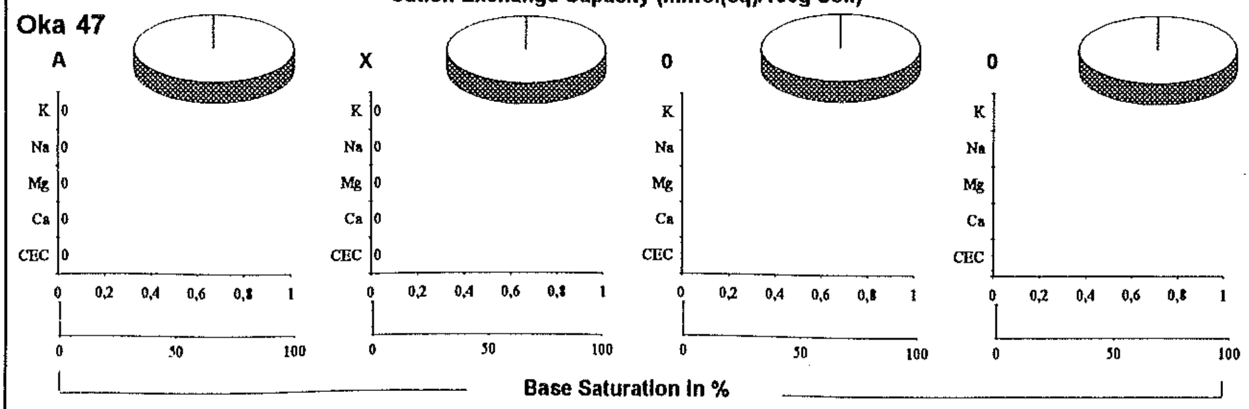


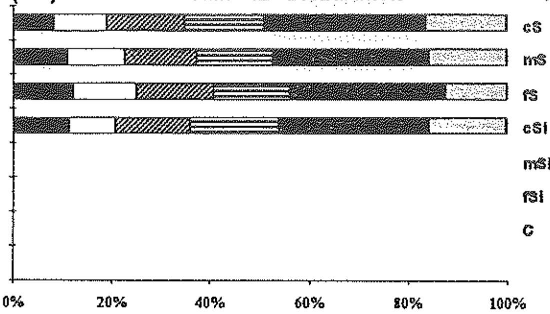
Figure 10: Reference Profile Oka 46

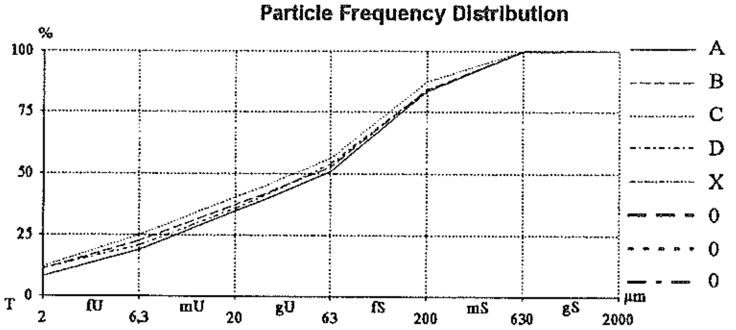
| Profil: Oka 46 | Site: Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 5 | 4,0km n.Leeubr.auf Adamax FBR,100m li | 15°02'17" | 19°02'28" | 10.6.91 |
| Soil Classification: FAO Humi-Calcaric Arenosol | Mapping Unit C5 | SA: USDA: | | Risk Class. |

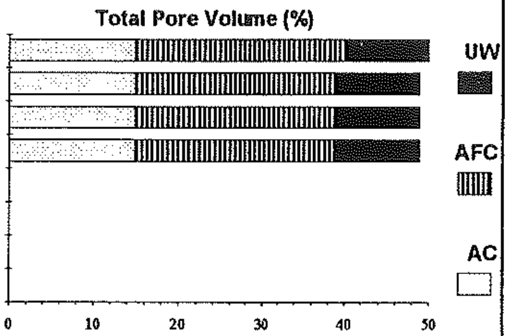
## Physical Soil Properties

Oka 46

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-19 | — | L | 10YR 3/3 | sig-sub' |
| B | 19-33 | 0,1 | L | 10YR 4/3-3/3 | sub' |
| C | 33-45 | 0,1 | L | 10YR 4/3 | sub' |
| D | 45-52 | 0,1 | L | 10YR 5/4 mit 10YR 5/ | sub' |
| X | 52 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

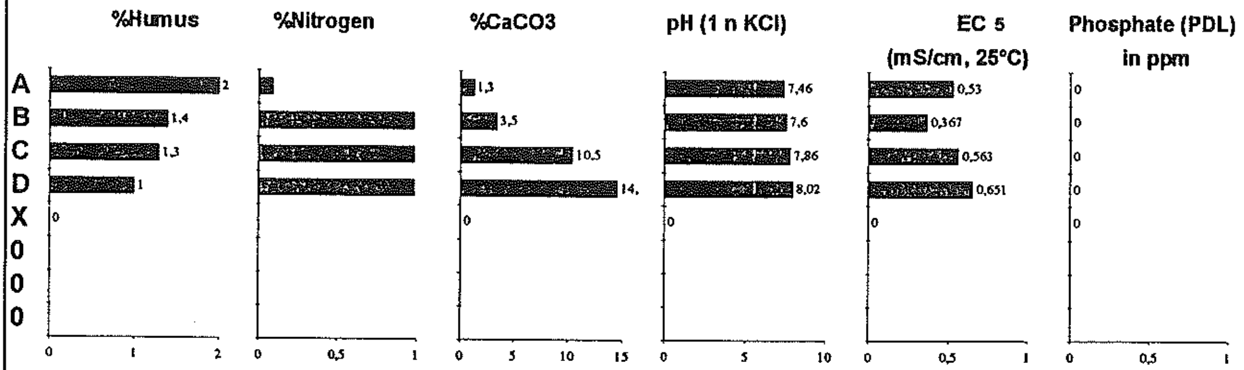



Infiltration: IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 22,2 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



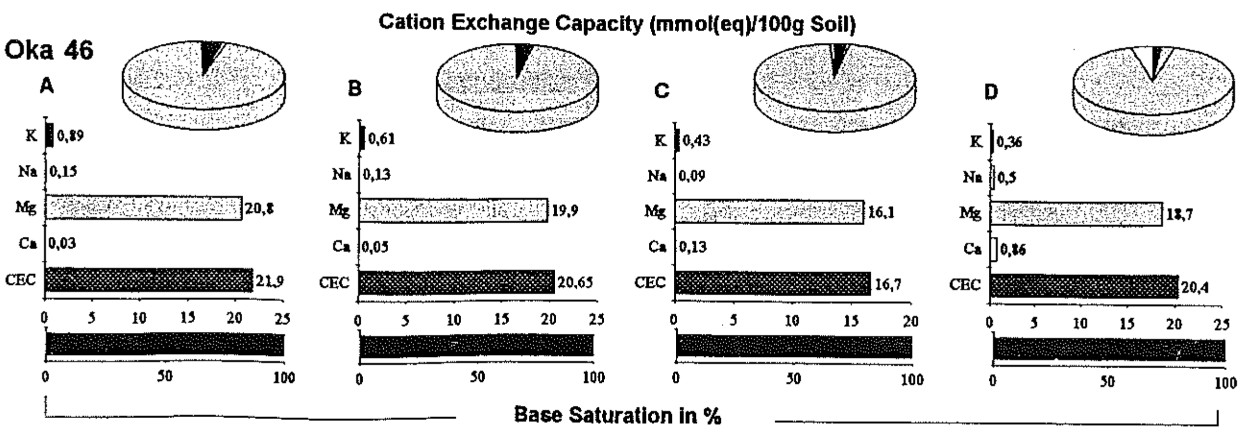



Figure 11: Reference Profile Oka 25

| Profil: Oka 25 | Site | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 5 | Karstveld<br>14,3 km n. Abzw. auf Okauk. FBR, rechts | 15°48'02" | 19°14'59" | 28.5.91 |

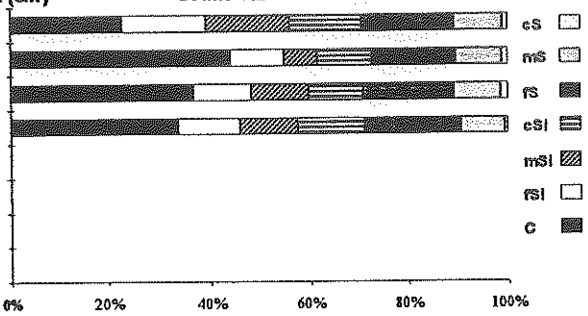
| Soil Classification: | FAO | Mapping Unit | SA: | Risk Class. |
|---|---|---|---|---|
| | Eutric Regosol | C2 | USDA: | |

## Physical Soil Properties

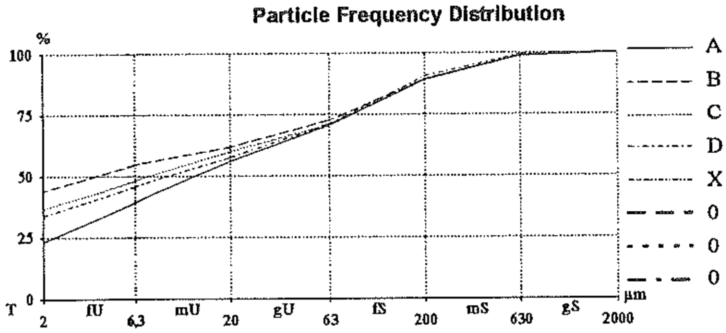
Oka 25

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-20 | 7,2 | L | 10YR 4/2-3/2 | sig |
| B | 20-36 | 0,1 | C | 7.5YR 3/2 - 10YR 4/2 | sig |
| C | 36-46 | 0,1 | CL | 10YR 4/2 | sig-sub' |
| D | 46-54 | 3,9 | CL | 10YR 3/3-3/2 | sub' |
| X | 54 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

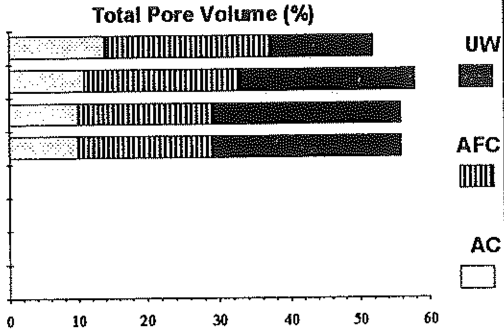
Grain Size Distribution




Particle Frequency Distribution

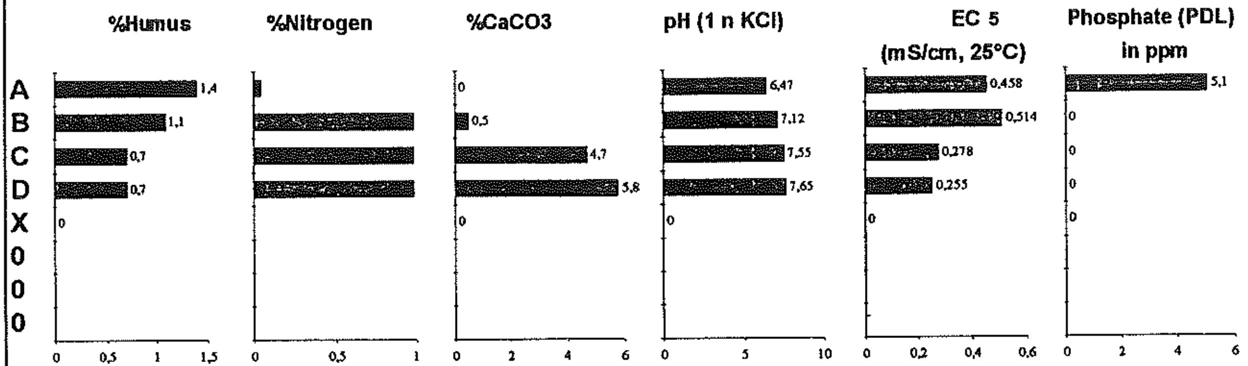



Total Pore Volume (%)




| Infiltration: | IIR(15 Min.): (cm/h) | IIR(30 Min.): (cm/h) | Basic IR: 9,7 (cm/h) | Erodibility: 1 (F-Index) |
|---|---|---|---|---|

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

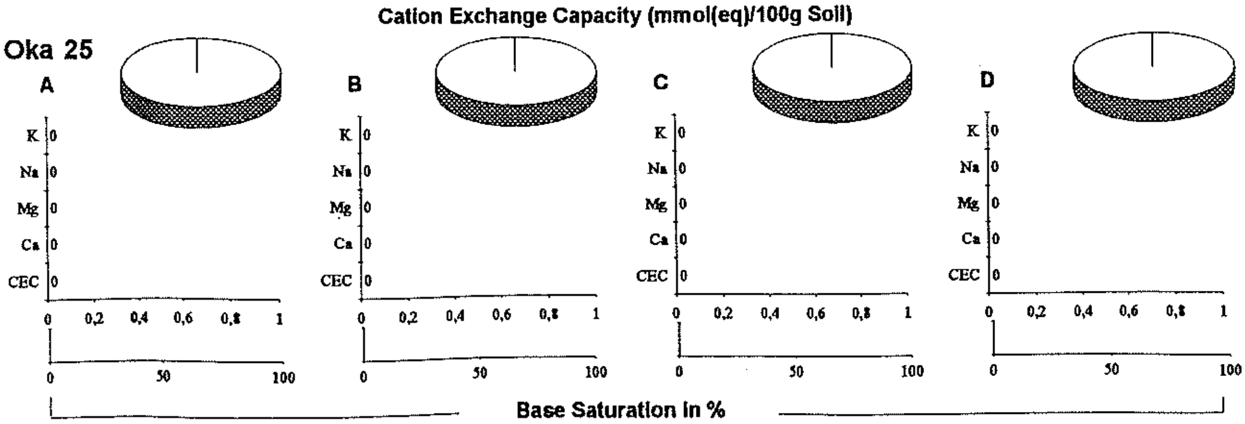


Figure 12: Reference Profile Oka 28

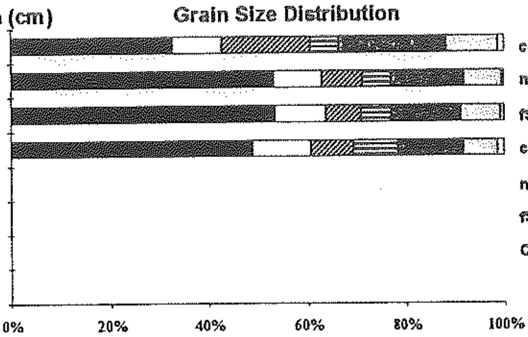
| Profil: Oka 28 | Site | Etosha Pan | Lon. | Lat. | Date |
|---|---|---|---|---|---|
| Number of Samples: 5 | 300 m ab Kreuz. Leeubr.-Sprook., links | | 15°49'00" | 19°04'20" | 4.6.91 |
| Soil Classification: | FAO: Calcaric Fluvisol | Mapping Unit: C5 | SA: | USDA: | Risk Class. |

## Physical Soil Properties

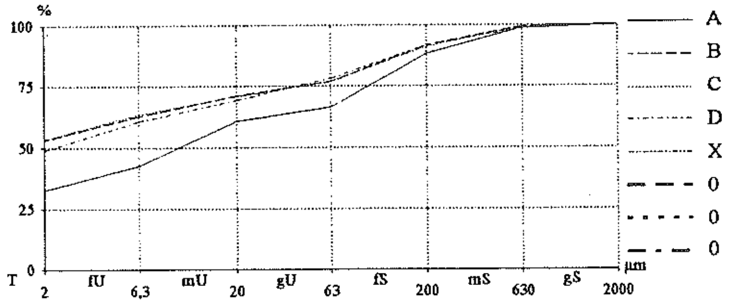
Oka 28

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-19 | 0,1 | CL | 10YR 4/2-3/2 | sub |
| B | 31-47 | 0,1 | C | Kalkstein | sub |
| C | 47-54 | 0,1 | C | 10YR 6/3-5/3 | sub |
| D | 71-86 | 0,1 | C | 2.5Y 6/2 - 10YR 6/3 | sub |
| X | 86 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

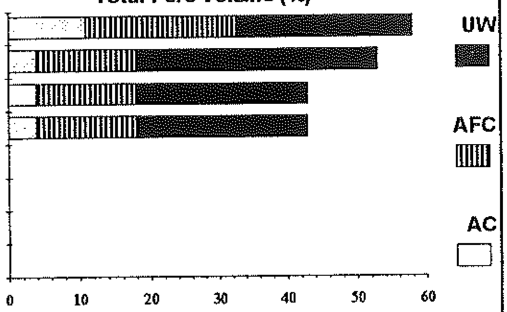
Grain Size Distribution




Particle Frequency Distribution

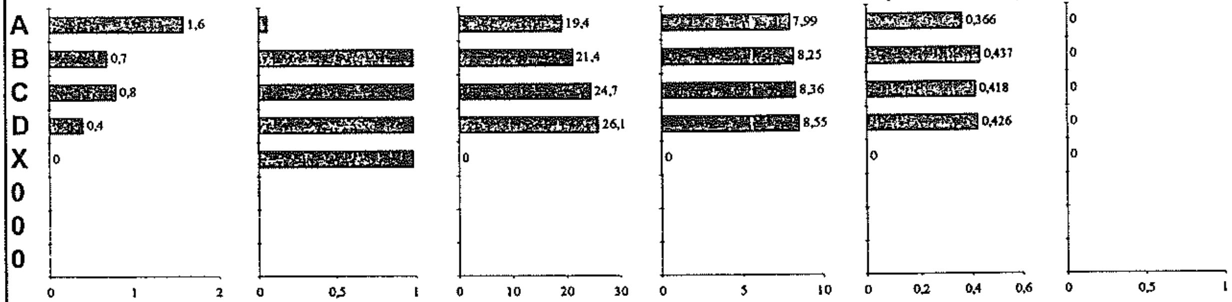



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 14,4 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

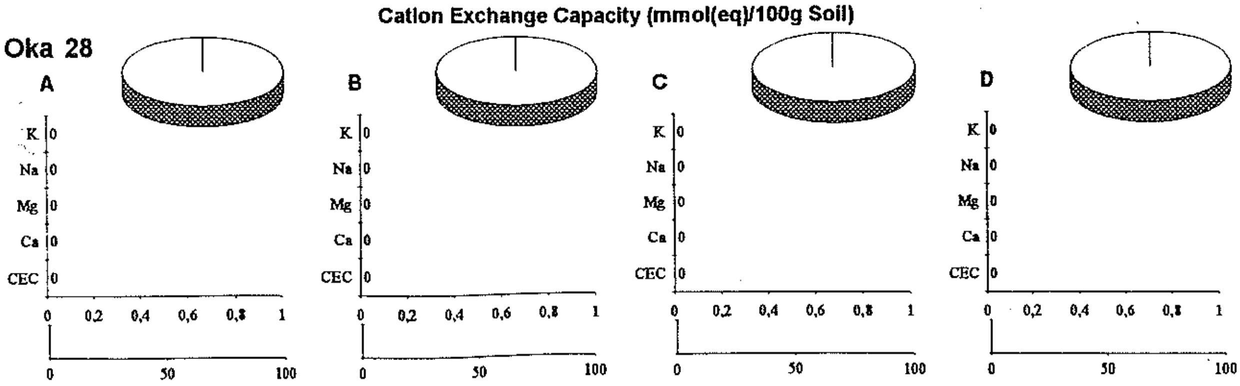
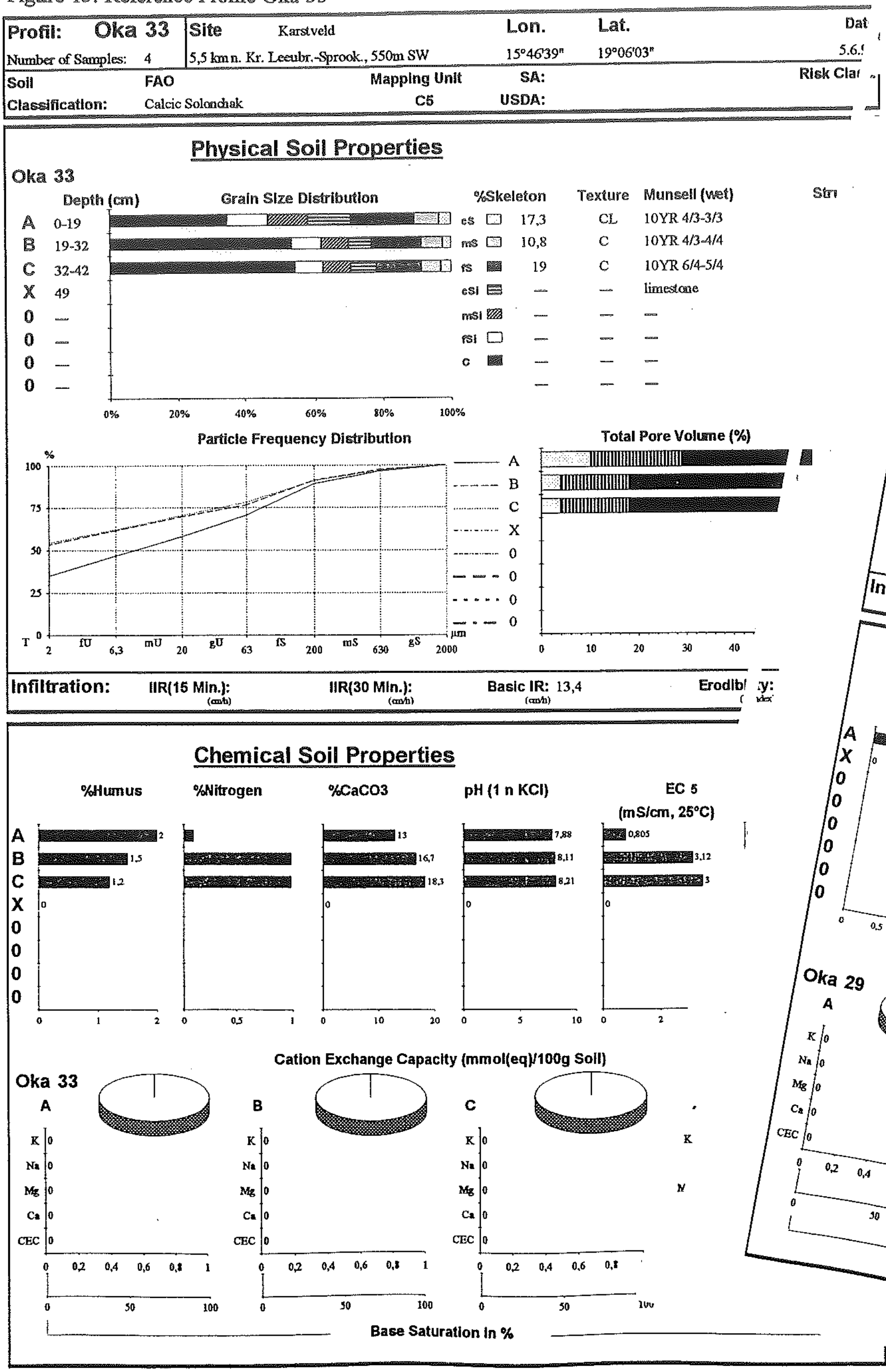


Figure 13: Reference Profile Oka 33



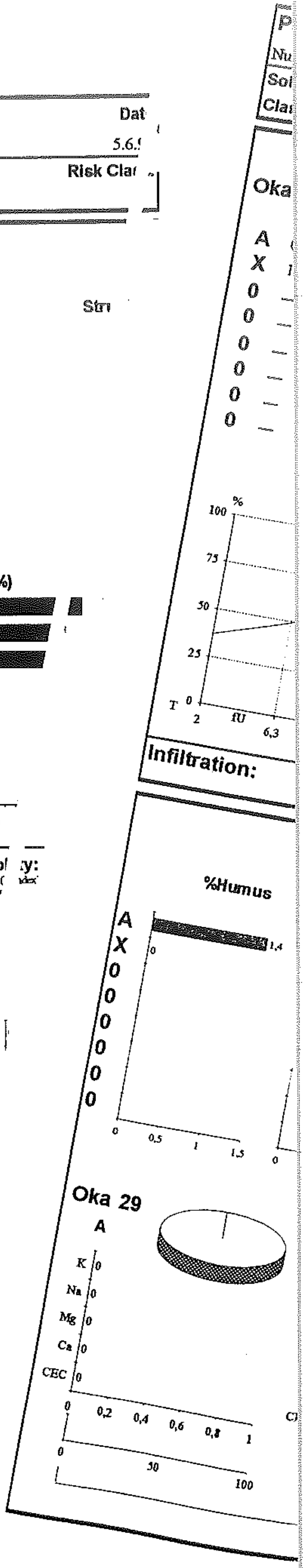



Figure 14: Reference Profile Oka 29

| Profil: Oka 29 | Site Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 2 | 1,1 km n. Kreuz. Leeubr.-Sprook., 150 m links | 15°48'37" | 19°04'31" | 4.6.91 |

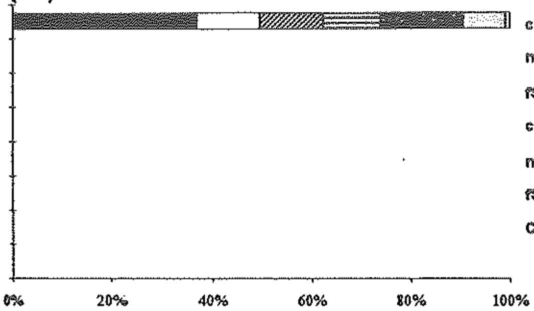
| Soil | FAO | Mapping Unit | SA: | Risk Class. |
|---|---|---|---|---|
| Classification: | Rendzic Leptosol | C5 | USDA: | |

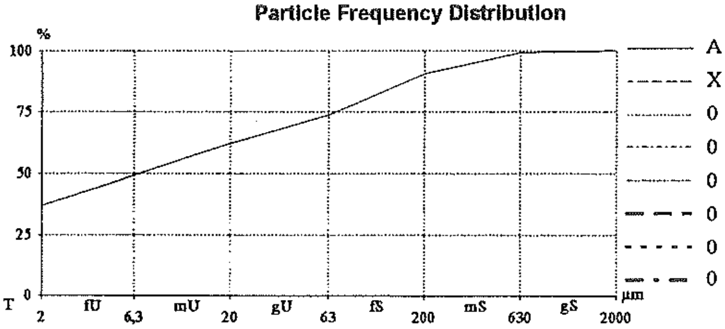
## Physical Soil Properties

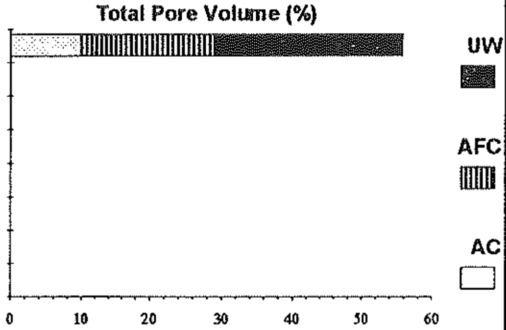
Oka 29

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-17 | 28,5 | CL | 10YR 5/2 | sig |
| X | 17 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

Grain Size Distribution

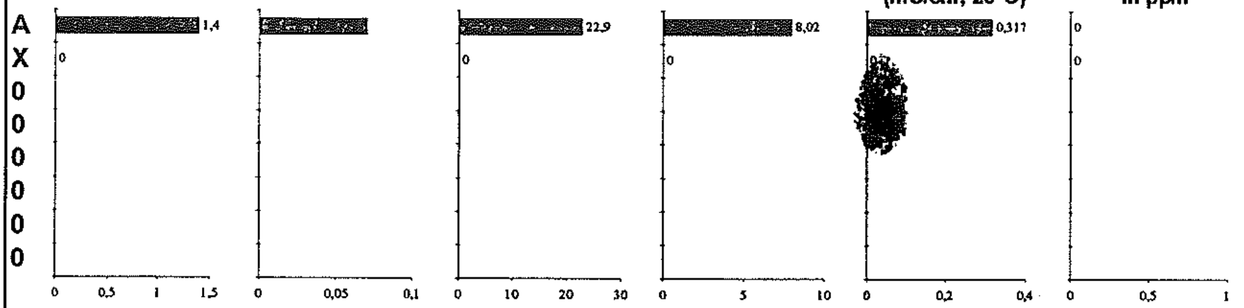


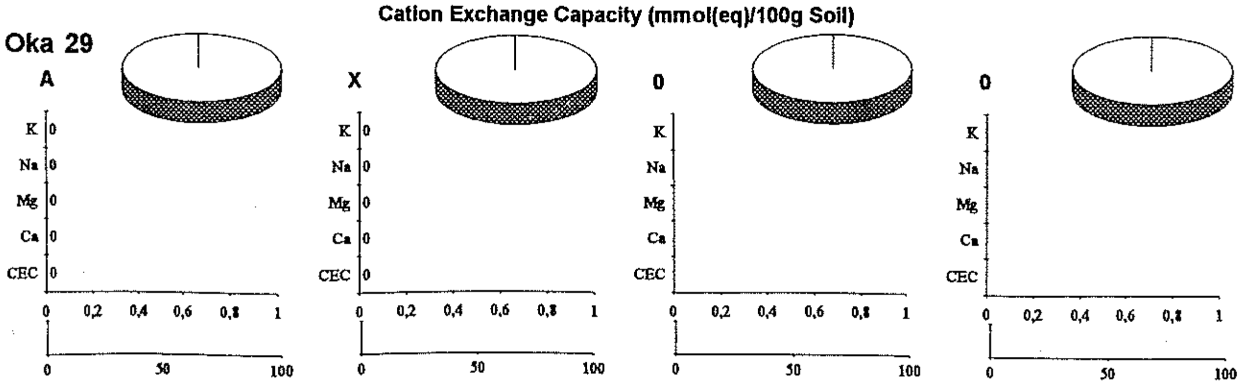

**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 8,5 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

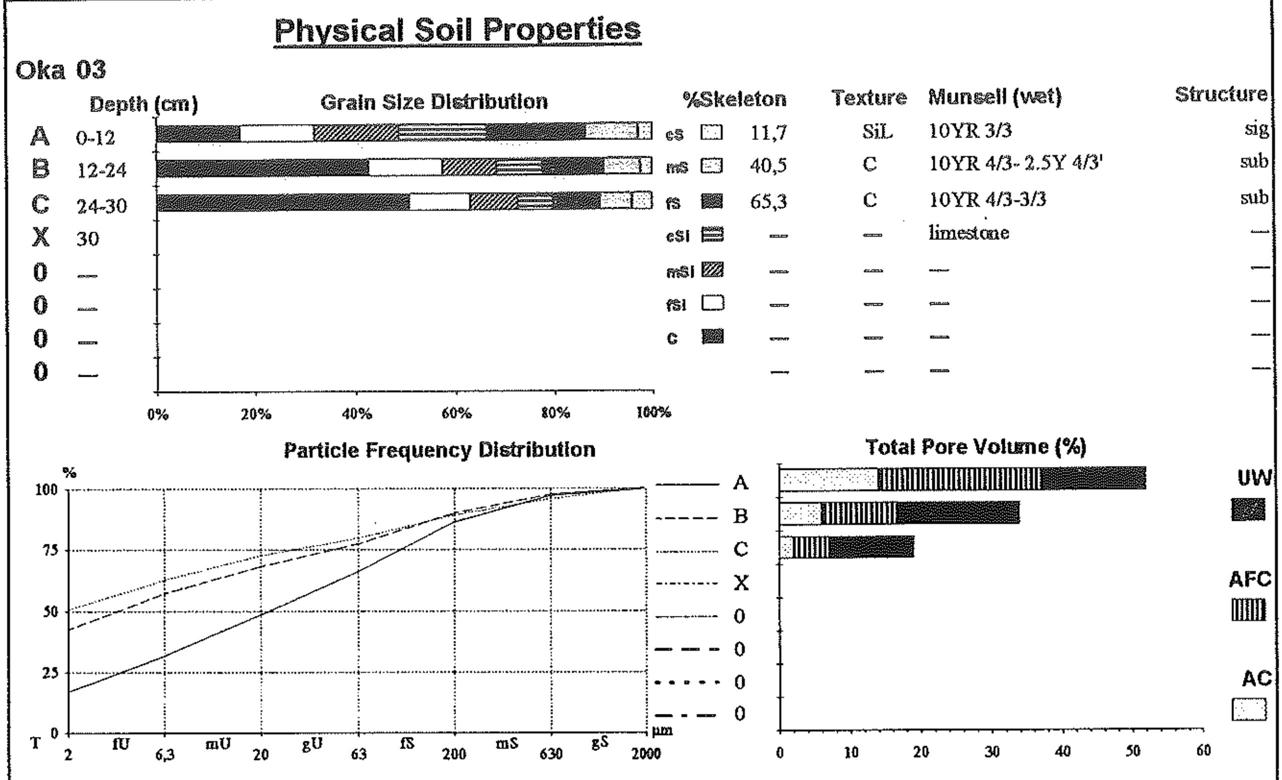
Oka 29




Base Saturation in %

Figure 15: Reference Profile Oka 3

| | | | | |
|---|---|---|---|---|
| **Profil:** Oka 03 | **Site** Etosha Pan | **Lon.** | **Lat.** | **Date** |
| Number of Samples: 4 | 4 km N von Okauk.-Okond., 100 m W v. pad | 15°54'15" | 19°08'37" | 14.5.91 |
| **Soil Classification:** FAO Rudi-Mollic Leptosol | **Mapping Unit** C5 | **SA:** **USDA:** | | **Risk Class.** |




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 17,9 (cm/h) Erodibility: 1 (F-Index)

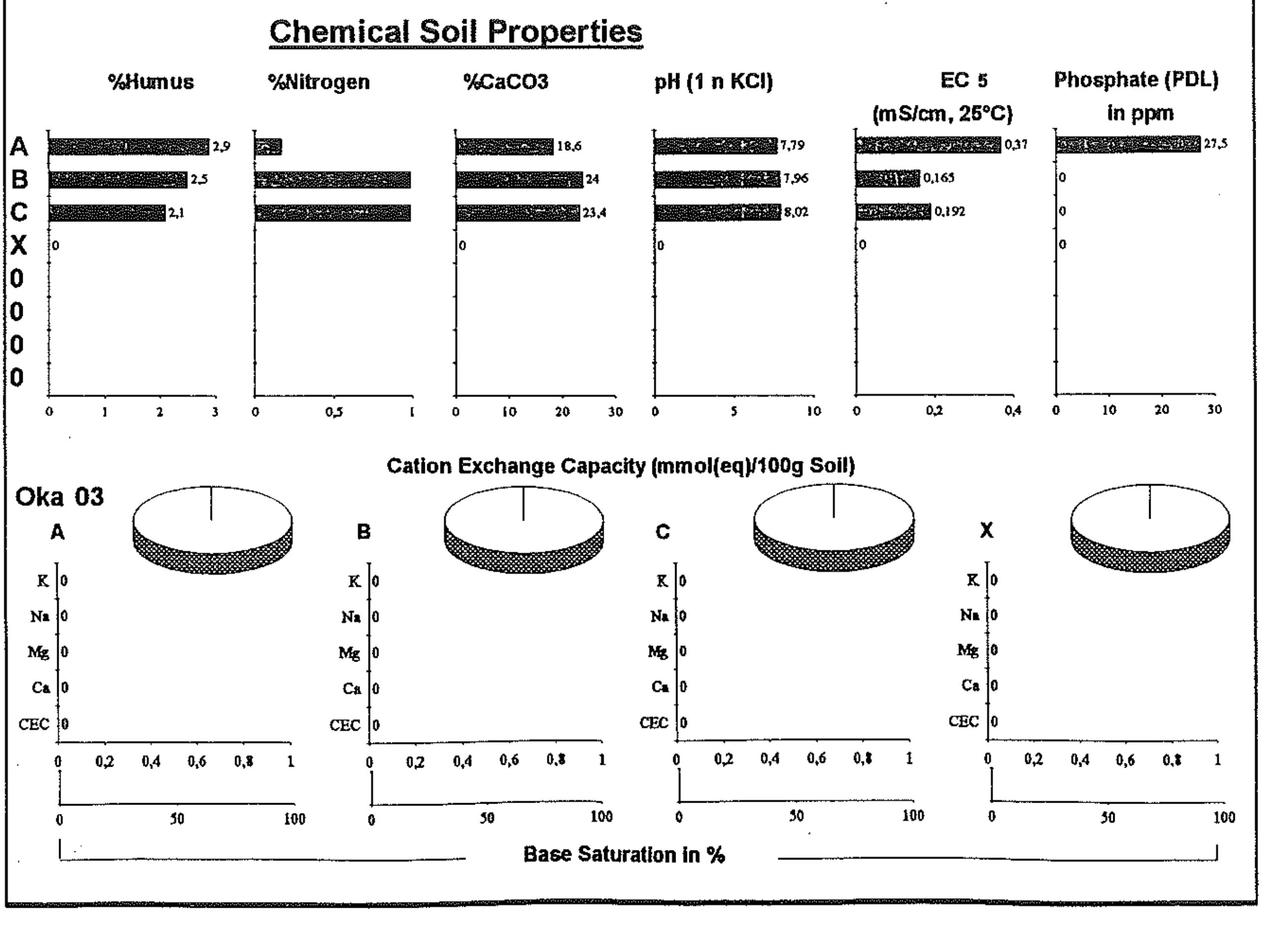


Figure 16: Reference Profile Oka 56

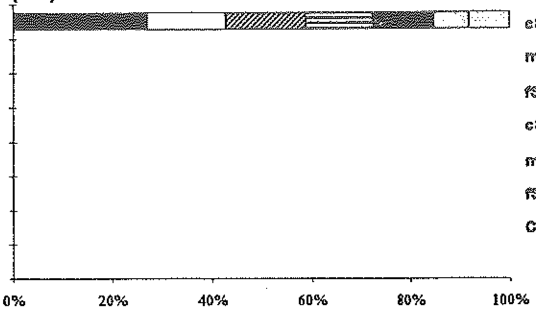
| **Profil:** Oka 56 | **Site** Etosha Pan | **Lon.** | **Lat.** | **Date** |
|---|---|---|---|---|
| Number of Samples: 2 | 2,1 km n. Einmünd. AF - Okond., 100 m rechts | 15°54'14" | 19°08'06" | 13.6.91 |
| **Soil** FAO | **Mapping Unit** | **SA:** | | **Risk Class.** |
| **Classification:** Hypercalcaric Regosol | C5 | **USDA:** | | |

## Physical Soil Properties

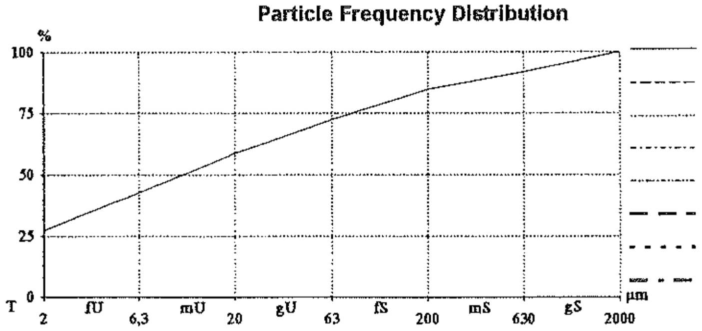
**Oka 56**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-15 | — | CL | 10YR 3/3-3/4 | sig |
| X | 36 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

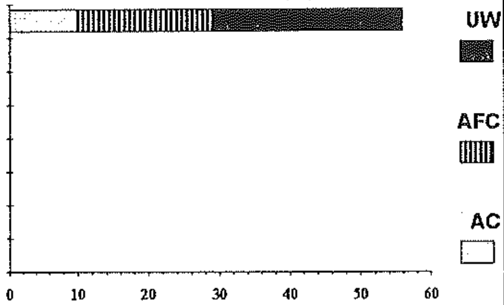
Grain Size Distribution




Particle Frequency Distribution

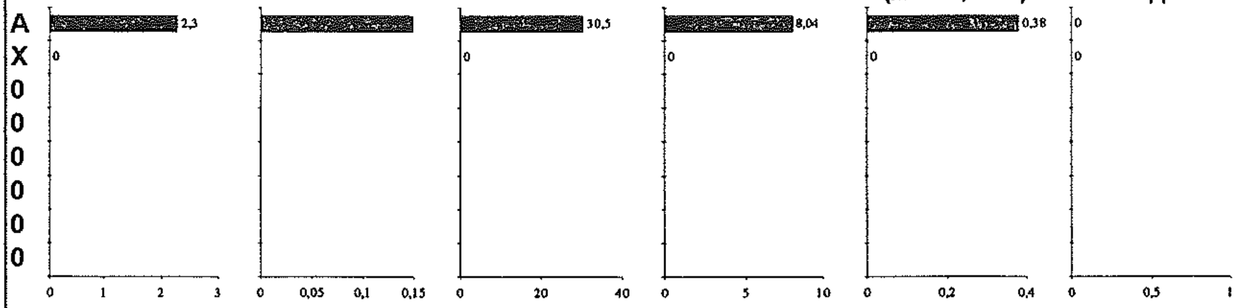



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 8,1 (cm/h) Erodibility: 1 (F-index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

**Oka 56**

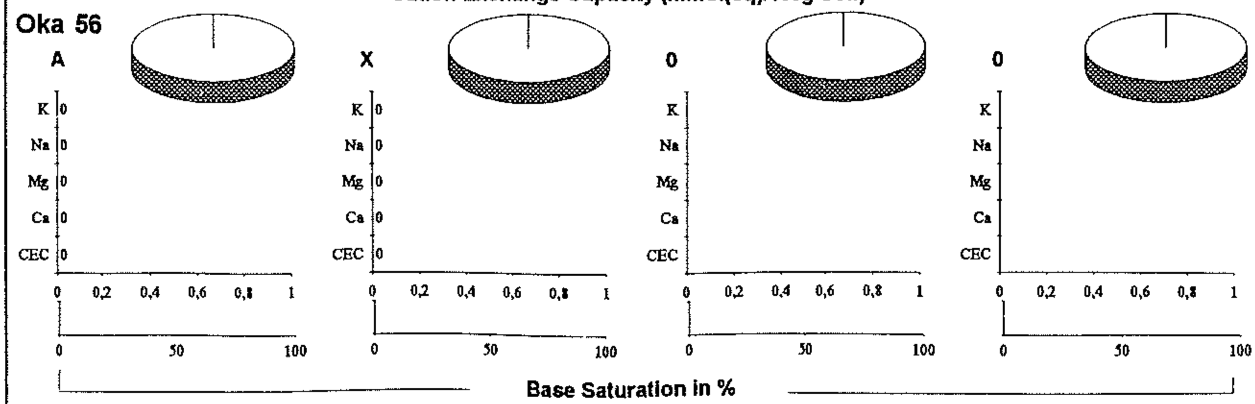


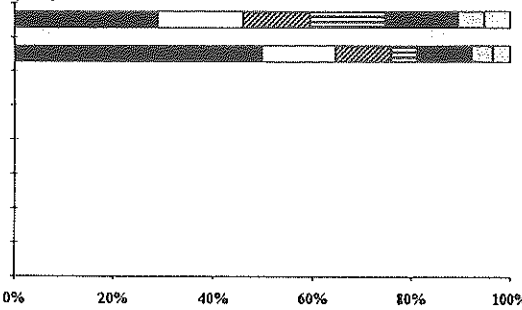
Figure 17: Reference Profile Oka 4

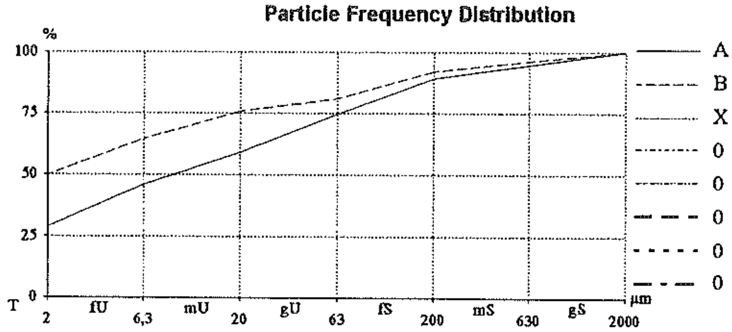
| Profil: Oka 04 | Site | | Lon. | Lat. | Date |
|---|---|---|---|---|---|
| Number of Samples: 3 | 7,4 km N Okauk.-Okond., 150 m v. pad | | 15°53'27" | 19°06'47" | 14.5.91 |
| Soil Classification: | FAO: Psammi-Calcaric Regosol | Mapping Unit: C5 | SA: | USDA: | Risk Class. |

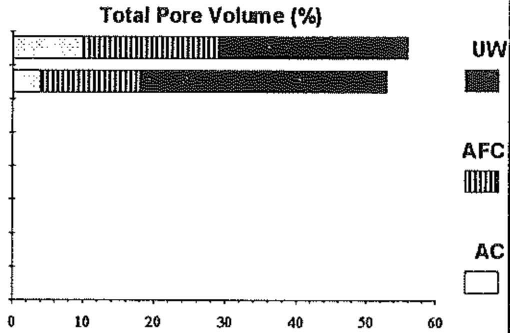
## Physical Soil Properties

**Oka 04**

| | Depth (cm) | Grain Size Distribution | | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|---|---|
| A | 0-18 | | eS | 0,1 | CL | 10YR 5/3-4/3 | koh-sub' |
| B | 18-40 | | mS | 0,1 | C | 10YR 5/3-5/4' | sub' |
| X | 40 | | fS | — | — | limestone | — |
| 0 | — | | cSi | — | — | — | — |
| 0 | — | | mSi | — | — | — | — |
| 0 | — | | fSi | — | — | — | — |
| 0 | — | | C | — | — | — | — |
| 0 | — | | | — | — | — | — |

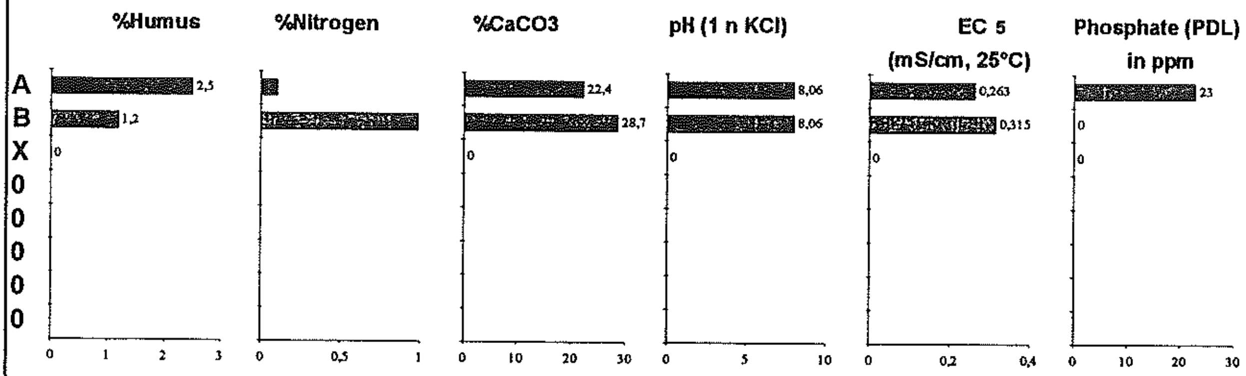



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 11,6 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



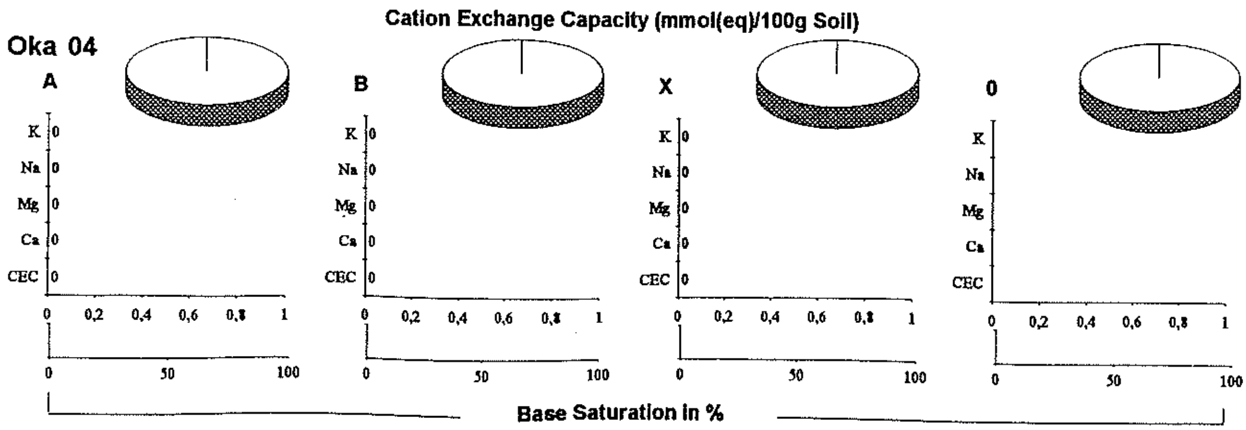
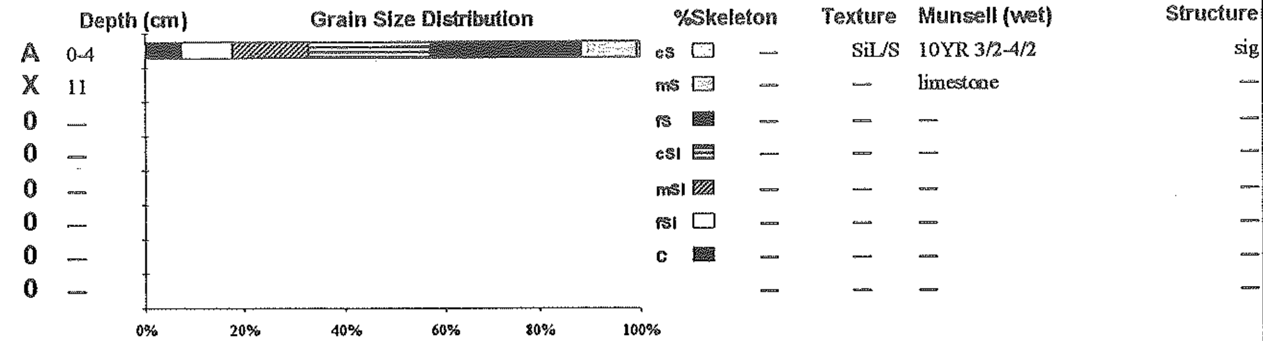



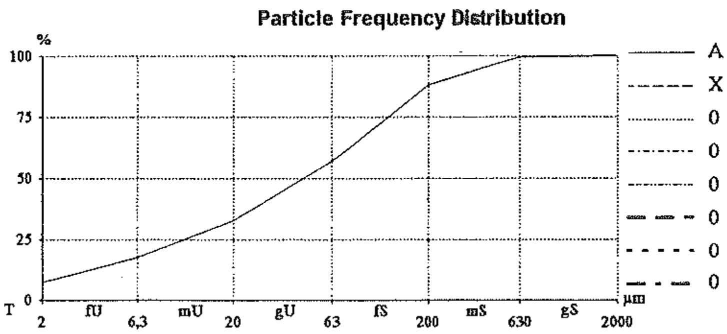
Figure 18: Reference Profile Oka 37

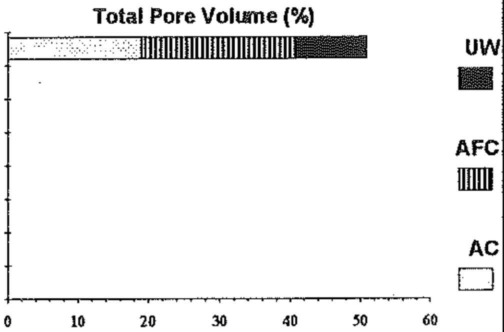
| Profil: **Oka 37** | Site Etosha Pan | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 2 | 4,1 km v. Leeubr.-Okauk., 400 m links | 15°50'50" | 19°05'50" | 7.6.91 |
| **Soil** FAO | **Mapping Unit** | **SA:** | | **Risk Class.** |
| **Classification:** Psammi-Eutric Leptosol | A6 | **USDA:** | | |

## Physical Soil Properties

**Oka 37**

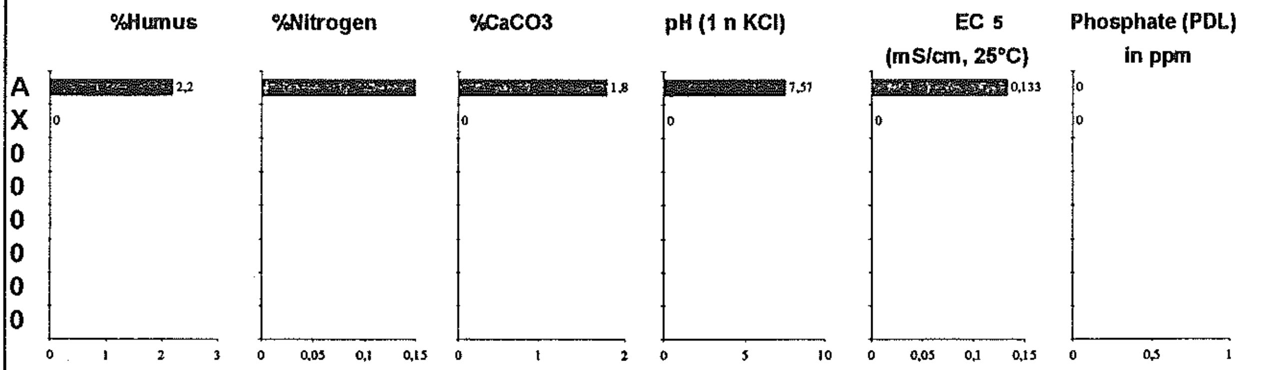



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 23,2 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



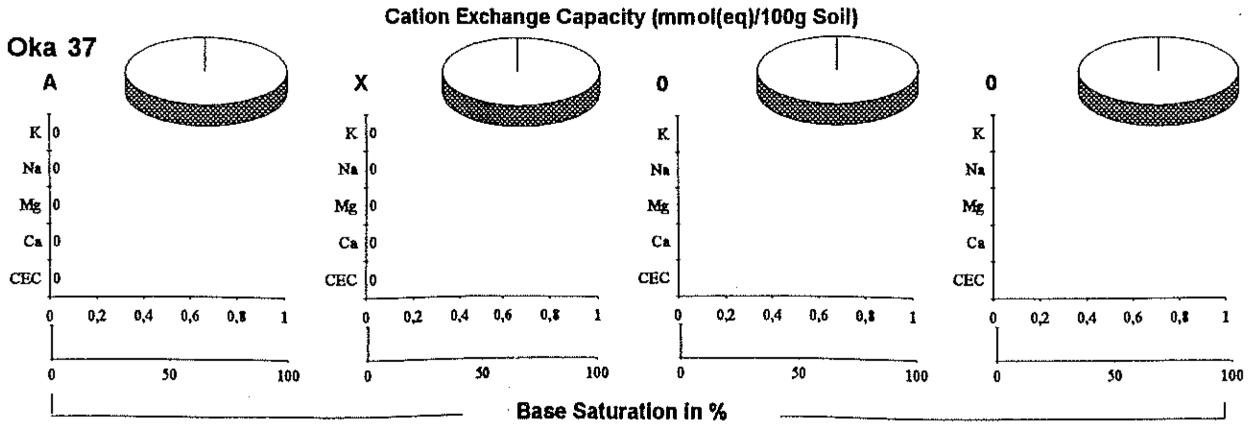



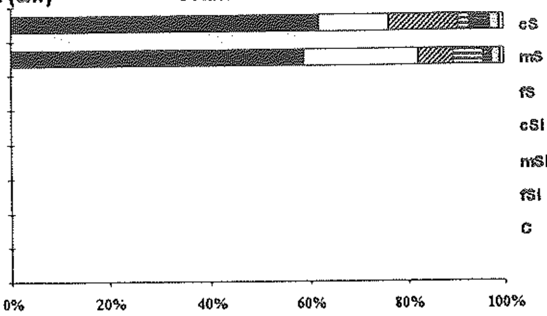
Figure 19: Reference Profile Oka 68

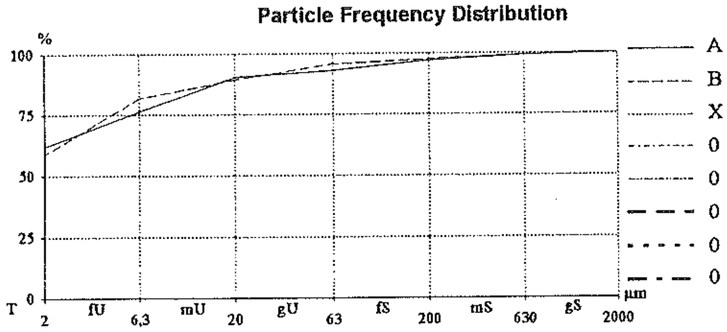
| | | | | | |
|---|---|---|---|---|---|
| **Profil:** Oka 68 | **Site** Karstveld | | **Lon.** | **Lat.** | **Date** |
| Number of Samples: 3 | 7,4 km n. Okauk.-Omb., 400m rechts | | 15°55'19" | 19°14'50" | 18.6.91 |
| **Soil** FAO | | **Mapping Unit** | **SA:** | | **Risk Class.** |
| **Classification:** Eutric Vertisol | | C2 | **USDA:** | | |

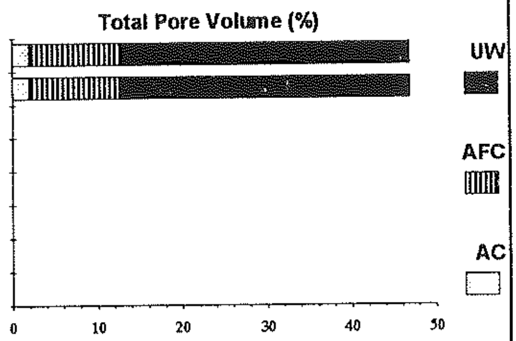
## Physical Soil Properties

**Oka 68**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-12 | 0,1 | C | 10YR 6/2-5/2 | pol |
| B | 28-34 | — | C | 10YR 6/3-6/2 | pol |
| X | ?? | — | — | too dense | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

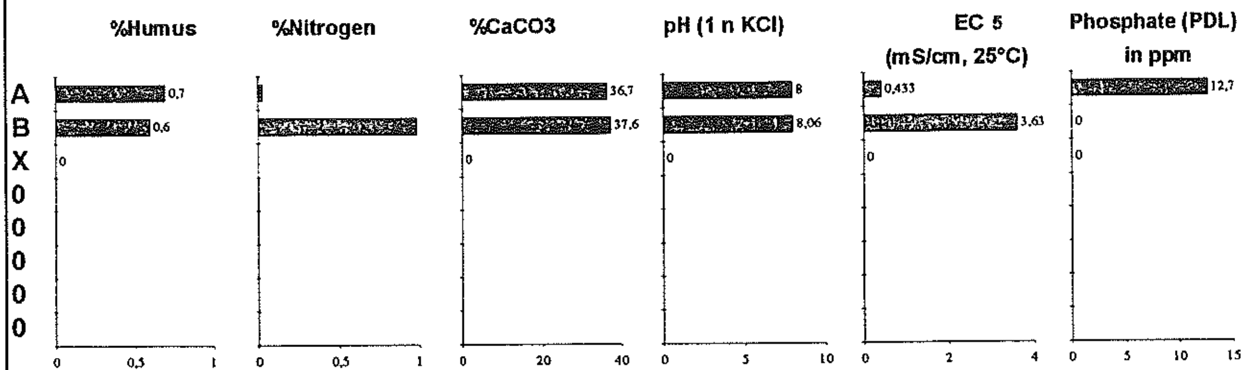


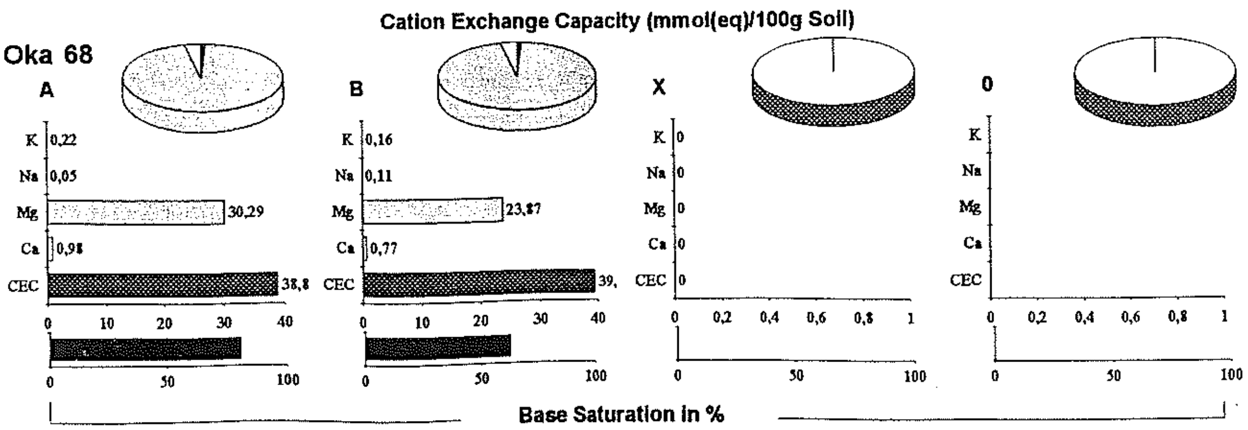




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



## Figure 20: Reference Profile Oka 70

| Profil: Oka 70 | Site: Etosha Pan | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 4 | 5,0 km n. Okauk.-Olibad, 50m links | 15°58'11" | 19°11'10" | 18.6.91 |

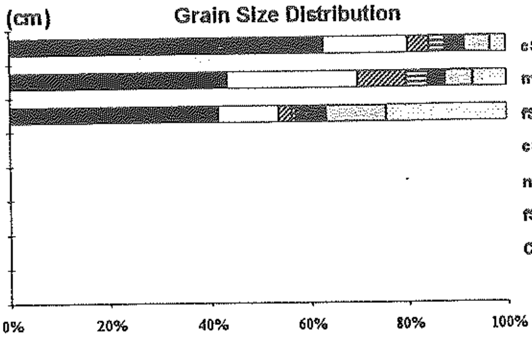
| Soil Classification: | FAO | Mapping Unit | SA: | Risk Class. |
|---|---|---|---|---|
| | Calcari-Hypersalic Fluvisol | D4 | USDA: | |

### Physical Soil Properties

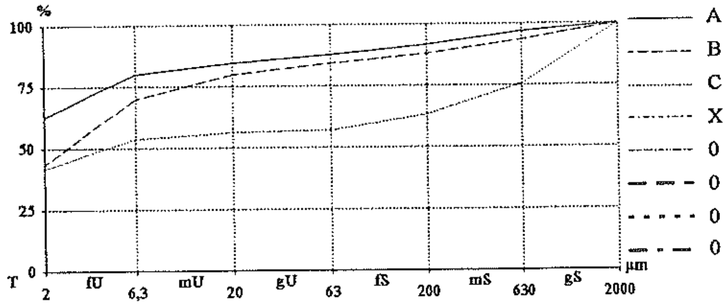
Oka 70

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-18 | 3,7 | C | 10YR 6/2-5/2 | pol-col |
| B | 23-30 | 5,5 | SiC | 10YR 5/2 | pol-col |
| C | 36-46 | 13,2 | C | 10YR 7/1-7/2 | sub-pol |
| X | 46 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

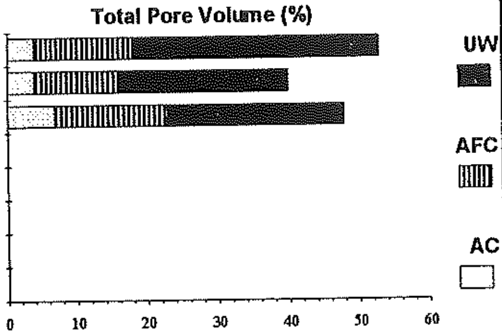
Grain Size Distribution




Particle Frequency Distribution

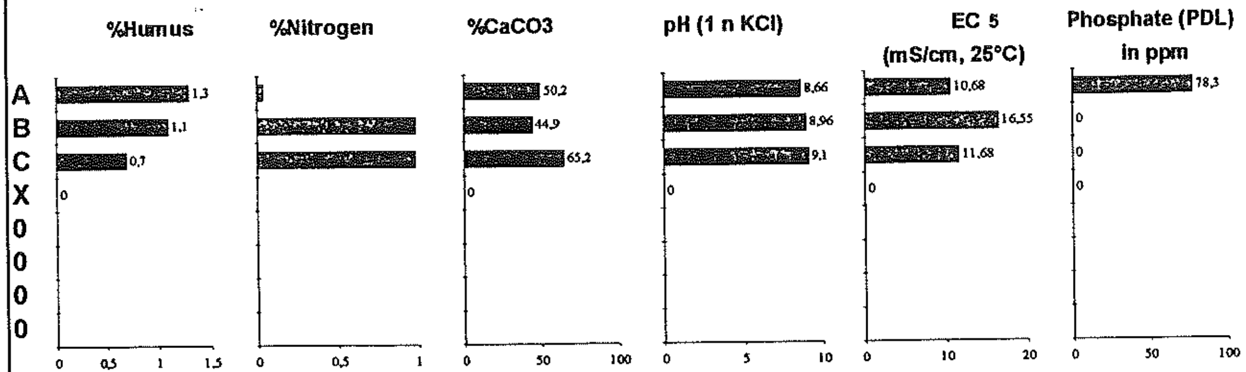



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: (cm/h) Erodibility: 1 (F-Index)

### Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

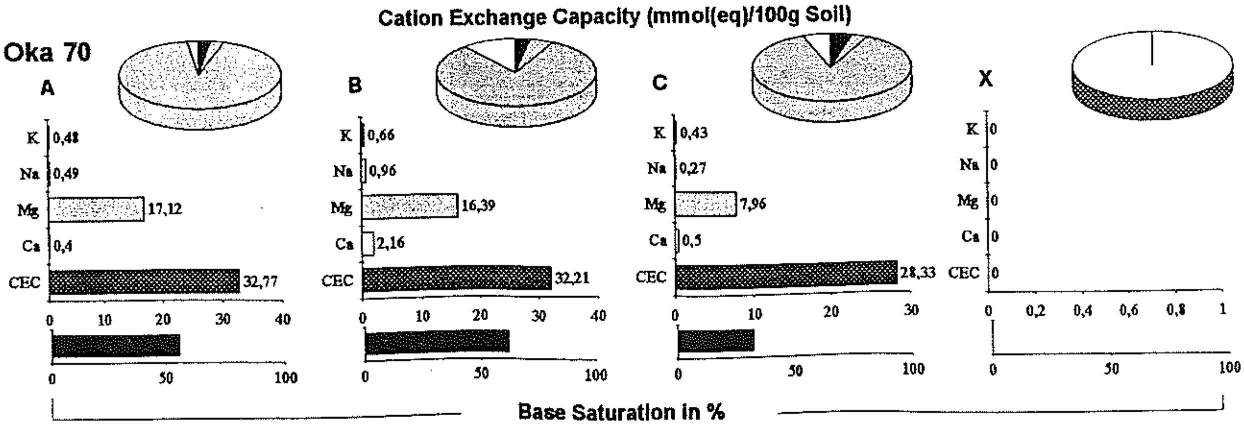


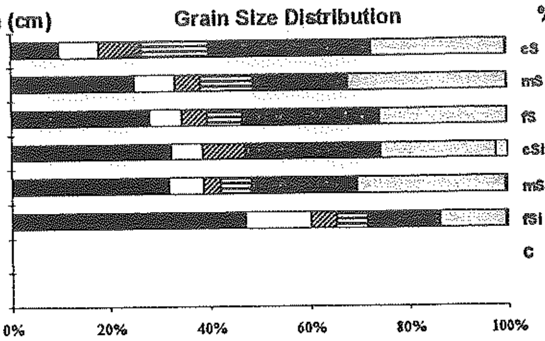
Figure 21: Reference Profile Oka 60

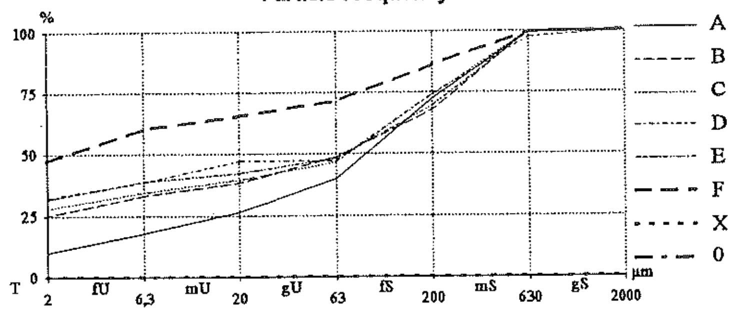
| Profil: Oka 60 | Site | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 7 | Etosha Pan<br>Wolfsness, links | 15°53'16" | 19°02'47" | 15.6.91 |
| Soil Classification: | FAO: Calcic Solonchak | Mapping Unit: A6 | SA:<br>USDA: | Risk Class. |

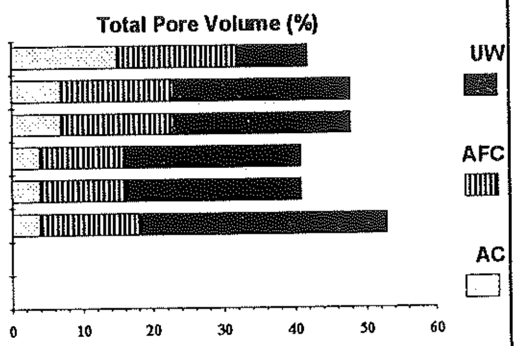
## Physical Soil Properties

Oka 60

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-12 | — | SL | 10YR 5/3 | sig-sub |
| B | 12-26 | — | SCL | 10YR6/4-5/4 | sub |
| C | 38-45 | — | SCL | 10YR 5/3 + 10YR7/3+6 | sub |
| D | 50-58 | — | SCL | 10YR 6/4-5/4 | sub-pol |
| E | 64-74 | — | SCL | 10YR 4/7 m. 10YR 6/3 | sub |
| F | 78-81 | — | C | 10YR 8/3-8/2 m.10YR | sub |
| X | 85 | — | — | limestone | — |
| 0 | — | — | — | — | — |

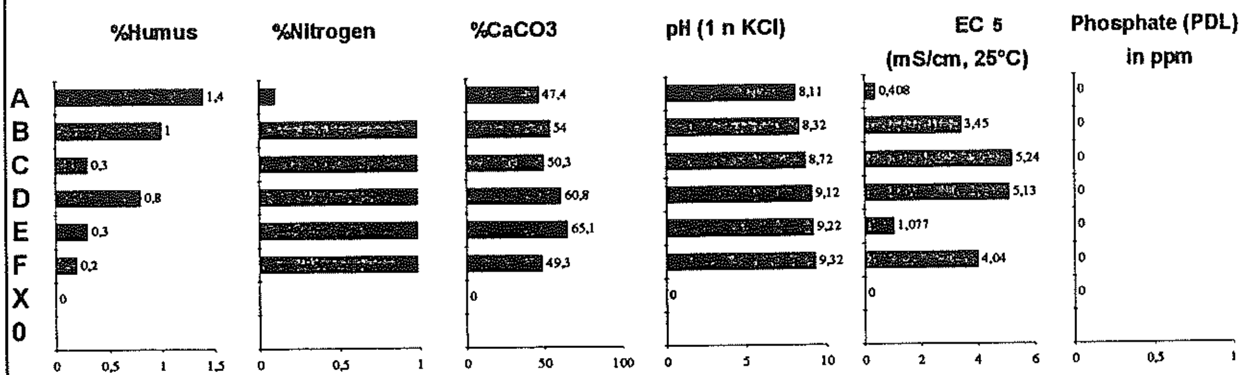



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 15,2 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

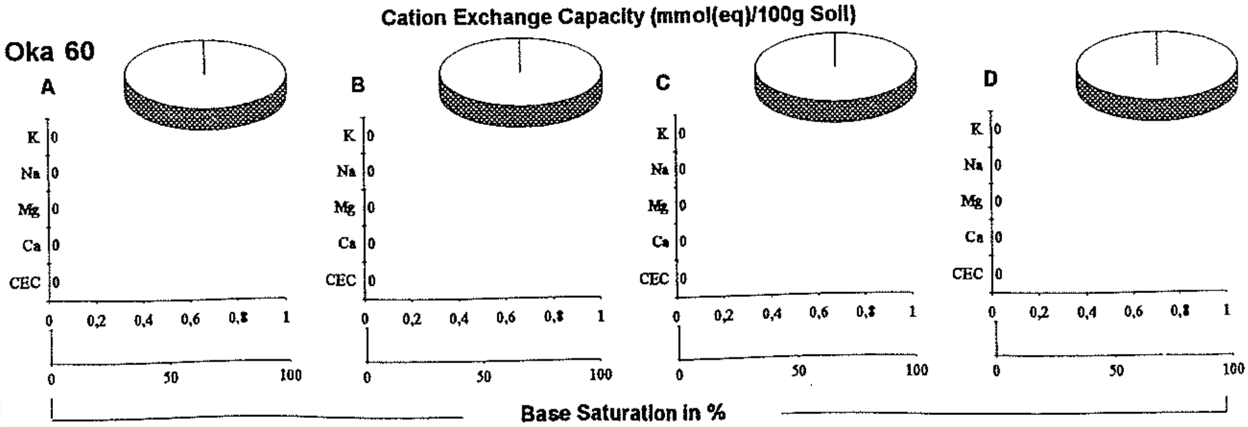


Figure 22: Reference Profile Odo 42

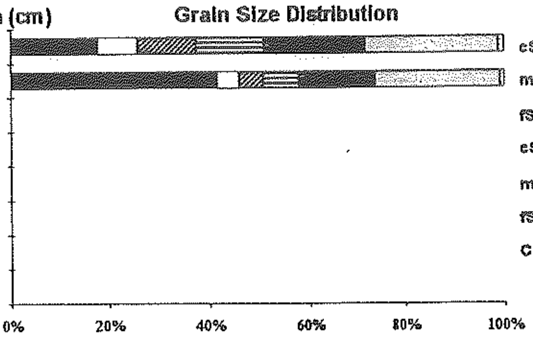
| Profil: Odo 42 | Site: Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 3 | 4,0 km n. Olibad, 200 m links | 16°09'41" | 19°13'26" | 5.7.91 |

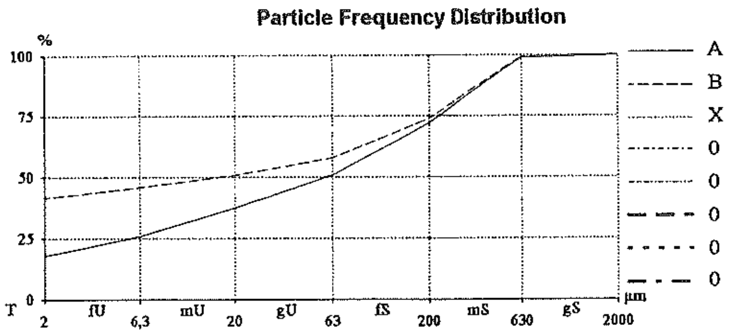
| Soil Classification: | FAO: Rudi-Psammi-Eutric Leptosol | Mapping Unit: C2 | SA: | Risk Class. |
|---|---|---|---|---|
| | | | USDA: | |

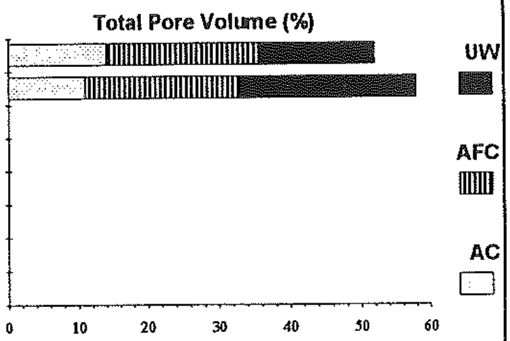
## Physical Soil Properties

Odo 42

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-19 | 0,1 | L | 10YR 3/2 | koh-pol' |
| B | 19-31 | 0,1 | C | 10YR 2/2 | koh |
| X | 37 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

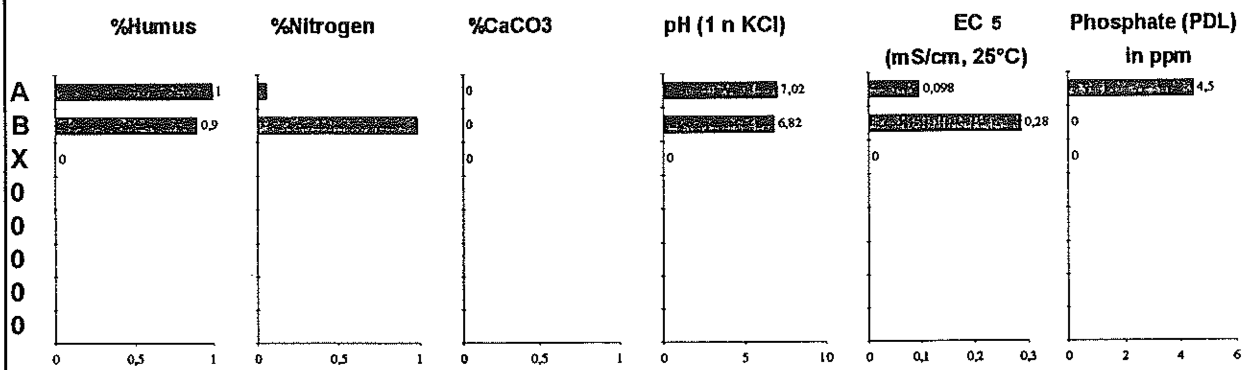



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 4,9 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



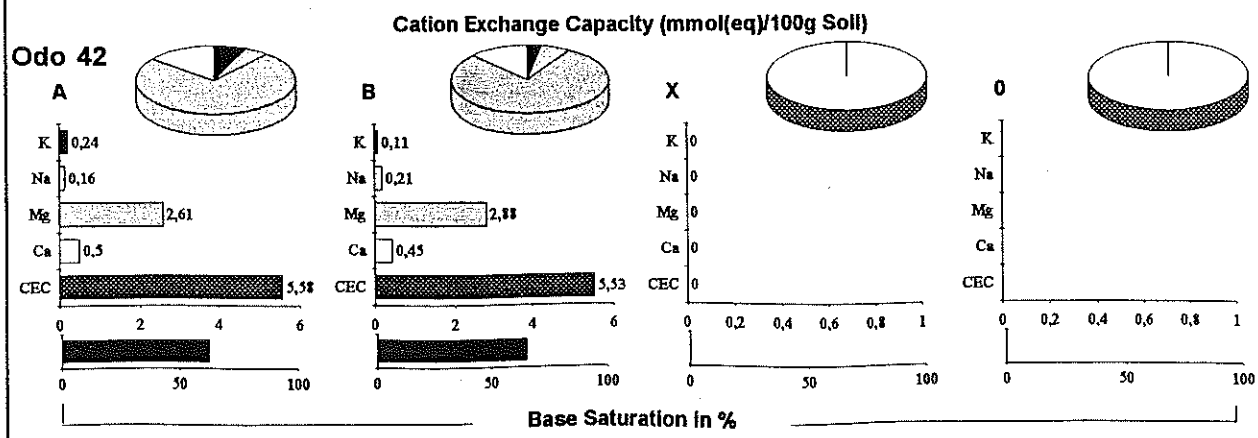



Figure 23: Reference Profile Odo 46

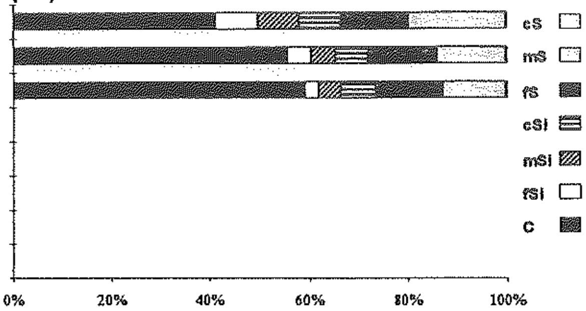
| **Profil:** | **Odo 46** | **Site** | Karstveld | **Lon.** | **Lat.** | **Date** |
|---|---|---|---|---|---|---|
| Number of Samples: | 4 | 1,4 km n. Aus a. FBR, rechts | | 16°12'22" | 19°12'27" | 9.7.91 |
| **Soil** | **FAO** | | **Mapping Unit** | **SA:** | | **Risk Class.** |
| **Classification:** | Psammi-Eutric Vertisol | | C2 | **USDA:** | | |

## Physical Soil Properties

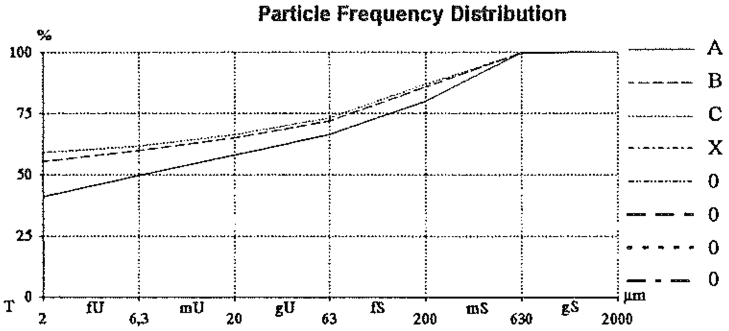
**Odo 46**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-16 | — | C/CL | 10YR 2/1 | pol |
| B | 27-36 | — | C | dito | — |
| C | 53-60 | — | C | dito | — |
| X | 60 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

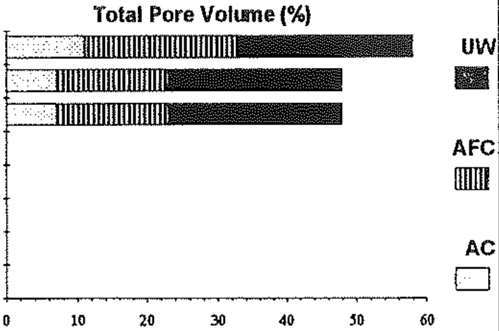
**Grain Size Distribution**




**Particle Frequency Distribution**

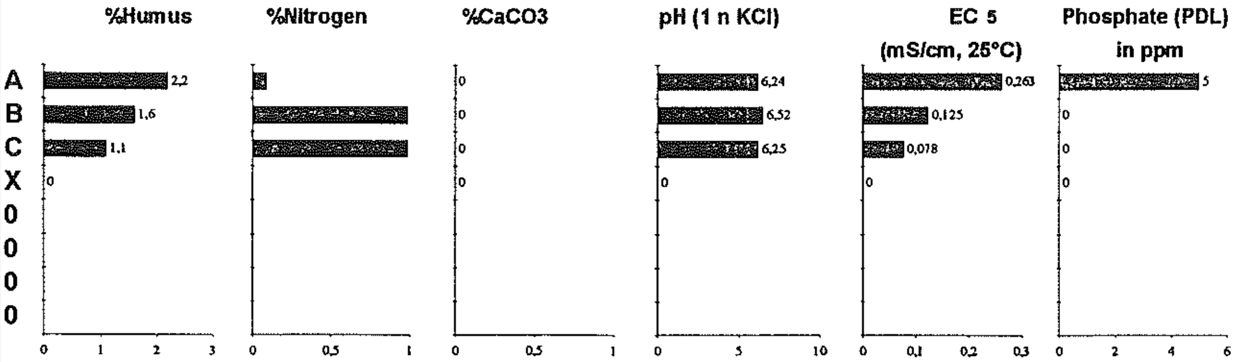



**Total Pore Volume (%)**




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) **Basic IR:** 9,5 (cm/h) **Erodibility:** 1 (F-Index)

## Chemical Soil Properties




**Cation Exchange Capacity (mmol(eq)/100g Soil)**

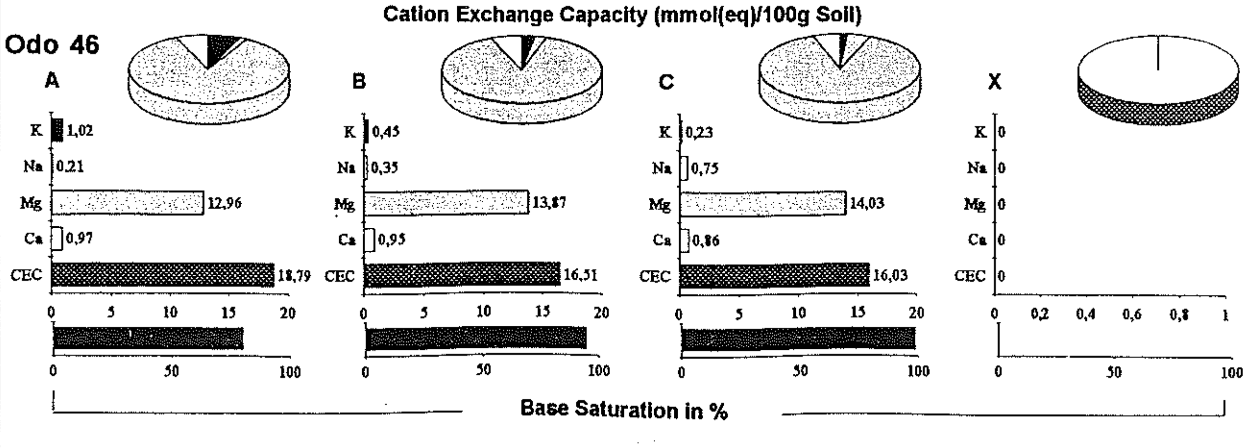


Figure 24: Reference Profile Odo 32

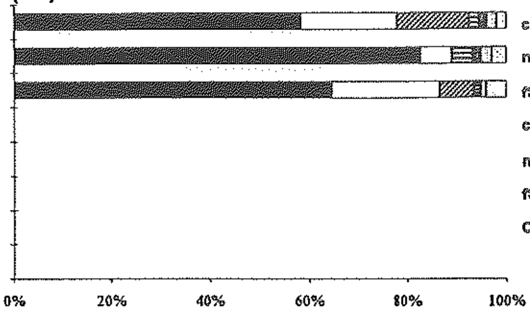
| Profil: **Odo 32** | Site Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 4 | 1,5 km Ri.Homeb v.Halapad, 100 m r. | 16°12'11" | 19°03'55" | 3.7.91 |
| Soil Classification: FAO Psammi-Eutric Vertisol | Mapping Unit C3 | SA: USDA: | | Risk Class. |

## Physical Soil Properties

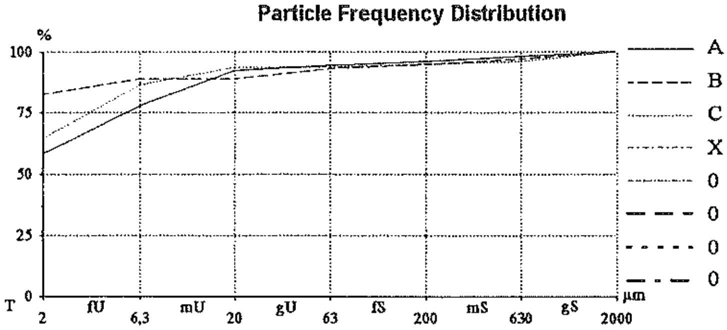
**Odo 32**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-10 | 20,9 | C | 10YR 6/1-5/1 | pol-col |
| B | 20-26 | 10,9 | C | 10YR 5/1-6/1 | pol-col |
| C | 35-40 | 19,4 | C | 10YR 4/1 | pol |
| X | ?? | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

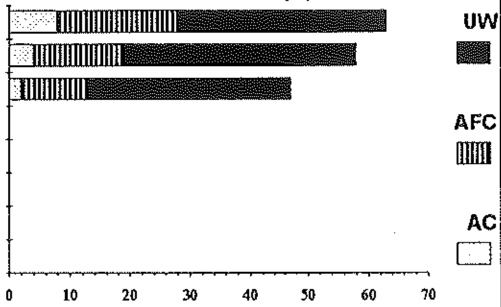
Grain Size Distribution




Particle Frequency Distribution

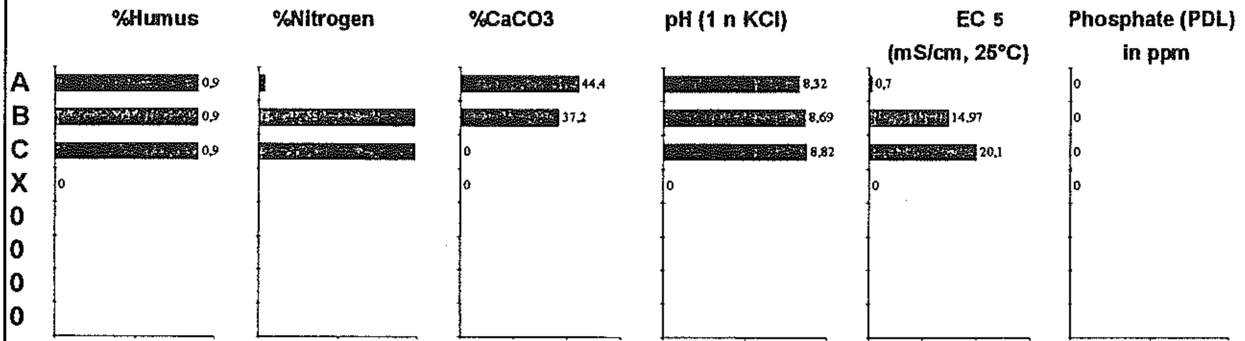



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

**Odo 32**

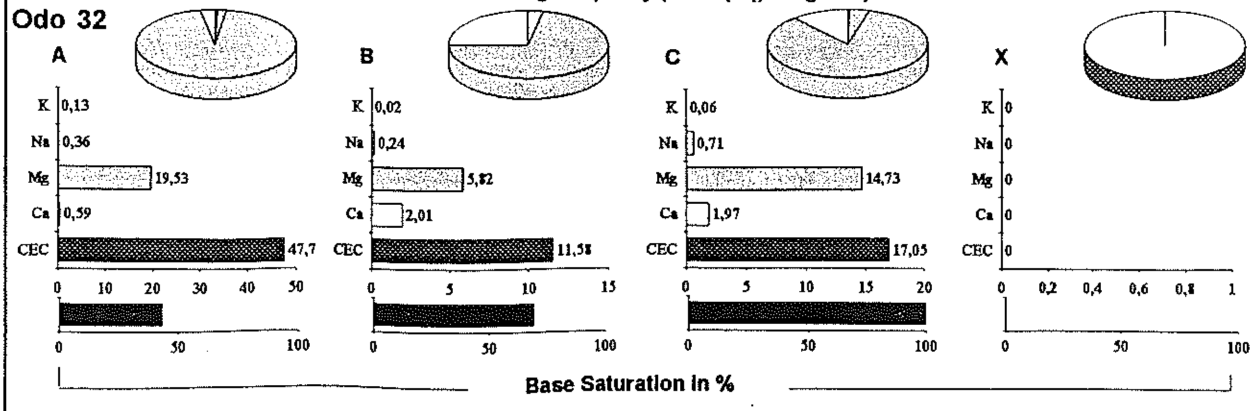


Figure 25: Reference Profile Odo 4

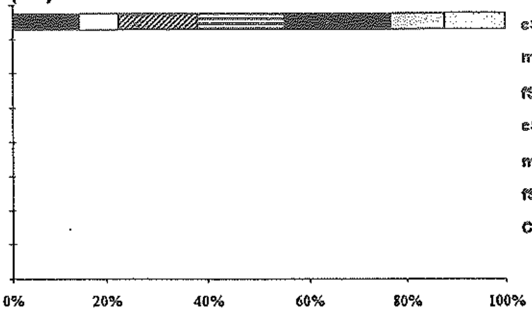
| Profil: Odo 04 | Site: Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 2 | 8,6 km E Abzw.Gaseb Ri.Gemsbofl., 150m r. | 16°02'49" | 19°12'37" | 20.6.91 |

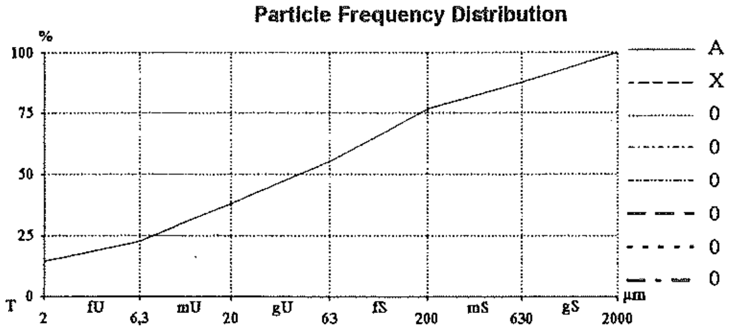
| Soil Classification: | FAO: Psammi-Lithic Leptosol | Mapping Unit: C2 | SA: | Risk Class. |
|---|---|---|---|---|
| | | | USDA: | |

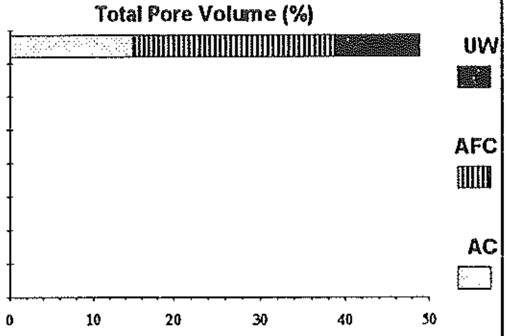
## Physical Soil Properties

Odo 04

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-11 | 31,1 | L | 10YR 3/2-3/4 | koh-sub' |
| X | 11 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

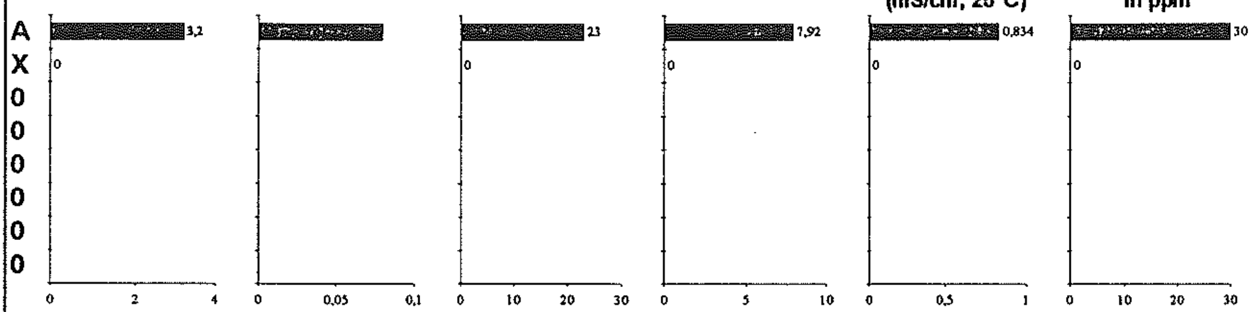



**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 18,5 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties



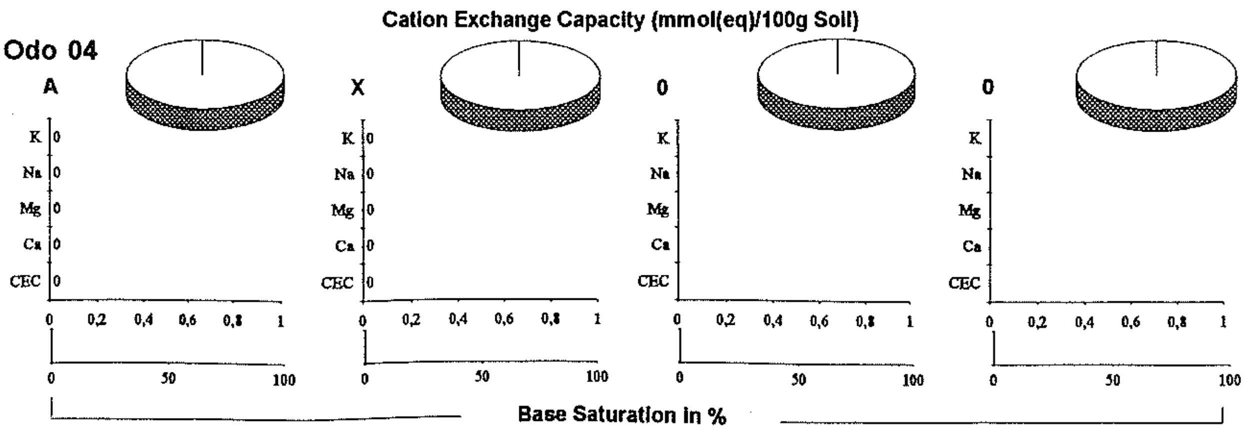



Figure 26: Reference Profile Odo 8

| Profil: Odo 08 | Site Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 2 | 6,7 km S Abzw. Gaseb, 200 m l. | 16°02'02" | 19°14'28" | 1.7.91 |

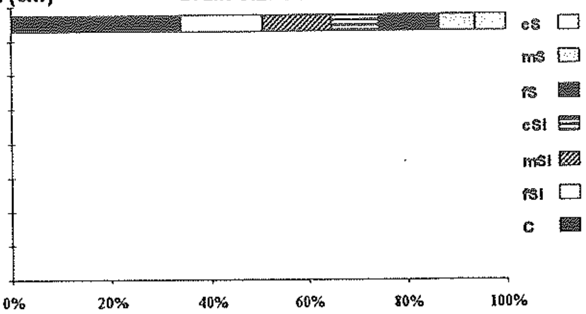
| Soil Classification: | FAO | Mapping Unit | SA: | Risk Class. |
|---|---|---|---|---|
| | Lithi-Calcaric Regosol | C2 | USDA: | |

## Physical Soil Properties

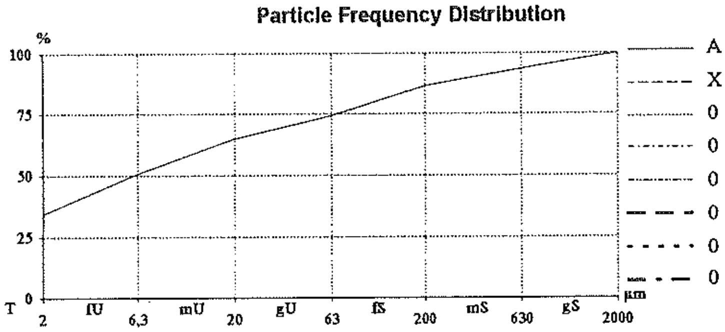
Odo 08

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-18 | — | CL | 10YR 4/3-3/3 | koh-sub' |
| X | 35 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

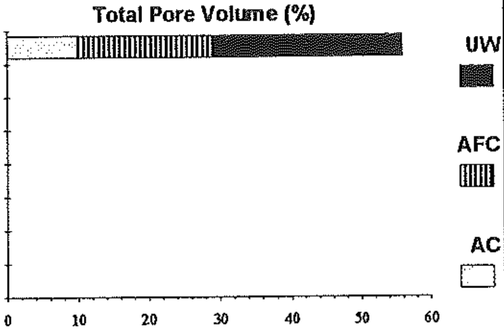
Grain Size Distribution




Particle Frequency Distribution

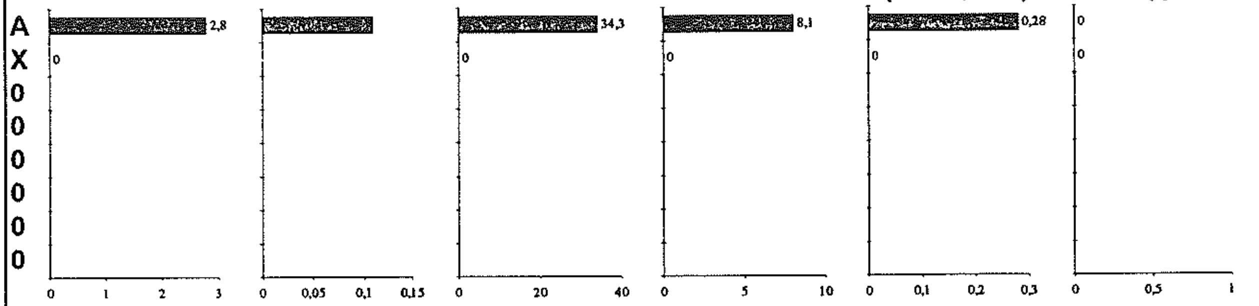



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 11 (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

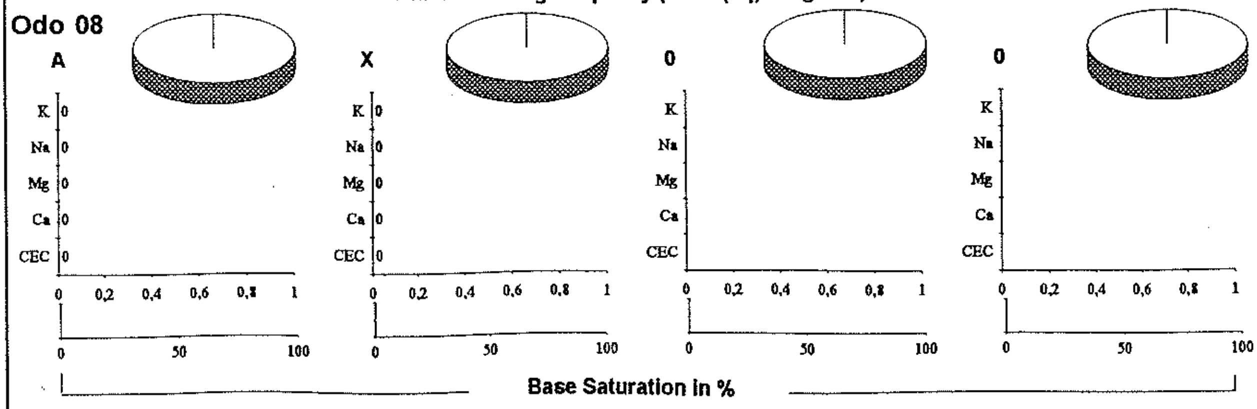


Figure 27: Reference Profile Odo 16

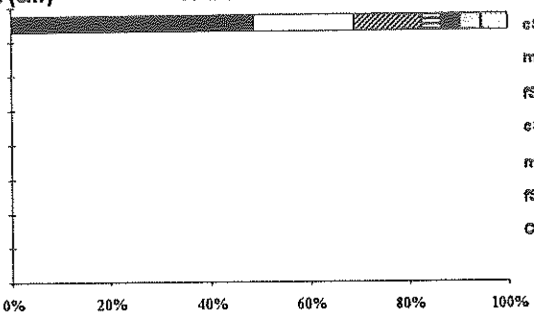
| | | | | | |
|---|---|---|---|---|---|
| **Profil:** Odo 16 | **Site** Karstveld | | **Lon.** | **Lat.** | **Date** |
| Number of Samples: 2 | 1 km E Einmünd. Halapad, r. | | 16°00'29" | 19°09'41" | 1.7.91 |
| **Soil Classification:** | **FAO** Hypersalic Fluvisol | **Mapping Unit** D4 | **SA:** **USDA:** | | **Risk Class.** |

## Physical Soil Properties

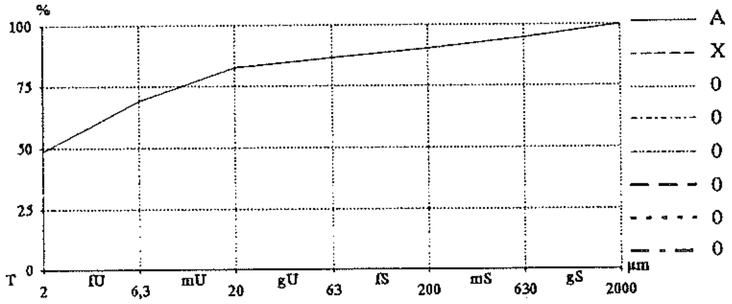
**Odo 16**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-10 | 6,6 | SiCL | 10 YR 3/3-4/3 | sub-pol |
| X | 30 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

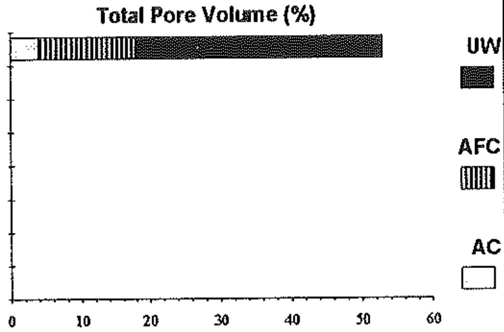
Grain Size Distribution




Particle Frequency Distribution

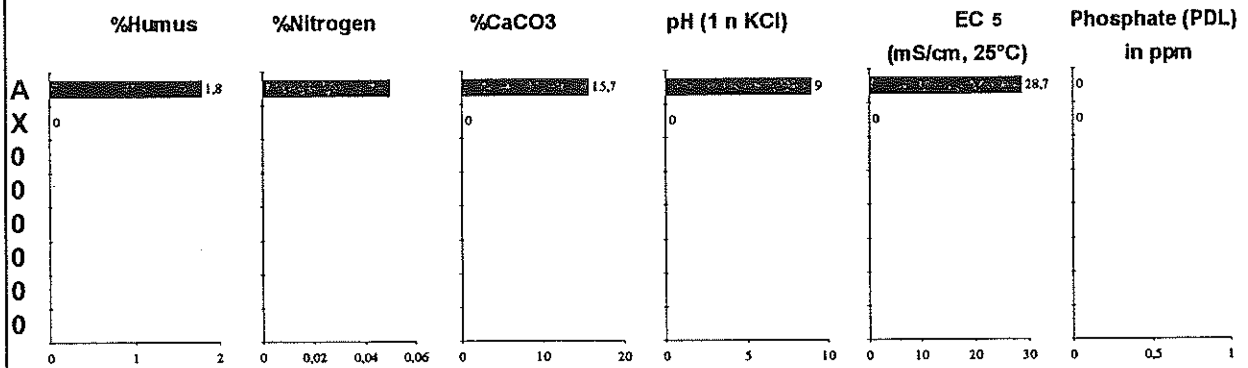



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: (cm/h) Erodibility: 1 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

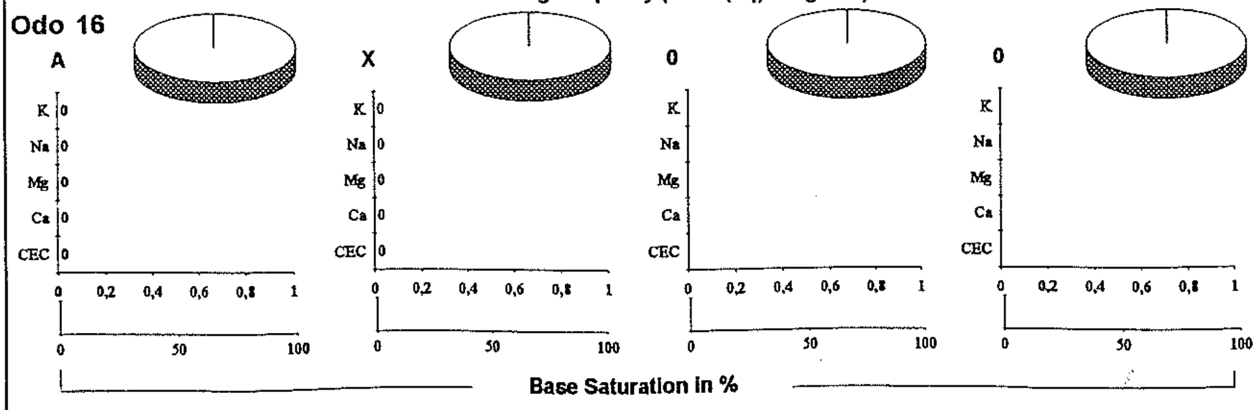


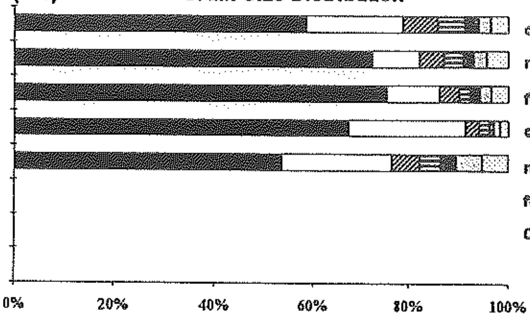
Figure 28: Reference Profile Odo 17

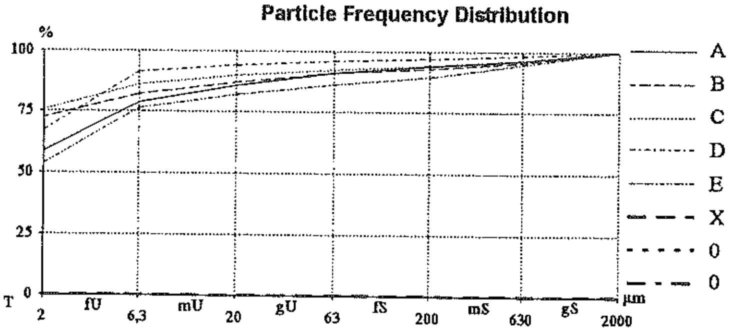
| Profil: Odo 17 | Site Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 6 | 1km W Abzw.Gemfla., auf Halapad, 100m l. | 16°01'23" | 19°09'15" | 2.7.91 |
| Soil Classification: FAO Calcic Solonchak | Mapping Unit C5 | SA: USDA: | | Risk Class. |

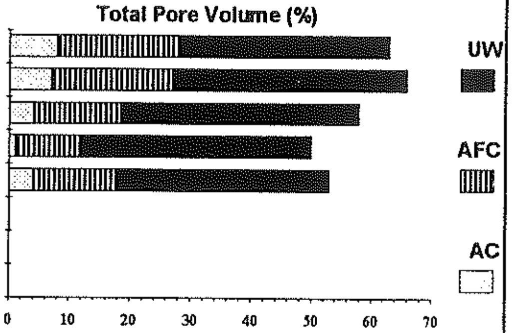
## Physical Soil Properties

Odo 17

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-9 | 12,8 | C | 10YR 4/3-3/2 | sig-koh |
| B | 9-24 | 4,3 | C | 10YR 5/2-4/2 | pol-col |
| C | 38-44 | — | C | 10YR 5/4-5/3-4/3' | pol-col' |
| D | 61-68 | — | C | 10YR 6/4 m.5/2-6/3 F | pol |
| E | 75-81 | — | C | 10YR 7/3 m. 8/3 Flec | sub |
| X | 81 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

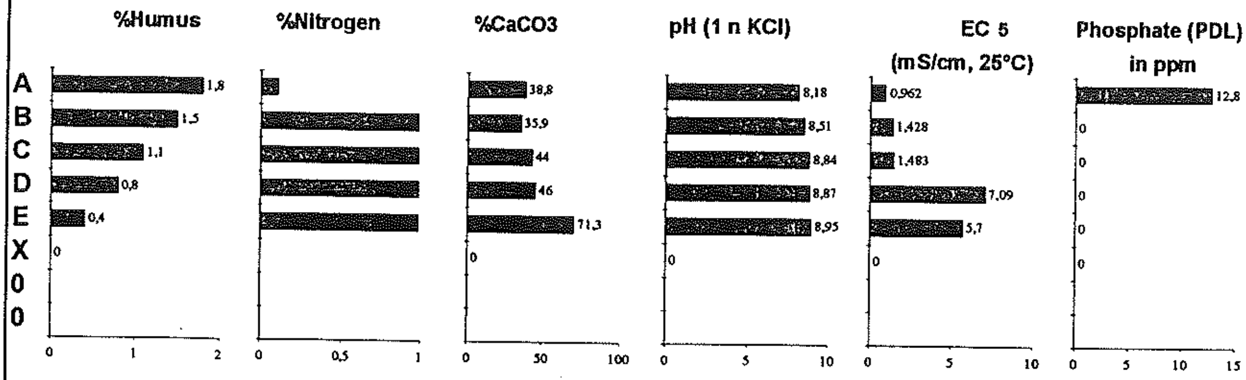



Infiltration: IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: (cm/h) Erodibility: 2 (F-Index)

## Chemical Soil Properties



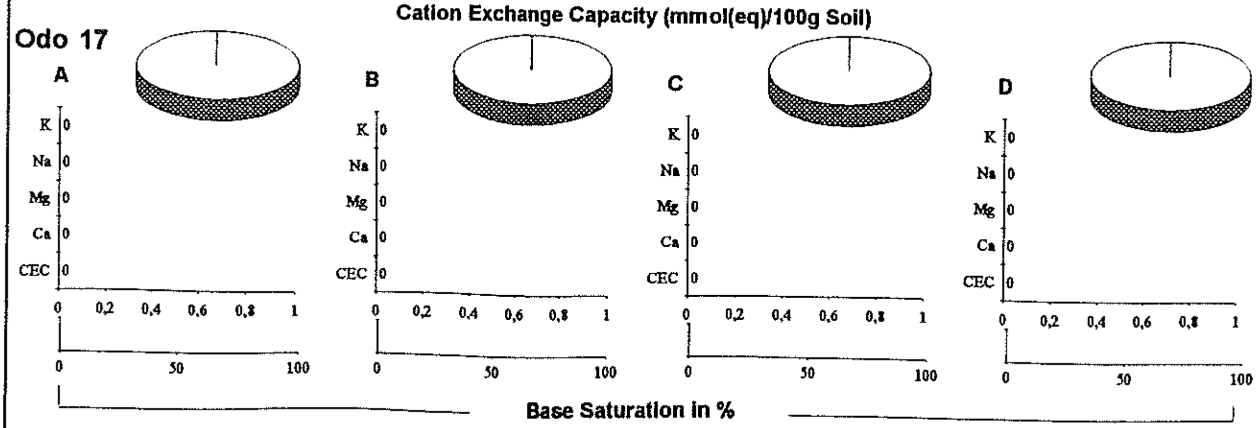



Figure 29: Reference Profile Odo 19

| Profil: Odo 19 | Site Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 2 | 7,5 km W Abzw. Halapad, 300 m r. | 16°04'38" | 19°07'39" | 2.7.91 |

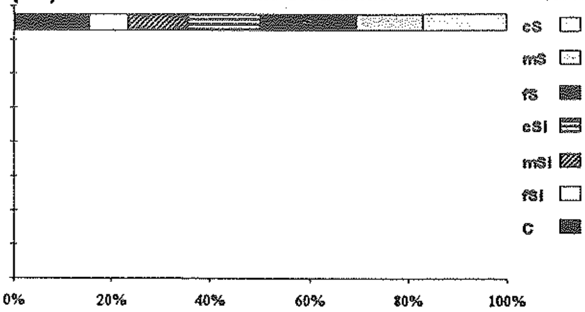
| Soil | FAO | Mapping Unit | SA: | Risk Class. |
|---|---|---|---|---|
| Classification: | Rendzic Rudi Leptosol | C5 | USDA: | |

## Physical Soil Properties

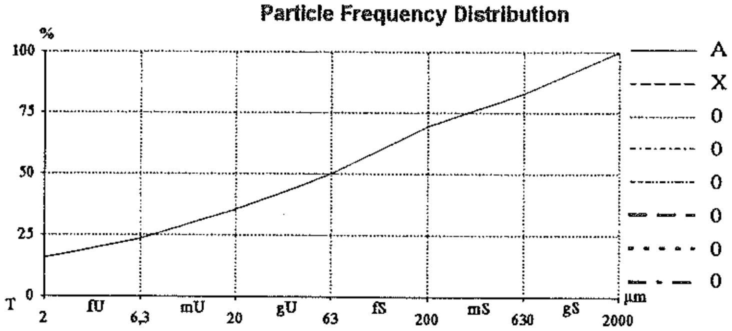
**Odo 19**

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-15 | 42,7 | L | 10YR 4/4-4/3 | koh |
| X | 15 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

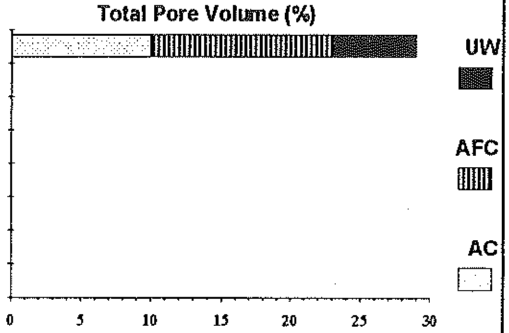
Grain Size Distribution




Particle Frequency Distribution

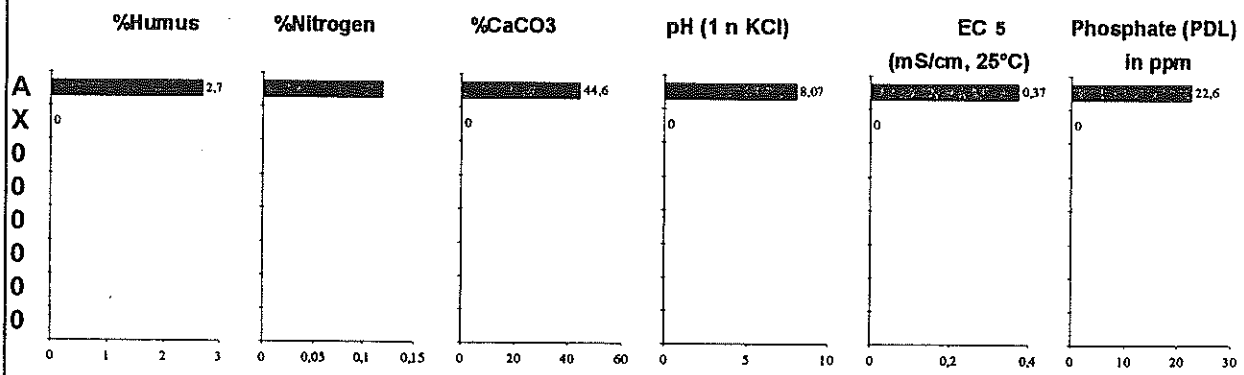



Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 11,3 (cm/h) Erodibility: 2,5 (F-Index)

## Chemical Soil Properties




Cation Exchange Capacity (mmol(eq)/100g Soil)

**Odo 19**

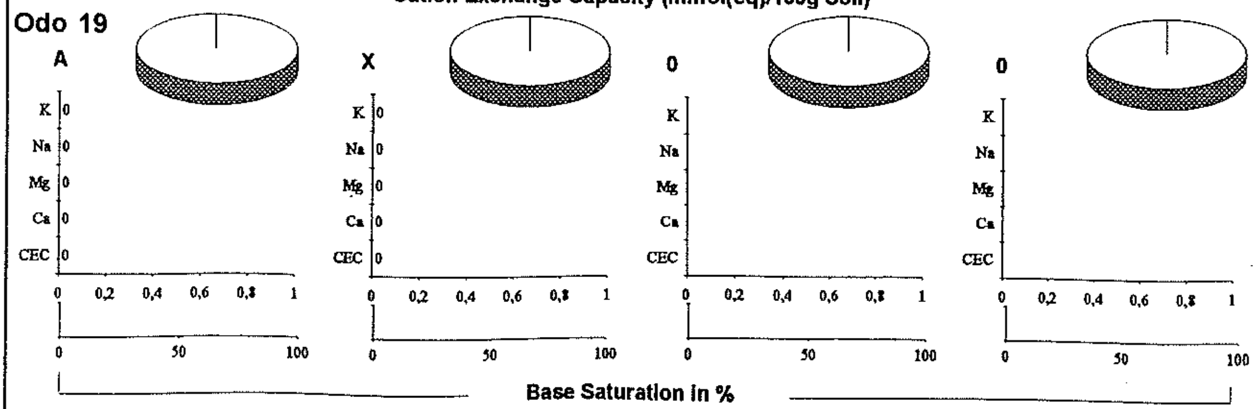


Figure 30: Reference Profile Odo 25

| Profil: Odo 25 | Site Karstveld | Lon. | Lat. | Date |
|---|---|---|---|---|
| Number of Samples: 2 | 1,0 km W Kapup.Abzw., 100 m l. | 16°04'58" | 19°07'11" | 2.7.91 |

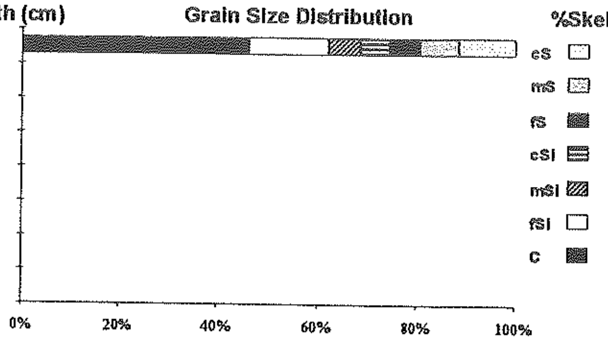
| | | | | |
|---|---|---|---|---|
| Soil Classification: | FAO Lithi-Hypercalcaric Regosol | Mapping Unit C5 | SA: USDA: | Risk Class. |

## Physical Soil Properties

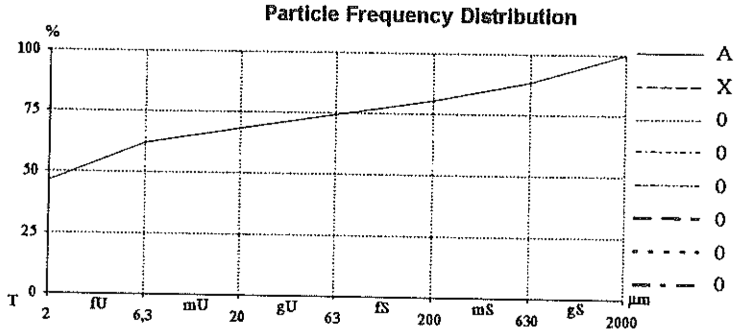
Odo 25

| | Depth (cm) | %Skeleton | Texture | Munsell (wet) | Structure |
|---|---|---|---|---|---|
| A | 0-20 | 6,8 | C | 10YR 4/3-5/3 | koh |
| X | 33 | — | — | limestone | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |
| 0 | — | — | — | — | — |

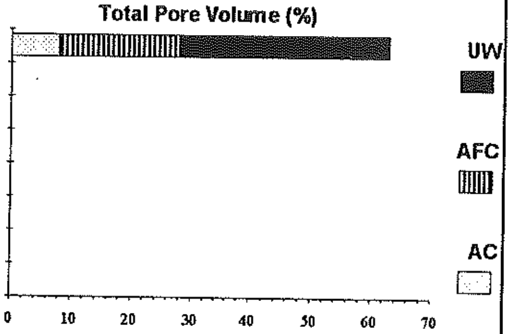
Grain Size Distribution




Particle Frequency Distribution



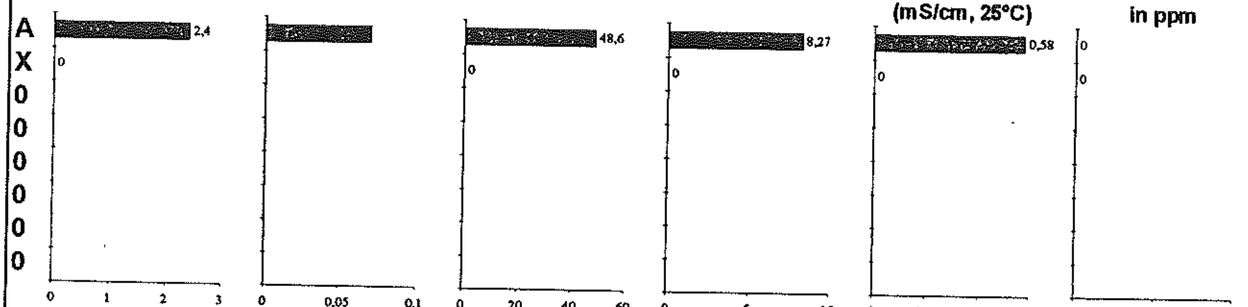

Total Pore Volume (%)




**Infiltration:** IIR(15 Min.): (cm/h) IIR(30 Min.): (cm/h) Basic IR: 3,3 (cm/h) Erodibility: 1 (F-Index)

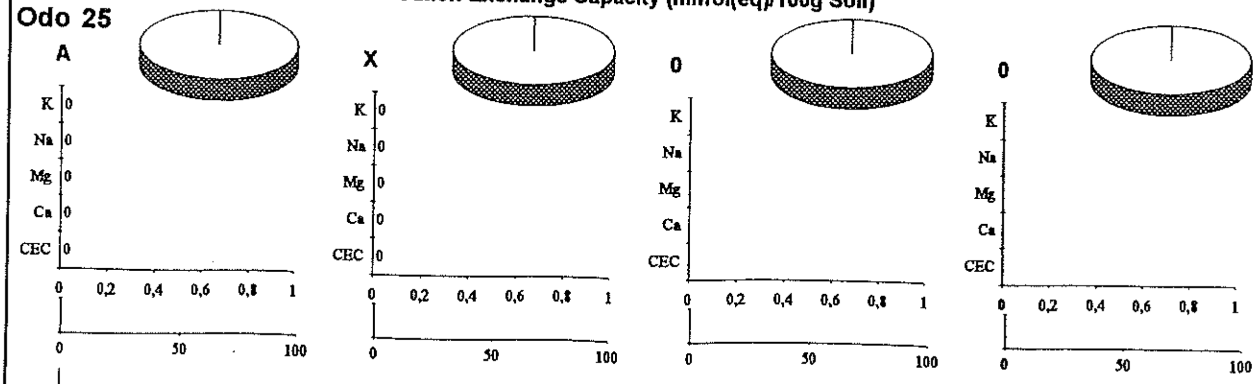
## Chemical Soil Properties

%Humus | %Nitrogen | %CaCO3 | pH (1 n KCl) | EC 5 (mS/cm, 25°C) | Phosphate (PDL) in ppm




Cation Exchange Capacity (mmol(eq)/100g Soil)

Odo 25




Base Saturation in %

## 7.7 Die physikalisch-chemischen Analysedaten der Böden im ENP

| Ort | Nr. | geogr. Länge | geogr. Breite | Tiefe cm | Munsellfarbe (feucht) | Corg. (%) | N (%) | P (ppm) | pH | Ca (%) | Lf. (mS/cm) | ESPo (%) | ESPu (%) | >2 mm | S (%) | U (%) | T (%) | Textur FAO | Bodentyp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nga 1 | A | 15°20'55" | 18°42'13" | 0-18 | 10YR 3/3-3/2 | 0,37 | 0,02 | 0,50 | 6,48 | 0,0 | 0,04 | *,* | *,* | 0,0 | 89,2 | 5,7 | 5,2 | LS | Cambic Arenosol |
| | B | | | 27-33 | 10YR 3/3-4/3 | 0,31 | *,* | *,* | 5,63 | 0,0 | 0,08 | *,* | *,* | 0,0 | 89,2 | 4,8 | 6,0 | LS | |
| | C | | | 47-55 | 10YR 4/3 | 0,22 | *,* | *,* | 6,34 | 0,0 | 0,09 | *,* | *,* | 0,0 | 88,5 | 5,9 | 5,5 | LS | |
| | D | | | 72-84 | 10YR 4/4-3/4 | 0,31 | *,* | *,* | 6,68 | 0,0 | 0,36 | *,* | *,* | 0,0 | 83,9 | 5,1 | 11,0 | LS | |
| | E | | | 120-127 | 10YR 4/4 | 0,16 | *,* | *,* | 7,34 | 0,0 | 1,03 | *,* | *,* | 0,0 | 79,5 | 8,5 | 12,0 | SL | |
| | F | | | 145-151 | 10YR 5/4-4/4 | 0,16 | *,* | *,* | 7,76 | 0,0 | 0,82 | *,* | *,* | 0,0 | 79,4 | 12,9 | 7,7 | LS | |
| | X | | | 163 | Sandstein (kalkig) | *,* | *,* | *,* | *,* | 0,0 | *,* | *,* | *,* | 0,0 | *,* | *,* | *,* | | |
| Nga 2 | A | 15°20'58" | 18°40'53" | 0-18 | 10YR 3/4-3/3 | 0,45 | 0,03 | 0,70 | 6,44 | 0,0 | 0,08 | *,* | *,* | 0,0 | 92,0 | 4,0 | 4,0 | FS | Xanti-Cambic Arenosol |
| | B | | | 47-53 | 10YR 3/4-7.5YR 3/4 | 0,21 | *,* | *,* | 6,44 | 0,0 | 0,07 | *,* | *,* | 0,0 | 90,0 | 4,6 | 5,3 | MS | |
| | C | | | 74-86 | 7.5YR 4/4-10YR 4/4 | 0,18 | *,* | *,* | 4,40 | 0,0 | 0,20 | *,* | *,* | 0,0 | 90,5 | 3,3 | 6,2 | FS | |
| | D | | | 118-129 | 7.5YR 4/6 | 0,13 | *,* | *,* | 3,64 | 0,0 | 0,44 | *,* | *,* | 0,0 | 90,6 | 2,9 | 6,5 | FS | |
| | E | | | 176-188 | 10YR 5/8 | 0,11 | *,* | *,* | 3,83 | 0,0 | 0,33 | *,* | *,* | 0,0 | 90,0 | 3,0 | 7,0 | FS | |
| | F | | | 212-219 | 7.5YR 5/8-10YR 5/8 | 0,09 | *,* | *,* | 4,26 | 0,0 | 0,25 | *,* | *,* | 0,0 | 90,7 | 3,5 | 5,8 | FS | |
| | G | | | 231-245 | 7.5YR 5/8 | 0,06 | *,* | *,* | 4,22 | 0,0 | 0,16 | *,* | *,* | 0,0 | 92,2 | 4,4 | 3,4 | FS | |
| | H | | | 256-265 | 7.5YR 5/8 | 0,06 | *,* | *,* | 4,42 | 0,0 | 0,18 | *,* | *,* | 0,0 | 92,2 | 4,7 | 3,1 | FS | |
| | K | | | 265-274 | 7.5YR 5/8 | 0,06 | *,* | *,* | 4,36 | 0,0 | 0,16 | *,* | *,* | 0,0 | 92,8 | 3,9 | 3,3 | FS | |
| | X | | | ?? | Sandstein | *,* | *,* | *,* | *,* | 0,0 | *,* | *,* | *,* | 0,0 | *,* | *,* | *,* | | |
| Nga 3 | A | 15°16'48" | 18°40'52" | 0-20 | 10YR 3/3-3/2 | 1,49 | 0,08 | 15,00 | 7,03 | 0,0 | 0,58 | *,* | *,* | 0,0 | 54,6 | 7,8 | 37,6 | SC | Mollic Fluvisol |
| | B | | | 27-38 | 10YR 3/3 | 0,98 | *,* | *,* | 7,49 | 0,7 | 0,32 | *,* | *,* | 0,0 | 53,5 | 4,0 | 42,5 | SC | |
| | C | | | 44-51 | 10YR 3/3-3/4 | 0,82 | *,* | *,* | 7,52 | 1,0 | 0,71 | *,* | *,* | 0,0 | 53,8 | 4,0 | 42,2 | SC | |
| | D | | | 68-76 | 10YR 4/3 | 0,60 | *,* | *,* | 8,00 | 5,5 | 0,23 | *,* | *,* | 0,0 | 54,4 | 4,5 | 41,1 | SC | |
| | X | | | 80 | Kalkstein | *,* | *,* | *,* | *,* | 0,0 | *,* | *,* | *,* | 0,0 | *,* | *,* | *,* | | |
| Nga 4 | A | 15°18'34" | 18°40'53" | 0-19 | 10YR 3/3 | 0,73 | 0,02 | *,* | 7,26 | 0,0 | 1,17 | *,* | *,* | 0,0 | 77,6 | 5,7 | 16,7 | SL | Psammi-Humic Cambisol |
| | B | | | 31-42 | 10YR 4/3 | 0,51 | *,* | *,* | 8,28 | 4,3 | 1,21 | *,* | *,* | 0,0 | 72,7 | 6,0 | 21,3 | SCL | |
| | C | | | 58-66 | 10YR 5/3 | 0,38 | *,* | *,* | 8,43 | 3,6 | 1,57 | *,* | *,* | 0,0 | 72,6 | 5,4 | 22,1 | SCL | |