

# Land and Soil Suitability Assessment of an Agricultural Land at University of Ilorin, Kwara State



**Project:** Soil Fertility Study of a Proposed Agricultural Project in the University of Ilorin, Kwara State, Nigeria

**Project Execution:** IITA- Soil Management Unit (SMU)

**Client:** OER Farms Limited

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We acknowledge the contributions of the following persons who provided logistics support or who are involved in the execution of this consultancy contract:

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## Acronyms

AoI	Area of interest
CEC	Cation Exchange Capacity
ECEC	Effective Cation Exchange Capacity
GIS	Geographical Information System
IITA	International Institute of Tropical Agriculture
LU	Land unit
masl	meters above sea level
NASA	National Aeronautics and Space Administration
ODK	Open Data Kit
SOC	Soil Organic Carbon
SRTM	Shuttle Radar Topography Mission
USGS	United State Geological Survey

## Executive Summary

For OER farms an area of about 6000 ha, located within the land of the University of Ilorin, Kwara state, has been surveyed to determine whether the land and soil is suitable to be used for agricultural purposes, and to identify the type of crops it is best suitable for. Our assessment addresses various aspects of land and soil suitability, including accessibility, possible constraints for mechanised operations (slope, soil depth, soil drainage and other), the physical conditions of the soil in relation to crop requirements for water uptake, and the soil fertility status in relation to crop nutrition.

Soils are developed in situ on rocks from the basement rock complex (gneisses, granites, and schist) that determines the geology in this part of the country. It generally results in soils of light texture that may also exhibit some fertility constraints and soil depth restrictions. The soils are considered vulnerable and susceptible to soil degradation depending on land use and management. The land use history may have had important influence and impact on the status of the soil fertility.

Of the 6000 ha of land, we found 4,436 ha that is suitable, in principle, for agricultural production. The 1,564 ha that is considered not suitable is because of soil depth restrictions (very shallow and shallow soils) mainly. It is the area in Section B, east of the Osin river (see Map 13). However, consistently deep, and very deep soils are not found anywhere within the area of interest. Soil depth may vary over short distances depending on what causes the soil depth restriction. For example, hardened plinthite can surface very locally, and is therefore difficult to map out. In Section A, which is mapped as moderately deep to deep soils and classified as suitable for agriculture, you will regularly find shallow soils locally. The current vegetation is an indication of where these shallow soils are found. And where dry woody vegetation is found soil depth should be investigated before deciding to reclaim the land. The larger part of suitable agricultural land is found in the western part of section B (see Map 13). All soils have a high gravel content.

The land that is considered suitable (LMU1 and LMU2) seems to have been cultivated for shorter or longer periods, we do not know. Soil organic carbon percentages are very low; there are nutrient limitations especially related to phosphorus. The soils are very sandy, having low percentages of clay, and the clay is a low-activity clay. With respect to soil quality management, soil organic carbon levels need to be drastically increased. It will require considerable amounts of external inputs of organic resources (several metric tons of manure per ha and worked into the soil) applied over several years to reach acceptable levels. The soil requires recapitalization of P to address the low availability of P. To increase the P-availability to the minimum required level of 16 ppm, an amount of 60 kg P<sub>2</sub>O<sub>5</sub> per ha would be required, and that needs to be applied in small amounts (low rates) over the years on top of what needs to be supplied to satisfy crop demand alone.

In general, these are conditions that do not favour high demanding crops like maize. Maize is a crop that has high nutrient and water requirements, which is partly due to its relatively small root system. Rather, woody crops would be favoured.

Cashew would be a very good crop for these areas, because of its draught hardiness and adaptability to adverse soil and environmental conditions. Cashew would require good soil organic matter management, requiring the application of manure in sufficient quantities, but these could be applied to the base of the trees making it more efficient. For nutrient management phosphorus would require attention (for P-recapitalization) and boron as micronutrient. Cashew is high in K demand, but that might not be a problem on these soils. Other tree and shrub crops could likewise be considered.

Maize, on the other hand, would require proper management. Also, because of ploughing (soil disturbance) extra effort will be required to increase and maintain soil

organic carbon levels. Fertilizer needs to be applied in small amounts (and therefore more frequently) in order not to run the risk of the nutrients being washed out and to get a better crop response. Water supply needs to be managed properly to avoid water stress and subsequent yield reduction. Furthermore, crop rotation would be advised, using a leguminous crop like soybean (select the right varieties) and use improved fallows to restore and maintain soil fertility. With the proper management practices in place acceptable maize yield can be obtained.

Soybean could as well be considered (as well as other leguminous crops), certainly as a crop in the crop rotation system. Because of its ability to fix nitrogen it works well on these relatively poor soils, though the P-limitations in the soil still needs to be addressed as these will then be the most limiting factor. Inoculation will be required, and the right varieties need to be selected that respond well to inoculation.

## INTRODUCTION

OER Farms Limited is forming a Joint Venture with the University of Ilorin on an agricultural project within the University's land. The proposed piece of land for the project is about 6,000 hectares part of which is already being used by adjoining local farmers for the cultivation of various annual crops. OER farms limited contracted IITA to conduct a soil fertility assessment of the proposed land to determine the suitability of the land and soils for various agricultural crops. The company is interested in maize, soybeans and cashew production but still opens to various options as the soil suitability assessment may unveil.

The land and soil suitability assessments are done as part of a feasibility survey to provide the basis for further planning of the project or as input for whole farm planning concerning the allocation of land resources to the production of the target crops but also to identify the works that are needed to make the land suitable for large mechanized production, infrastructural development required as well as other input required for a sustainable and profitable agribusiness. This report presents the results and the findings from the land and soil suitability assessment.

## METHODS & DATA SOURCES

### Approach

IITA was asked to make an assessment of the suitability of the land and soils for commercial farming. The suitability assessment took into account aspects that are considered important in making investment decisions:

- Accessibility of the terrain
- Topography: slope and relief
- Water resources and availability of water
- Land use and land cover to identify available land and possible implications for land clearing
- Soil properties and site characteristics

The general requirements which are relevant to modern and mechanised farming are defined. Constraints were identified and described in relation to these requirements. For accessibility that means the terrain needs to be accessible for smaller trucks, tractors etc. For the slope/landform the requirements are that the land needs to be flat to gently undulating to allow for mechanized operations and slopes need to be straight and not converging. For the water resources focus was on surface water only; that is the drainage network, streams and rivers that may serve as a source of water for (supplementary) irrigation. Investigating the ground water resources is outside the scope of this study. The current land use and land cover are assessed to identify potentially cultivatable land and to identify the requirements for land clearing.

For suitability assessment of the soil, the following criteria are considered:

- Stoniness at soil surface and in the soil profile in relation to possibility for mechanised field operation
- Soil depth (effective), in relation to possible rooting depth restrictions



- Soil drainage in relation to possible drainage restriction and water logging risk related to soil aeration
- Soil texture and physical properties in relation to water holding capacity, infiltration, workability and soil degradation
- Soil fertility in relation to possible nutrient limitations for crop production, including soil reaction, organic carbon, macro and micronutrient levels in the soil.

Map layers were generated for the following themes, based on which the evaluation is done:

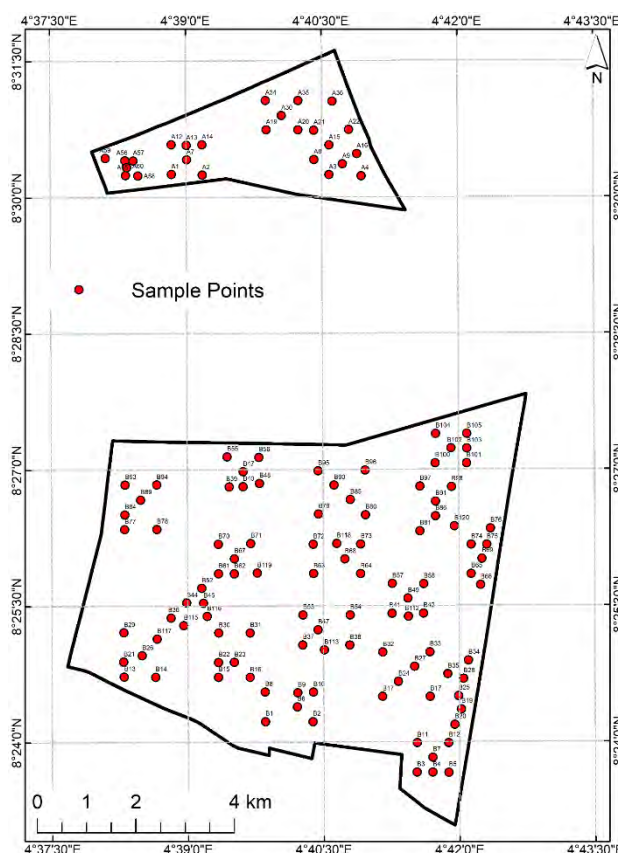
- Road network (access roads, tracks)
- Drainage network, rivers and streams
- Topography: elevation, slope and contour
- Land use and land cover
- Built-up area and settlements

Mapping of these different features is done using satellite imagery. The most recent, commercially available, high-resolution imagery of the area and the publicly available imagery were acquired. Recent imagery is used for mapping of the features mentioned above by image interpretation and on-screen digitizing, and these are verified in the field. Elevation is mapped using existing STRM data.

In the field, observations are made on land use and land cover, terrain, and soil characteristics. Map 1 presents the soil sampling design showing a combination of a fixed grid sampling and a sampling frame approach. This is done to identify the most representative locations for the sample collection across the AoI.

The observations in the field are made according to standard operating procedure and data was recorded electronically using ODK Collect, and forms designed for this purpose and adapted to this study. The data collected were used for ground truthing for the image interpretation and for the validation of data and maps generated.

At each point of observation soil samples are taken from the topsoil (0-20 cm) and subsoil (20 - 50 cm) for analyses in the laboratory. The soil samples were analysed for gravel content, particle size, organic carbon, exchangeable acidity, total nitrogen, available phosphorus, exchangeable potassium, exchangeable sodium, exchangeable calcium,



*Map 1. Map of the locations of the sampling points*

exchangeable magnesium, sulphur, manganese, zinc, boron, copper, and iron using wet chemistry standard analysis procedures. Methods of soil analysis and their references are provided below:

1. Organic Carbon by Chromic acid digestion  
Heanes D. L. (1984). Determination of total organic carbon in soils by an improved chromic acid digestion and spectrophotometric procedure. *Comm. in Soil Sci., and plant analysis*. 15:1191-1213
2. Nitrogen in soil by Kjeldahl digestion and colorimetric determination on Technicon AAI Autoanalyzer.
3. Soil pH. Determined in water on 1:2.5 soil/water ratio.  
Okalebo J.R, Gathua K.W and Woormer P.L. (2002). *Laboratory methods of soil and plant analysis: A working manual*. 2nd Edition. TSBF-CIAT 128pp
4. Extractable Phosphorus, Exchangeable Cations and micronutrients in soil are done by Mehlich 3 extraction. Phosphorus is determined colorimetrically using the Technicon AAI Auto-analyser, while the cations are determined using Atomic Absorption Spectrophotometer (Model Buck 211) and /or by ICP-OES (Perkin Elmer Optima 8000). A.Mehlich (1984). Mehlich 3 soil test extractant: A modification of Mehlich 2 extractant. *Commun. in Soil Sci. Plant Anal.*, 15(12), 1409-1416.
5. Exchangeable Acidity is determined by titration method after extraction with 1N KCl.  
Anderson. J.M and Ingram J.S (1993). *TSBF a handbook of methods*. 221p.
6. Bray -1- P in soil. Bray, R. H and L.T Kurtz, 1945. Determination of total and organic and available phosphorous in soils. *Soil Sci*. 59:39-45.
7. Olsen P in soil. Olsen, S.R, C.V. Cole, F.S Watanabe and L.A Dean (1954). Estimation of available phosphorous in soils by extraction with sodium bicarbonate. U.S.D.A, Circ.939.
8. ECEC is by sum of exchangeable cations and exchangeable Acidity.
9. Soil particle size analysis is done by the hydrometer method.  
Bouyoucos G.H. (1951). A recalibration of the hydrometer for making mechanic analysis of soils. *Agron. Jour*. 43:434 – 438.

## Activities

Activities have been carried out in the chronological order as indicated in the table below.

*Table 1. Chronology of activities for the land and soil suitability assessment of proposed agricultural land within the University of Ilorin premises.*

<b>Timelines</b>	<b>Activities</b>
July 19 – 30, 2021	Preparation and logistic arrangements: Organizing the field work, recruitment and orientation course for the field workers on field survey procedures; Getting ready all equipment and materials for the field work
August 2 - 6	GIS –Sampling design and preparation of the ODK forms and electronic tools

August 9	Arrival on the field at University of Ilorin
August 10 – 20	Soil survey and sample collection
August 23 – 27	Soil sample registration and sample preparation for chemical analyses at Ibadan
August 30 – October 8	Laboratory analysis – Soil analysis at Ibadan
October 8 – November 20	Data quality control and data analyses, Image interpretation and GIS mapping
November 20 - 25	Report writing
November 25 - 30	Presentation and submission of final report to OER Farms

### Data Sources

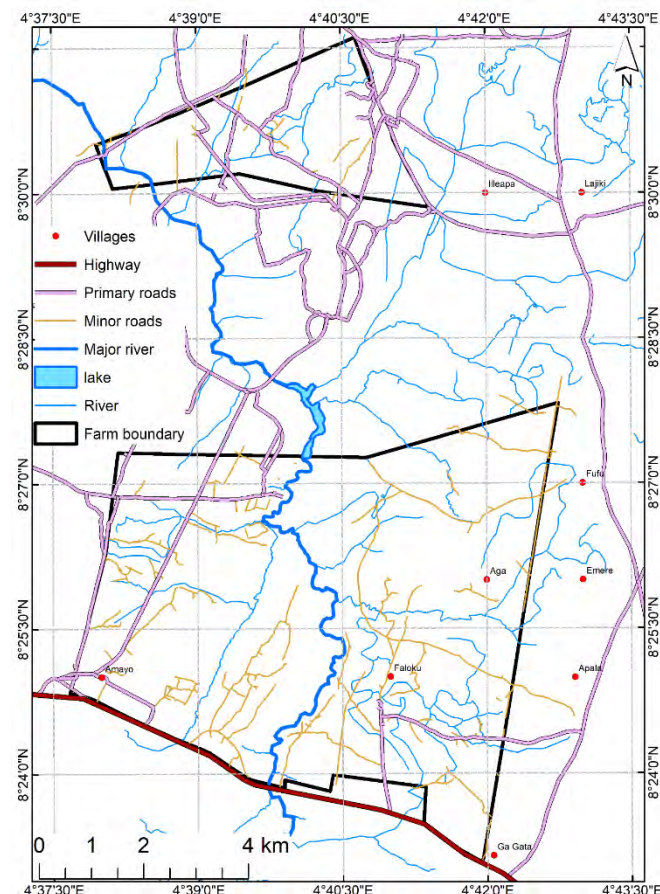
Table 2 Data sources used for this study

SN	Type of data	Data source	Spatial resolution	Usage
1	WorldVIEW 2	Digital Globe ( <a href="https://www.digitalglobe.com/">https://www.digitalglobe.com/</a> )	0.4m, 1.6m	Creation of drainage network, road network, Rock outcrop
2	NASA Shuttle Radar Topography Mission (SRTM)	USGS Earth Explorer ( <a href="https://earthexplorer.usgs.gov/">https://earthexplorer.usgs.gov/</a> )	30m	Creation of Contour, slope & land unit map

## RESULTS

### Location and general landscape characteristics of the Area of Interest

The Area of Interest (AoI) is located within the perimeter of the acquired land of the University of Ilorin, Ilorin, Kwara State. The AoI is divided in two parts. One part, section A, is situated in the north and the other part, section B, is located to the south of the main campus of the University of Ilorin. The section B is bounded in the south by the 'Omu Aran-Oja Oba' road. The total AoI measures in total six thousand hectares. Section B is further divided into a west and east section, by a small river that runs from south to the north midway through this section. The western parts of both section A and section B are



*Map 2 Map of the farmland showing the boundary of the study area, roads and tracks, and drainage networks*

largely cultivated, whereas in the eastern parts we find isolated and sometime fields clustered together fields in a landscape that is dominated by larger parts of bushland. The area falls within the guinea savanna ecological zone. There are forest and woodland patches remaining and there is a young oil palm plantation within Section B, the western. The total cropped area accounts for about 45% of the land while the remaining land is either forest or fallow.

The landform is undulating, which means that there is a regular sequence of gentle slopes, generally convex to straight slopes with a gradient of up to 5-6%. In parts, especially the eastern part of section B, the landform is rolling with moderate slopes. Landform and soil are typical for landscape and soils that are derived from the basement rock complex, which consist of hard crystalline and metamorphic rocks (granite and gneisses). The soils are developed in situ and have generally a sandy texture. There are few parts with a flat to almost flat topography.

### Access to the terrain, Road and Tracks

There are several classes of roads that provide access to the different sections of the land. Both sections can be accessed via the main campus, but which will not be the preferred route of entry. Section A can be accessed from the north by a tarmac road that branches off from the 'Share-Oja Oba' road. The 'Apata-Yakuba-Lajiki' road, which is a dirt, but all-weather road, runs along the eastern border of section A. There are some few minor roads and tracks within the section. A highway connecting Ilorin to Offa (popularly known as 'Offa' Road) borders the south of section B and provides access to both the

western and eastern part of this section. There are many single dirt roads that connect to the different parts of especially the western part of section B. The eastern part of section B is not that well unlocked.

Generally, accessibility to the terrain is good. The only section that might be difficult to access currently is the northeast of section B. The accessibility of this part of the area needs to be improved by the construction of an access road, if that part is to be developed further. The whole section A is having a better road infrastructure. There are fine networks of tracks that seem to be in good condition. The road network is mapped in Map 2.

### **Water resources and drainage network**

The main drainage channel runs in the general direction from south to north. It forms the western border of Section A and runs through the middle of section B (See Map 2). The river is dammed at the south end of the university campus area, forming a lake that may be used as a source of supplementary irrigation, if access is provided. The artificial lake is located within the University campus area just to the north of section B. It is no longer in use as such, and access to this resource could mean an important benefit. The upstream catchment area is relatively small, however. It means that the volume of water that will be concentrated at this point will be limited and will probably not provide sufficient water for irrigation for the whole section B. But the volume of water it potentially can provide needs to be determined. It will nevertheless be an important source of water. For section A, the amount of water that can be provided through boreholes should be investigated, as this will be the only source available for possible supplemental irrigation. There are several seasonal streams/tributaries running in different sections of the land towards the main drainage channel. The drainage pattern is 'trellis'.

### **Topography**

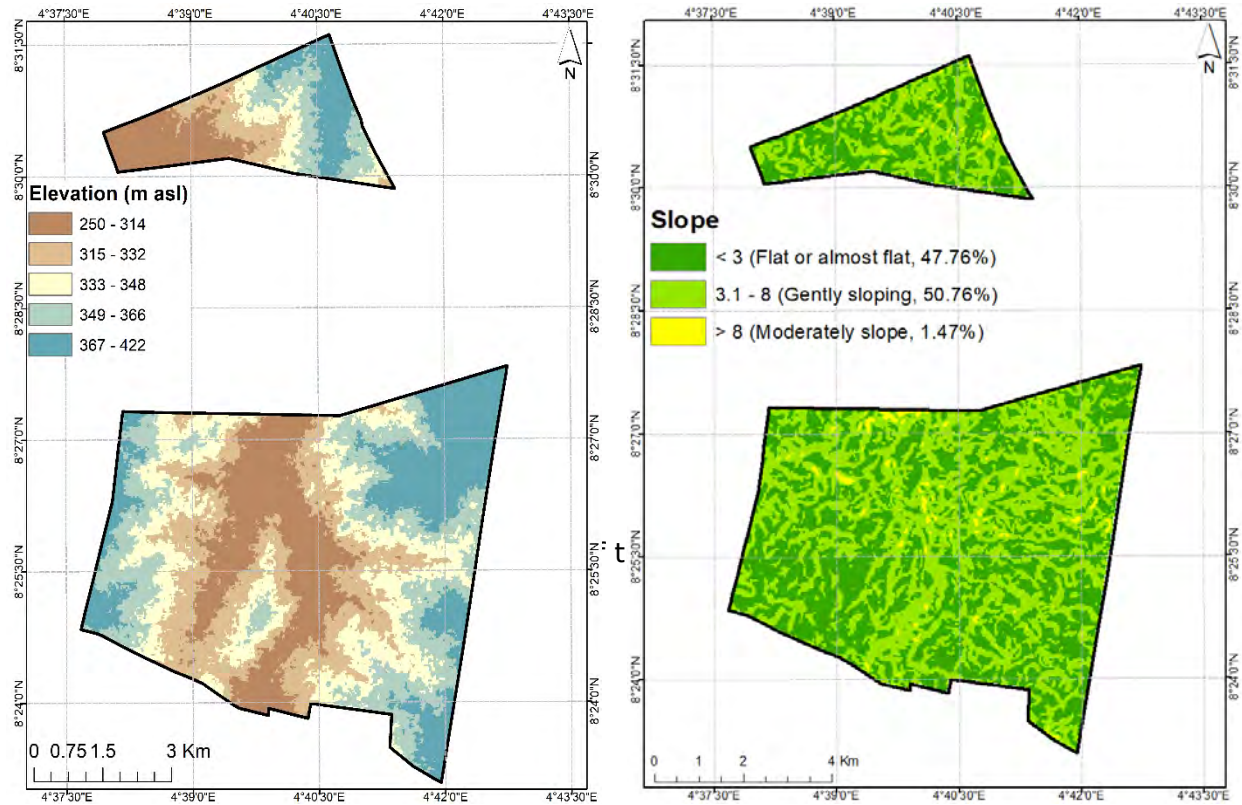
The elevation ranges from 250 masl to 422 masl, with the higher parts concentrated in the eastern part of the terrain, both for section A and Section B. For section A the eastern part is rather flat land whereas the western part is gently sloping down to the west towards the main drainage channel bordering this section in the west. The slopes are long (length of the slope of more than 1 km) and straight.

In Section B the slopes are generally gently sloping towards the main drainage channel in the centre of this section. That means sloping eastward in the western part and sloping westward in the eastern part. That is the general pattern. Slopes in the western part are convex to straight and long (up to 1km and more). Slopes do generally not exceed 5-6%, meaning there are no constraints for mechanised operations (from the point of view of slope steepness that is). The eastern part seems to be hillier with steeper slopes in the middle section. Slopes may be up to 'moderately steep' in some places, which means that the land can still be worked mechanically, but measures will need to be taken to control erosion.

We find a typical toposequence with on the hill tops or plateau flat to almost flat terrain, gently sloping to moderately sloping mid-slopes and gently sloping foot-slopes towards the main drainage channel. The valley is V-shaped, meaning that there is no extended/broad valley bottom with flat land and soil developed on sedimentary materials.

It is a landscape that is typical for a landscape developed on the basement rock complex. You find gently undulating to sometimes rolling landscapes with rock outcrops and/or shallow soils on the top of the hills. You may also find hardened plinthite (or ironstone) on the upper slopes and on the hill tops (the exposed landscape elements), as

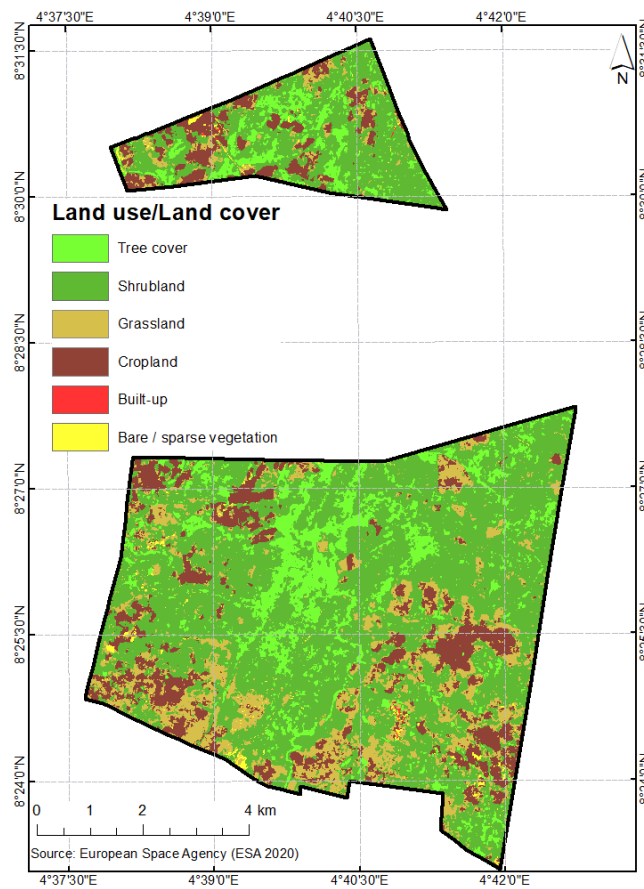
this hardened plinthite rock surfaces where it has prevented these landscape elements from further erosion (and therefore remains as part of the former plain and hill tops in the landscape. We have indeed found hardened plinthite as rock outcrop, but it is rather localized and difficult to map out.



Map 3 Map of elevation and slope glasses of the Aol

## Land use and Land cover

Most of the land has been cleared at some point in time and currently about 45% of the AoI is cropland (Map 4). The land use and land cover map does probably not adequately



*Map 4 land use and land cover map*

map all areas that are being cultivated actually, but it shows the area where the cultivated land is concentrated. It is in the western part of Section A, the western part of section B, and in the southern part of the eastern part of section B. There is no consistent pattern of contiguous fields apart from the south-western corner. But rather small to intermediate sized field that are clustered together intersected by bushland. In section B there is a large section that is planted with oil palm, of maybe two to three years old. It is intercropped with roselle (*Hybiscus sabdariffa*) and maize (see picture below) and it shows that the soil is quite suitable for this kind of crop (shrub). The soil type seems to be the major factor that seems to have influenced land use, with those areas that are only marginally suitable not being used for cultivation. The land cover found in these areas is also indicative of the poor soil conditions. We find woody vegetation with small trees characteristics of dry conditions that is related to the sandy and shallow soils (see picture below). We see such vegetation in the eastern part of section A, for example. It is advised to leave those patches of land intact and not to use it for cultivation. Most areas which are more favourable to crop production are already in use. There are no settlements within the AoI, but about 10 settlements are found within the vicinity of the AoI.

The vegetation is generally open, with medium tree densities and some shrub vegetation or herbaceous vegetation as understory. Major parts of the woodland are indigenous non-economic trees. Some of these woody vegetation patches are indicative of less suitable land and soil conditions. The cultivated land is mainly used for cassava, maize, yam, soybean and rice cultivation.

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*Woody vegetation on poor soils*



*Shrub vegetation*



*Maize cultivated on very stony soils*



*Osin stream within the east subsection of section B*



*A freshly prepared land for planting within the Aol*





*Oil palm plantation intercropped with Rosette and maize within the central part of section B*



*Rice field in the west subsection of section B*

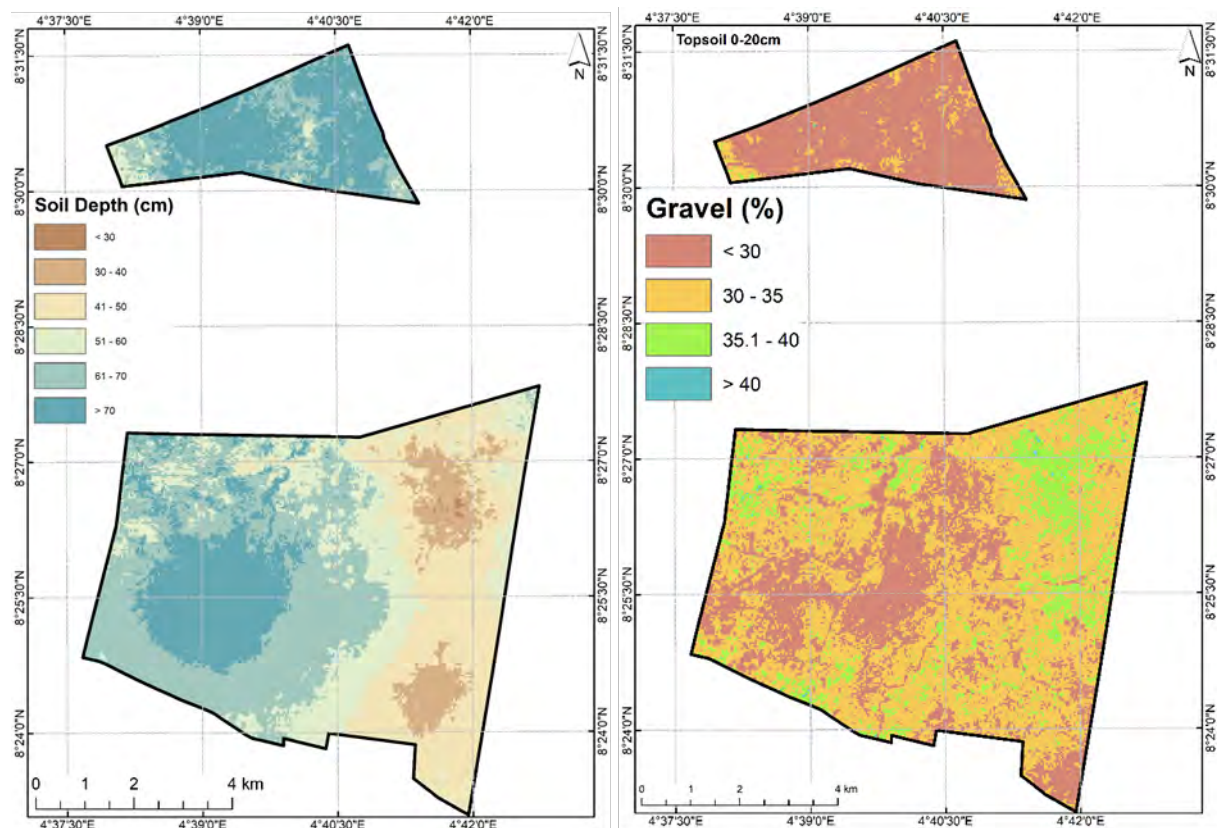


*Yam field within section A of the Aol*

## Soil characteristics

### Soil depth and texture

Soil depth restrictions are measured by augering, indicating the depth at which one cannot further drill down in the soil. Depth restriction does not equate to rooting depth restriction but is a good indicator of effective soil depth. Restrictions generally occur because of the increasing gravel content with depth. It may also be associated with hardened plinthite (iron stone) found at shallow depth. Crop roots will have difficulties penetrating such soil layers. The soil depth varies from very shallow (<25 cm) to deep (>100 cm). The very shallow soils occupy about 15% of the AoI, whereas 30% is shallow (>25 cm <50 cm depth), and 55% moderately deep (>50 cm <120 cm). Map 5 gives the general pattern, but it cannot adequately display the local variability and thus may not adequately reflect the area percentages given for the different depth classes. The eastern part of the Section A still has about 38% of soils that are shallow, which does not show on the map. The far western part of Section A has 50% of the soils that are very shallow, which is only partly reflected in the map. In Section B, the eastern part we find many shallow and very shallow soils. Indeed, in the middle of the northern part and the southern part of that whole eastern section we tend to find very shallow soils. But even in the areas around those the soils can be very shallow. The occasional sampling location with a deeper soil tends to increase the average value and for the proper interpretation of the map one must assume the soil depth class if effectively one class lower as is indicated on the map. The whole eastern section should be considered marginally suitable for mechanised farming operations. The possibilities for crop production in this area are limited.



Map 5 Soil depth and gravel content distribution

This is less so for the western part of Section B, with predominantly moderately deep soil. Though there are still limitations related to soil depth that may impact on the water availability for the crop.

Gravel content was determined for all soil samples. Gravel content varies widely from 0 to 80% (100% soil to 20% soil) and the regions of high gravel content (40 - 80%) are widespread and are not localized to a particular section within the AoI. On average the gravel content of the soil is 35%. Gravel content is associated with soil depth. The shallower the soil, the higher the gravel content is likely to be. The map of gravel content (Map 5) reflects and mirrors the information in the soil depth map to large degree and provides some additional details.

The probability of finding soil depth restriction within 100 cm depth of the soil is high (50%) and when these occur the restrictions are sometimes severe with soils having a depth of less than 30 cm, more importantly in the eastern part of section B. The implication of high gravel content is that the soils have an effectively lower clay and silt percentage, which may put them effectively in a different soil textural class and which will negatively affect the hydrological properties (i.e., water holding capacity especially). However, also the SOC content and available nutrients in actual sense will be lower than the measured values (because the analysis is done on the samples from which the gravel has been removed). This needs to be taken into account when interpreting the results of the analysis.

Soils in this area are derived from the Basement Rock Complex, which generally results in light textured soils. The soil textural class varies between loamy sand (80%) and sandy loam (20%). Based on the textural composition, over 90% of the sampling points are categorized as belonging to either the 'less' or 'least desirable' soil textural type, implying a low moisture holding capacity and indicating the moisture available for plant uptake at field capacity is rather low. The soils have been classified as 'well' to 'extremely well' drained in all cases and there is very little structural development (formation of soil aggregates and peds).

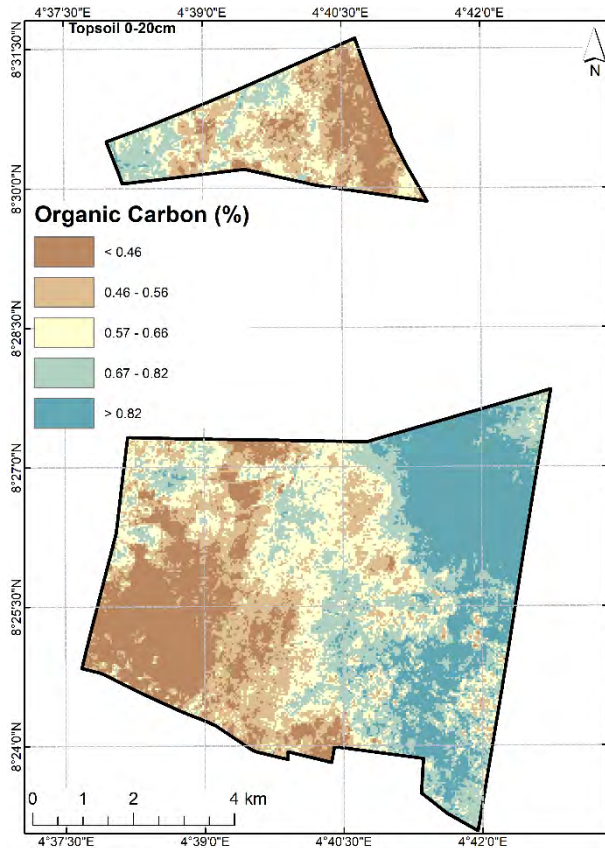
Together with the shallowness of the soil this means that there is a high risk of soil moisture deficits and limited water availability for plant uptake at time of short dry spells if the rainfall distribution pattern is somewhat irregular. Moisture deficit may occur only after a few dry days and supplementary irrigation may be needed depending on the water requirements and drought resistant characteristics of the crop. Deeper rooting crops have an advantage in such situation. Moisture deficit affects the availability of nutrients and impacts on the uptake of the nutrients by plants. The sandy and gravelly texture and little developed structure affect root development as well. Soil amendments are needed to improve the soil physical characteristics and the only practical measure is to increase soil organic matter by adding manure, compost, or other organic resources.

### **Soil organic carbon**

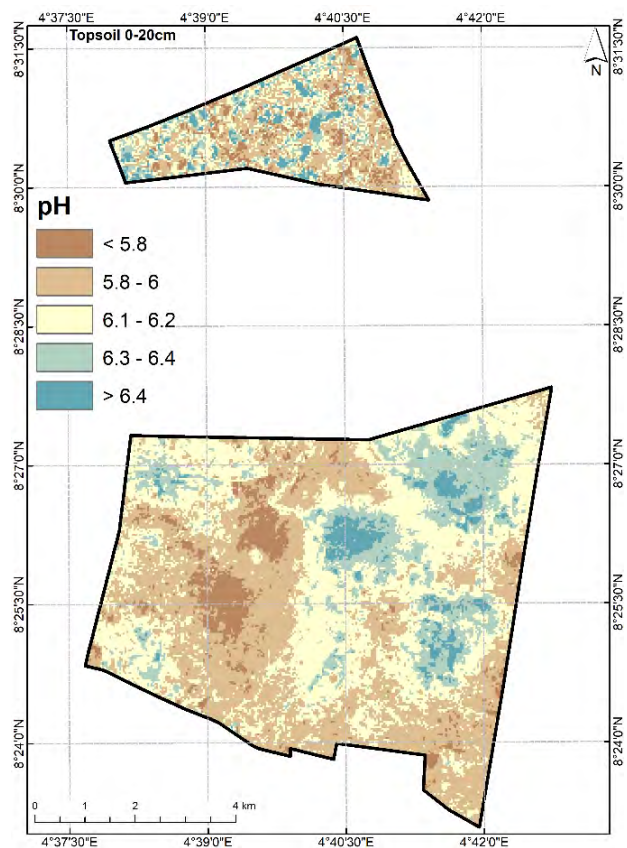
The soil contains considerable and varying amounts of gravel, and the gravel percentage is used for correction of the soil nutrient concentrations to reflect the effective amounts of plant nutrients available for plant uptake. The rating of sufficiency levels is based on these corrected values.

Soil organic carbon (SOC) is an important quality indicator as it supplies many plant nutrients and regulates many other soil properties. Over 90% of the AoI has soils which are either very low (SOC<0.7%) or low (<1.2%) in soil organic carbon (OC). The SOC variations partly reflect the land use and land cover pattern across the AoI (Map 6), in which the very low SOC areas are associated with intensively cropped areas. A

considerable part of the AoI has extremely low SOC percentages, which is quite common for these types of soil and when little effort is made to manage soil organic carbon properly. The SOC has a strong influence on other soil properties especially for the sandy soils of the farm, whether related to hydrologic properties, soil chemical properties or soil biological properties. It requires adequate soil organic carbon management with large amounts of external organic resources to be applied to correct for the extremely low SOC percentages. We are talking about several metric tons per ha for a prolonged period of time.



Map 7 Soil organic carbon distribution



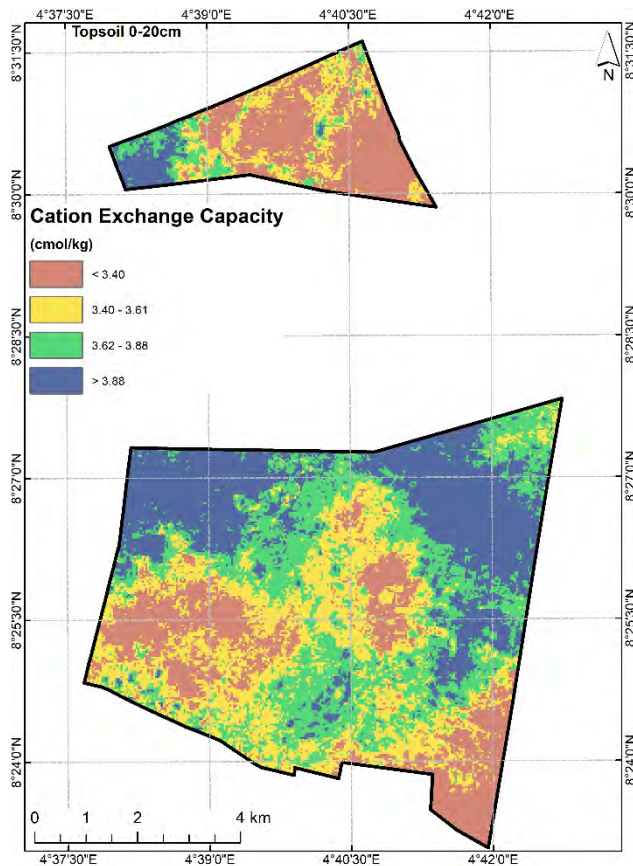
Map 6 Soil pH distribution

## Soil pH

Soil pH is a master variable in soils because it controls many chemical and biochemical processes operating within the soil. pH is a measure of the acidity or alkalinity of a soil. Soil pH is very important in crop production because soil pH regulates plant nutrient availability by controlling the chemical form of the different nutrients and herewith also influences their chemical reactions. As a result, soil and crop productivity are linked to soil pH value. Soil pH is generally at optimum level within the AoI ( $5.5 < \text{pH} < 7.0$ ) of the topsoil (Map 7). In terms of distribution, the eastern part of section B has higher soil pH values. That is the areas that are not cultivated tend to have higher pH, and those parts that are cultivated have lower pH. Application of ammonium-based fertilizers has an acidifying effect and should be applied with care especially in those areas where the pH is already at 5.5. or even below. Otherwise, there are no management concerns with respect to the soil pH.

## Soil nutrient

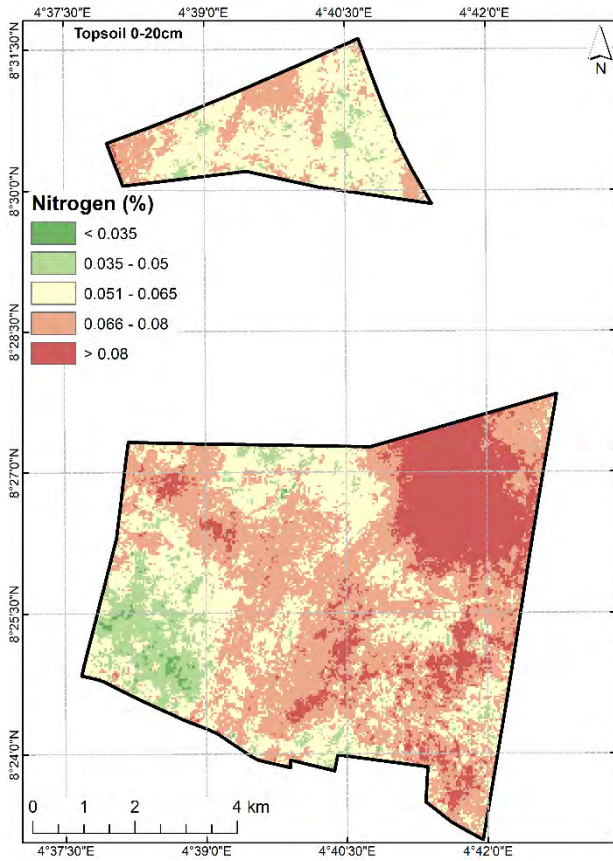
The capacity of the soil to hold nutrients other than N and P (that is Ca, Mg, K and Na, is reflected in the ECEC), is strongly related to the soil organic carbon content, for this type of soils. The ECEC is considered critically low in over 90% of the land. Regions of extremely low ECEC are prevalent in the section A and in the central and southern portions of section B (Map 8). As is with SOC, the distribution is closely related to the area that is being cultivated.



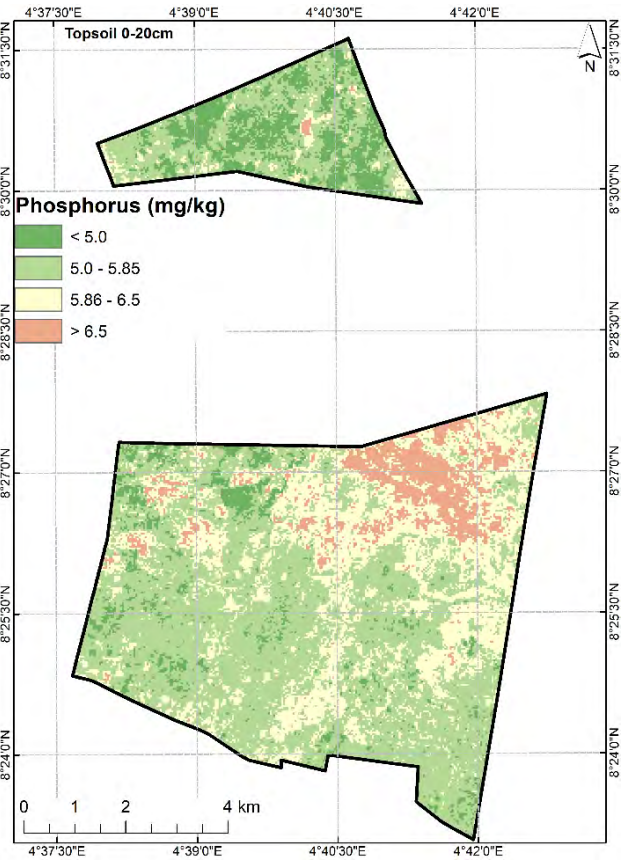
*Map 8 Cation exchange capacity of the soils across the farm*

The soils of the AoI are limiting in nitrogen with over 90% of the land being very low in soil nitrogen and follows a similar pattern of variation as that of SOC and ECEC (Map 9). Similarly, phosphorus (P) is critically low in 90% of the AoI. Region of adequate phosphorus content is about 8% of the total farm area and this is found at the northeast of section B (Map 10). P-recapitalisation of the soil is recommended, and this should be done gradually over the years in combination with the other measures proposed such that it will sort effect.

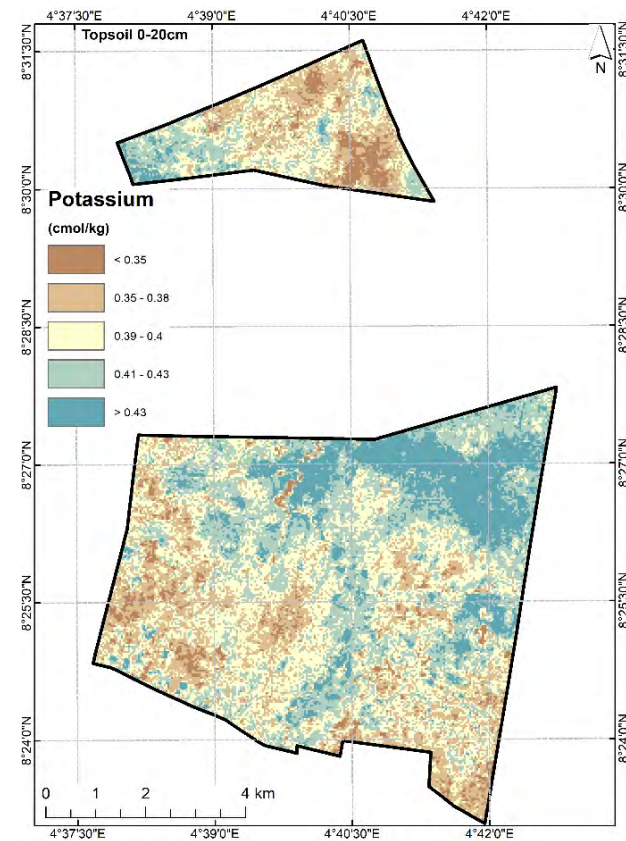
Potassium is at adequate level across the sections of the farm. The northeast subdivisions of section B are regions with the highest potassium concentration (Map 11). Generally, there are no management concerns with potassium across the entire AoI. Similarly, secondary macronutrients, such as calcium and sulphur are at adequate levels in over 90% of the AoI, while magnesium (Mg) on the other hand is consistently low.



Map 11 Total soil nitrogen



Map 10 Distribution of available phosphorus



Map 9 Exchangeable potassium

In terms of their distribution (See Appendix), the highest concentrations of calcium are within the northeast and northwest of section B, and the extreme west of section A. The entire western part of section B has higher level of sulphur in the soils than any other parts within the AoI.

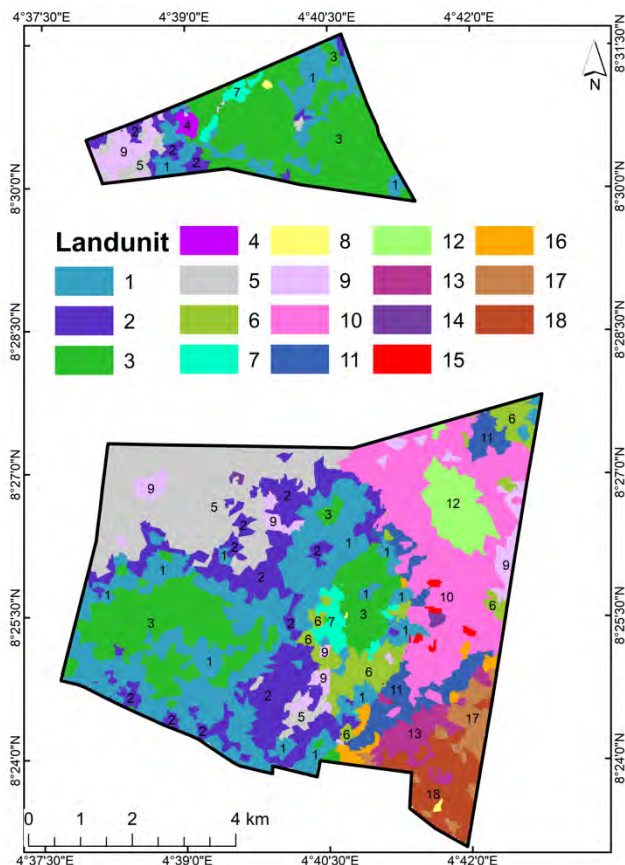
In terms of the micronutrient content, manganese, iron, and zinc are at adequate levels in over 95% of the land while boron and copper are limiting in most part of the AoI (See Appendix). Generally, the soil fertility is rated low and therefore requires nutrient application in form of mineral fertilizer and manure for sustainable crop production. Tables with the results of the soil analysis for each sampling location and maps of soil functional properties are included in the Appendix.

### Land use zoning and suitability assessment

Land units are defined based on a few land and soil characteristics that are defining in terms of soil quality (and suitability) and at the same result in a number of distinctive soil types relevant to the area under consideration. The resulting land units are homogenous regarding their soil properties and at the same time present a meaningful spatial pattern (distribution pattern with the AoI). The soil properties that are considered for this purpose are: soil depth, soil organic carbon, pH and cation exchange capacity (CEC). We also look at the field pattern, because current and past land use is often quite determining for the soil condition and indicative of soil quality, and the land cover (or vegetation type) gives an indication of the requirements for land clearing.

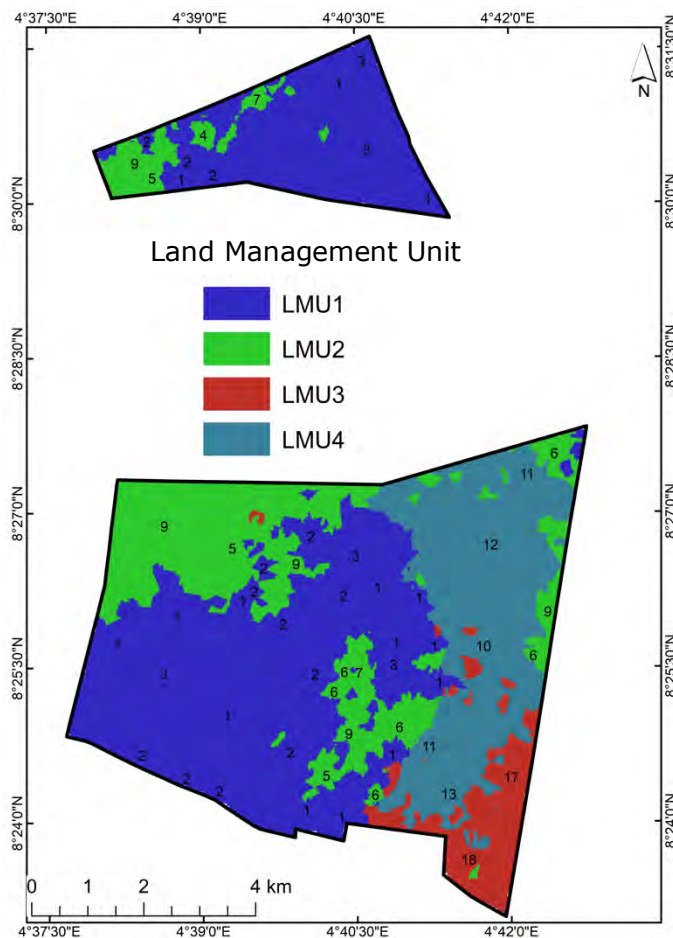
The maps of these individual properties are first classified into meaningful classes and are subsequently overlain. The result is a land unit map in which each land unit has a unique combination of the defining soil characteristics. Map 12 below presents the land

units and in Appendix 4 the corresponding unique combination of soil properties' classes is given (explaining what each Land Unit represents in terms of class values for soil depth, soil organic carbon, soil pH and ECEC).



Map 12 Land unit map (for the explaining variables see Appendix 4)

For purpose of generating the land suitability map, we group the land units such that some larger meaningful units are obtained. We refer to these units as land management units (LMUs), with each unit having its specific set of constraints that determines its suitability. For the grouping certain soil properties carry more weight than others, depending on the relevance of the properties for the suitability assessment. For example, in our case there is little variation in soil pH, and it is all within a range that is not considered limiting for crop production. Therefore, soil pH carried little weight in defining the LMUs, in contrast to soil depth, for example. Below (Map 13) the different Land Management Units are displayed and in the subsequent sections the land and soil characteristics of each of these units is presented and the integrated assessment of their suitability is made, looking at suitability for mechanised operations, suitability for the different types of crops and soil fertility.



*Map 13 Land Management Unit map of the OER Ilorin farmland*

## LMU1

The units associated with this group are located in the south-western part of section B and the eastern part of section A (land units 1, 2 and 3). The total area of LMU1 is 3,125 ha. These areas have moderately deep to deep soils in places and a relatively low gravel content. These are important determinant features, because these are considered permanent features that are difficult to change or influence by management. The pH is relatively low but does not constitute a problem, yet. The SOC levels are very low, and so is the CEC, which means there is a fertility problem. With respect to nutrient availability, phosphorus is very low. The soil fertility, however, can be managed. Restoring soil fertility will require application of considerable amounts of organic resources (external inputs) and



recapitalization of soil P. Soil organic matter management will require, apart from the external inputs of organic resources, proper crop rotation (if annual crops are cultivated) and management of crop residue. The fertilization of any crop will need to be done through the frequent application of small amounts, with the timing of the application in synchrony with the demand for the nutrient. This will increase the fertilizer use efficiency, rather than when the fertilizer is applied in larger amounts in one or two applications. The latter will carry the risk of low recovery rates and therefore limited crop response to the application and consequently low nutrient use efficiencies. Recapitalization of soil P also needs to be done gradually and in small steps by applying P in excess to the crop P demand (by applying a P-fertilizer or compound fertilizer with relatively high P content). Additional application of Mg might be required depending on the type of crop grown (and the Mg demand of that crop).

These soils are best suited for any permanent crop (any woody crop - tree or shrub) that has a deeper rooting system and that would make better use of the available water. Without further measures the water use efficiency of any annual crop will be rather low (meaning you need a lot of water)

For section A, the eastern part, the situation is a little different in that we find short distance variation in soil depth. This means the location of the plots will have to be carefully selected and the plots will remain relatively small, making it less efficient for mechanised operations. The current land cover (the bush and woodlands) providing a good indication of where the relatively shallow soils are found. Cultivation should be done in those parts that have been reclaimed earlier and where fields/plots are present.

Otherwise for the units in Section B there is no specific constraint for mechanised operation, though the terrain gently sloping. It is advised to construct graded bunds for erosion control and to plough in the direction of the contours.

## **LMU2**

LMU2 is comparable to LMU1 with only some gradual changes. Soil depth seems to be little less than is found for LMU1, though still moderately deep in general. The gravel content is, as consequence, a little higher in general. On the other hand, SOC in places tends to be higher, being rated as low still, but not extremely low. Consequently, the CEC is also higher than for LMU1 (though still rated as very low) and the soils seems to be a little richer in nutrients. If the slightly lower soil depth is not considered to be of consequence, the soil condition of this LMU seems to be a little more favourable for agricultural use than the LMU1. However, we have observed some rock outcrop of hardened plinthite especially in Section A and we do not know how extensive or prevalent this is. The shallow soils in Section A might interfere with mechanized operations. The severity of the possible problem with shallow soils and hardened plinthite at the soil surface or at shallow depth should be investigated before these lands are claimed for mechanised agriculture. For Section B this seems to be less a concern. LMU2 covers 1,311 ha in total.

## **LMU3**

This is a relatively small unit, consisting of land units 15, 16, 17 and 18, found in the south-eastern part of Section B. It covers 364 ha in total. This LMU is partly cultivated. Fields or plots can be seen, but do not form a continuous pattern. There are some bushy areas for which old field patterns are still visible, but the plots do seem not to have been used for quite some time. These areas have shallow to very shallow soils, but have characteristics associated with the less intensive use; that is, a slightly higher SOC content, that puts these units in the category of low SOC content but not very low. Consequently, the pH seems to be a little higher and the CEC is a little higher as well, though still rated

as very low. Apart from the extreme south-eastern corner where CEC still is extremely low.

It is advised to exercise some caution in using these areas for crop cultivation. For commercial production they are probably not suited, but for family farming they might be considered for growing soybean or maybe some vegetables or maybe some cassava or maize on specific spots. Soil depth is the main problem.

#### **LMU4**

The units in LMU4 occupy the north-eastern part of Section B, and measures 1,299 ha in total. These are the gently sloping areas that are for the larger part not being cultivated. We see very few isolated fields (patterns from some previous plots) which increase in number at the lower sloped and in the valley (the units in the valley bottom are excluded from this LMU). The soils are very shallow to shallow and not considered suitable for cropping. This area seems to have some favourable characteristics associated with the land not being used for cropping or other agricultural purposes, such as a relatively high SOC content (though still rated as low) and an optimal pH. Furthermore, the CEC is relatively high and total N, available P and exchangeable potassium are relatively high as well. Nonetheless it is not advised to reclaim this part of the land.

### **Summary and Conclusion**

All the soils within the 6000 ha of land have some constraints. None of the soils have the highest suitability class or rating. But that is also not be expected in this part of the country; that is, the land and soils developed on the basement rock complex. The constraints are mainly associated with soil depth and that includes soil texture and gravel content. Gravel content is high in the soils in this area and the texture is sandy, which has implications for the water holding capacity and herewith water availability to the crop. However, it also impacts on the soil organic matter and soil fertility (nutrient content).

The current land use and vegetation is indicative of the soil condition and soil quality. Land that has not been reclaimed, or that has been reclaimed in the past but has been abandoned since, and where we find vegetation that is indicative of dry conditions should be left alone and not be claimed for agricultural use. Where possible these areas could be allocated for putting up the offices, stores, sheds, etc., if applicable.

The areas that are fit for agricultural use seem to be in use for that purpose already. The photos of the current land use also illustrate its suitability for agricultural use. The photos show extensive parts of flat to gently undulating land, with a healthy crop. The soils should, however, be considered vulnerable and require careful management to enhance and improve soil fertility. An important aspect of the management will be to enhance and maintain soil organic matter levels in the soil and to recapitalize the soil with phosphorus. Otherwise, the indicated areas seem suitable for mechanised operations, with these areas being characterized by long and straight to slightly convex slopes. There is no problem with stones or rock outcrop hindering mechanised operations for those area that area indicated as priority areas.

The riverine areas associated with the main drainage channel, the Osin river, can be quite wet. Woody vegetation can be found in parts that have not been cleared. It is advised to maintain this woody vegetation for the protection of the stream. Where the trees have been cut grass could be planted to protect the stream (from sedimentation) and to keep the sediment load low and the protect it against riverbank erosion.

## Appendix 1: Soil analysis results

Sample	pH	Particle size				Exchangeable bases				Al+H	ECEC	Base Sat	Organic C	Total Avail.			Micro-nutrients					
		Gravel	Sand	Silt	Clay	Ca	Mg	Na	K					N	P	Mn	Fe	Cu	Zn	B	S	
ID	Water	%	%	%	%	cmol /kg	cmol /kg	cmol /kg	cmol /kg	cmol /kg	cmol /kg	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
TOP A1	6.25	9.04	90.40	4.20	5.40	1.33	0.25	0.55	0.33	0.07	2.53	97.23	0.36	0.02	9.19	6.25	10.20	0.51	8.45	0.37	10.70	
TOP A12	6.75	4.10	84.40	6.20	9.40	2.54	0.25	0.82	0.52	0.11	4.24	97.40	0.54	0.04	6.19	38.25	14.45	0.94	14.49	0.28	10.70	
TOP A13	5.85	18.15	90.40	4.20	5.40	1.92	0.50	0.36	0.34	0.10	3.22	96.89	0.70	0.10	3.16	41.60	18.60	0.16	5.97	0.00	168.42	
TOP A14	6.20	0.00	80.40	5.60	14.00	1.53	0.48	0.52	0.42	0.08	3.03	97.36	0.90	0.07	3.85	15.55	31.80	0.25	7.52	0.57	18.61	
TOP A15	6.60	49.88	92.40	3.60	4.00	1.43	0.89	0.33	0.35	0.06	3.06	98.04	0.63	0.05	7.73	16.25	3.80	1.27	9.15	0.57	6.05	
TOP A16	5.45	16.36	86.40	4.20	9.40	1.18	0.35	0.22	0.28	0.11	2.13	94.84	0.65	0.08	2.44	30.70	18.60	0.02	7.33	0.00	68.85	
TOP A19	5.95	0.00	93.80	4.80	1.40	0.95	0.49	0.22	0.47	0.07	2.20	96.82	0.29	0.05	2.79	7.85	4.35	0.68	7.11	0.35	8.84	
TOP A20	6.75	0.00	92.40	3.60	4.00	1.87	1.24	0.35	0.51	0.06	4.03	98.51	0.58	0.07	7.41	17.65	2.20	1.26	9.92	0.30	10.24	
TOP A21	6.25	22.88	94.00	3.60	2.40	1.76	0.71	0.82	0.46	0.07	3.82	98.17	0.37	0.05	7.90	20.10	7.65	0.54	18.23	0.39	28.84	
TOP A22	5.80	0.00	92.40	3.60	4.00	0.89	1.54	0.29	0.50	0.13	3.35	96.12	0.30	0.04	5.54	14.20	4.40	0.43	13.02	0.42	8.37	
TOP A3	6.00	17.98	92.60	7.40	2.00	1.98	0.66	0.14	0.14	0.08	3.01	97.34	0.78	0.09	1.68	35.05	20.85	0.95	8.80	0.00	45.59	
TOP A30	6.98	16.58	91.20	2.20	6.60	1.49	0.71	0.67	0.25	0.06	3.18	98.11	0.70	0.09	6.14	24.75	16.75	0.62	7.45	0.53	15.82	
TOP A34	5.70	80.15	90.40	4.20	5.40	1.89	0.55	0.22	0.32	0.07	3.05	97.70	1.11	0.10	1.63	21.15	17.70	0.56	7.36	0.00	17.21	
TOP A35	5.40	9.01	87.00	5.60	7.40	2.09	0.64	0.48	0.23	0.08	3.52	97.73	0.42	0.05	3.67	13.45	28.85	2.15	10.39	0.24	22.80	
TOP A36	6.00	0.00	89.20	4.80	6.00	1.97	0.49	0.35	0.47	0.10	3.38	97.04	0.26	0.46	5.92	14.35	4.35	2.26	10.73	0.46	9.77	
TOP A4	5.65	0.00	92.40	3.60	4.00	0.89	0.65	0.25	0.39	0.10	2.28	95.61	0.26	0.04	4.06	13.15	3.10	1.14	6.16	0.29	7.44	
TOP A55	5.60	0.00	91.00	3.60	5.40	3.90	0.67	0.25	0.38	0.06	5.27	98.86	0.98	0.08	4.28	20.85	34.00	1.02	13.24	0.00	14.42	
TOP A56	5.80	11.37	86.40	4.20	9.40	2.06	0.46	0.32	0.40	0.10	3.34	97.01	1.04	0.09	1.32	24.65	23.25	0.21	6.77	0.00	61.41	
TOP A57	5.85	14.12	85.00	3.60	11.40	2.52	0.79	0.90	0.46	0.08	4.75	98.32	0.79	0.09	7.90	16.45	31.35	0.32	17.05	0.17	24.66	
TOP A58	5.55	30.27	77.20	6.80	16.00	2.62	1.11	0.54	0.58	0.07	4.92	98.58	0.78	0.06	7.37	24.70	6.10	1.86	13.86	0.25	4.65	
TOP A59	6.90	48.07	92.40	4.20	3.40	1.94	0.36	0.78	0.46	0.06	3.60	98.33	0.58	0.07	9.19	38.60	12.15	0.48	12.66	0.12	13.03	
TOP A60	6.65	49.54	85.20	4.80	10.00	2.71	0.77	0.41	0.53	0.07	4.49	98.44	0.80	0.06	6.25	20.30	5.50	0.78	7.65	0.28	10.70	
TOP A66	7.36	0.00	90.20	3.60	6.20	3.61	1.13	0.77	0.38	0.05	5.94	99.16	2.12	0.12	0	60.60	14.89	0.51	21.72	0.25	14.85	
TOP A7	6.60	0.00	85.00	3.60	11.40	2.87	0.36	0.28	0.51	0.07	4.09	98.29	0.40	0.06	4.17	14.30	8.15	0.78	12.79	0.23	13.49	
TOP A8	5.90	0.00	91.00	3.60	5.40	1.66	0.65	0.67	0.40	0.09	3.47	97.41	0.40	0.03	4.19	16.25	4.20	0.43	11.93	0.11	17.21	
TOP A9	5.65	0.00	93.00	3.60	3.40	1.84	0.24	0.19	0.21	0.08	2.56	96.88	0.24	0.03	6.33	20.70	13.35	0.80	2.90	0.50	16.28	

Sample ID	pH Water	Particle size				Exchangeable bases				Al+H ECEC	Base Sat	Organic C	Total N	Avail. P	Micro-nutrients						
		Gravel	Sand	Silt	Clay	Ca	Mg	Na	K						Mn	Fe	Cu	Zn	B	S	
		%	%	%	%	cmol /kg	cmol/k g	cmol /kg	cmol /kg						cmol /kg	cmol /kg	%	%	mg/kg	mg/kg	mg/kg
SUB A1	5.50	37.11	88.40	5.60	6.00	3.10	0.84	0.34	0.56	0.11	4.95	97.78	0.09	0.021	13.97	10.15	4.80	1.235	13.135	0.293	6.979
SUB A12	5.95	40.93	75.20	12.80	12.00	1.88	0.86	0.35	0.33	0.12	3.54	96.61	0.29	0.017	8.82	9.25	6.60	0.655	9.240	0.344	2.791
SUB A13	5.95	21.28	82.40	13.60	4.00	1.24	0.93	0.24	0.37	0.09	2.87	96.86	0.13	0.011	13.03	8.40	1.45	1.400	6.025	0.349	6.513
SUB A14	6.15	0.00	89.20	4.80	6.00	1.86	0.56	0.40	0.45	0.06	3.33	98.20	0.32	0.014	2.73	2.35	4.10	0.270	12.510	0.597	6.048
SUB A15	6.45	66.06	89.00	3.60	7.40	2.00	0.541	0.34	0.49	0.08	3.45	97.68	0.20	0.034	3.29	17.85	11.10	1.150	18.400	0.221	22.797
SUB A16	5.80	16.17	73.20	14.80	12.00	1.92	0.97	0.38	0.35	0.09	3.71	97.57	0.07	0.023	8.76	18.95	6.70	1.445	8.775	0.329	0.000
SUB A19	6.25	0.00	87.00	3.60	9.40	1.30	0.316	0.31	0.31	0.08	2.32	96.55	0.21	0.042	6.69	13.70	10.05	0.640	13.765	0.300	32.566
SUB A2	5.90	66.56	91.80	4.80	3.40	1.16	1.61	0.51	0.84	0.09	4.21	97.86	0.65	0.047	7.81	32.65	8.25	0.785	13.790	0.319	15.818
SUB A20	6.70	36.86	86.40	3.60	10.00	1.38	0.62	0.38	0.49	0.05	2.92	98.29	0.33	0.026	4.68	9.65	2.90	0.600	11.490	0.400	9.305
SUB A21	5.85	32.33	83.00	11.60	5.40	1.36	0.421	0.31	0.28	0.09	2.46	96.34	0.24	0.031	4.33	15.55	11.90	0.820	19.810	0.628	20.936
SUB A22	5.55	0.00	93.00	4.80	2.20	1.58	0.421	0.28	0.34	0.11	2.73	95.97	0.27	0.008	3.33	20.55	8.60	0.770	18.805	0.286	18.144
SUB A3	6.00	29.14	80.40	13.60	6.00	1.30	0.84	0.34	0.45	0.10	3.03	96.70	0.41	0.063	15.53	10.50	4.60	1.125	10.920	0.749	7.444
SUB A30	6.40	54.13	83.00	5.60	11.40	2.18	0.591	0.44	0.78	0.08	4.07	98.03	0.22	0.029	8.67	31.00	13.60	0.825	17.590	0.386	17.679
SUB A34	5.55	61.27	85.00	7.60	7.40	1.46	0.538	0.31	0.40	0.09	2.80	96.78	0.46	0.063	9.00	28.50	10.80	0.920	15.830	0.428	24.657
SUB A35	5.80	17.48	89.20	4.80	6.00	1.26	0.45	0.40	0.42	0.11	2.64	95.83	0.31	0.050	4.35	10.70	8.00	0.585	3.875	0.243	13.027
SUB A36	6.10	46.97	76.40	15.60	8.00	0.95	0.39	0.32	0.31	0.08	2.05	96.10	0.63	0.084	16.08	17.65	2.45	0.850	6.060	0.997	3.257
SUB A4	6.05	63.13	87.00	3.60	9.40	1.84	0.412	0.28	0.30	0.09	2.92	96.92	0.13	0.029	7.76	15.80	11.50	1.165	9.650	0.500	15.818
SUB A48	5.05	0.00	55.00	31.60	13.40	1.74	0.606	0.41	0.72	0.12	3.60	96.66	0.49	0.066	3.95	13.90	13.15	1.585	17.585	0.486	13.957
SUB A55	5.70	19.23	79.00	5.60	15.40	2.55	0.443	0.28	0.23	0.10	3.60	97.22	0.47	0.060	3.91	12.15	14.30	0.540	4.650	0.436	12.561
SUB A56	5.45	30.17	77.80	14.80	7.40	1.60	0.46	0.25	0.35	0.11	2.77	96.03	0.12	0.028	6.98	16.90	7.00	1.190	13.050	0.364	3.257
SUB A57	5.50	23.56	79.00	7.60	13.40	1.55	0.389	0.25	0.31	0.10	2.60	96.15	0.57	0.067	6.98	20.40	14.10	0.775	2.840	0.336	16.748
SUB A58	5.50	64.08	81.00	7.60	11.40	5.01	0.406	0.29	0.42	0.10	6.23	98.39	0.47	0.062	8.24	12.90	17.55	1.030	8.065	0.471	11.166
SUB A59	6.70	67.55	87.00	3.60	9.40	2.28	0.344	0.27	0.40	0.12	3.41	96.49	0.29	0.036	10.55	15.70	9.50	0.835	11.185	0.428	69.785
SUB A60	6.15	61.20	84.60	5.40	10.00	2.67	0.508	0.32	0.20	0.09	3.79	97.63	1.03	0.121	1.12	26.30	20.75	0.470	10.650	0.000	27.449
SUB A7	5.95	0.00	73.00	13.60	13.40	1.34	0.685	0.52	0.33	0.08	2.95	97.29	0.16	0.024	8.14	9.75	14.90	1.035	8.855	0.000	7.909
SUB A8	5.25	0.00	71.00	19.60	9.40	1.59	0.443	0.31	0.38	0.09	2.81	96.80	0.22	0.048	7.89	8.75	5.25	0.730	8.405	0.357	6.513
SUB A9	5.50	0.00	85.00	7.60	7.40	1.43	0.339	0.22	0.32	0.10	2.41	95.85	0.11	0.031	6.13	15.85	4.70	1.180	6.215	0.578	29.310

Sample ID	pH Water	Particle size				Exchangeable bases				Al+H cmol/kg	ECEC cmol/kg	Base Sat %	Organi c C %	Total N %	Avail. P mg/kg	Micro-nutrients					
		Gravel %	Sand %	Silt %	Clay %	Ca cmol/kg	Mg cmol/kg	Na cmol/kg	K cmol/kg							Mn mg/kg	Fe mg/kg	Cu mg/kg	Zn mg/kg	B mg/kg	S mg/kg
		TOP 41	5.65	24.60	84.40	5.60	10.00	1.49	0.35							0.40	0.34	0.10	2.68	96.27	0.27
TOP B1	5.70	30.52	86.40	3.60	10.00	1.54	0.47	0.44	0.34	0.10	2.89	96.54	0.30	0.05	4.47	11.95	6.55	0.41	6.99	0.39	20.94
TOP B10	6.00	38.28	83.00	3.60	13.40	2.52	0.61	0.41	0.44	0.06	4.04	98.52	0.69	0.08	9.60	23.50	24.00	1.01	13.15	0.39	13.49
TOP B100	5.85	0.00	86.60	5.40	8.00	2.91	0.52	0.22	0.44	0.10	4.19	97.61	1.25	0.16	1.73	20.70	23.50	1.24	2.55	0.00	21.40
TOP B101	7.00	50.44	92.80	4.80	2.40	6.22	1.57	0.43	0.64	0.06	8.92	99.33	1.33	0.08	29.13	27.20	5.60	0.95	22.85	0.54	12.10
TOP B102	6.80	8.63	88.40	4.80	6.80	2.01	0.78	0.52	0.29	0.11	3.71	97.04	0.52	0.07	9.24	17.80	30.45	0.49	6.18	0.29	13.19
TOP B103	6.15	55.70	90.40	3.60	6.00	1.56	0.37	0.40	0.32	0.08	2.73	97.07	0.61	0.08	6.33	21.85	17.45	0.76	3.73	0.25	19.54
TOP B104	6.05	37.36	76.60	5.40	18.00	3.24	0.89	0.14	0.26	0.08	4.62	98.27	1.82	0.15	0.92	24.15	20.85	1.15	10.19	0.00	13.96
TOP B105	5.90	36.08	89.80	4.80	5.40	1.44	0.64	0.29	0.45	0.10	2.92	96.58	0.73	0.05	5.13	14.70	4.40	1.74	14.69	0.49	14.42
TOP B11	5.44	43.41	90.40	4.20	5.40	1.75	0.43	0.25	0.10	0.10	2.63	96.20	1.20	0.09	2.19	24.40	21.75	0.52	4.44	0.00	25.12
TOP B112	6.15	0.00	88.40	3.60	8.00	1.48	0.42	0.40	0.28	0.08	2.66	97.00	0.30	0.02	4.09	14.95	12.10	0.54	1.65	0.47	13.96
TOP B113	5.50	59.27	83.00	7.60	9.40	2.67	0.47	0.25	0.49	0.11	3.99	97.24	0.54	0.07	12.16	16.10	11.45	1.49	10.19	0.65	14.42
TOP B115	6.05	34.28	72.40	10.80	16.80	3.94	0.94	1.01	0.50	0.07	6.46	98.92	0.76	0.05	9.81	11.75	38.60	1.09	19.01	0.60	23.73
TOP B116	5.30	16.68	88.40	4.20	7.40	0.78	0.66	0.73	0.38	0.12	2.67	95.51	0.40	0.06	5.86	13.30	12.80	0.03	3.07	0.36	11.63
TOP B117	5.30	25.05	81.00	5.60	13.40	1.84	0.41	0.25	0.36	0.10	2.96	96.62	0.33	0.05	2.29	16.20	18.85	1.51	18.23	0.47	17.21
TOP B118	7.15	7.51	92.40	3.60	4.00	2.39	0.44	0.44	0.30	0.04	3.61	98.89	0.36	0.06	12.10	22.85	21.85	1.27	8.33	0.56	26.98
TOP B119	5.65	14.77	89.00	3.60	7.40	2.52	1.24	0.29	0.50	0.07	4.62	98.49	1.10	0.09	1.02	19.05	30.35	0.92	9.44	0.00	26.98
TOP B12	6.00	18.73	60.40	10.20	29.40	1.46	0.40	1.21	0.77	0.06	3.90	98.46	0.75	0.08	7.29	17.40	22.60	0.41	13.93	0.30	9.77
TOP B120	6.55	40.01	84.40	3.60	12.00	2.66	0.69	0.52	0.58	0.08	4.53	98.24	1.76	0.15	14.27	31.75	29.55	0.18	12.93	0.22	59.55
TOP B13	5.10	45.84	74.60	15.40	10.00	2.30	0.64	0.22	0.40	0.12	3.68	96.74	1.47	0.13	2.65	29.35	14.40	1.19	4.69	0.02	46.52
TOP B14	6.15	31.43	85.00	5.60	9.40	2.36	0.52	0.32	0.34	0.07	3.61	98.06	0.28	0.04	1.41	7.05	6.70	0.62	11.04	0.34	45.59
TOP B15	5.90	37.96	90.40	4.20	5.40	1.68	0.66	0.29	0.36	0.08	3.07	97.40	1.13	0.08	1.63	13.95	21.70	0.05	7.98	0.00	23.26
TOP B16	6.10	30.90	91.20	4.80	4.00	3.46	1.19	0.51	0.58	0.10	5.84	98.29	0.52	0.07	7.73	12.05	7.90	0.62	12.28	0.46	25.00
TOP B17	6.25	41.13	77.00	7.60	15.40	2.95	0.56	0.38	0.42	0.06	4.37	98.63	0.62	0.05	11.76	23.50	10.35	1.03	16.86	0.28	14.42
TOP B18	6.05	0.00	80.40	7.60	12.00	1.31	0.40	0.40	0.28	0.09	2.48	96.37	0.33	0.04	3.54	7.55	7.50	0.32	2.32	0.59	38.15
TOP B19	5.70	40.42	88.60	5.40	6.00	2.12	0.55	0.22	0.16	0.07	3.11	97.75	1.46	0.16	5.60	32.75	30.40	0.83	5.56	0.00	23.26
TOP B2	5.55	26.35	88.40	3.60	8.00	1.34	0.43	0.40	0.16	0.11	2.44	95.49	0.34	0.03	5.40	11.60	15.20	0.86	0.47	0.40	21.40
TOP B20	5.75	12.51	79.80	8.20	12.00	0.83	0.28	0.96	0.58	0.10	2.75	96.36	0.43	0.04	10.00	10.90	9.25	0.98	9.71	0.03	12.56

TOP B21	6.05	30.53	82.40	4.80	12.80	3.06	0.63	0.71	0.40	0.06	4.86	98.77	0.56	0.07	6.86	8.40	13.85	1.15	15.32	0.46	50.71
TOP B22	5.60	45.02	87.00	7.60	5.40	1.68	0.42	0.28	0.30	0.09	2.77	96.75	0.39	0.05	7.24	7.45	13.05	0.86	1.82	0.21	22.80
TOP B24	6.15	53.25	82.60	5.40	12.00	2.74	0.71	0.29	0.32	0.09	4.15	97.83	1.76	0.12	1.27	37.60	27.80	0.80	3.50	0.14	13.96
TOP B25	6.20	36.99	85.20	5.80	9.00	0.94	0.51	0.61	0.38	0.09	2.53	96.45	0.32	0.01	3.38	8.70	7.45	0.82	10.78	0.77	36.75
TOP B26	7.00	0.00	81.00	5.60	13.40	3.12	0.47	0.31	0.45	0.05	4.40	98.86	0.36	0.02	6.68	9.10	2.60	0.64	15.06	0.22	31.64
TOP B27	7.05	31.04	87.80	4.20	8.00	3.35	1.07	1.09	0.54	0.05	6.10	99.18	1.88	0.13	9.86	29.65	17.50	0.34	10.84	0.29	9.77
TOP B28	5.65	22.06	89.00	3.60	7.40	1.24	0.66	0.46	0.31	0.09	2.76	96.74	0.51	0.07	7.33	14.15	28.10	0.79	9.75	0.29	9.30
TOP B29	6.30	20.54	90.40	3.60	6.00	0.93	0.33	0.44	0.38	0.07	2.15	96.75	0.22	0.01	4.78	25.20	8.85	0.29	3.45	0.38	71.65
TOP B3	5.85	29.85	86.40	4.20	9.40	1.40	0.42	0.25	0.34	0.10	2.51	96.02	1.60	0.14	1.07	21.25	28.85	0.69	7.30	0.13	20.94
TOP B30	5.80	23.57	86.40	4.20	9.40	1.62	0.51	0.70	0.36	0.10	3.29	96.96	0.39	0.11	7.43	17.45	5.30	0.66	10.75	0.33	11.63
TOP B31	5.60	0.00	90.40	3.60	6.00	1.48	0.49	0.40	0.28	0.09	2.74	96.71	0.28	0.05	4.71	25.65	28.55	1.16	2.25	0.33	20.94
TOP B32	6.25	17.21	92.60	4.20	3.20	1.42	0.39	0.71	0.33	0.08	2.93	97.27	0.65	0.08	7.86	16.30	7.20	1.08	1.79	0.43	13.03
TOP B33	7.25	35.99	84.60	4.20	11.20	3.23	0.90	1.38	0.75	0.06	6.32	99.05	1.22	0.09	11.67	43.20	18.90	0.77	17.81	0.38	13.96
TOP B34	5.45	30.52	84.40	3.60	12.00	1.44	0.39	0.40	0.32	0.10	2.65	96.23	0.26	0.01	6.64	22.00	23.40	1.33	1.75	0.70	67.46
TOP B35	5.80	28.06	82.60	5.40	12.00	2.67	0.61	0.22	0.40	0.09	3.98	97.74	1.84	0.16	1.58	26.75	26.50	0.65	10.53	0.00	37.22
TOP B36	5.95	0.00	85.80	4.80	9.40	0.85	0.72	0.35	0.49	0.08	2.49	96.79	0.39	0.05	4.63	13.65	4.70	1.22	15.21	0.33	7.91
TOP B37	6.40	38.91	88.40	4.20	7.40	1.80	0.47	0.77	0.48	0.06	3.58	98.32	0.75	0.10	8.48	24.10	7.85	0.12	12.05	0.23	13.49
TOP B38	5.80	31.53	82.60	5.40	12.00	2.96	0.80	0.32	0.48	0.10	4.66	97.86	1.14	0.09	1.12	19.50	33.05	0.92	11.88	0.06	168.42
TOP B39	6.35	45.76	91.00	3.60	5.40	3.61	0.87	0.90	0.54	0.06	5.98	99.00	0.40	0.06	6.19	30.25	7.25	0.32	17.38	0.35	55.36
TOP B4	6.20	7.07	82.40	5.60	12.00	1.46	0.48	0.48	0.30	0.07	2.79	97.49	0.47	0.05	4.47	19.10	21.65	0.52	4.63	0.37	17.21
TOP B40	5.85	0.00	84.60	5.40	10.00	2.46	0.45	0.29	0.42	0.10	3.72	97.31	0.56	0.71	1.07	34.05	17.20	1.60	1.86	0.00	39.08
TOP B42	6.80	54.16	79.00	7.60	13.40	4.93	0.74	0.36	0.66	0.06	6.75	99.11	0.89	0.06	9.50	22.00	9.95	0.97	20.37	0.47	22.33
TOP B44	5.35	35.29	82.40	5.60	12.00	1.92	0.36	0.36	0.34	0.11	3.09	96.44	0.44	0.03	13.58	17.20	18.60	1.15	1.84	0.34	37.22
TOP B45	5.60	0.00	78.40	9.60	12.00	1.09	0.32	0.40	0.32	0.10	2.23	95.52	0.34	..031	4.59	19.00	13.80	0.53	2.78	0.31	41.87
TOP B46	6.30	0.00	94.20	4.80	1.00	1.78	1.04	0.42	0.52	0.08	3.84	97.92	0.79	0.05	5.52	21.60	6.05	0.72	8.37	0.27	6.51
TOP B47	5.50	19.88	87.00	3.60	9.40	2.33	0.48	0.22	0.34	0.10	3.46	97.11	0.54	0.07	2.29	20.95	18.50	0.98	3.95	0.00	63.74
TOP B48	5.55	67.06	72.40	14.20	13.40	1.06	0.40	0.98	0.61	0.07	3.12	97.76	0.76	0.06	10.48	21.35	13.90	1.33	5.98	0.24	19.07
TOP B49	6.85	54.62	85.20	6.20	8.60	3.11	0.63	0.32	0.28	0.06	4.41	98.64	1.02	0.08	9.64	18.65	15.85	0.77	9.64	0.11	11.17
TOP B5	5.45	29.69	86.40	4.20	9.40	1.06	0.38	0.22	0.30	0.08	2.04	96.08	1.12	0.14	1.12	32.70	16.65	0.47	3.10	0.00	30.24
TOP B52	5.55	17.96	80.40	3.60	16.00	1.34	0.54	0.48	0.36	0.10	2.82	96.45	0.39	0.05	7.26	17.00	19.25	1.10	7.58	0.36	25.12
TOP B53	6.20	20.72	91.00	3.60	5.40	2.63	0.36	0.25	0.42	0.06	3.72	98.39	0.41	0.05	5.03	12.25	5.15	0.74	12.72	0.84	24.19
TOP B54	5.45	32.71	84.40	6.20	9.40	0.87	0.43	0.18	0.36	0.11	1.95	94.36	1.18	0.09	1.17	16.00	18.45	0.35	11.04	0.00	28.84

TOP B55	6.50	19.16	87.00	7.60	5.40	5.35	0.33	0.82	0.38	0.07	6.95	98.99	0.36	0.03	6.19	18.10	18.95	1.10	12.40	0.15	13.96
TOP B56	6.00	40.10	91.00	3.60	5.40	2.56	0.36	0.31	0.43	0.07	3.73	98.12	0.33	0.04	2.14	11.30	10.29	0.74	7.17	0.54	12.56
TOP B57	6.40	56.95	82.40	7.60	10.00	2.54	0.54	0.44	0.32	0.07	3.91	98.21	0.54	0.07	80.27	16.75	25.40	1.30	8.89	0.45	24.19
TOP B58	5.45	24.10	86.60	5.40	8.00	3.06	0.54	0.22	0.16	0.11	4.09	97.31	1.10	0.08	2.29	20.35	23.55	0.60	2.98	0.01	6.51
TOP B6	6.10	0.00	91.20	4.80	4.00	3.46	1.19	0.51	0.58	0.10	5.84	98.29	0.52	0.071	7.726	12.05	7.90	0.620	12.280	5	16.74
TOP B61	5.75	0.00	86.40	5.60	8.00	2.81	0.45	0.34	0.59	0.10	4.29	97.67	0.34	0.02	4.42	26.80	5.50	0.19	14.95	0.34	29.31
TOP B62	6.50	0.00	86.40	4.20	9.40	2.30	0.76	0.29	0.20	0.10	3.64	97.26	0.88	0.10	1.58	25.05	26.85	0.58	9.23	0.27	39.08
TOP B63	6.50	0.00	91.20	4.80	4.00	1.98	0.64	0.33	0.49	0.08	3.52	97.73	0.55	0.08	4.41	18.60	6.15	1.06	6.98	0.50	8.37
TOP B64	6.30	22.61	74.60	5.40	20.00	1.88	0.46	0.22	0.38	0.09	3.03	97.03	0.84	0.06	2.60	15.50	24.00	0.89	3.08	0.08	45.59
TOP B65	6.05	43.11	82.40	5.60	12.00	1.62	0.54	0.44	0.22	0.09	2.91	96.91	0.36	0.04	20.22	19.35	8.05	0.61	3.25	0.33	33.96
TOP B67	6.25	22.05	83.00	4.80	12.20	2.12	0.51	0.31	0.43	0.07	3.44	97.96	0.48	0.06	2.10	11.05	13.30	0.70	19.02	0.62	37.68
TOP B68	6.25	33.64	89.00	3.60	7.40	1.97	0.48	0.28	0.35	0.09	3.17	97.16	0.48	0.06	4.52	11.20	9.15	0.69	15.04	0.41	9.77
TOP B69	5.05	33.56	93.00	3.60	3.40	2.67	0.69	0.25	0.28	0.10	3.99	97.49	1.12	0.07	2.09	19.35	29.15	1.57	8.74	0.02	17.68
TOP B7	6.00	65.14	73.00	11.60	15.40	3.44	1.05	0.88	0.50	0.08	5.95	98.65	1.19	0.09	14.24	20.30	11.25	1.02	19.35	0.27	12.56
TOP B70	5.65	0.00	91.20	4.80	4.00	2.25	0.74	0.34	0.45	0.08	3.86	97.93	0.36	0.18	6.08	10.40	5.65	1.17	13.72	0.59	8.84
TOP B71	4.95	65.01	64.40	25.60	10.00	2.30	1.01	0.56	0.52	0.12	4.51	97.34	0.76	0.06	15.63	34.95	17.15	0.57	6.88	0.49	21.87
TOP B72	6.95	17.65	95.00	3.60	1.40	2.64	0.52	0.18	0.30		3.64	100.00	0.60	0.05	2.85	12.00	27.55	1.17	13.21	0.00	33.03
TOP B73	6.75	29.44	88.40	3.60	8.00	1.56	0.45	0.48	0.46	0.07	3.02	97.68	0.51	0.08	8.99	29.10	9.85	0.38	3.70	0.46	34.89
TOP B74	6.40	33.85	90.40	4.20	5.40	1.84	0.55	1.03	0.71	0.08	4.21	98.10	1.36	0.09	10.29	17.55	24.40	1.15	6.62	0.18	15.35
TOP B75	6.20	25.20	85.00	3.60	11.40	2.87	0.70	0.36	0.44	0.07	4.44	98.43	1.21	0.10	1.07	18.90	47.65	1.41	10.42	0.10	16.75
TOP B76	6.15	33.88	82.40	5.60	12.00	1.78	0.43	0.36	0.26	0.09	2.92	96.92	0.61	0.07	4.84	19.75	11.05	0.31	7.24	0.22	29.78
TOP B78	5.65	20.42	84.40	5.60	10.00	1.80	0.32	0.40	0.28	0.08	2.88	97.22	0.31	0.05	7.94	12.75	17.20	1.25	7.29	0.32	39.08
TOP B79	6.70	0.00	86.40	5.60	8.00	0.89	0.71	0.35	0.31	0.05	2.31	97.84	0.53	0.08	6.09	8.95	2.35	1.48	7.46	0.39	6.98
TOP B8	5.90	29.45	82.40	5.60	12.00	2.42	0.53	0.48	0.40	0.09	3.92	97.70	0.63	0.09	7.13	17.80	14.65	0.41	6.13	0.51	23.73
TOP B81	6.15	39.85	92.60	5.40	2.00	2.34	0.61	0.29	0.24	0.06	3.53	98.30	1.22	0.14	2.39	32.55	21.50	0.77	6.80	0.00	20.01
TOP B84	5.55	70.64	92.80	4.80	2.40	2.79	0.99	0.36	1.03	0.12	5.29	97.73	0.84	0.06	7.70	22.95	6.20	1.55	20.22	0.26	26.52
TOP B85	5.20	20.34	89.00	3.60	7.40	2.40	0.29	0.55	0.31	0.10	3.65	97.26	0.39	0.05	5.76	20.05	22.30	0.46	21.80	0.32	13.49
TOP B86	6.30	50.34	89.00	3.60	7.40	4.91	0.90	0.41	0.51	0.07	6.80	98.97	1.54	0.12	9.10	23.55	17.70	0.85	20.40	0.60	21.87
TOP B89	6.75	43.12	82.40	5.60	12.00	2.36	0.78	0.88	1.22	0.06	5.30	98.87	0.36	0.06	11.35	17.00	34.40	0.82	10.37	0.58	56.29
TOP B9	6.40	30.55	92.40	3.60	4.00	1.58	0.58	0.56	0.50	0.07	3.29	97.87	0.49	0.06	4.65	40.90	18.55	0.49	6.97	0.35	17.68
TOP B90	5.65	17.67	89.00	3.60	7.40	1.74	0.42	0.31	0.34	0.08	2.89	97.23	0.56	0.04	3.67	11.60	11.15	1.15	10.72	0.37	19.07
TOP B91	6.55	53.62	79.00	7.60	13.40	5.04	1.17	1.03	0.56	0.06	7.86	99.24	1.84	0.14	22.05	33.05	24.95	1.52	25.99	0.72	20.47

TOP B93	7.10	70.03	65.00	23.60	11.40	3.21	1.01	0.85	1.29	0.04	6.40	99.37	0.95	0.11	11.24	42.90	27.40	0.75	18.91	0.91	26.05
TOP B94	5.30	54.41	56.40	25.60	18.00	1.50	0.52	0.52	0.46	0.09	3.09	97.09	0.60	0.08	12.84	22.55	14.55	0.49	7.64	0.46	27.45
TOP B94	5.05	0.00	46.60	35.40	18.00	4.31	1.06	0.29	0.50	0.11	6.27	98.25	1.30	0.11	6.77	18.75	32.85	0.69	5.13	0.00	99.30
TOP B95	5.45	0.00	92.80	4.80	2.40	3.39	0.70	0.23	0.58	0.10	5.00	98.00	0.56	0.04	6.42	20.20	5.20	1.36	11.38	0.76	7.44
TOP B96	6.30	32.39	93.00	3.60	3.40	1.96	0.54	0.41	0.53	0.07	3.51	98.00	0.57	0.07	6.73	24.95	23.75	0.78	11.04	0.31	52.57
TOP B97	7.20	54.04	80.60	5.40	14.00	5.82	1.03	0.47	0.38	0.05	7.74	99.35	3.16	0.18	8.45	54.95	46.35	0.97	23.56	0.00	61.41
TOP B98	6.40	48.65	85.20	4.80	10.00	4.02	0.90	0.31	0.41	0.05	5.69	99.12	1.30	0.09	11.33	21.10	9.95	0.32	17.81	0.45	6.05

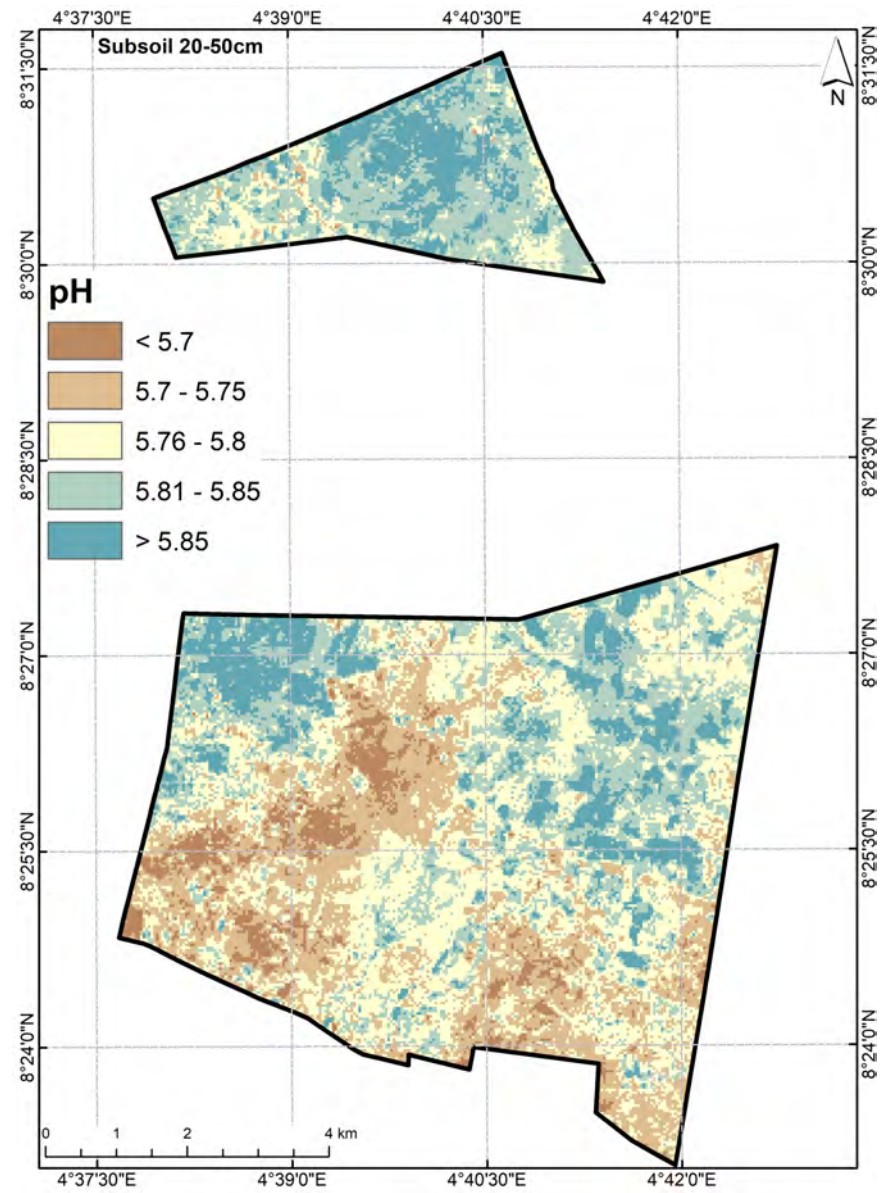
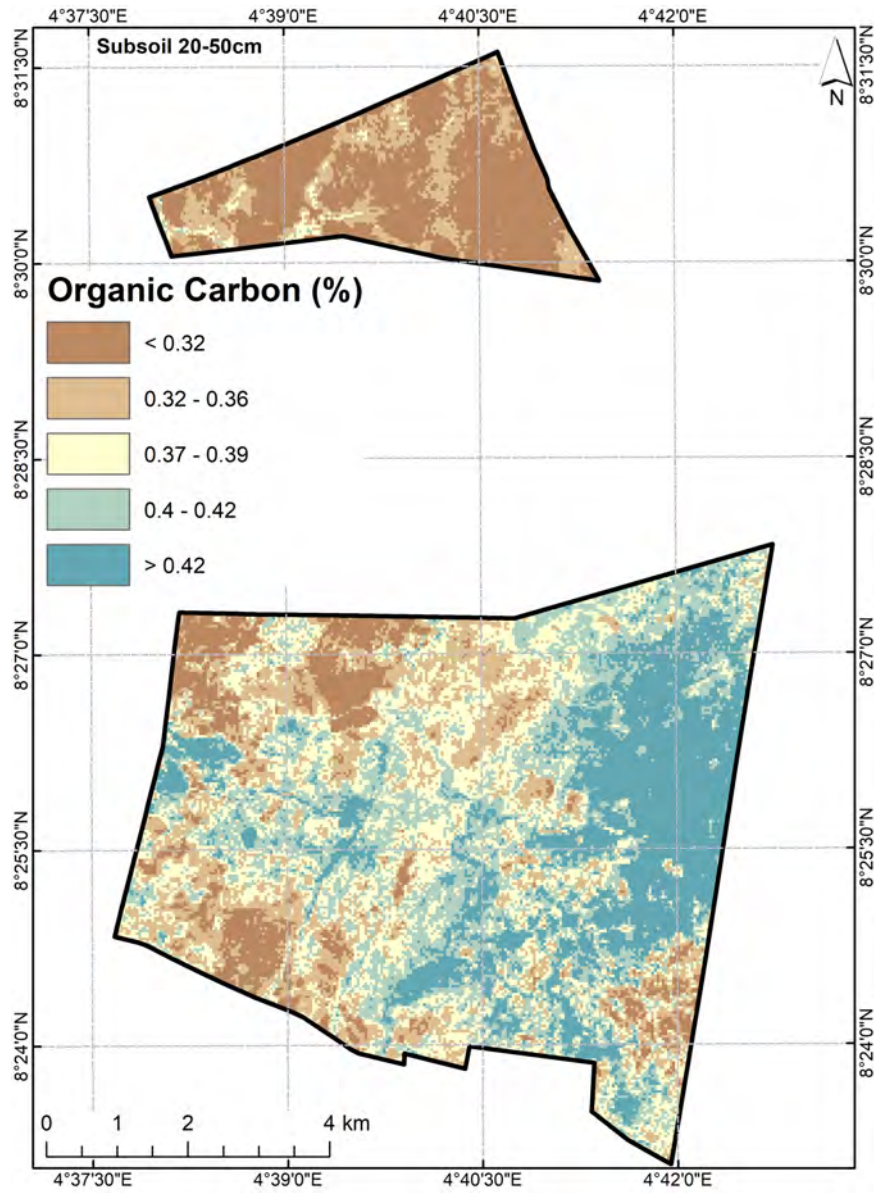
Sample ID	pH	Particle size				Exchangeable bases				Al+H	ECEC	Base Sat	Organic C	Total N	Avail. P	Micro-nutrients					
		Gravel %	Sand %	Silt %	Clay %	Ca cmol/kg	Mg cmol/kg	Na cmol/kg	K cmol/kg							Mn mg/kg	Fe mg/kg	Cu mg/kg	Zn mg/kg	B mg/kg	S mg/kg
SUB B1	5.65	65.90	85.20	6.80	8.00	2.84	1.21	0.38	0.43	0.12	4.98	97.59	0.32	0.02	8.43	24.60	2.60	1.78	11.68	0.25	10.24
SUB B2	5.40	40.14	82.40	6.20	11.40	1.55	0.65	0.11	0.30	0.13	2.73	95.25	0.76	0.06	3.62	16.75	22.40	0.54	10.39	0.08	16.28
SUB B3	5.60	40.19	84.60	5.40	10.00	1.56	0.32	0.36	0.22	0.09	2.55	96.46	1.10	0.08	1.53	24.35	20.85	0.69	3.97	0.04	43.27
SUB B4	5.55	0.00	72.40	14.80	12.80	1.76	0.51	0.55	0.35	0.10	3.27	96.94	0.32	0.04	11.24	10.35	17.95	1.84	15.21	0.09	8.43
SUB B6	5.50	36.51	91.00	3.60	5.40	3.28	0.92	0.33	0.38	0.11	5.02	97.81	0.62	0.08	16.29	23.55	21.80	0.72	27.59	0.22	29.31
SUB B8	5.65	34.85	83.00	9.60	7.40	2.36	0.76	0.34	0.31	0.11	3.88	97.16	0.43	0.03	8.09	11.75	7.15	0.77	14.62	0.62	31.64
SUB B9	6.12	52.67	85.60	4.20	10.20	2.61	0.73	0.44	0.59	0.07	4.44	98.42	0.42	0.06	4.91	19.85	10.05	0.98	19.72	0.30	13.49
SUB B10	5.75	52.00	77.00	13.60	9.40	1.92	0.61	0.41	0.51	0.10	3.55	97.18	0.55	0.07	7.38	27.45	15.25	1.20	19.90	0.76	21.87
SUB B12	6.10	28.45	66.40	12.80	20.80	2.76	0.48	0.92	0.52	0.08	4.76	98.32	0.43	0.06	9.43	45.05	19.20	1.03	11.26	0.50	40.48
SUB B13	4.80	57.29	81.00	14.00	5.00	2.38	0.59	0.29	0.36	0.14	3.75	96.27	1.52	0.12	3.82	30.05	28.20	1.44	14.12	0.00	106.07
SUB B14	5.40	43.10	73.00	15.60	11.40	2.52	0.56	0.31	0.32	0.10	3.81	97.37	0.22	0.03	9.95	8.65	14.10	1.05	18.23	0.27	58.15
SUB B15	5.65	56.43	85.00	5.60	9.40	5.20	1.01	0.29	0.31	0.09	6.90	98.69	0.49	0.06	13.14	18.60	15.40	0.71	5.49	0.07	9.30
SUB B16	5.85	33.94	82.40	3.60	14.00	1.71	0.46	0.52	0.44	0.09	3.22	97.20	0.21	0.03	6.27	27.00	16.40	1.05	7.16	0.37	84.21
SUB B18	5.60	34.26	86.40	5.60	8.00	1.43	0.37	0.32	0.20	0.11	2.43	95.47	0.19	0.02	4.34	11.70	13.35	0.73	1.14	0.40	16.75
SUB B20	6.15	31.98	85.80	6.80	7.40	1.17	0.41	0.16	0.19	0.06	1.99	96.98	0.27	0.01	5.52	8.50	5.15	1.16	5.72	0.33	2.33
SUB B22	5.35	39.02	77.00	13.60	9.40	2.33	0.62	0.22	0.25	0.07	3.49	97.99	0.27	0.01	6.48	5.60	6.75	1.44	9.06	0.39	10.70
SUB B23	6.05	26.73	85.20	4.80	10.00	2.07	0.90	0.28	0.31	0.09	3.65	97.53	0.26	0.04	6.42	12.95	5.15	1.61	11.58	0.31	5.12
SUB B25	5.40	0.00	66.40	22.20	11.40	2.15	0.48	0.32	0.26	0.09	3.30	97.28	1.08	0.08	3.21	21.50	25.30	0.87	8.54	0.09	76.76
SUB B26	7.20	36.79	85.00	3.60	11.40	2.30	0.42	0.28	0.30	0.05	3.35	98.51	0.33	0.06	9.35	12.45	23.15	1.65	6.09	0.36	31.94
SUB B27	5.85	43.98	78.40	6.80	14.80	2.53	0.42	0.48	0.25	0.10	3.78	97.36	0.35	0.05	7.76	7.10	18.20	1.35	22.55	0.56	9.77

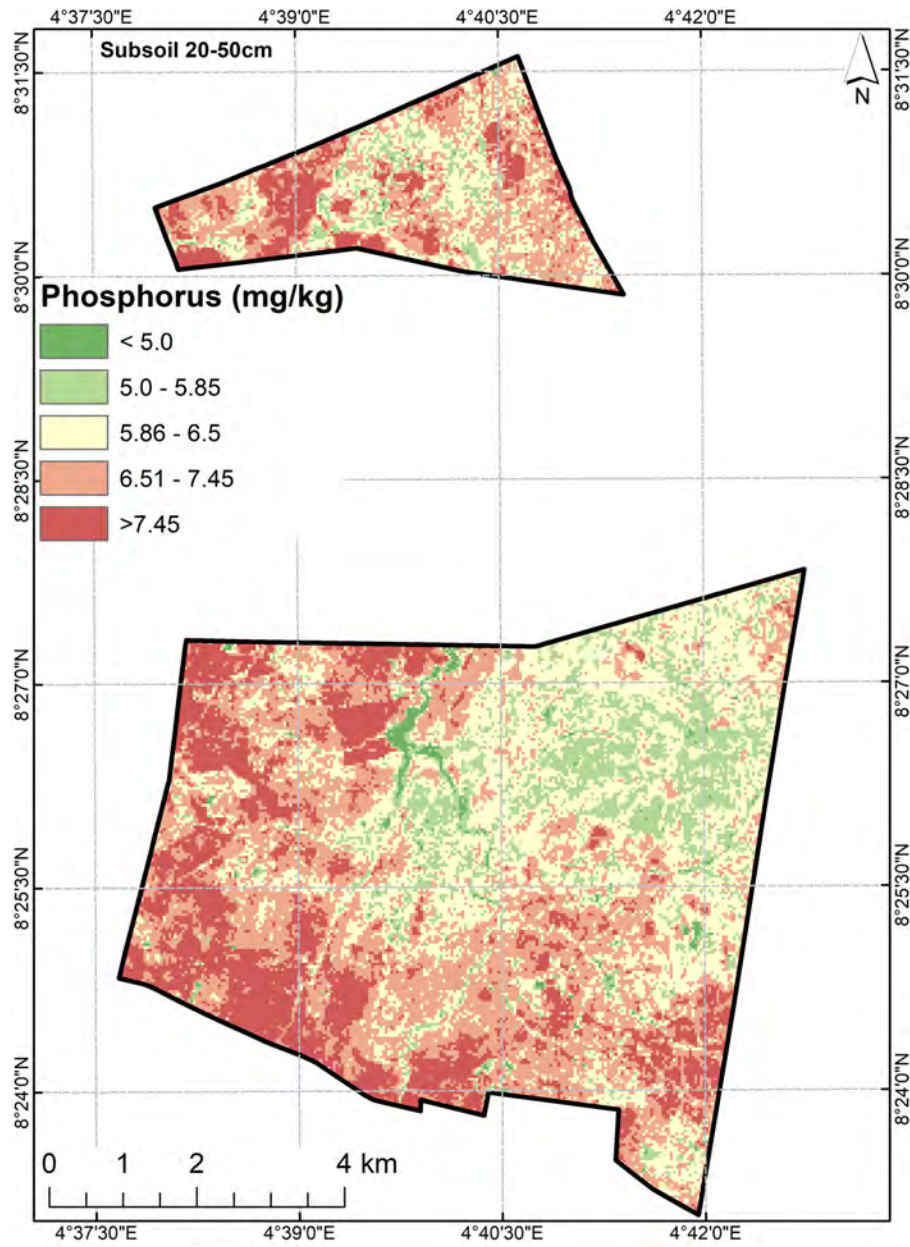
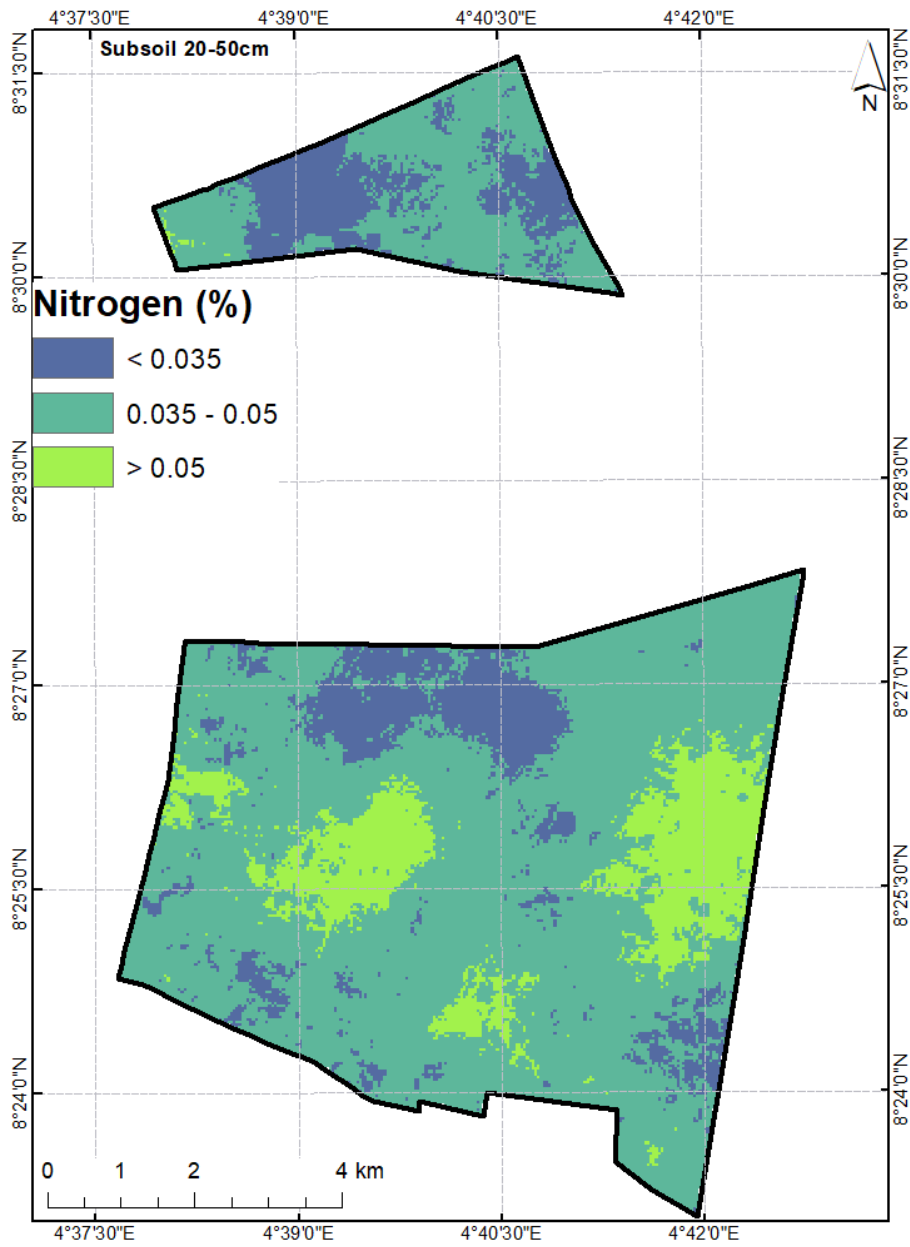


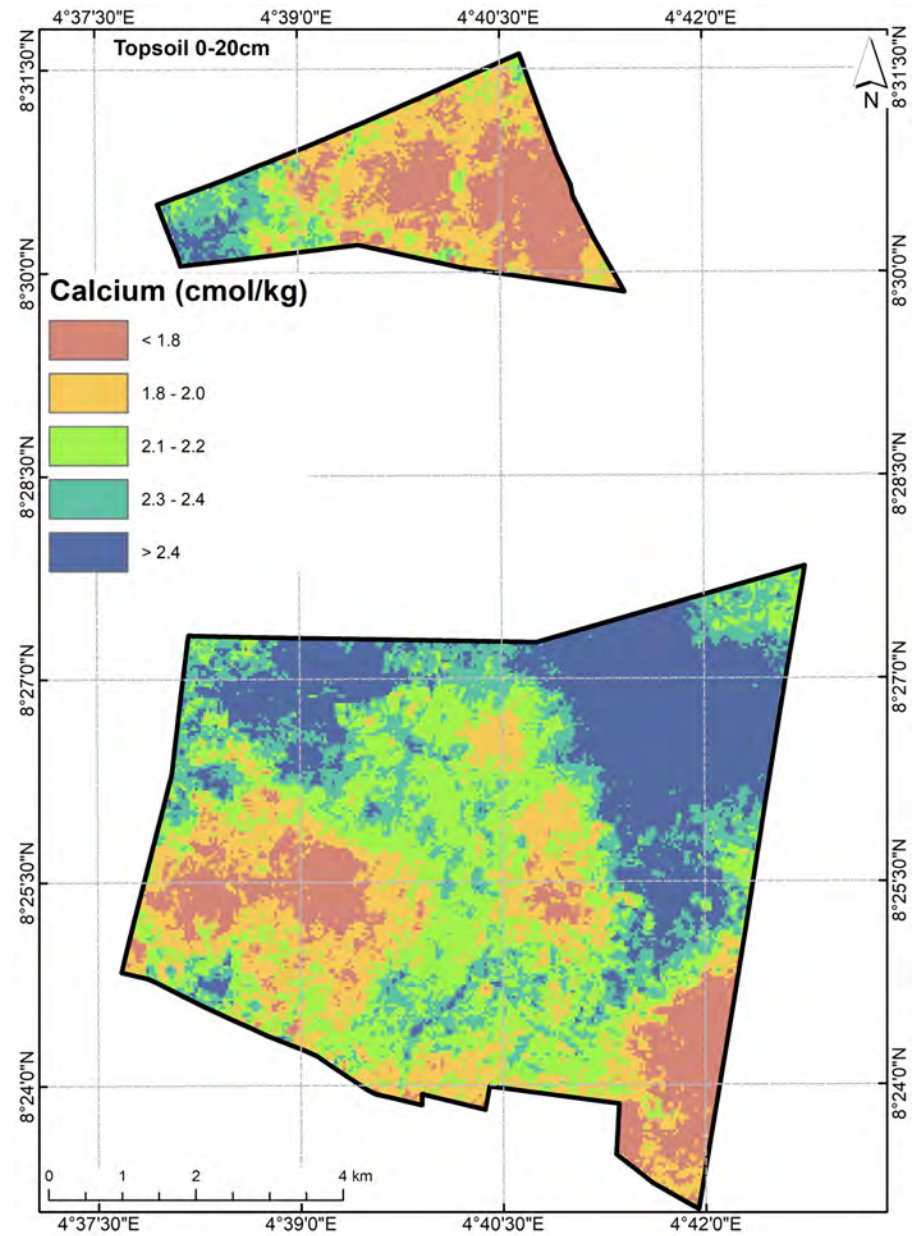
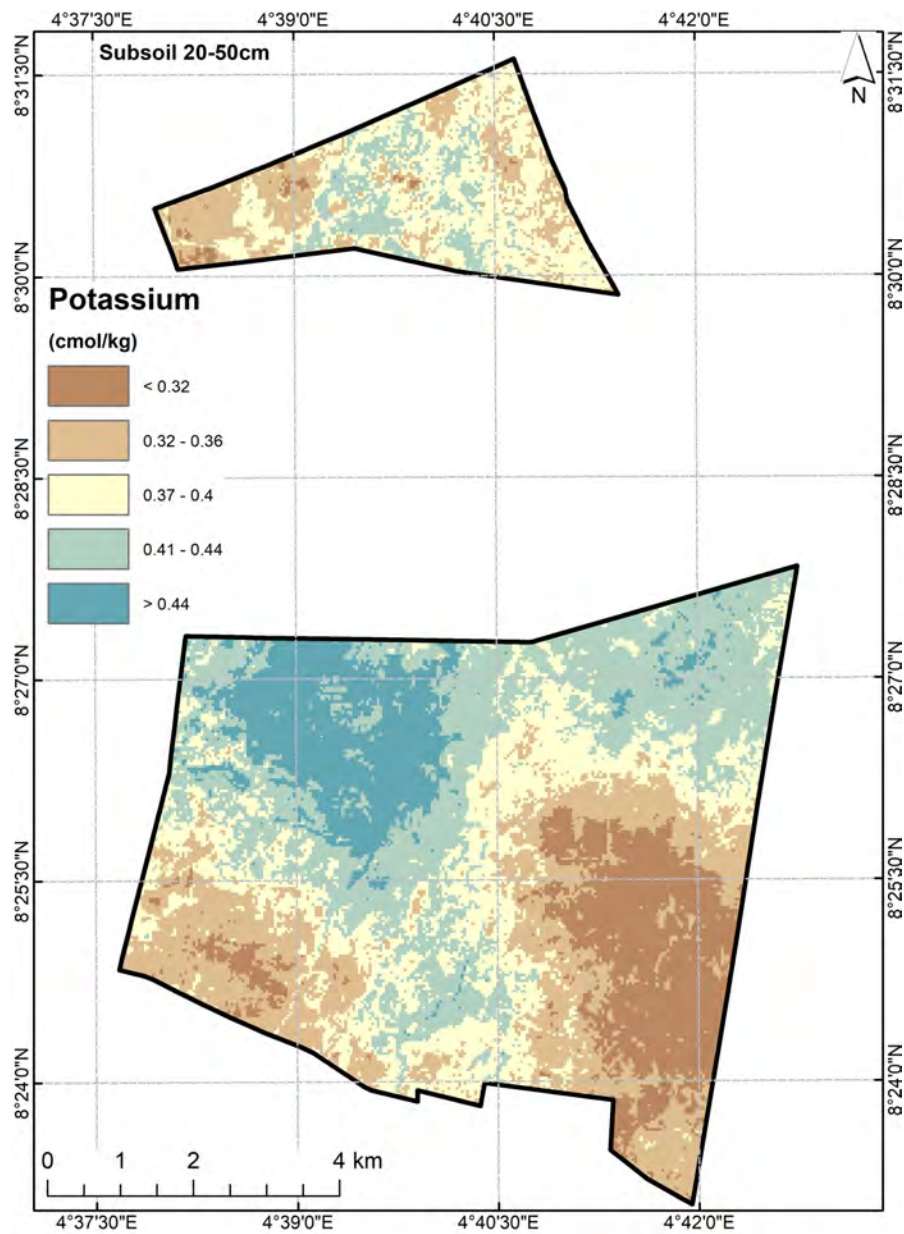
SUB B28	5.15	32.97	80.40	7.60	12.00	0.98	0.31	0.28	0.18	0.12	1.87	93.59	0.24	0.03	6.27	14.45	8.20	0.57	1.42	0.17	18.14
SUB B30	6.30	42.47	74.40	9.60	16.00	1.55	0.66	0.44	0.49	0.07	3.21	97.82	0.35	0.06	7.10	23.10	4.40	0.56	8.30	0.40	12.56
SUB B31	5.75	0.00	91.20	4.80	4.00	2.46	0.78	0.32	0.41	0.08	4.05	98.02	0.19	0.24	6.42	14.10	5.60	1.01	10.41	0.36	8.84
SUB B32	5.35	33.98	79.00	5.60	15.40	2.13	0.86	0.76	0.29	0.10	4.14	97.59	0.36	0.03	9.33	16.25	19.75	0.59	25.06	0.01	11.17
SUB B33	6.70	50.89	76.40	11.60	12.00	1.65	0.70	0.64	0.44	0.08	3.51	97.72	0.60	0.09	12.78	22.55	12.80	0.39	8.76	0.57	19.54
SUB B34	4.75	36.85	80.40	11.60	8.00	1.22	0.41	0.44	0.30	0.13	2.50	94.80	0.14	0.02	8.00	33.00	15.35	0.84	2.87	0.41	25.12
SUB B36	5.30	28.04	0	8.20	15.40	1.28	0.47	0.36	0.30	0.09	2.50	96.40	1.00	0.09	1.83	18.30	17.60	0.03	8.49	0.00	7.44
SUB B37	6.45	53.84	84.40	5.60	10.00	2.36	1.40	0.41	0.74	0.09	5.00	98.20	0.77	0.07	13.42	23.30	5.75	0.41	11.33	0.31	21.87
SUB B38	5.75	34.95	74.40	13.60	12.00	1.92	0.55	0.44	0.24	0.10	3.25	96.92	0.27	0.04	9.37	21.05	14.15	0.82	4.52	0.60	11.17
SUB B39	5.75	43.41	82.40	4.20	13.40	2.28	0.42	0.34	0.57	0.11	3.72	97.05	0.19	0.01	4.76	25.10	8.95	0.74	13.35	0.49	10.24
SUB B40	5.80	18.97	84.40	5.60	10.00	1.53	0.44	0.40	0.40	0.09	2.86	96.86	0.09	0.01	8.25	21.10	19.25	0.64	2.33	0.31	62.34
SUB B41	5.85	22.04	89.00	3.60	7.40	2.54	0.76	0.25	0.28	0.11	3.95	97.21	1.04	0.13	1.93	8.00	22.20	0.87	6.93	0.00	10.24
SUB B42	6.35	52.76	84.60	5.40	10.00	2.22	0.54	0.25	0.16	0.06	3.23	98.14	1.36	0.11	1.32	21.05	25.55	1.25	8.17	0.02	62.34
SUB B44	5.30	37.32	76.40	9.60	14.00	0.88	0.56	0.33	0.38	0.12	2.27	94.71	0.38	0.05	10.61	15.45	5.65	1.14	4.53	0.45	10.70
SUB B45	5.15	25.96	74.60	5.40	18.00	1.83	0.49	0.25	0.18	0.08	2.83	97.17	1.06	0.08	1.43	36.10	17.65	0.84	6.75	0.00	16.75
SUB B46	6.00	0.00	94.60	4.20	1.20	0.73	0.29	0.61	0.25	0.08	1.96	95.92	0.33	0.02	6.81	7.80	9.30	0.41	10.99	0.41	17.68
SUB B47	6.25	31.98	87.20	4.80	8.00	1.15	0.34	0.33	0.54	0.10	2.46	95.93	0.47	0.07	5.92	20.70	9.25	0.46	5.85	0.37	13.49
SUB B48	5.90	63.95	83.00	9.60	7.40	1.74	0.41	0.41	0.47	0.08	3.11	97.43	0.27	0.01	11.46	12.35	9.30	1.14	0.97	0.48	17.21
SUB B52	5.80	29.62	83.60	5.60	10.80	1.33	0.88	0.42	0.56	0.10	3.29	96.96	0.51	0.07	7.88	10.70	3.10	1.01	9.38	0.66	4.47
SUB B53	6.70	27.78	91.80	5.40	2.80	1.46	0.91	0.29	0.39	0.12	3.17	96.21	0.39	0.02	6.24	8.65	6.65	0.83	13.54	0.44	8.37
SUB B54	5.15	33.70	71.00	17.60	11.40	1.89	0.70	0.31	0.48	0.10	3.48	97.12	0.37	0.02	9.25	11.65	9.50	1.03	8.69	0.45	5.58
SUB B55	6.40	30.33	92.40	3.60	4.00	1.57	0.74	0.37	0.51	0.07	3.26	97.85	0.43	0.06	9.52	12.25	4.20	1.13	9.25	0.51	8.84
SUB B56	5.80	57.19	85.80	4.80	9.40	1.59	0.62	0.38	0.76	0.12	3.47	96.54	0.46	0.03	9.93	15.40	4.45	0.65	17.77	0.35	8.37
SUB B57	6.50	54.88	74.40	15.60	10.00	2.07	0.55	0.44	0.26	0.07	3.39	97.94	0.17	0.02	81.94	11.20	18.95	0.64	6.56	0.57	57.69
SUB B58	5.35	39.57	84.60	5.40	10.00	1.93	0.50	0.14	0.12	0.11	2.80	96.08	0.86	0.11	1.93	18.50	14.35	0.70	1.71	0.15	5.12
SUB B62	6.15	0.00	85.20	4.80	10.00	1.78	1.19	0.41	0.59	0.10	4.07	97.54	0.31	0.05	5.80	22.05	5.40	3.80	9.04	0.04	6.98
SUB B63	6.00	0.00	85.80	4.20	10.00	0.73	0.49	0.50	0.25	0.07	2.04	96.56	0.28	0.03	6.52	31.80	1.85	0.79	3.13	0.45	7.44
SUB B64	6.20	31.44	88.40	4.20	7.40	1.35	0.44	0.18	0.26	0.08	2.31	96.54	0.69	0.05	1.48	15.95	27.10	0.54	7.58	0.00	42.34
SUB B67	5.90	0.00	76.40	9.60	14.00	1.30	0.74	0.35	0.45	0.10	2.94	96.60	0.35	0.05	7.81	19.40	2.10	0.45	7.92	0.46	10.70
SUB B68	5.40	43.94	88.40	4.80	6.80	2.36	0.46	0.54	0.38	0.09	3.83	97.65	0.31	0.02	5.33	17.40	18.75	1.25	15.41	0.35	23.26
SUB B69	5.00	48.87	74.40	6.20	19.40	1.31	0.47	0.22	0.22	0.12	2.33	94.86	1.14	0.12	2.44	17.70	25.10	1.06	7.40	0.48	33.50
SUB B70	5.25	0.00	84.40	6.20	9.40	0.73	0.17	0.70	0.48	0.10	2.18	95.41	0.26	0.05	7.10	9.55	13.70	0.62	7.74	0.60	12.56
SUB B71	5.00	70.72	66.40	24.20	9.40	3.13	1.44	0.47	0.56	0.11	5.71	98.07	0.76	0.09	2.75	59.55	25.20	0.60	8.26	0.00	30.24

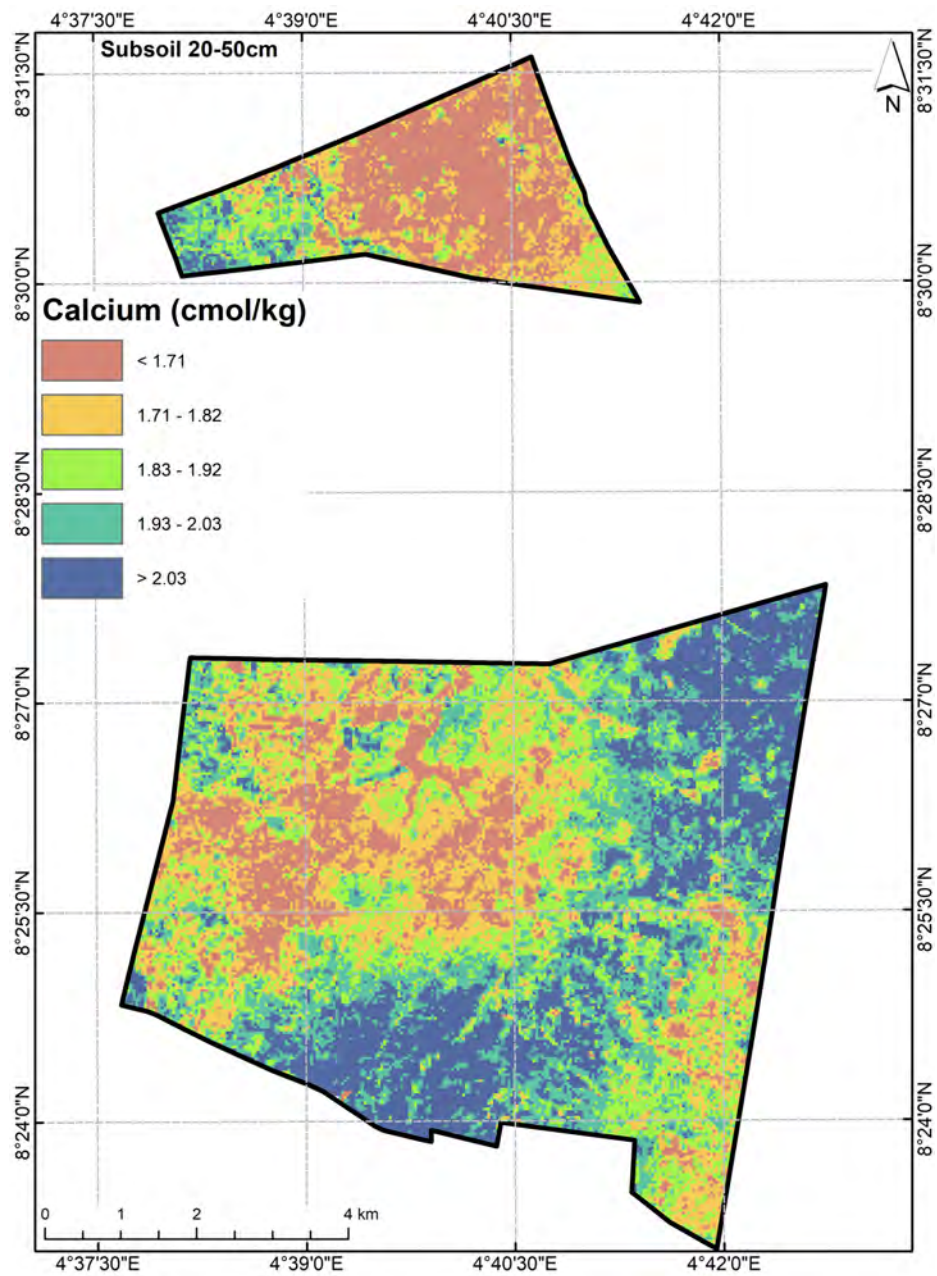
SUB B72	4.65	13.95	86.40	6.20	7.40	0.58	0.25	0.72	0.31	0.11	1.97	94.41	0.19	0.03	7.48	12.70	4.80	0.94	7.07	0.44	170.74
SUB B74	6.20	58.52	89.00	3.60	7.40	2.86	0.66	0.32	0.62	0.07	4.53	98.46	0.83	0.07	1.99	32.90	32.25	0.86	20.51	0.00	26.98
SUB B75	5.65	0.00	85.20	6.80	8.00	2.89	1.36	0.48	0.44	0.08	5.25	98.48	0.27	0.04	6.98	15.70	8.75	1.79	9.99	0.21	0.00
SUB B76	5.82	36.90	80.80	8.40	11.80	3.77	0.48	0.57	0.35	0.10	5.27	98.10	0.42	0.06	3.90	40.20	16.10	0.43	13.89	0.26	10.70
SUB B77	5.75	24.45	82.40	4.20	13.40	1.22	0.49	0.32	0.54	0.09	2.66	96.62	1.32	0.16	2.90	19.95	32.15	0.33	14.35	0.19	18.14
SUB B80	6.85	20.26	82.40	5.60	12.00	1.94	1.00	0.24	0.43	0.05	3.66	98.63	0.49	0.04	6.63	15.10	3.30	2.29	11.81	0.47	11.17
SUB B84	6.15	65.73	83.00	11.60	5.40	2.07	0.46	0.50	0.81	0.06	3.90	98.46	0.42	0.03	5.83	12.30	13.60	0.48	9.94	0.41	22.33
SUB B85	5.10	33.08	87.00	3.60	9.40	2.30	0.62	0.25	0.36	0.11	3.64	96.97	0.33	0.02	5.78	17.30	7.60	1.04	11.28	0.45	18.14
SUB B89	6.70	41.44	76.40	13.60	10.00	1.93	0.58	0.84	1.12	0.07	4.54	98.46	0.17	0.01	17.93	11.00	21.40	0.47	7.22	0.34	44.20
SUB B90	5.60	30.47	89.00	3.60	7.40	1.83	0.40	0.28	0.47	0.09	3.07	97.07	0.19	0.01	4.92	37.30	5.90	0.42	4.19	0.31	25.59
SUB B93	6.60	70.96	64.40	20.20	15.40	2.29	0.88	0.60	1.44	0.07	5.29	98.68	1.88	0.13	8.35	21.40	37.50	0.31	22.12	0.00	29.31
SUB B93b	6.71	0.00	67.20	18.60	14.20	2.20	0.81	0.61	1.26	0.06	4.94	98.79	2.02	0.14	9.41	19.55	43.60	0.47	21.40	0.28	96.77
SUB B95	5.60	27.27	89.00	3.60	7.40	1.90	0.23	0.24	0.30	0.09	2.76	96.73	0.30	0.02	8.99	13.50	9.00	0.94	2.08	0.30	25.59
SUB B100	5.30	9.65	84.40	6.80	8.80	1.04	0.63	0.67	0.40	0.10	2.84	96.48	0.28	0.03	5.05	16.00	26.45	0.75	4.85	0.24	6.98
SUB B101	7.20	45.83	93.00	3.60	3.40	3.01	0.86	0.86	0.54	0.05	5.32	99.06	0.53	0.04	10.62	13.50	19.15	0.26	21.99	0.25	13.03
SUB B102	6.30	14.25	81.00	7.60	11.40	1.88	0.61	0.27	0.44	0.07	3.27	97.86	0.25	0.02	2.05	7.05	10.75	0.39	16.00	0.31	7.44
SUB B104	5.80	43.19	67.00	9.60	23.40	3.66	0.76	0.34	0.42	0.08	5.26	98.48	0.43	0.04	3.05	17.65	25.75	0.82	7.66	1.12	30.71
SUB B112	5.90	0.00	74.40	14.80	10.80	2.59	0.43	0.65	0.31	0.09	4.07	97.79	0.31	0.02	8.19	10.50	3.25	0.77	10.78	0.49	8.37
SUB B113	5.05	54.05	78.40	11.60	10.00	2.42	0.42	0.31	0.51	0.09	3.75	97.60	0.43	0.03	7.94	20.65	14.55	0.54	12.83	0.36	4.65
SUB B115	5.75	0.00	64.40	18.80	16.80	3.36	1.36	0.78	0.48	0.08	6.06	98.68	0.86	0.08	11.95	15.30	50.15	0.99	8.42	0.15	10.70
SUB B116	5.65	27.61	85.40	6.20	8.40	1.38	0.76	0.32	0.49	0.11	3.06	96.41	0.38	0.06	10.93	17.50	5.80	0.92	9.06	0.36	11.17
SUB B117	5.60	52.91	86.40	3.60	10.00	0.55	0.40	0.96	0.30	0.11	2.32	95.27	0.17	0.03	4.71	19.85	24.00	0.24	0.23	0.38	73.97
SUB B118	6.45	0.00	89.20	4.80	6.00	2.32	0.93	0.41	0.45	0.07	4.18	98.33	0.24	0.04	6.71	8.45	5.70	0.45	10.82	0.48	7.91
SUB B119	5.15	30.89	86.40	4.20	9.40	1.41	0.61	0.29	0.38	0.10	2.79	96.41	1.67	0.14	2.50	18.35	24.00	0.30	2.01	0.00	13.96

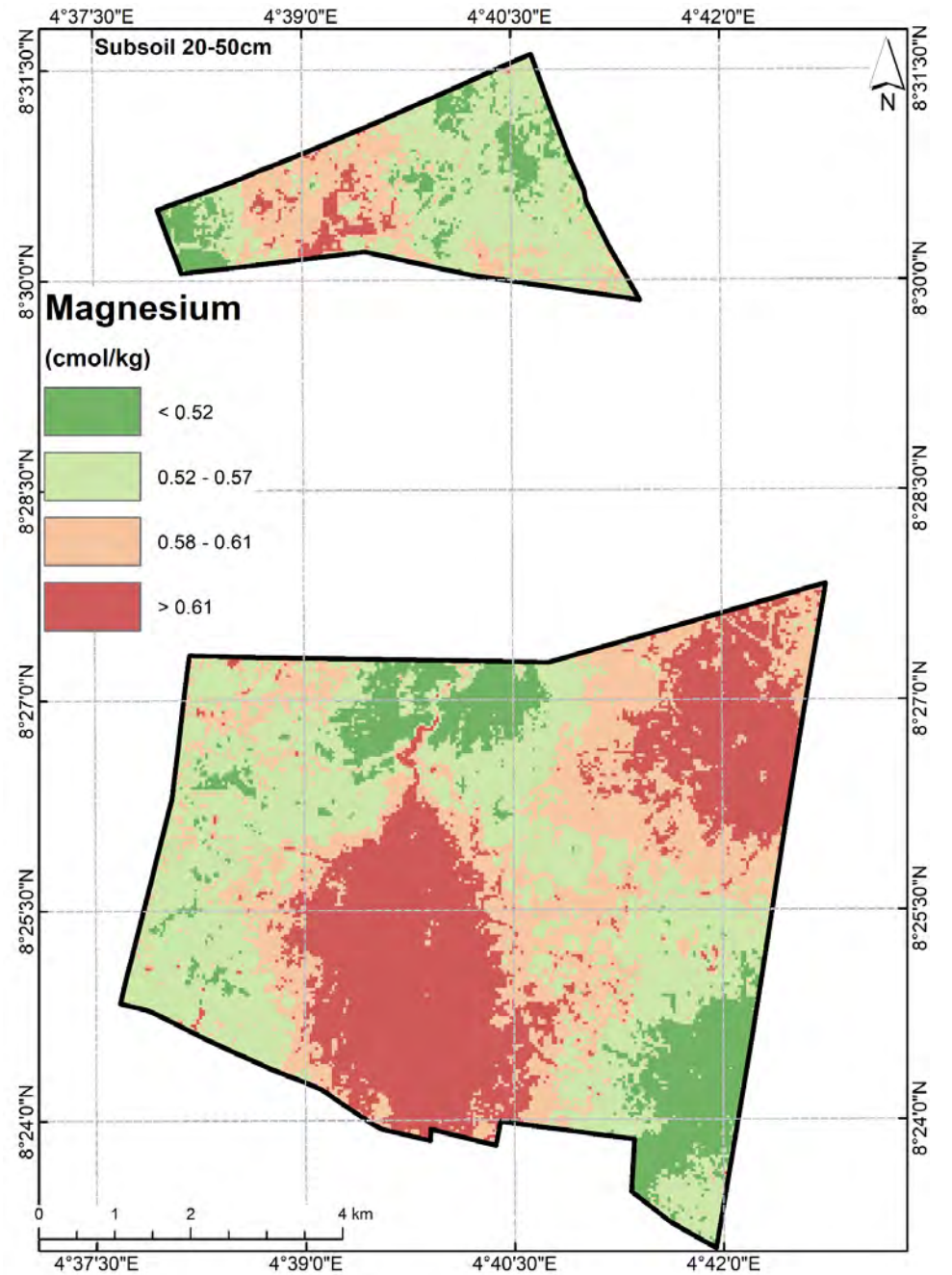
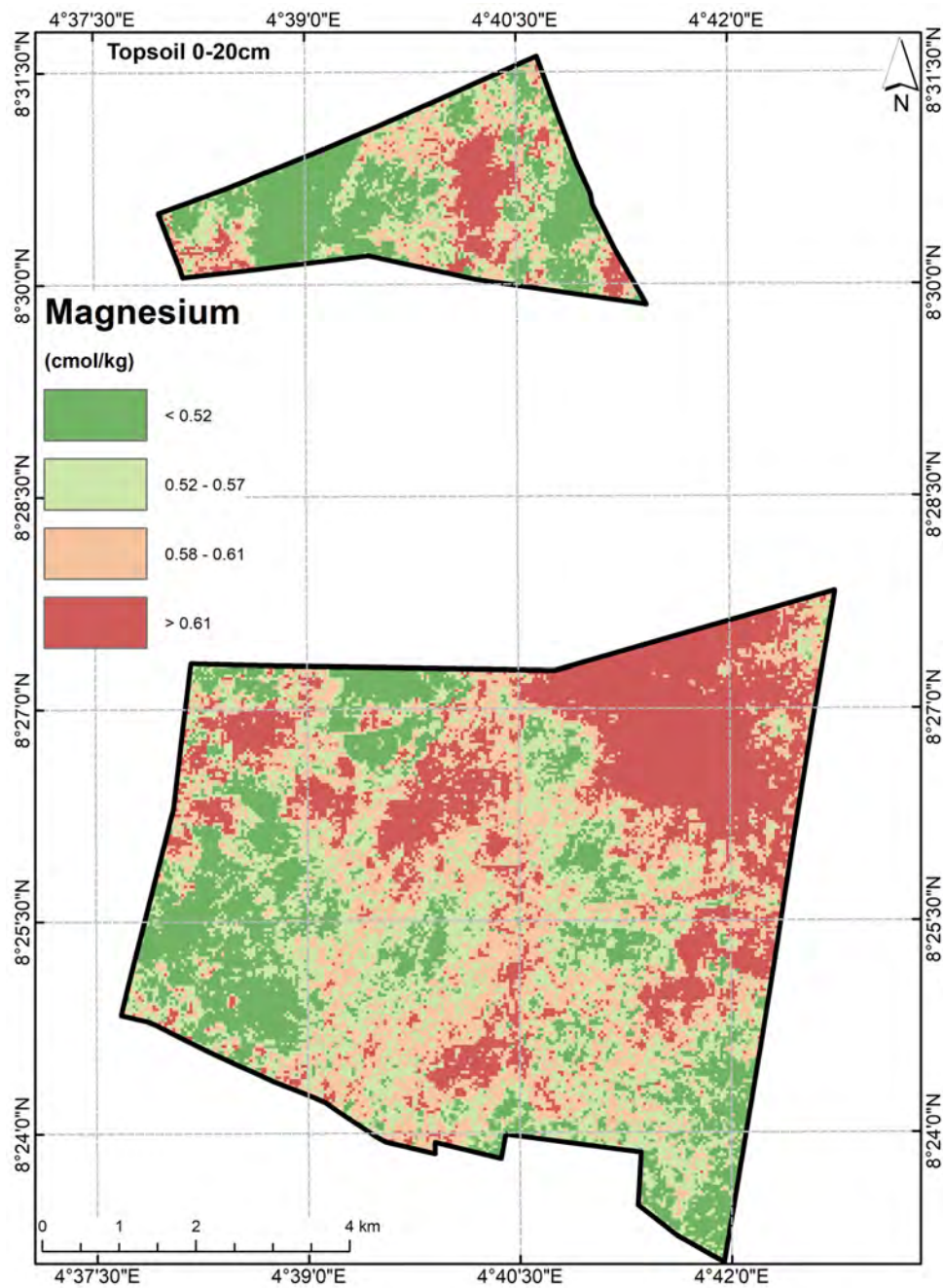
Appendix 2: Maps of the spatial patterns of soil function properties of the Aol

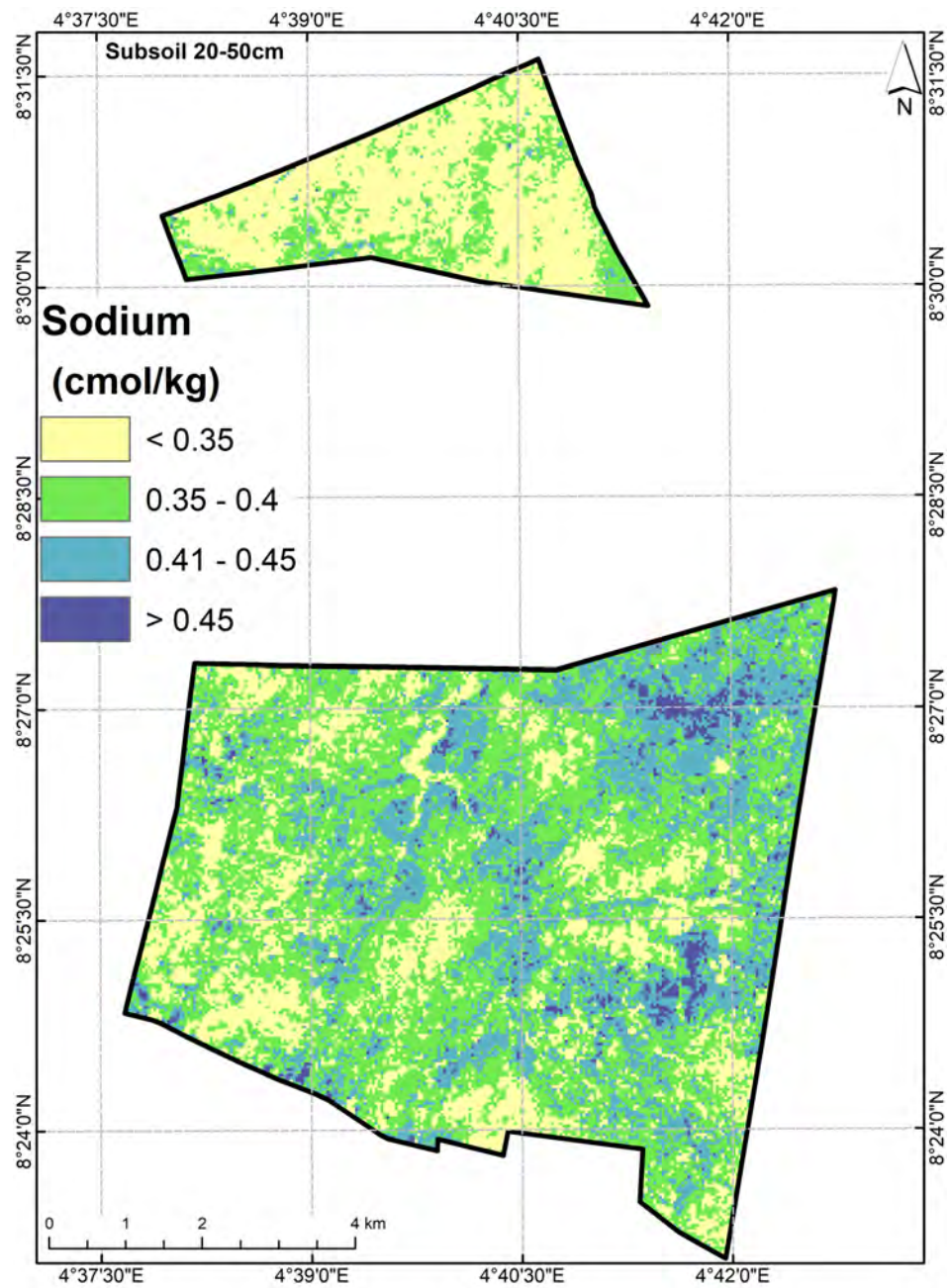
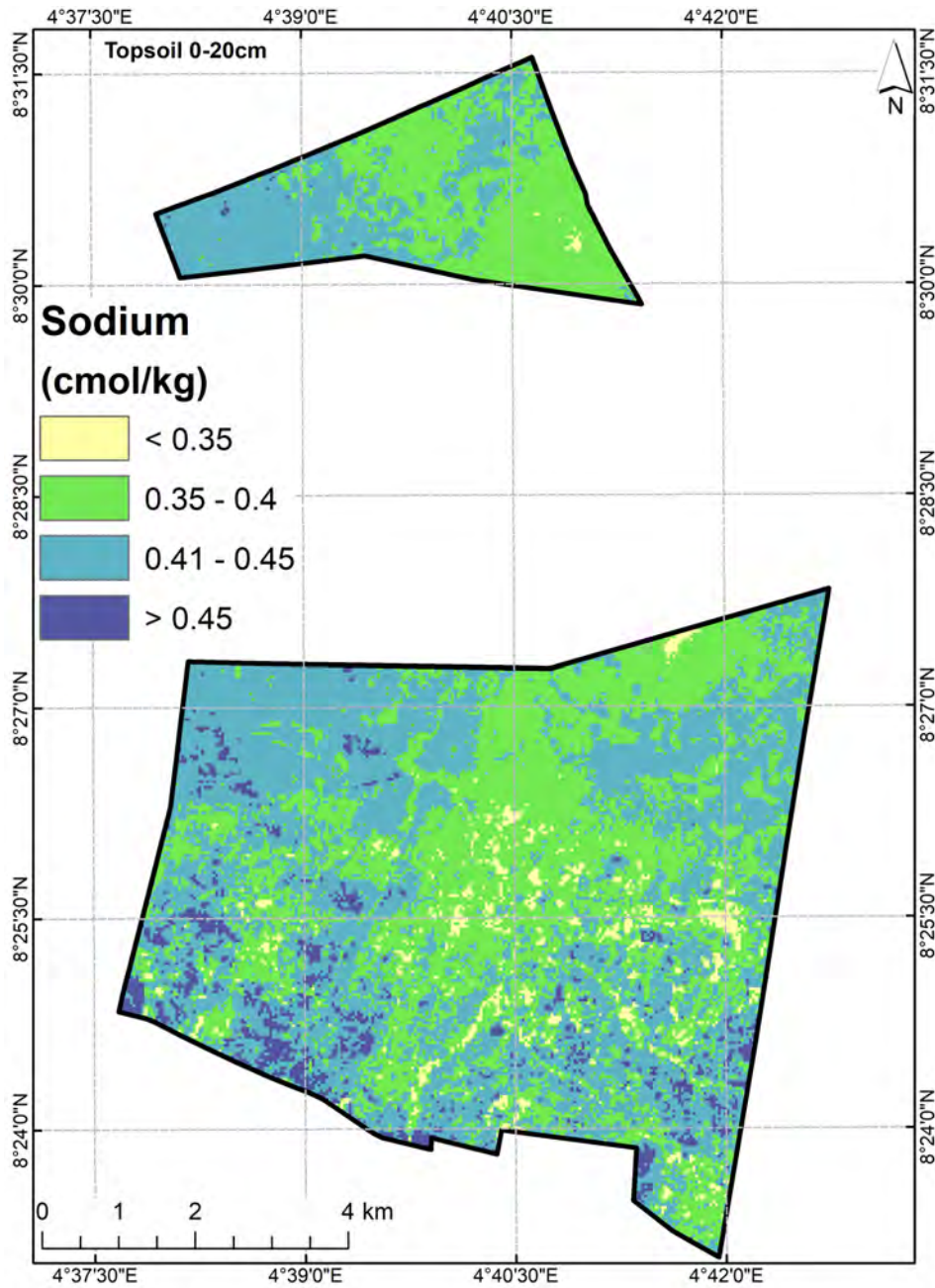




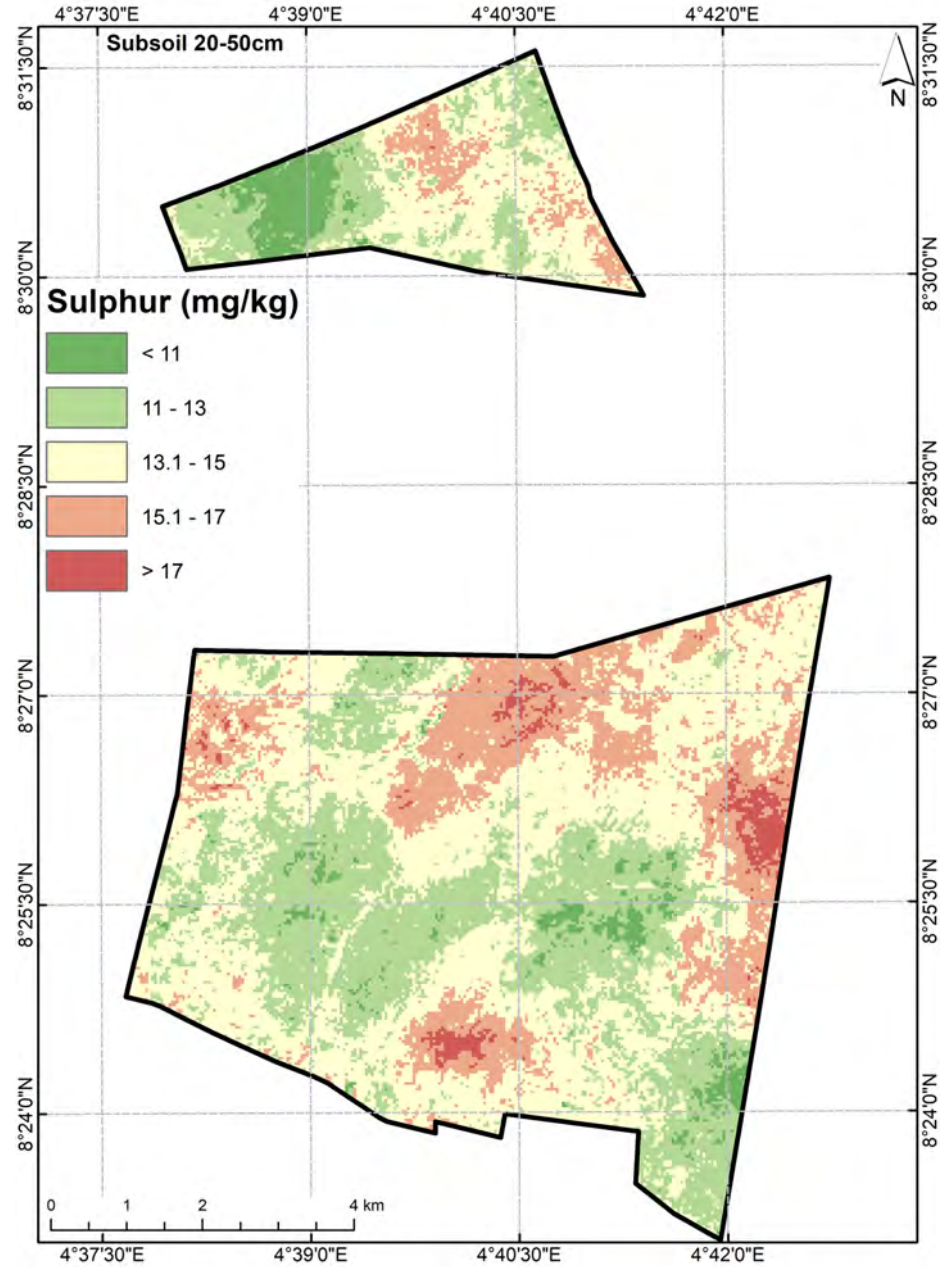
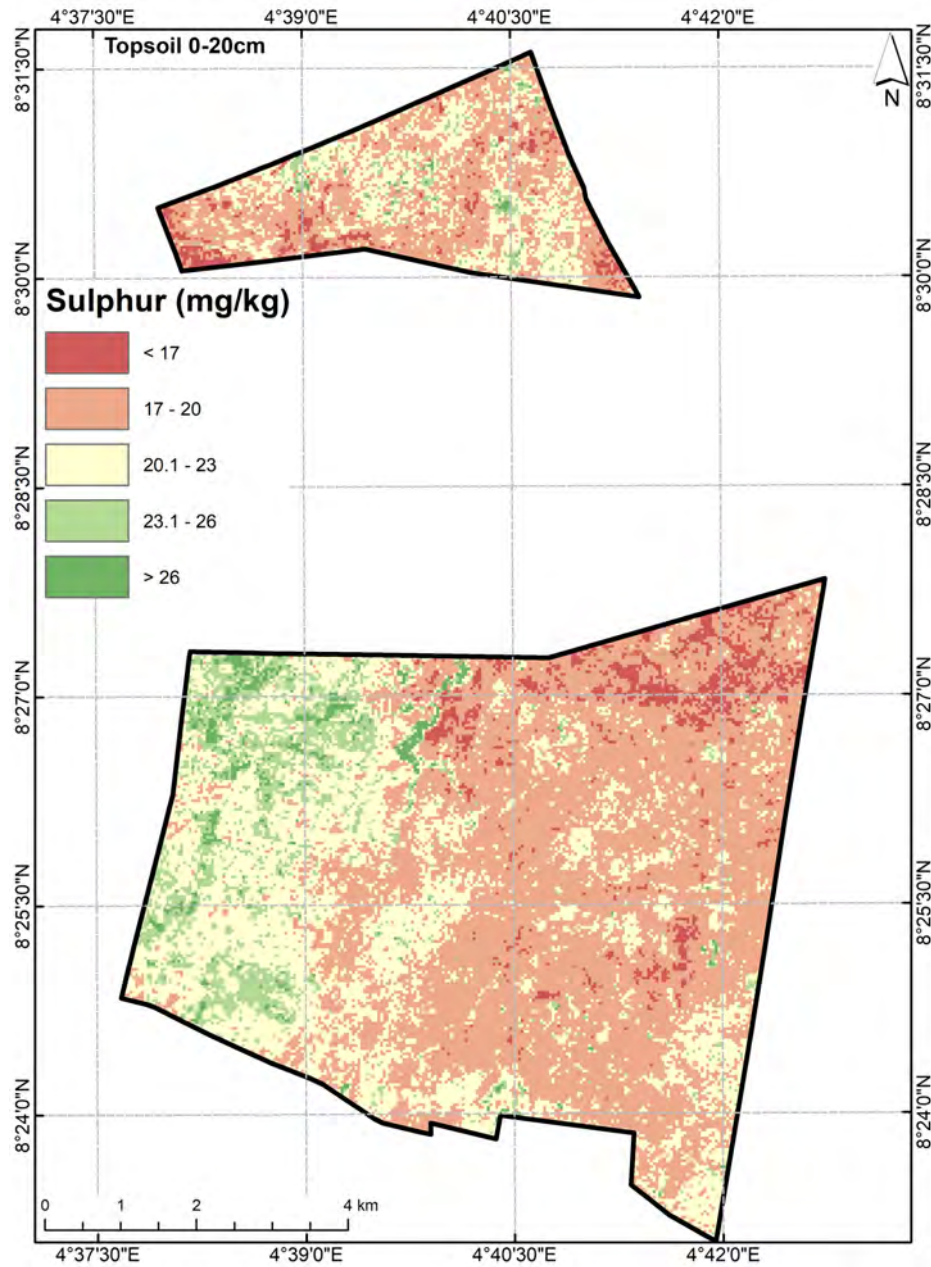


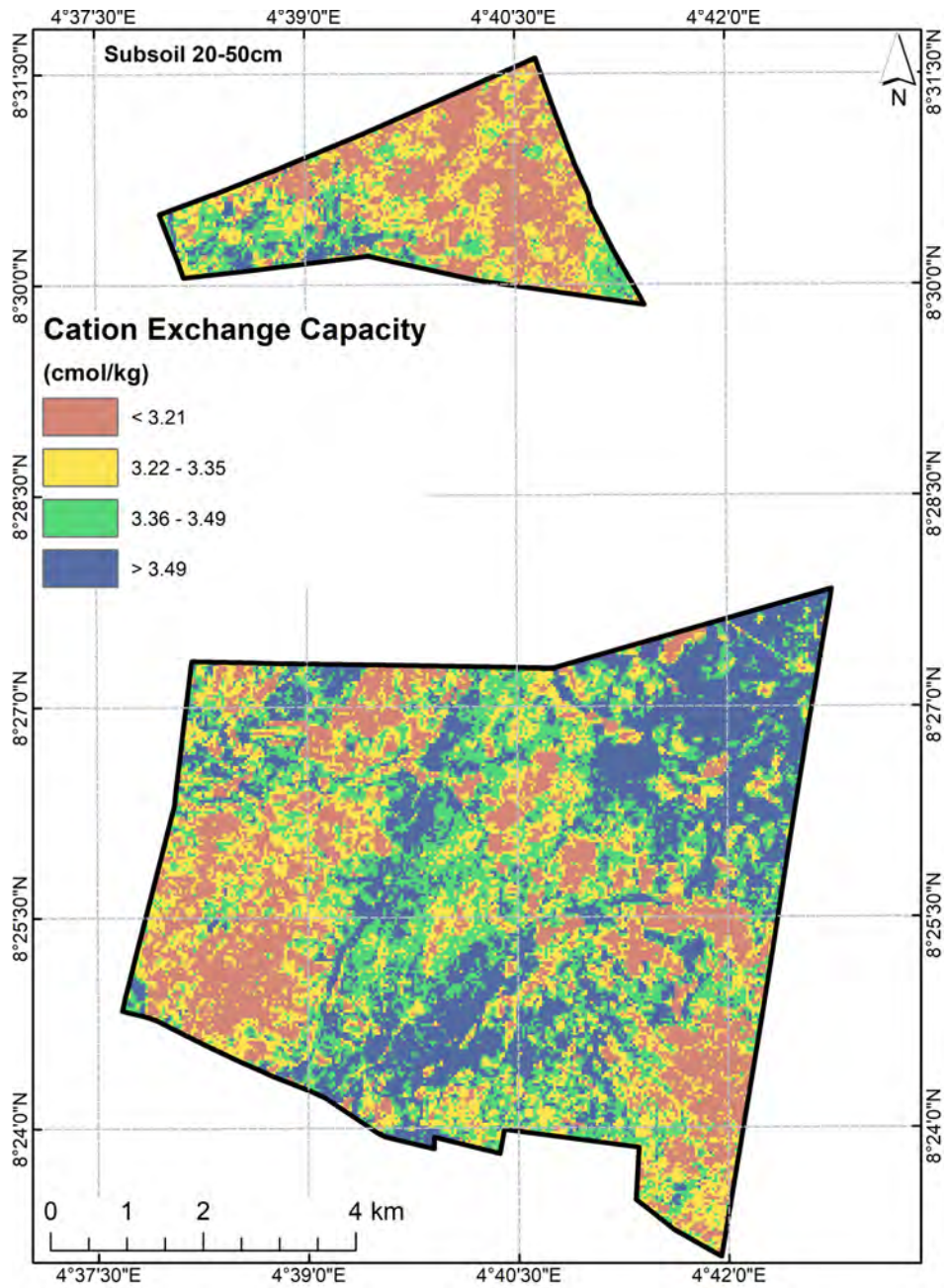


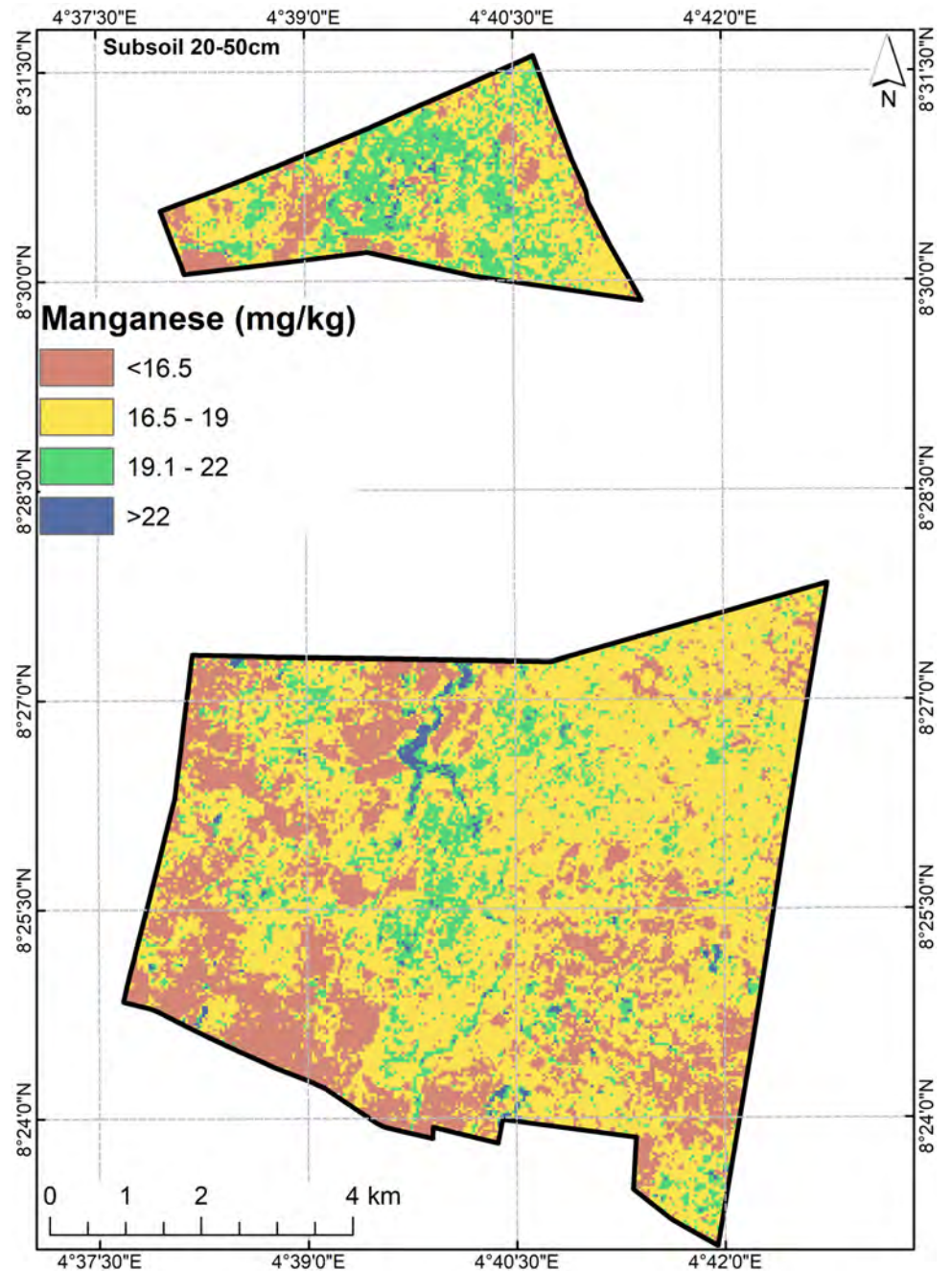
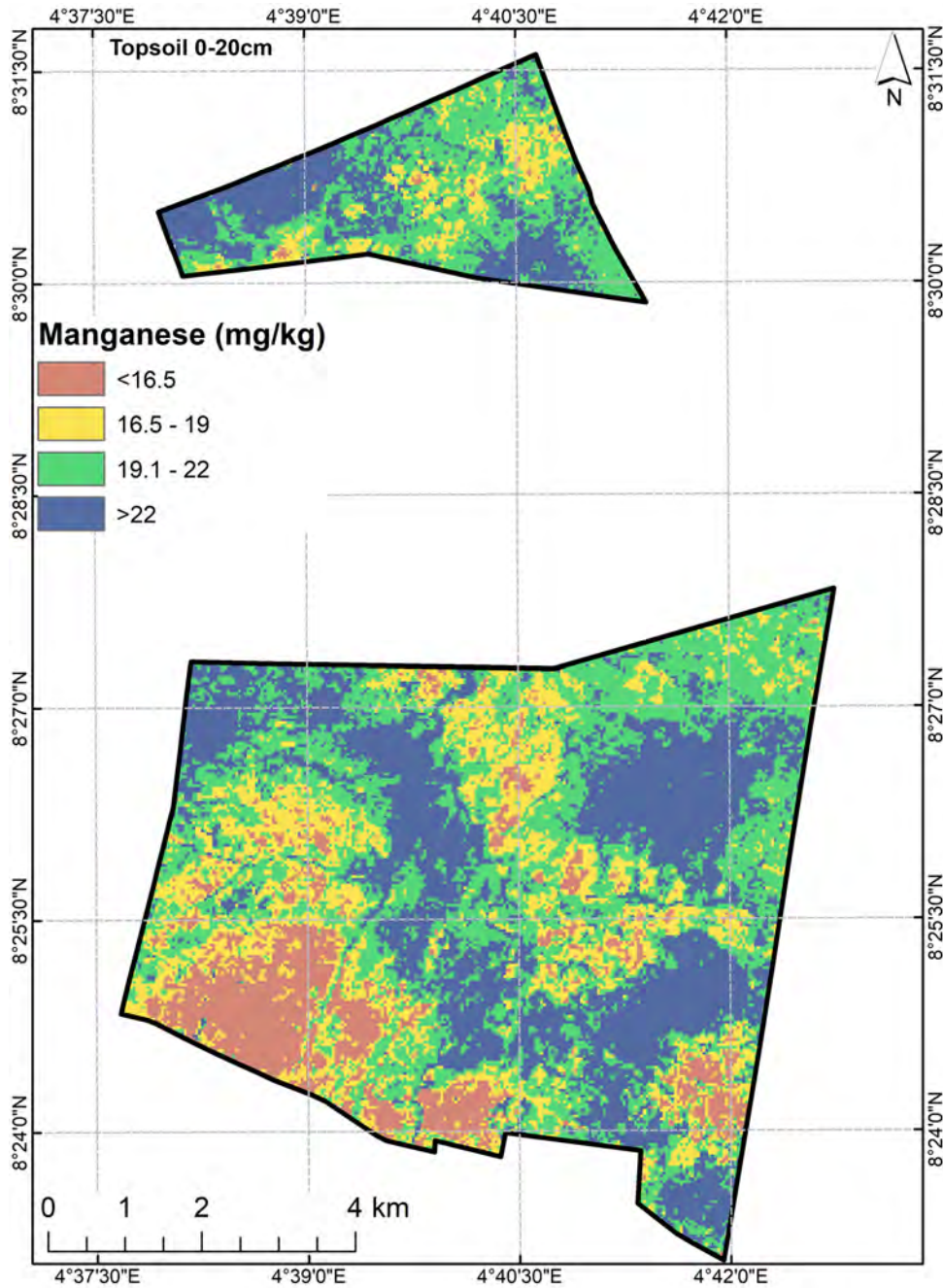


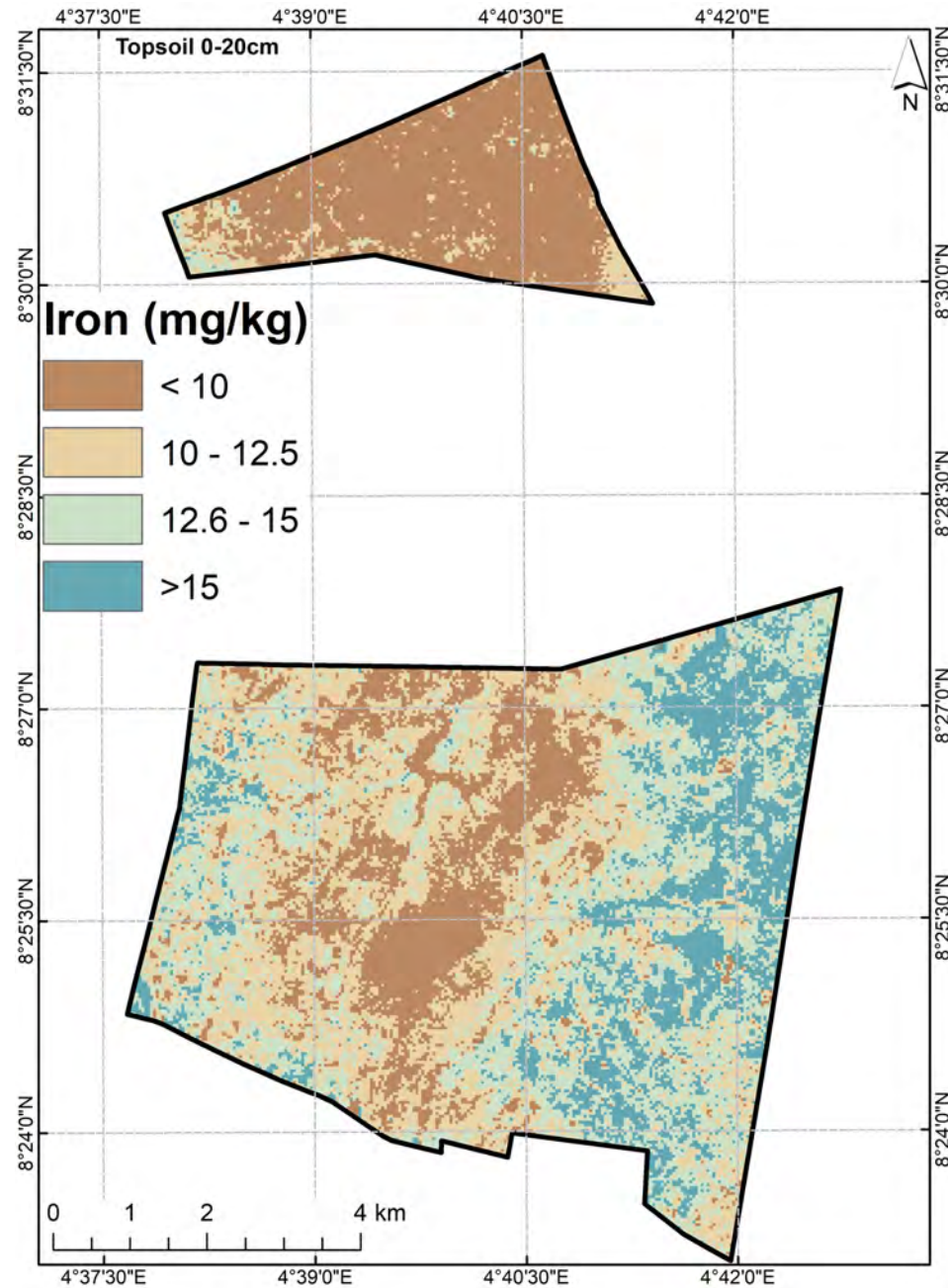
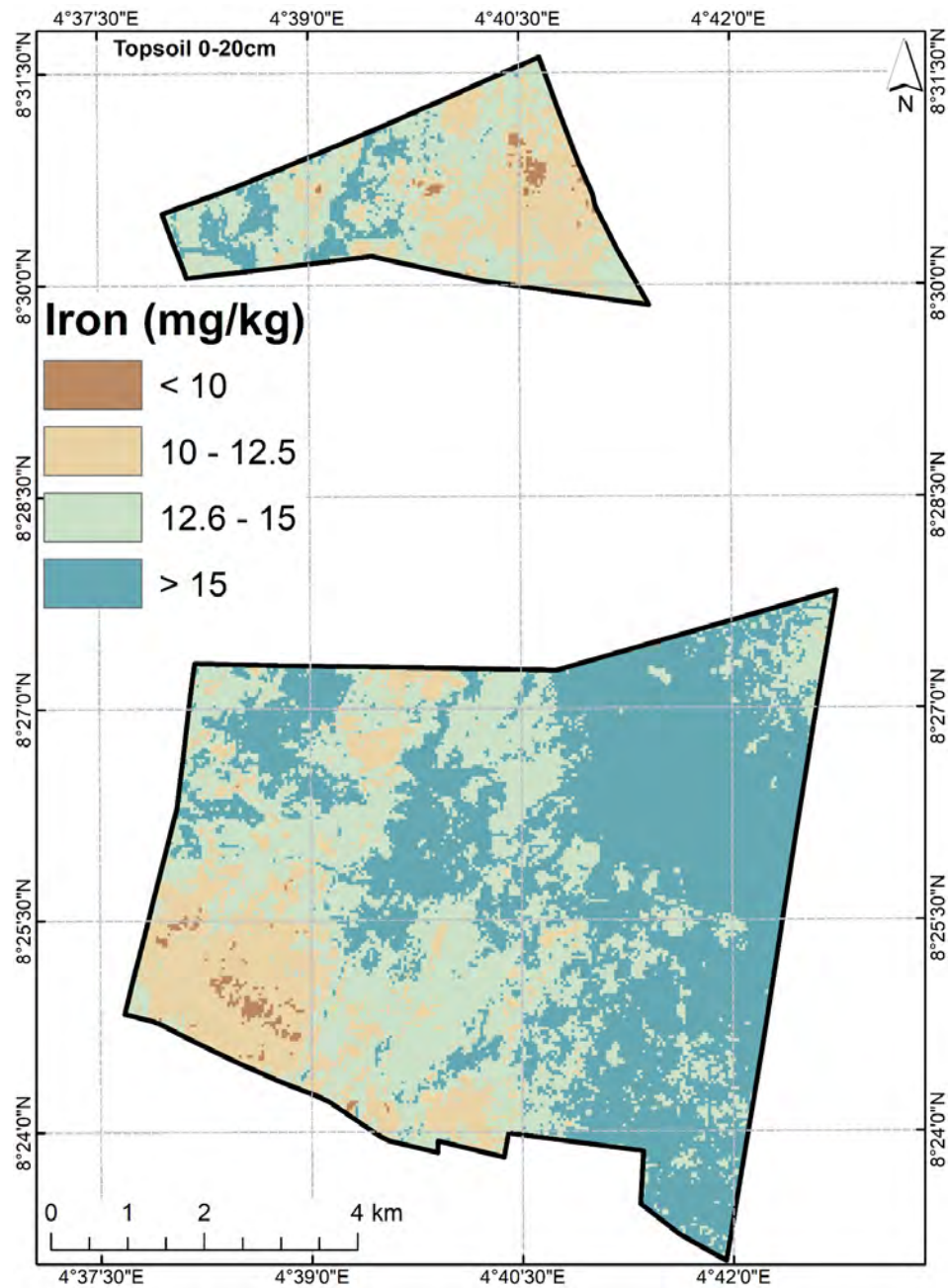


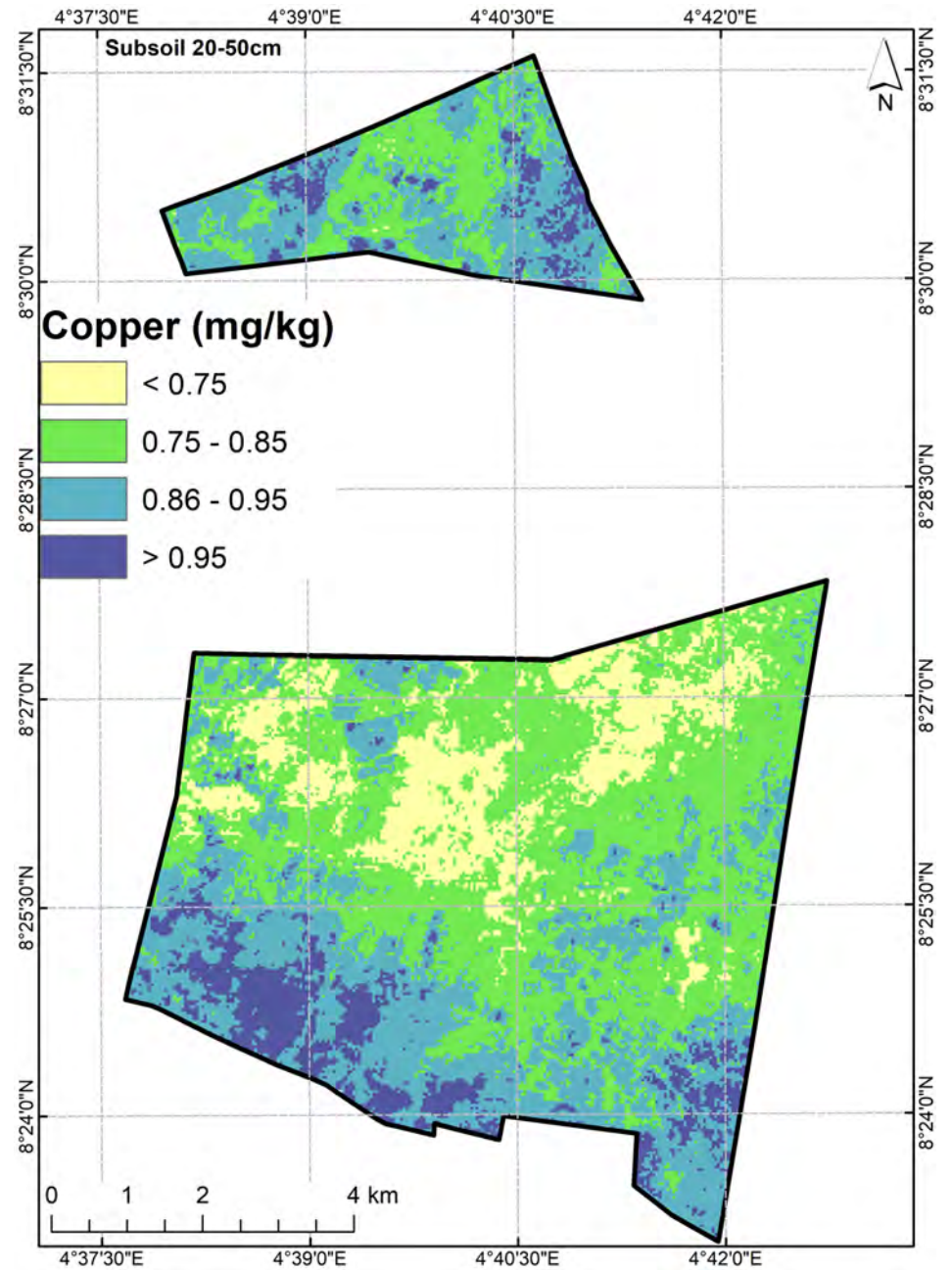
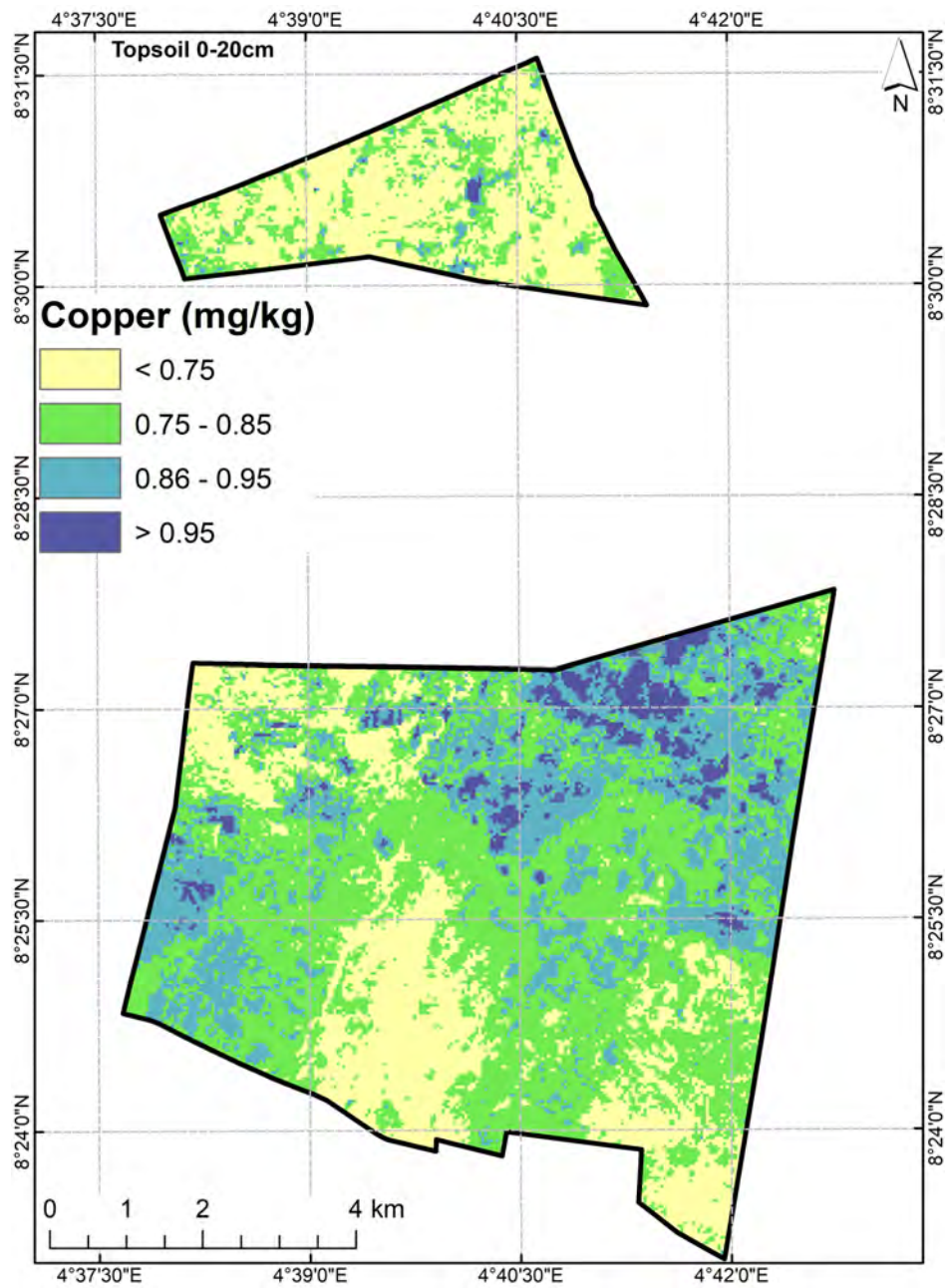


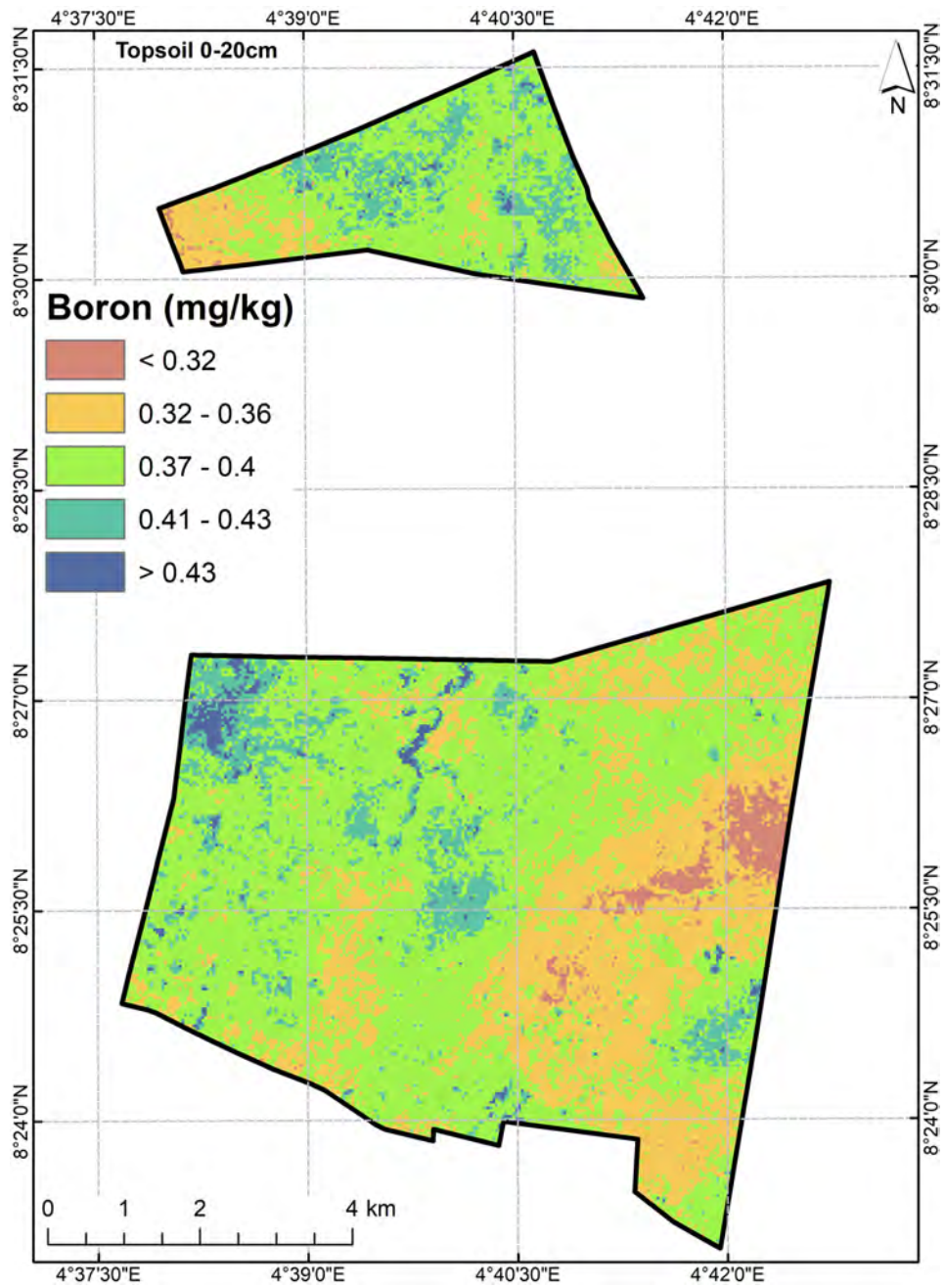


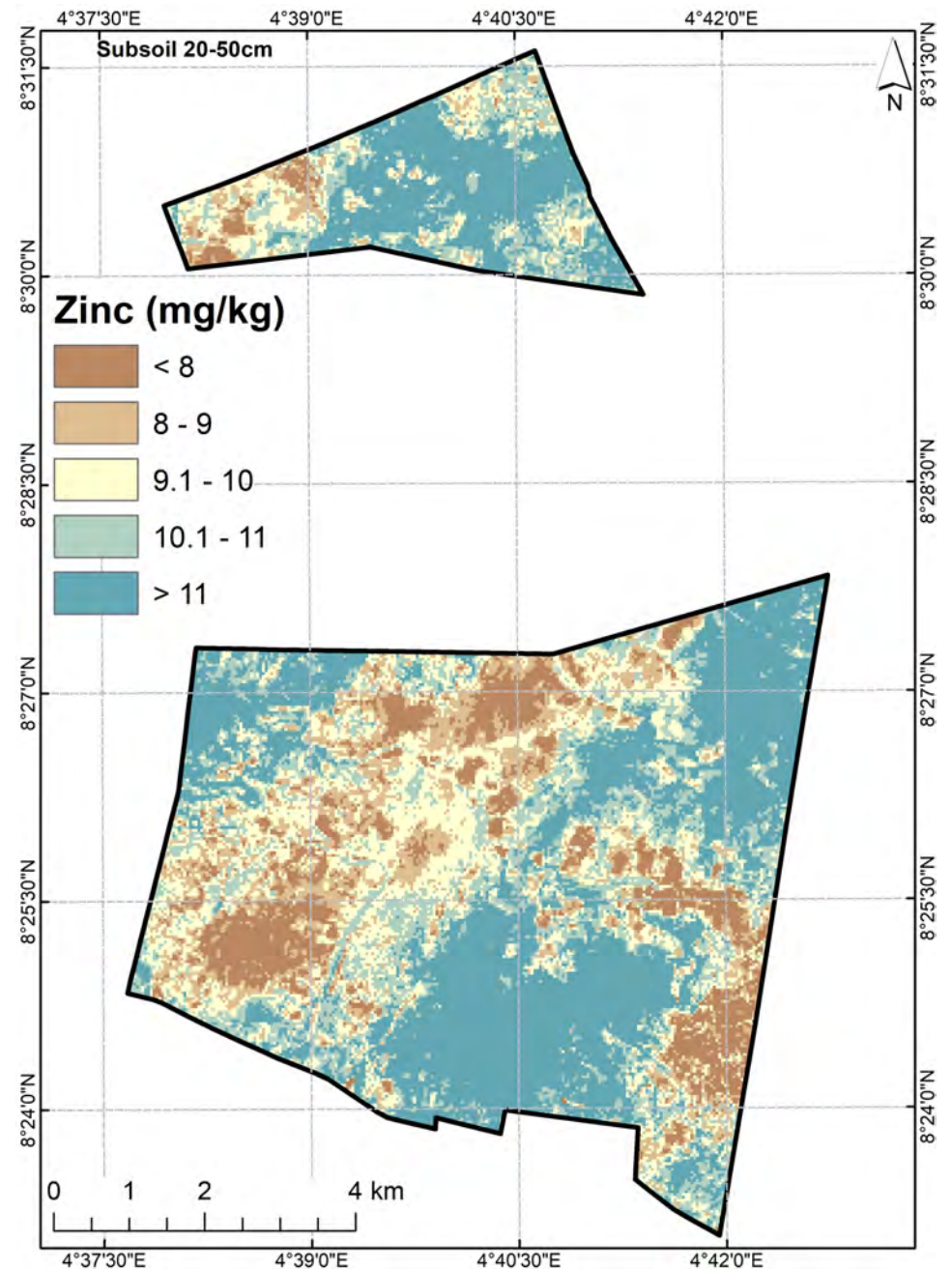
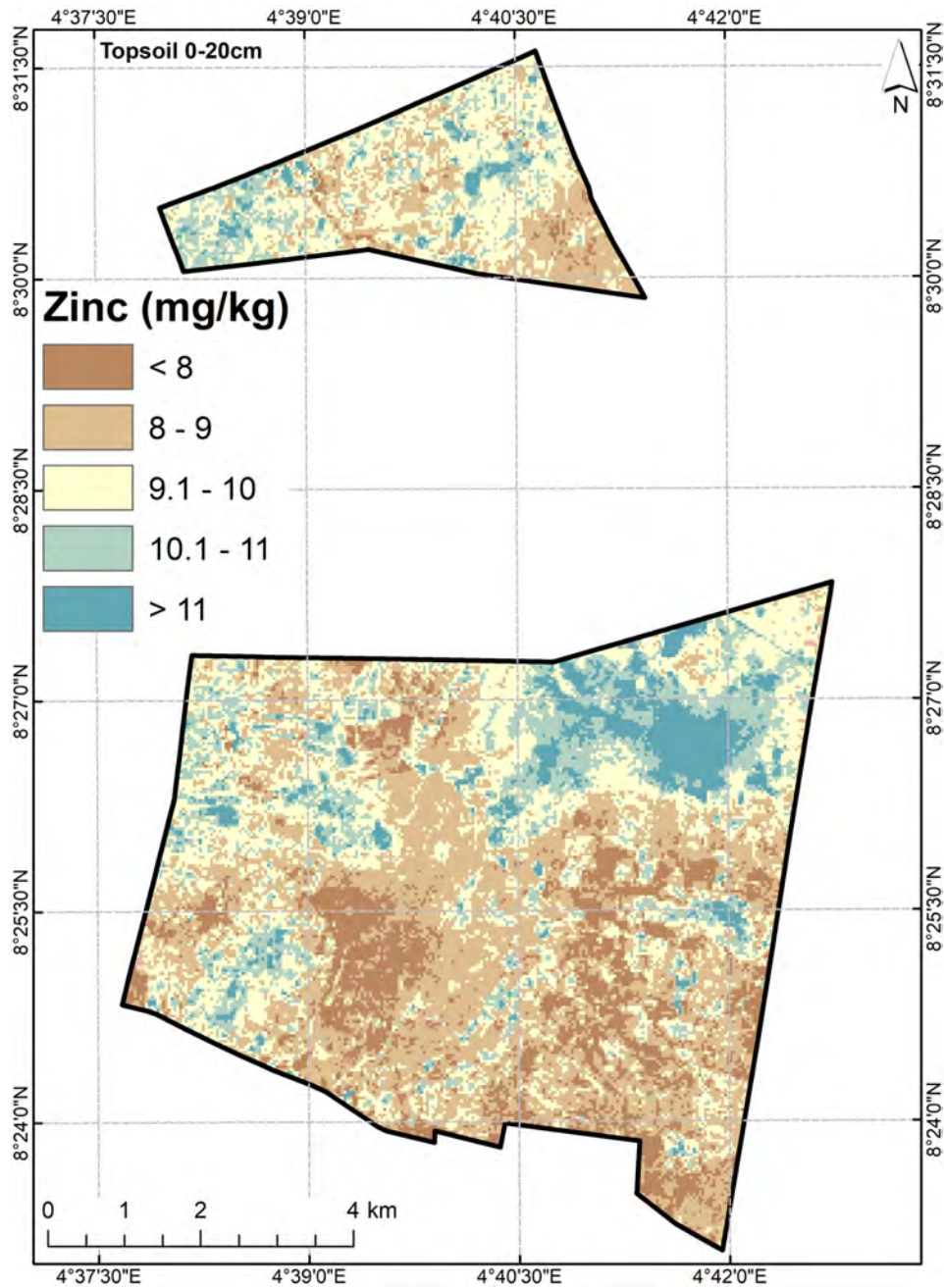


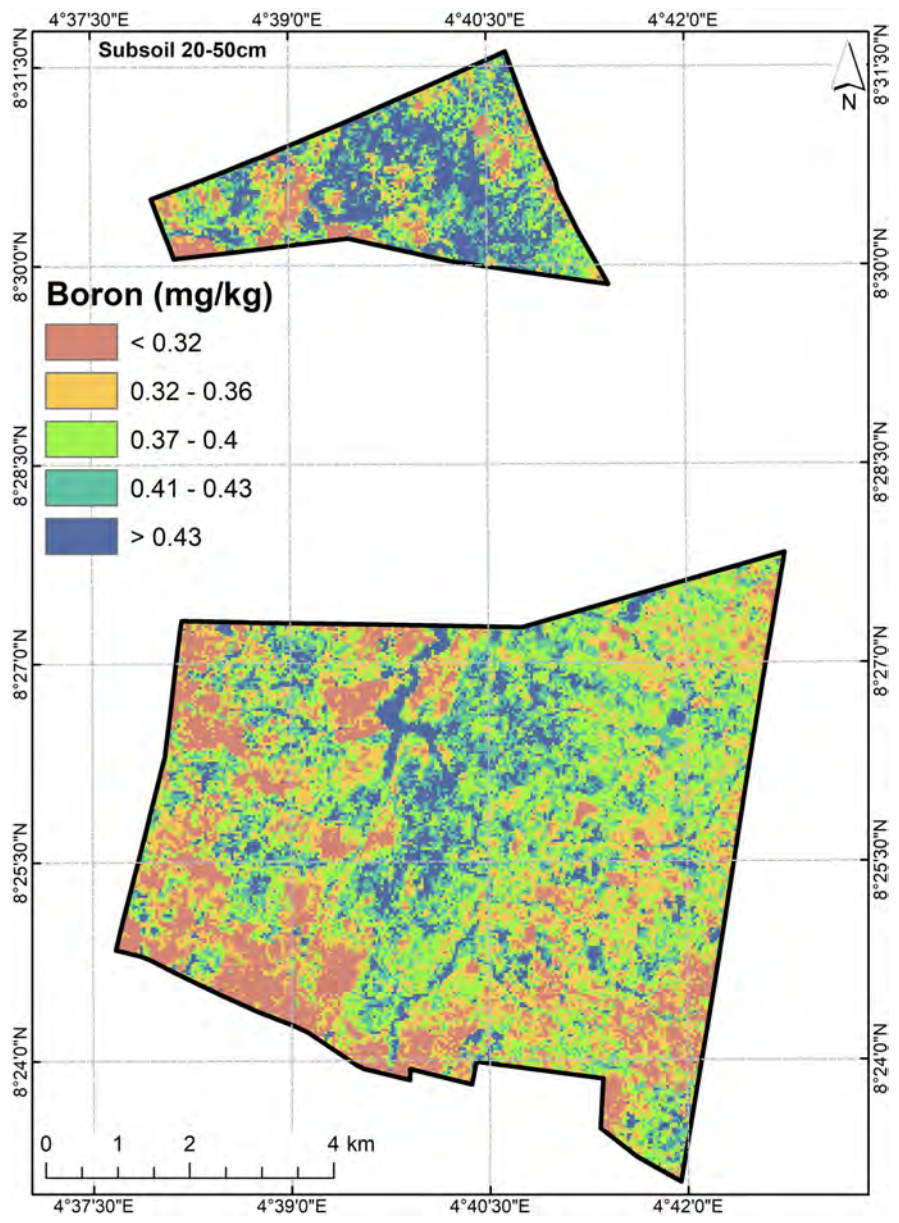














## Appendix 3 Farm Observation (field survey) data

ID	lat	lon	Terrain/topographic position	flooding	LandUse	soil depth	Topsoil colour	Subsoil colour	Remarks
OER B119	8.4310	4.6629	Upland	2	Woodland	45	10YR3/2 very dark grayish brown	10YR3/2 very dark grayish brown	Forest land.
OER B116	8.4231	4.6536	Upland	0	Woodland	80	10YR3/3 DARK BROWN	10YR4/3 BROWN	Forest land.
OER B115	8.4214	4.6493	Upland	0	Crop_mngd_int	80	10YR3/2 very dark grayish brown	10YR4/1 DARK GRAY	Rice farmland with tendency of waterlogged when there is excessive rain.
OER B13	8.4120	4.6383	Upland	0	Crop_mngd_int	60	7.5YR3/4 DARK BROWN	7.5YR4/4 BROWN	Cashew plantation is about 75 to the point. The plot is currently maize farm.
OER B117	8.4190	4.6444	Upland	0	Crop_mngd_int	70	10YR4/3 BROWN	7.5YR3/4 DARK BROWN	present of Stones at 45cm Dept. Maize Farmland.
OER B14	8.4120	4.6441	Upland	0	Idle	55	10YR3/4 DARK YELLOWISH BROWN	10YR4/4 dark yellowish brown	Idle land with more broadleaf.
OER B1	8.4038	4.6643	Midslope	1	Crop_mngd_int	60	10YR2/2 very dark brown	10YR4/2 dark grayish brown	Maize farmland which is directly slope to the base of the river. About 300m to the base of the water.
OER B10	8.4091	4.6731	Midslope	1	Crop_mngd_int	50	10YR3/3 DARK BROWN	10YR3/4 dark yellowish brown	Maize farm with present of broken rock.
OER B113	8.4169	4.6752	Upland	0	RngLnd_mngd	50	10YR3/2 very dark grayish brown	10YR3/4 dark yellowish brown	Idle land.
OER Kwara	8.5041	4.6530	Upland	0	Woodland	35	10Yr 2/1	10YR3/3	Near river
OER Kwara	8.5069	4.6502	Upland	0	Idle	130	10YR4/4	10YR5/6	No
OER A12	8.5097	4.6473	Ridge_Crest	0	Crop_mngd_int	90	10YR3/3	10YR4/4	NO
OER Kwara A13	8.5095	4.6501	Midslope	0	Idle	140	10YR4/3	10YR3/6	Building construction going on
OER Kwara A14	8.5097	4.6530	Bottomland	1	Idle	110	10YR3/2	10YR5/6	20 meters to water body.
OER Kwara A19	8.5123	4.6648	Upland	0	Crop_mngd_int	70	7.5YR4/2	7.5YR5/6	No
OER Kwara A30	8.5149	4.6676	Upland	0	Idle	45	7.5YR3/4	7.5YR4/6	No
OER Kwara A34	8.5177	4.6647	Upland	0	Idle	30	7.5YR3/4	7.5YR4/6	No
OER Kwara A35	8.5177	4.6707	Midslope	0	Crop_mngd_int	120	10YR3/3	10YR4/4	No
OER Kwara A20	8.5123	4.6707	Ridge_Crest	0	Crop_mngd_int	30	10YR4/3	10YR4/4	Crop area
OER Kwara A21	8.5122	4.6736	Upland	0	Crop_mngd_int	100	10YR3/2	10YR4/4	Crop area
OER Kwara A8	8.5069	4.6736	Upland	0	Idle	120	10YR3/3	10YR/4	No
OER Kwara A3	8.5041	4.6763	Upland	0	Tree_crop	70	10YR3/2	10YR4/6	No
OER Kwara A4	8.5039	4.6823	Upland	0	Crop_mngd_int	30	10YR3/2	10YR4/4	Taking 10 meters away from the point due to is farmed area.
OER Kwara A9	8.5068	4.6794	Upland	0	Idle	105	7.5YR3/4	7.5YR4/6	No

OER Kwara A16	8.5095	4.6822	Upland	0	Idle	120	10YR4/3	10YR4/4	No
OER Kwara A15	8.5095	4.6764	Upland	0	Crop_mngd_int	25	10YR3/2	10YR4/4	Cassava farm
OER Kwara A22	8.5129	4.6816	Upland	0	Idle	70	10YR4/3	10YR4/4	Adjusted because of boundary.
7OER Kwara A36	8.5184	4.6800	Upland	0	Idle	90	7.5YR4/4	7.5YR4/6	600m away from boundary
OER Kwara A57	8.5067	4.6403	Midslope	0	Idle	35	10YR4/3	10YR4/4	No
OER Kwara A56	8.5068	4.6388	Ridge_Crest	0	Crop_mngd_int	60	5YR3/2	P5YR3/4	Cropped area
OER Kwara A60	8.5055	4.6391	Upland	0	Idle	25	10YR3/3	10YR4/3	Stony area
OER Kwara A55	8.5041	4.6389	Midslope	1	Idle	120	7.5YR2/0	10YR3/2	River bank
OER Leads A58	8.5040	4.6412	Upland	0	Idle	25	10YR3/1	10YR4/3	Rocky Area
OER Kwara A59	8.5072	4.6351	Upland	0	Crop_mngd_int	25	10yr3/3	10YR3/4	Cropped Area
OER Kwara B96	8.4499	4.6828	Upland	0	Idle	22	10YR3/1	0	Hard pan at 22 40cm depth.
OER Kwara B95	8.4497	4.6741	Upland	0	Idle	70	19YR3/3	10YR4/4	No
OER Kwara B90	8.4471	4.6771	Upland	0	Idle	45	10YR3/3	7.5YR4/6	No
OER Kwara B85	8.4444	4.6800	Upland	0	Crop_mngd_int	80	10YR3/2	10YR4/4	Yam farm
OER Kwara B80	8.4417	4.6828	Upland	0	Crop_mngd_int	80	10YR2/1	10YR3/2	Cropped area
OER Kwara B79	8.4418	4.6742	Upland	0	Crop_mngd_int	100	10YR3/3	10YR4/6	Cropped area
OER kwara	8.5042	4.6473	Ridge_Crest	0	RngLnd_mngd	60	10YR4/3	10yr3/6	No
OER B16	8.4119	4.6615	Upland	0	Woodland	60	10YR3/2 very dark grayish brown	10YR3/3 DARK BROWN	Forest land. Part of the surface has been removed by the excavation.
OER B21	8.4148	4.6382	Upland	0	Crop_mngd_int	40	10Y3/2 very dark grayish brown	10YR 3/4 dark yellowish brown	Present of a rock in about 5m to the point
OER B15	8.4119	4.6557	Midslope	0	Idle	55	10YR3/3 DARK BROWN	10YR3/4 dark yellowish brown	Idle land, most of the surface layers has been removed by laterite people. And the major point was pick 3m away from point.
OER B22	8.4146	4.6556	Upland	0	Idle	100	10YR3/3 DARK BROWN	10YR4/4 dark yellowish brown	Idle land. Most surface has been removed by the laterite people.
OER B26	8.4159	4.6416	Upland	0	Crop_mngd_int	100	10YR3/4 DARK YELLOWISH BROWN	10YR4/3 BROWN	Wide range open field.
OER B30	8.4200	4.6557	Upland	0	Woodland	100	10YR4/2 DARK GRAYISH BROWN	10YR4/2 dark grayish brown	Forest land with present of earth cast.
OER B23	8.4146	4.6586	Upland	0	Idle	65	10YR3/3 DARK BROWN	10yr3/4 dark yellowish brown	Idle land with plenty of herbs trees like dongoyaro also fruit trees (cashew).
OER B31	8.4200	4.6615	Upland	0	Woodland	80	10YR3/3 DARK BROWN	10yr3/4 dark yellowish brown	Forest land with part of the top soil excavated by the laterite workers.
OER B40	8.4469	4.6603	Upland	0	Crop_mngd_int	80	10YR3/4 DARK YELLOWISH BROWN	10yr4/4 dark yellowish brown	Plot land currently in use for cultivation of maize and oil palm.

OER B39	8.4468	4.6577	Upland	0	Crop_mngd_int	50	10YR3/3 DARK BROWN	10yr4/4 dark yellowish brown	Plot land currently in for beans cultivation and their are palm trees of about 2 to 3years.
OER B36	8.4228	4.6469	Upland	0	Crop_mngd_int	100	10YR3/4 DARK YELLOWISH BROWN	10yr5/4 yellowish brown	Land currently use for yam farm.
OER B37	8.4178	4.6712	Midslope	1	Woodland	55	10YR2/2 VERY DARK BROWN	10yr 3/2 very dark grayish brown	Forest land with a lot of alterations by laterite workers.
OER B38	8.4177	4.6799	Midslope	2	Crop_mngd_int	100	10YR3/2 very dark grayish brown	10yr5/1 gray	Swamped area & Grazing zone
OER B45	8.4255	4.6529	Upland	0	Woodland	100	10YR3/3 DARK BROWN	10yr4/3 brown	Forest land.
OER B44	8.4256	4.6498	Upland	0	Idle	70	10YR3/3 DARK BROWN	10yr3/4 dark yellowish brown	Idle land.
OER B29	8.4201	4.6382	Upland	0	Crop_mngd_int	80	10YR4/3 BROWN	10yr4/4	Newly plough plot with a side demarcation with planted trees. Close by maize farm.
OER B47	8.4496	4.6603	Midslope	0	Crop_mngd_int	30	10YR4/4 DARK YELLOWISH BROWN	10yr4/4 dark yellowish brown	Plot land currently in use for maize and cassava cultivation, age range between 2 to 3weeks.
OER B52	8.4282	4.6526	Upland	0	Crop_mngd_int	70	10YR4/2 DARK GRAYISH BROWN	10yr3/3 dark brown	Present of earth cast on the surface of the land, and land currently use for cultivation of maize farm.
OER B2	8.4037	4.6730	Upland	1	Tree_crop	50	10YR3/3 DARK BROWN	10yr5/1 gray	Cashew plantation farm.
OER B47	8.4206	4.6740	Upland	0	Crop_mngd_int	65	10YR3/2 very dark grayish brown	10yr4/3 brown	Maize farm with earth cast on the surface of the soil. River Oyun pass across the farmland.
OER B53	8.4233	4.6712	Upland	0	Woodland	60	10YR3/2 very dark grayish brown	10yr3/3 dark brown	Forest land with part cultivated. Also close to river Oyun.
OER B54	8.4233	4.6799	Upland	0	Crop_mngd_int	70	10YR5/2 grayish brown	10yr5/3 brown	Maize farm.
OER B55	8.4524	4.6574	Upland	1	Crop_mngd_int	60	10YR3/3 DARK BROWN	10yr4/3 brown	Plot land currently in use for maize cultivation, and beside is yam farm.
OER B56	8.4522	4.6632	Upland	0	RngLnd_mngd	45	10YR3/3 DARK BROWN	10yr3/4 dark yellowish brown	Open graze land.
OER B61	8.4309	4.6557	Upland	0	Crop_mngd_int	90	10YR3/3 DARK BROWN	10yr4/3 brown	There are earth cast on the surface of the land. Also, there are present of fruit trees. The plot is currently in use for the cultivation of maize and cassava.
OER B62	8.4309	4.6586	Upland	0	Crop_mngd_int	100	10YR3/3 DARK BROWN	10yr3/4 dark yellowish brown	Earth cast present on this plot.
OER B6	8.4064	4.6701	Midslope	2	Crop_mngd_int	100	10YR4/2 DARK GRAYISH BROWN	10yr4/3 brown	Swamped field. Currently use for cultivation of rice. Beside the farm there is a present of rock.
OER B77	8.4391	4.6385	Upland	0	RngLnd_ext	50	10YR3/3 DARK BROWN	10yr4/4 dark yellowish brown	Open grazing land.
OER B78	8.4391	4.6444	Upland	0	Crop_mngd_int	65	10YR4/3 BROWN	10yr4/4 dark yellowish brown	Cultivated maize farmland.
OER B70	8.4363	4.6557	Upland	0	Crop_mngd_int	100	10YR4/3 BROWN	10yr4/4 dark yellowish brown	Yam, cassava, and maize farm plot
OER B67	8.4337	4.6586	Upland	0	Crop_mngd_int	90	10YR4/4 DARK YELLOWISH BROWN	10yr4/4 dark yellowish brown	Mature Maize farm, almost ready for harvest.
OER B71	8.4364	4.6617	Upland	1	Woodland	40	10YR5/3 BROWN	10yr5/3 brown	Forest land. About 100m Close to river side.
OER B89	8.4445	4.6414	Upland	1	Crop_mngd_int	75	10YR4/3 BROWN	10yr4/4 dark yellowish brown	Mature Maize cultivated farmland.
OER B93	8.4473	4.6385	Upland	0	Crop_mngd_int	50	7.5YR4/2 BROWN	7.5yr4/4 brown	Stoney maize farm.

OER B84	8.4418	4.6385	Upland	1	Crop_mngd_int	50	7.5YR3/2 DARK BROWN	7.5yr4/3 brown	Mature Maize farmland with stoney soil.
OER B9	8.4090	4.6702	Midslope	1	Crop_mngd_int	60	10YR3/2 very dark grayish brown	10yr3/3 dark brown	Present of earth cast on the surface, rock is also present close to the point. Directly slope to river side.
OER B8	8.4092	4.6642	Midslope	0	Woodland	50	10YR3/2 very dark grayish brown	10yr3/4 dark yellowish brown	Alternative of laterite workers around this point, Forest land. Point was taken at the exact coordinates because it hasn't been alter. Stoney land with maize cultivation.
OER B94	8.4472	4.6444	Midslope	1	Crop_mngd_int	50	7.5YR4/4 BROWN	7.5yr4/4 brown	
OER B48	8.4475	4.6633	Midslope	2	Crop_mngd_int	n/a	10YR3/6 dark yellowish brown	7.5yr4/4 brown	Sugar cane plot with part of the land stoney. Maize cultivation at the other end of the plot.
OER B76	8.4362	4.7080	Midslope	1	Crop_mngd_int	74	10YR 3/2 very dark grayish brown	10YR 4/3 brown	The field is currently cultivated with maize and okro. The plot is also falls within the border area
OER B66	8.4307	4.7069	Midslope	0	Crop_mngd_int	25	10YR 2/2 very dark brown	n/a	The sampling point fell outside the area with about 131meters therefore the sample was taken at the close border. The depth was limited at about 25 cm due to Iron-Manganese concretion and shown at the surface in the plots. The plot is currently cultivated with maize
OER B69	8.4334	4.7051	Footslope	2	Idle	100	10YR 3/3 dark brown	10YR 4/2 dark grayish brown	There was presence of mottle at the subsoil. The sampling point falls inside the stream therefore the samples were taken beside the stream
OER B65	8.4308	4.7022	Midslope	0	Crop_mngd_ext	35	10YR 3/3 dark brown	7.5YR 4/3 brown	The field currently uncultivated with the regrowth of some weeds. The soil is limited by gravel at about 35 cm
OER B75	8.4362	4.7052	Midslope	0	Woodland	60	10YR 3/3 dark brown	7.5 YR 3/3 dark brown	The land was currently left fallowed, and the depth was limited by gravel at about 60 cm
OER B74	8.4362	4.7023	Midslope	0	Crop_mngd_int	35	10YR 2/2 very dark brown	7.5YR 3/3 dark brown	The soil is somewhat shallow due to gravel and Iron-Manganese concretion. The field is currently cultivated with guinea corn and maize
OER B42	8.4236	4.6934	Midslope	1	Crop_mngd_int	35	10YR 3/4 very dark yellowish brown	10YR 4/4 dark yellowish brown	The field was currently cultivated with maize plant and the depth was limited by concretion at about 35 cm depth.
OER B112	8.4230	4.6907	Midslope	1	Crop_mngd_int	75	10YR 3/4 dark yellowish brown	7.5 YR 5/6 strong brown	The field is currently cultivated with maize plant
OER B41	8.4236	4.6877	Midslope	1	Crop_mngd_int	70	10YR 3/4 dark yellowish brown	10YR 3/4 dark yellowish brown	The field was currently cultivated with maize and okro and the depth is limited at about 65 cm. There was presence of manganese at the lower depth and there was presence of water at the depth of 60 cm down
OER B57	8.4290	4.6877	Midslope	3	Crop_mngd_int	45	10YR 3/2 very grayish dark brown	10YR 3/4 dark grayish brown	There were patches of flood in the field, the field is currently cultivated with maize. There were noticeable rock outcrop towards the south of the field which also closer to the stream
OER B49	8.4263	4.6906	Midslope	0	Crop_mngd_int	25	10YR 3/2 very dark grayish brown	n/a	The plot is currently cultivated with maize and beans and the soil is very shallow with effective depth of 25cm
OER B58	8.4290	4.6935	Midslope	3	Crop_mngd_ext	35	10YR 4/4 dark yellowish brown	10YR 4/4 dark yellowish brown	The field is currently left uncultivated and the depth is limited at about 35 cm due to water.

OER B104	8.4565	4.6958	Footslope	1	Woodland	60	10YR 4/1 dark gray	10YR 4/4 dark yellowish brown	The sampling point falls beside the river channel. The field is left fallowed with many trees and shrubs
OER B105	8.4565	4.7015	Midslope	0	Woodland	25	10YR 3/2 very dark grayish brown	n/a	The plot is left with many trees and shrubs. The depth is very shallow due to gravel impediment
OER B103	8.4538	4.7015	Midslope	0	Woodland	18	10YR 4/4 dark yellowish brown	n/a	Fallowed land with shallow depth of about 18 cm. The depth is limited by gravel. There was evidence of deforestation
OER B101	8.4511	4.7015	Midslope	1	Crop_mngd_int	48	10YR 3/2 very dark grayish brown	10YR brown	The depth is limited at about 48 cm due to its gravel content. The field is currently cultivated with maize
OER B102	8.4539	4.6986	Midslope	0	Crop_mngd_ext	85	10YR 3/3 dark brown	10YR 4/6 dark yellowish brown	The field has previously been cultivated due to the presence of ridge. The soil is well deep
OER B100	8.4511	4.6957	Midslope	0	Woodland	48	10YR 3/4 dark yellowish brown	7.5 YR 4/4 brown	The field is fallowed with covered trees and shrubs. It is close the stream
OER B98	8.4468	4.6987	Midslope	0	Crop_mngd_int	40	10YR 3/2 very dark grayish brown	10YR 3/3 dark brown	The field is currently cultivated with maize and has some trees and shrubs
OER B91	8.4441	4.6957	Midslope	1	Crop_mngd_int	10	10YR 3/2 very dark grayish brown	n/a	The field is currently cultivated with maize, and it is very shallow and stoney
OER B97	8.4469	4.6929	Midslope	0	Crop_mngd_int	15	10YR 3/2 very dark brown	n/a	The plot is currently cultivated with guinea corn, the soil is very shallow and limited at depth of about 15 cm
OER B81	8.4387	4.6928	Midslope	0	Crop_mngd_int	25	10YR 3/1 very dark grey	n/a	The soil is very shallow with gravel impediment. The sampling point falls at the border of yam farm and forest
OER B120	8.4396	4.6992	Midslope	0	Crop_mngd_int	8	10YR 2/2 very dark brown	n/a	The field is currently cultivated with maize and the soil is very shallow with gravel impediment.
OER B19	8.4065	4.7027	Midslope	0	Crop_mngd_int	20	10YR 3/2 very dark grayish brown	n/a	The sampling fell outside the border area and was shifted to this point. The field is currently cultivated with pepper and maize. The soil is very shallow due to gravel impediment
OER B25	8.4084	4.6998	Midslope	0	Crop_mngd_int	55	10YR 4/4 dark yellowish brown	7.5YR 4/4 brown	The field is currently cultivated with pepper
OER B20	8.4040	4.7009	Midslope	1	Crop_mngd_int	60	10YR 4/3 brown	10YR 5/4 Yellowish brown	The subsoil is clayey sand and the clay increasing down the depth. The field is close to the river. The field is in between cultivated maize farm.
OER B28	8.4116	4.7008	Midslope	1	RngLnd_ext	50	10 YR 3/4 Dark yellowish brown	10YR 4/4 dark yellowish brown	The sampling is shifted to this point. The field is left fallowed but close to the river and cultivated farm
OER B35	8.4124	4.6979	Midslope	1	Crop_mngd_int	15	10YR 3/4 dark yellowish brown	n/a	The sampling is shifted to this point. The field is currently cultivated with maize, okro and pepper.
OER B34	8.4145	4.7041	Ridge_Crest	0	Idle	60	7.5YR 3/3 dark brown	5YR 3/3 dark reddish brown	The soil is shallow due to granite impediment. The sampling point is shifted to this this point because it falls out of boundary. The soil has small stones
OER B33	8.4165	4.6946	Midslope	1	Crop_mngd_int	38	10YR 3/2 very dark grayish brown	7.5 YR 3/3 dark brown	The field is currently cultivated with maize. There was rock outcrop at the extreme North Eastern part of the plot.
OER B27	8.4138	4.6917	Midslope	1	Crop_mngd_int	18	10YR 3/1 very dark gray	n/a	There was rock outcrop and iron manganese concretion on the plot and the field is currently cultivated with maize.

OER B24	8.4111	4.6888	Midslope	0	Crop_mngd_int	21	10YR 3/3 dark brown	n/a	The soil is shallow and limited at about 20 cm due to gravel. The field is currently cultivated with maize
OER B32	8.4164	4.6859	Midslope	1	Crop_mngd_int	70	10YR 3/3 dark brown	10YR 3/4 dark yellowish brown	The field is currently cultivated with Cassava and close the stream
OER B17	8.4083	4.6859	Midslope	0	Crop_mngd_int	20	7.5YR 3/3 dark brown	n/a	The field is currently cultivated with maize, guinea corn and beans and the soil is shallow due to gravel impediment
OER B17	8.4083	4.6946	Footslope	3	Crop_mngd_int	35	10YR 4/1 dark gray	10YR 5/1 gray	The field is currently cultivated with maize and there was pieces of iron manganese concretion on the surface. The plot is close to the stream and there was water at about 35 cm depth.
OER B72	8.4363	4.6732	Midslope	0	Crop_mngd_int	50	10 YR 4/4 dark yellowish brown	7.5YR 4/3 brown	The field is currently cultivated with maize. There was noticeable rock outcrop
OER B118	8.4364	4.6775	Midslope	0	Idle	80	7.5YR 3/3 dark brown	7.5YR 3/3 dark brown	The field has been previously cultivated but currently uncultivated
OER B68	8.4336	4.6790	Midslope	0	Woodland	40	10YR 4/2 dark grayish brown	10YR 5/2 grayish brown	The field is a forest area with many trees and shrubs.
OER B73	8.4363	4.6819	Midslope	0	Woodland	10	10YR 4/3 brown	n/a	The sampling point falls within the forest area with shallow depth due to gravel impediment
OER B64	8.4308	4.6819	Midslope	0	Crop_mngd_int	80	10YR 3/4 dark grayish brown	10YR 4/4 dark grayish brown	The field is currently cultivated with maize plant
OER B63	8.4309	4.6732	Midslope	0	Idle	75	10 YR 3/3 dark brown	10YR 3/4 dark yellowish brown	The trees have been cut in preparation for cultivation
OER B12	8.3998	4.6980	Midslope	1	Crop_mngd_int	70	10YR 3/2 very dark yellowish brown	10YR 4/3 brown	The field is currently cultivated with maize.
OER B7	8.3971	4.6951	Midslope	0	Crop_mngd_int	18	7.5YR 3/3 dark brown	n/a	The field is currently cultivated with maize and it is stoney at the surface.
OER B4	8.3944	4.6951	Midslope	1	Crop_mngd_int	100	10YR 4/3 brown	10YR 4/3 brown	The field is currently cultivated with maize and well deep
OER B3	8.3944	4.6921	Midslope	0	Idle	40	10YR 3/3 dark brown	10YR 3/4 dark yellowish brown	The field is left uncultivated and fall in between two cultivated farms
OER B5	8.3943	4.6980	Midslope	0	Idle	25	7.5YR 3/4 dark brown	n/a	The field is left uncultivated. The sampling point falls beside the excavated point and the was iron manganese concretion on the surface
OER B11	8.3998	4.6922	Midslope	0	Idle	20	7.5YR 3/4 dark brown	n/a	The point fall on the road therefore the sample was taken close to the bush at about 3 metres away to the point. There were some iron manganese concretion and gravels on the surface.
OER B86	8.4414	4.6957	Midslope	1	Crop_mngd_int	12	10YR 3/2 very dark grayish brown	n/a	Shallow soil depth The field is currently cultivated with maize and has some trees. The soil is very shallow and stoney

## Appendix 4 Composition of the individual land units and their size

Landunit code	ECEC (class)	SOC (class)	Soil Depth (class)	Soil pH (class)	Class combination	Area (Ha)
1	1	1	3	1	1131	1,224.4
2	1	2	2	1	1221	692.9
3	1	2	3	1	1231	1,207.7
4	1	3	1	1	1311	17.1
5	1	3	2	1	1321	758.7
6	1	3	3	1	1331	218.6
7	2	2	2	1	2221	86.1
8	2	2	3	1	2231	5.7
9	2	3	2	1	2321	225.1
10	3	2	2	1	3221	787.9
11	3	3	2	1	3321	215.2
12	3	3	2	2	3322	165.0
13	3	3	3	1	3331	118.7
14	4	3	1	1	4311	11.7
15	4	3	1	2	4312	15.6
16	4	3	2	1	4321	48.0
17	4	3	2	2	4322	107.6
18	4	3	3	1	4331	192.8