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# **Soil Maps for GIZ ProSoil Project in Madagascar**

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ISRIC - World Soil Information

1. **Introduction**

Soil degradation is a global issue. Soil protection and rehabilitation of degraded soils safeguard the natural resource of agricultural production which secures income and food supplies and reduces poverty and hunger in rural areas. Germany’s Federal Ministry for Economic Cooperation and Development (BMZ) intends to make a significant contribution to this objective through substantial investments in soil protection and rehabilitation with a view to enhancing food security as well as adaptation to climate change and exploring co-benefits with carbon sequestration. Subsequent programs are implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Kreditanstalt für Wiederaufbau and NGOs with a focus in Africa (Benin, Burkina Faso, Ethiopia, Kenya, Madagascar, Tunisia) and India and as part of BMZ’s ONEWORLD – No Hunger Initiative.

The World Overview of Conservation Approaches and Technologies (WOCAT – [www.wocat.net](http://www.wocat.net) ) is a global network on Sustainable Land Management (SLM) that promotes the documentation, sharing and use of information and knowledge to support adaptation, innovation and decision-making in SLM. WOCAT supports governments and their development partners in effective Knowledge Management (KM) and Decision Support (DS) tools and processes.

GIZ ProSoil project asked WOCAT Consortium through WOCAT secretariat for contribution to knowledge management and decision support in the soil protection and rehabilitation initiatives including: 1) Good SLM Practices documented and shared, including national soil maps in the Good SLM Practices compilations; 2) Mapping, digital solutions and platforms.

**This report provides an overview of soil maps compiled for the earmarked study areas of the GIZ ProSoil project in Madagascar (Figure 1).**

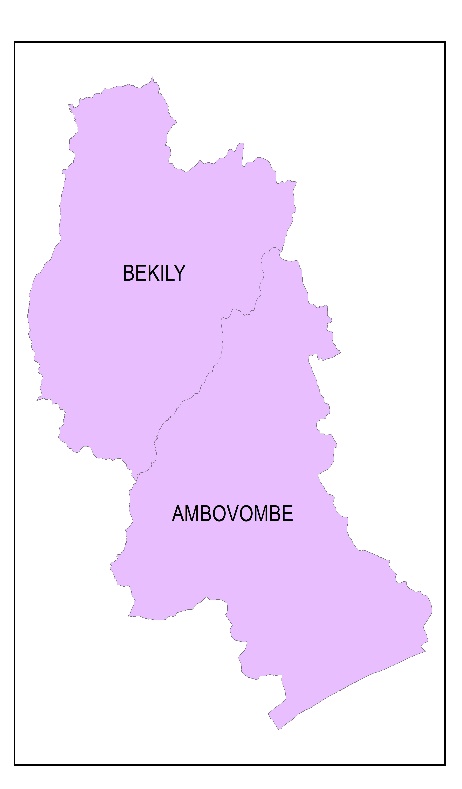
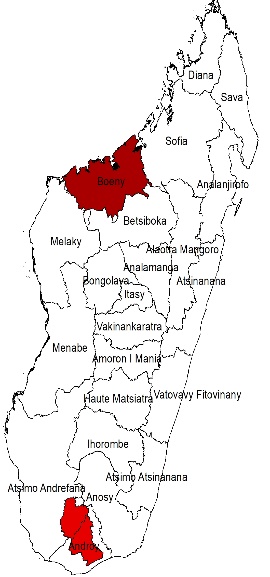


Figure 1. Locations of the GIZ ProSoil project areas in Madagascar

**The soil maps are compiled from ISRIC’s global product SoilGrids(v2), African SoilGrids nutrients and SoilGrids GAGA.** Theses**oil maps include soil type, soil pH, soil texture (sand, clay, silt) content, coarse fragment, bulk density, CEC, CaCO3, SOC content, soil organic density, SOC stock, total Nitrogen, extractable Al, extractable B, extractable Ca ,extractable Cu, extractable Fe, extractable K, extractable Mg, extractable Mn, extractable Na, extractable P, extractable Zn, total P,** root zone plant-available water holding capacity (**RZ-PAWHC) and rootable depth. The soil types were predicted based on IUSS-FAO WRB at spatial resolution of 250 meters; the soil property maps (pH, texture, coarse fragment, SOC) are mapped at 250 meter resolution for depth of 0-30cm** that are aggregated by soil depths of 0-5cm, 5-15cm, 15-30cm. Soil nutrient, water holding capacity and rootable depth are mapped at spatial resolution of 250 meters for depth of 0-30cm. Table 1 summaries the soil maps, units, spatial resolution and sources.

**Table 1. Compiled soil properties/maps for the GIZ ProSoil project areas in Madagascar.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Soil property** | **Soil depth (cm)** | **Unit\*** | **Spatial resolution (meter)** | **Data layer name and format** | **Source** |
| **Soil type** |  |  | **250** | **WRB\_MostProbable.tif** | **SoilGrids v2 (based on IUSS-FAO WRB)** |
| **Sand** | **0-30** | **%** | **250** | **sand\_0\_30\_cm\_%.tif** | **SoilGrids v2** |
| **Silt** | **0-30** | **%** | **250** | **Silt\_30\_cm\_%.tif** | **SoilGrids v2** |
| **Clay** | **0-30** | **%** | **250** | **clay\_0\_30\_cm\_%.tif** | **SoilGrids v2** |
| **Coarse fragment** | **0-30** | **%(vol)** | **250** | **cfvo\_0\_30\_cm\_vol%.tif** | **SoilGrids v2** |
| **Bulk density** | **0-30** | **kg/dm³** | **250** | **Bdod\_0\_30\_cm\_kg\_dm3.tif** | **SoilGrids v2** |
| **pH in water** | **0-30** | **unitless** | **250** | **pH\_0\_30cm\_unitless.tif** | **SoilGrids v2** |
| Cation exchange capacity(**CEC)** | **0-30** | **cmol(c)/kg** | **250** | **CEC\_0\_30\_cm\_cmol(c)\_kg.tif** | **SoilGrids v2** |
| **SOC content** | **0-30** | **g/kg** | **250** | **SOC\_0\_30cm\_g\_kg.tif** | **SoilGrids v2** |
| **SOC density** | **0-30** | **kg/cm3** | **250** | **ocd\_0\_30\_cm\_kg\_m3.tif** | **SoilGrids v2** |
| **SOC stock** | **0-30** | **kg/m²** | **250** | **ocs\_0\_30\_cm\_kg\_m2.tif** | **SoilGrids v2** |
| Total Nitrogen | **0-30** | **g/kg** | **250** | **Nitrogen\_0\_30cm\_g\_kg.tif** | **SoilGrids v2** |
| Extractable Al | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Al\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable B | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_B\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Ca | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Ca\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Cu | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Cu\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Fe | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Fe\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable K | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_K\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Mg | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Mg\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Mn | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Mn\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable N | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_N\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Na | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Na\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable P | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_P\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| Extractable Zn | 0-30 | **ppm by** Mehlich 3 | **250** | Nutrient\_Extractable\_Zn\_0\_30cm\_ppm.tif | African SoilGrids: nutrient |
| **Electrical conductivity (EC)** | 0-30 | **dS/m** | 250 | EC\_0\_30\_cm\_dS\_m.tif | African SoilGrids: nutrient |
| **RZ-PAWHC** | **0-30** | **% (vol)** | 1000 | gyga\_af\_agg\_30cm\_awcpf23\_m\_1km\_v%.tif | African SoilGrids: GYGA |
| Rootable depth (for maize) | **0-30** | **cm** | 1000 | gyga\_af\_erzd\_m\_1km\_cm (rootable depth for maize).tif | African SoilGrids: GYGA |

\*SoilGrids v2 are mapped with the measurement units. Reason for this is that all SoilGrids properties required to be mapped as integer values for computational and storage efficiency. These units can be somewhat unconventional for reporting soil property values. These units can be converted into more conventional units as we have done for the figures shown in this report e.g. cmol(c)/kg for CEC and % for clay.

1. **SoilGrids (v2)**

SoilGridsTM (hereafter SoilGrids **v2) are** global soil property maps that are predicted using state-of-the-art machine learning methods using over 230 000 soil profile observations (WoSIS database, Batjes *et al*. 2017, 2020) and more than 400 environmental covariates from Earth observation derived products and other environmental information including climate, land cover and terrain morphology (Poggio *et al.,* 2020, <https://www.isric.org/explore/soilgrids>). The SoilGrids are mapped at six standard depth intervals (0-5cm, 5-15cm, 15-30cm, 30-60cm, 60-100cm, 100-200cm) at a spatial resolution of 250 meters. Prediction uncertainty is quantified by the lower and upper limits of a 90% prediction interval. Currently soil properties in the SoilGrdis include: pH, bulk density, coarse fragments content, sand content, silt content, clay content, cation exchange capacity (CEC), total nitrogen, soil organic carbon content, soil organic carbon density and soil organic carbon stock. Figures 2-6 show some of the layouts of the soil properties.

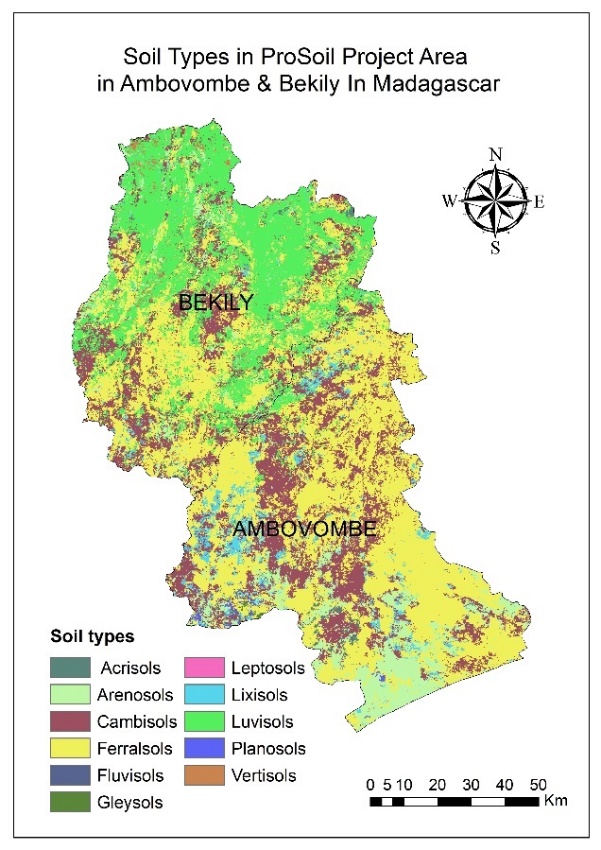
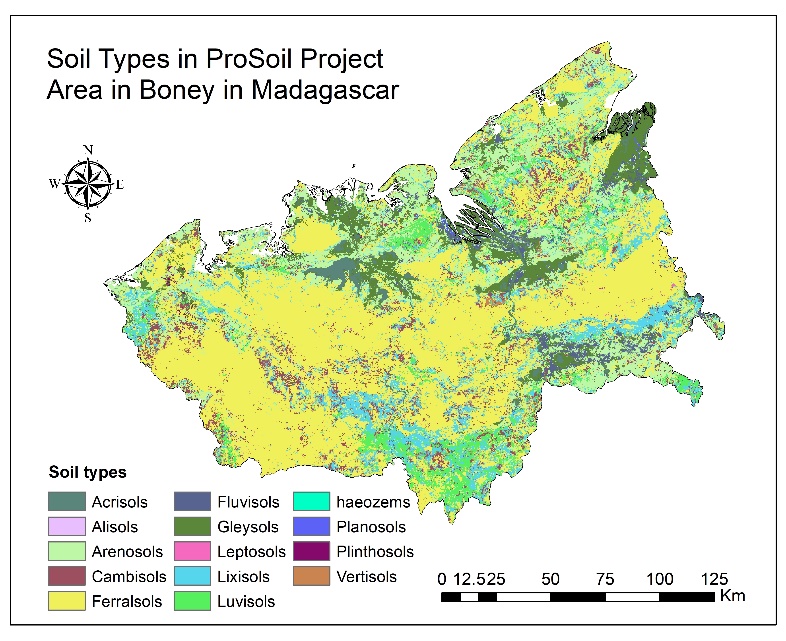


Figure 2. Soil types of the ProSoil project areas in Madagascar

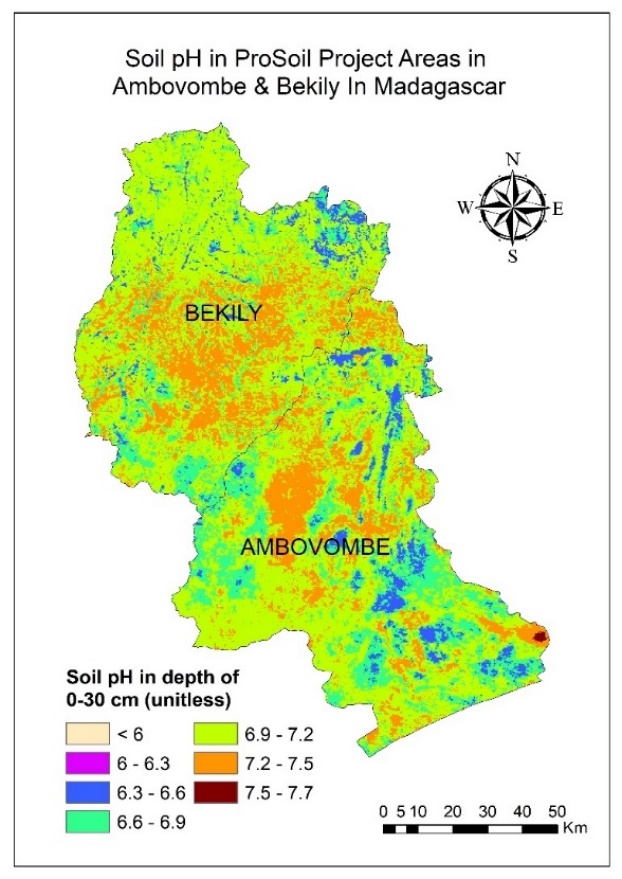
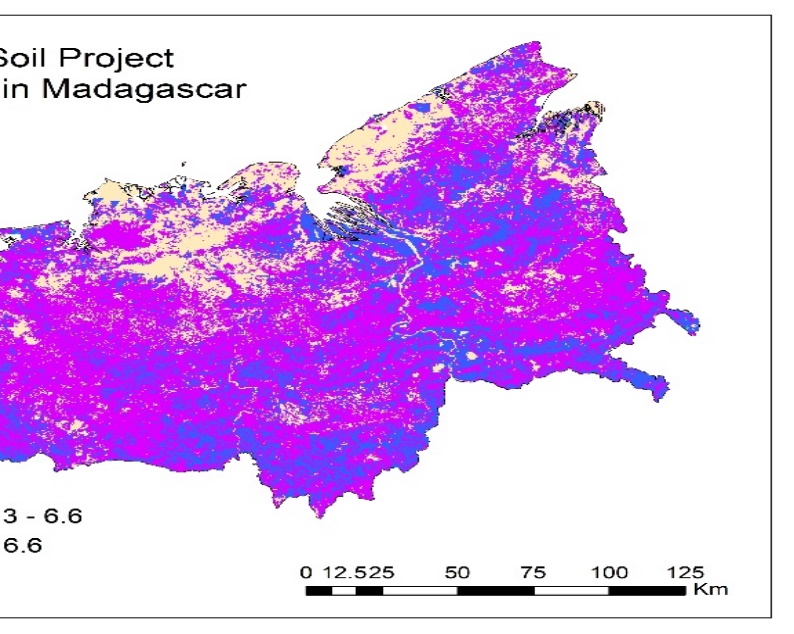


Figure 3. Soil pH of the ProSoil project areas in Madagascar

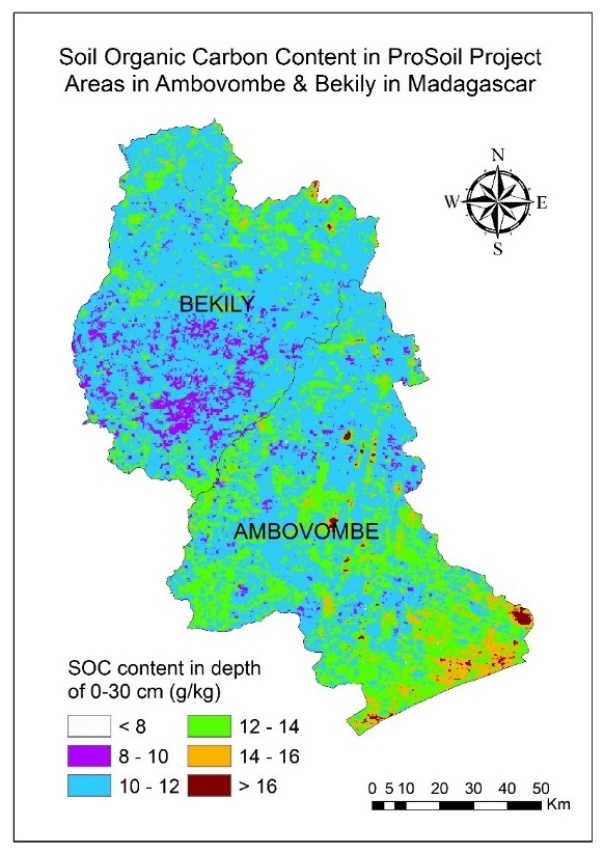
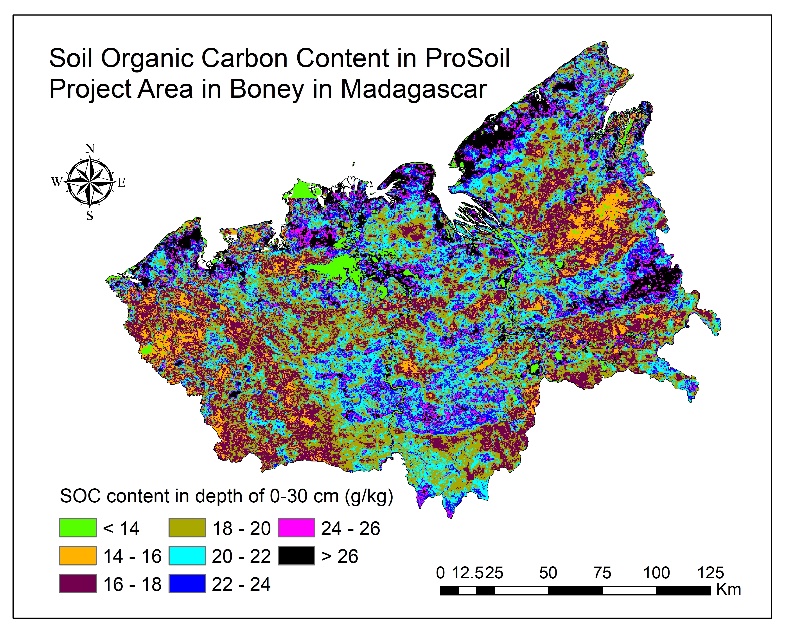


Figure 4. Soil organic carbon content of the ProSoil project areas in Madagascar

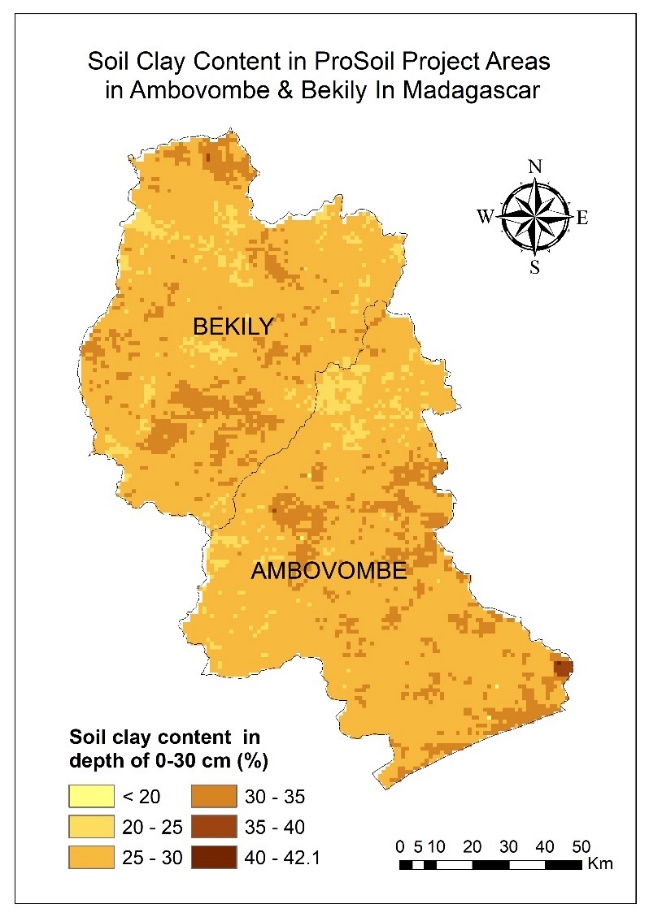
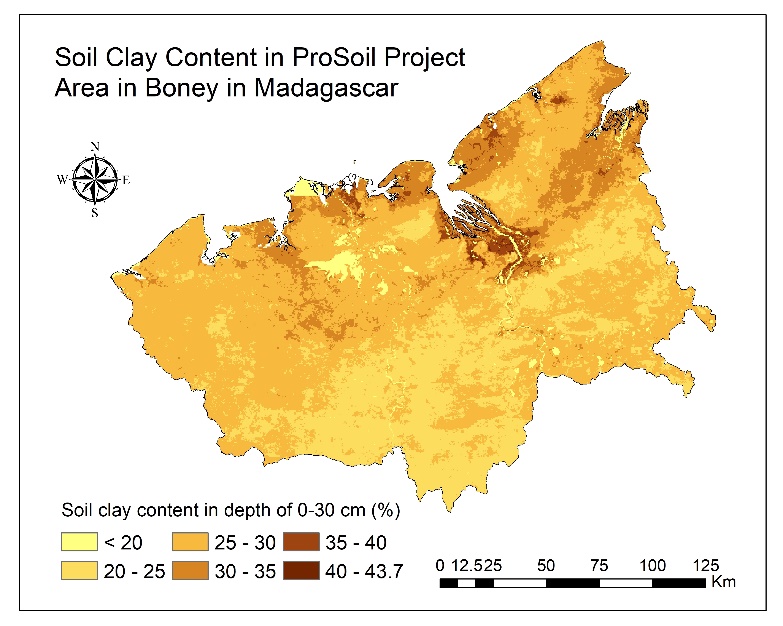


Figure 5. Soil clay content of the ProSoil project areas in Madagascar

1. **African SoilGrids: nutrient maps**

The SoilGrids v2 does not consider soil nutrients. Nutrients maps were therefore extracted from the African SoilGrids dataset that contains gridded soil nutrient maps of Sub-Saharan at 250 meter spatial resolution Africa. These maps were developed based on a large set of soil observation and environmental covariates in a machine learning modelling framework (Hengl *et al*., 2017). The maps include total nitrogen (N), total phosphorus (P), extractable phosphorus (P), extractable potassium (K), extractable calcium (Ca), extractable magnesium (Mg), extractable sodium (Na), extractable iron (Fe), extractable manganese (Mn), extractable zinc (Zn), extractable copper (Cu), extractable aluminum (Al) and extractable boron (B). Figures 6-7 show examples of extractable Mg and extractable K for the ProSoil project areas in Madagascar.

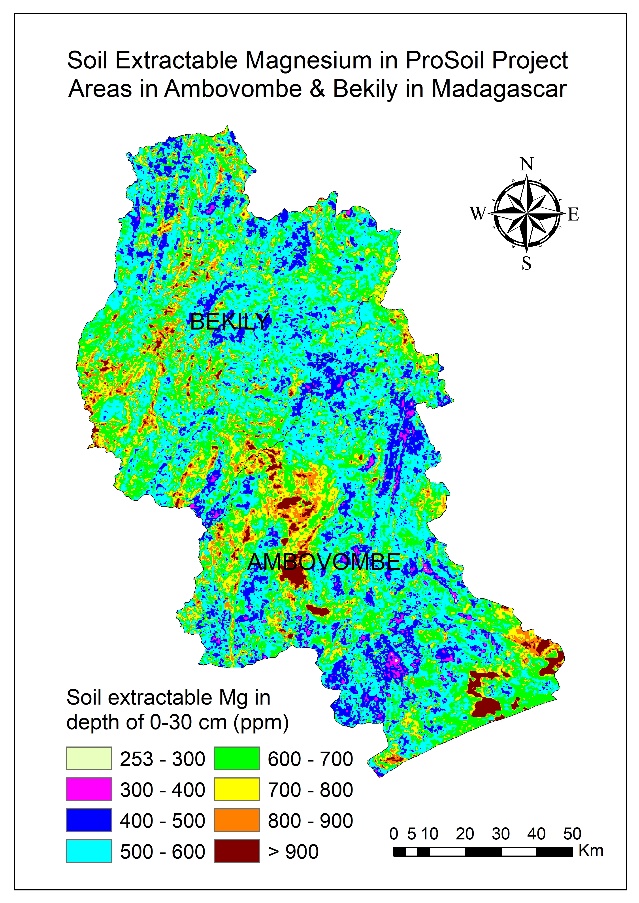
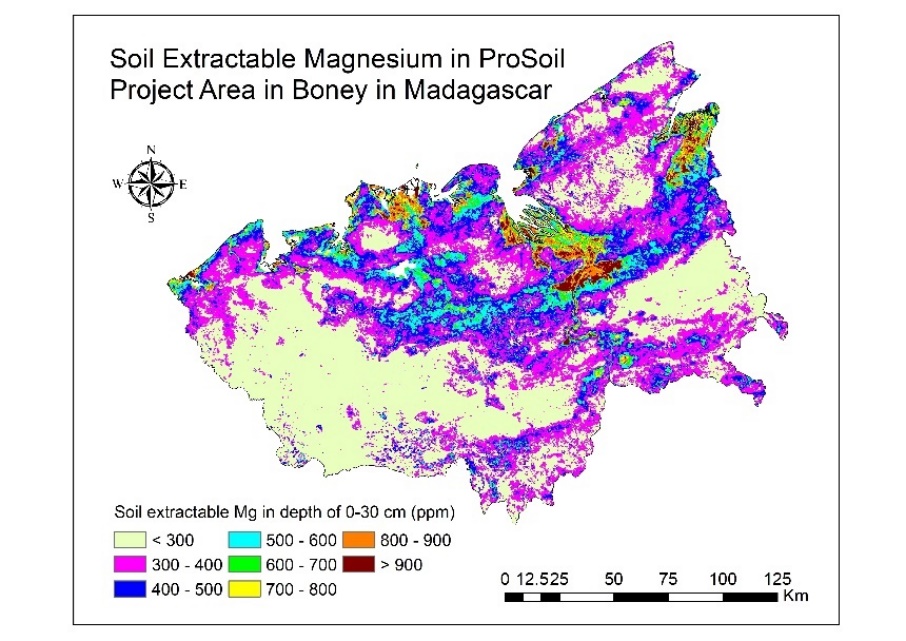


Figure 6. Soil extractable Magnesium content of the ProSoil project areas in Madagascar

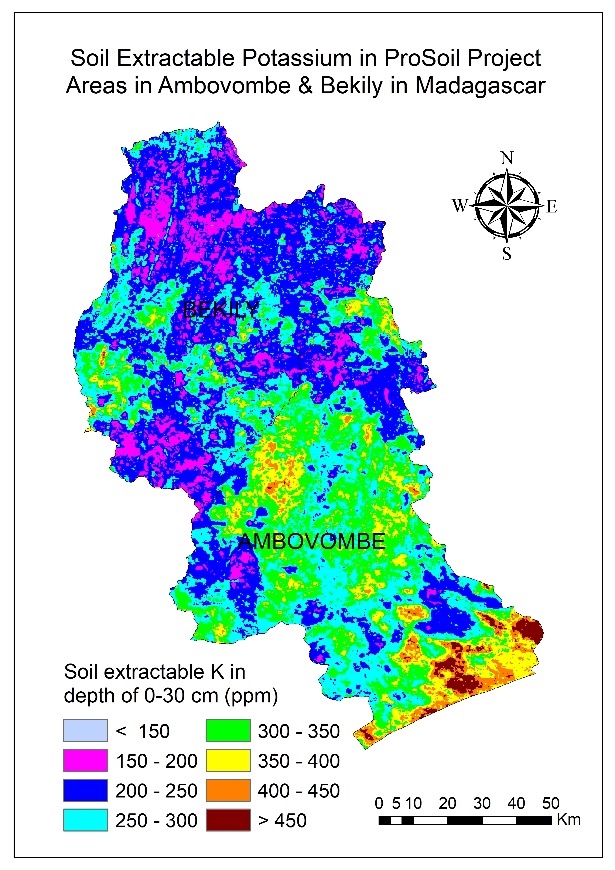
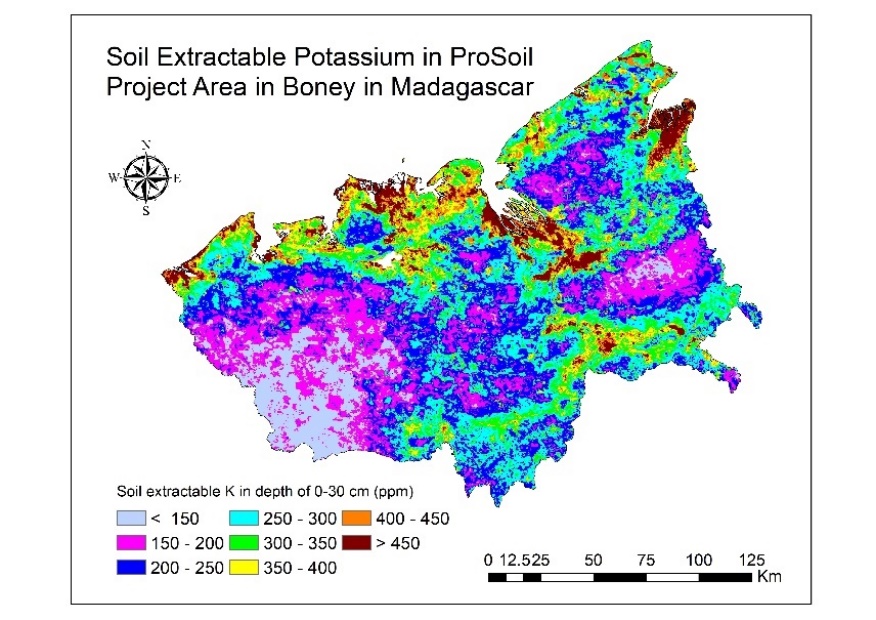


Figure 7. Soil extractable Potassium content of the ProSoil project areas in Madagascar.

1. **African SoilGrids: GYGA maps**

Maps of soil functional properties root zone plant-available water holding capacity (RZ-PAWHC) and rootable depth for maize were developed by ISRIC under the Global Yield Gap and Water Productivity Atlas (GYGA) project in collaboration with Africa Soil Information Service (AfSIS) (Leenaars *et al*., 2015, 2018). The root zone plant available water holding capacity of the soil fine earth fraction, with field capacity defined at h=200 cm or pF 2.3, aggregated for the top 30 cm, mapped at 1km resolution. Figures 8-9 show rootable depth and root zone-plant available water holding capacity in the ProSoil project areas in Madagascar.

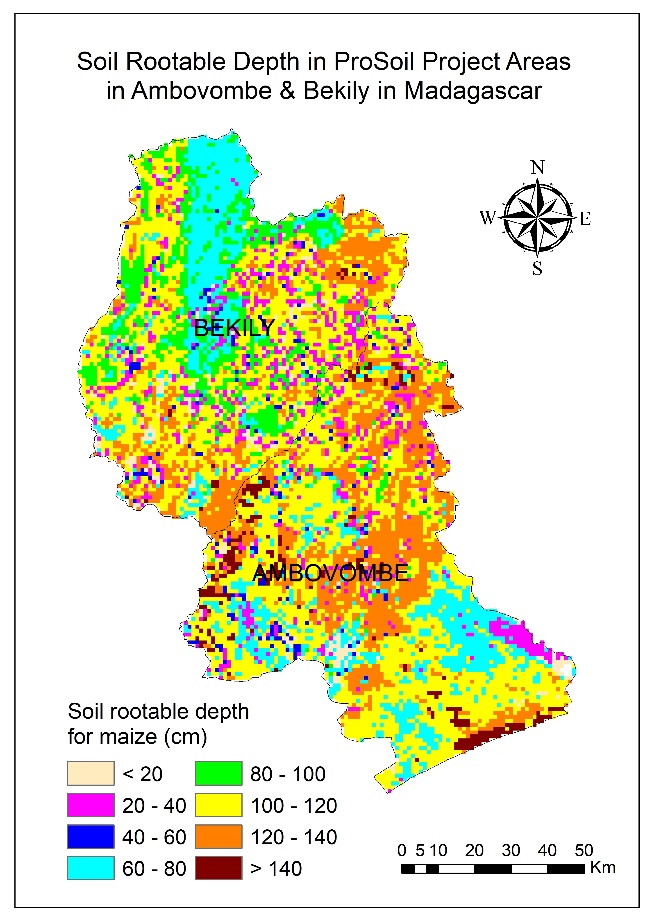
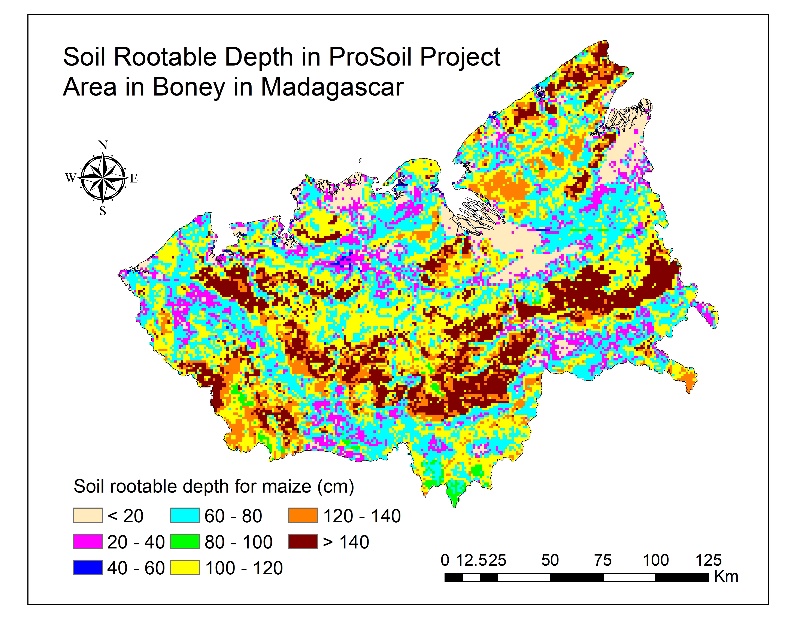


Figure 8. Soil rootable depth of the ProSoil project areas in Madagascar.

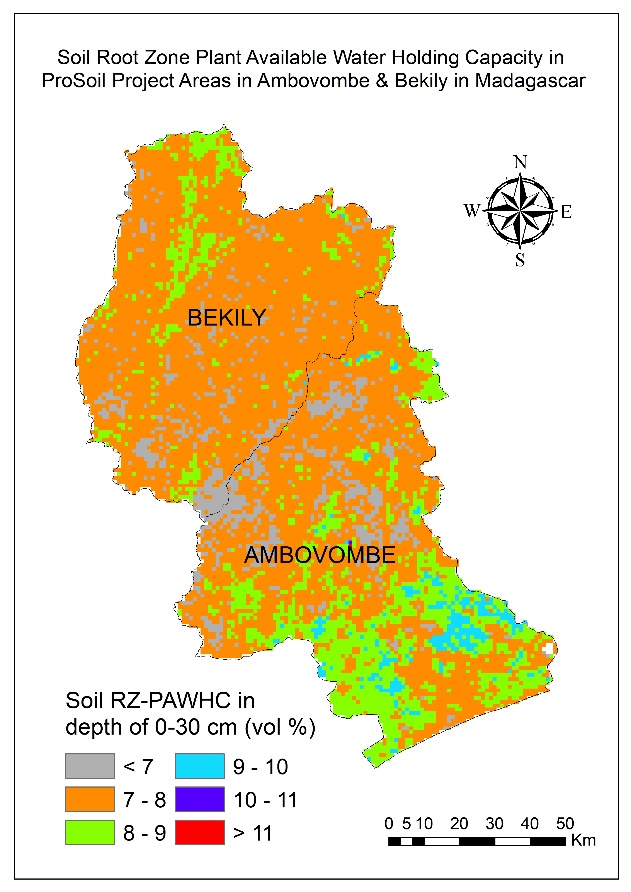
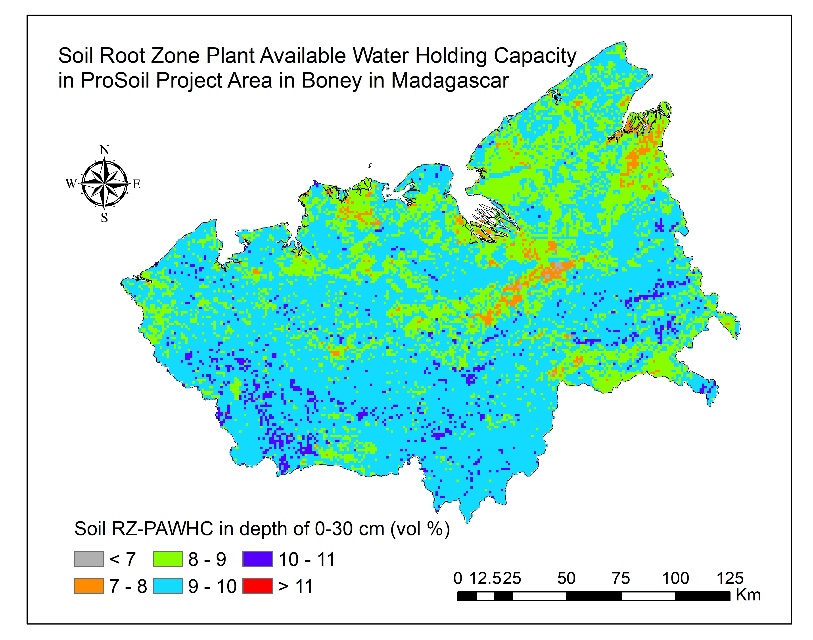


Figure 9. Root zone plant available water holding capacity of the ProSoil project areas in Madagascar.

All the attribute layers of the maps are uploaded on the GIZ created Teams channel: WOCAT-ProSoil Cooperation with guests/Madagascar for access. Herewith we visualized some of the soil properties and soil type and the visualized maps are also uploaded on the Teams channel.

**References**

Batjes, N.H., Ribeiro, E, and van Oostrum, A., 2020. Standardised soil profile data to support global mapping and modelling (WoSIS snapshot 2019). Earth System Science Data [doi: 10.5194/essd-12-299-2020](https://doi.org/10.5194/essd-12-299-2020" \t "_blank)

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