Mapping location, extent and drainage status of organic soils in East Africa

Reni Barthelmes¹, Alexandra Barthelmes¹, René Dommann ² & Hans Joosten¹

¹ Greifswald University, Institute for Botany and Landscape Ecology, Soldmannstraße 23, 17487 Greifswald, Germany (karen-d.barthelmes@web.de)
² Smithsonian Institution, National Museum of Natural History, 10th and Constitution Avenue NW MRC 112, PO Box 37012, Washington, DC 20019-7012, USA

INTRODUCTION

When considering peatlands and organic soils in the tropics, the huge areas in SE Asia prevail in public and scientific perception, whereas Africa has largely been out of focus. The extent and status of peatlands and organic soils in East Africa was largely speculative, although their presence is known since decades. They basically occur in the high altitudes of the uplifted flanks of the East African Rift System, isolated volcanoes and the Ethiopian highlands, in the Zambezian floodplains (e.g. Zambia), and in coastal environments (e.g. Mozambique and Madagascar). Their coverage in recent soil maps or GIS databases is very poor and their drainage status widely unknown, although they play a crucial role for water supply and regulation, water and nutrient retention, food security, and for overall livelihoods. In spite of rapid developing remote sensing methods, peatland and organic soil mapping from space still has to struggle with the complexity of peatlands and their use. Furthermore, drained and used organic soils loose many of their key features like the even vegetation and high soil moisture. Accordingly, our mapping approach concentrates on the merging of already existing, often national geospatial soil and proxy information and the use of recent satellite and aerial imagery. We conducted a nationwide GIS and remote sensing based organic soil mapping for Burundi, Kenya, Rwanda, Tanzania, Uganda and Zambia at scale 1:25,000.

METHODS

Our mapping approach links various science networks, methodologies and databases, including those of peatland/landscape ecology for understanding where peatlands may occur (cf. Figure 1) and follows a broad definition of organic soils as having a minimum soil organic carbon threshold of 12% and it considers any depth of the organic layer larger than 10 cm. Spatially explicit information on soil and proxy data has been assessed from open access online archives. In order to avoid high costs our approach for wall-to-wall organic soil mapping across vast areas basically uses freely available GIS, satellite and aerial imagery. For example, we applied the Topographical Wetness Index from the African Soil Information Service. The mapping has been carried out manually in high resolution (1:25,000). The resulting GIS database includes for every organic soil polygon information on key references, the reliability of the integrated information (3 classes: confirmed, probable and possible occurrence of organic soil following a detailed decision key) and information on drainage and degradation intensity (3 classes: no, slight and heavy degradation; cf. Figure 2).

RESULTS

Our mapping resulted in the identification of 27,308 km² of organic soils in the Lake Victoria neighbouring countries and Zambia. Burundi contains 657 km² of organic soils (= 2.4% of the country area), Kenya 4559 km² (10.1 %), Rwanda 1,202 km² (4.6%), Tanzania 4,221 km² (0.4 %), Uganda 4,113 km² (1.7 %) and Zambia 16,664 km² (6.3%; Table 1).

Many organic soils are still unaffected by human activity (24,024 km² = 88.0 % of the total mapped organic soils). Zambia hold most of these undisturbed organic soils with 15,165 km² followed by Tanzania and Uganda with 3,993 km² and 3,907 km², respectively. The largest areas of pristine organic soils are located in at Lake Bangweulu and the Zambezi Floodplains (Zambia), in the extensive valleys that end in Lake Kyoga and around Lake Victoria in Uganda and northeastern Tanzania (Figure 3).

The degradation hotspots are situated in the highest areas of the African rift system in Burundi, where slight and heavily drained and degrading organic soils cover 600 km² (91% of the total mapped organic soil area), and only 57 km² (9%) have remained untouched (Table 1, Figure 3). In contrast Zambia sustain 15,165 km² (91%) of organic soils pristine an only 1499 km² (9%) are degrading. In Rwanda and Kenya approximately half of the organic soils are drained and degrading, including 552 km² (40% of the total mapped organic soils) in Rwanda, and 207 km² (45%) in Kenya. Only 5% of the organic soils in Uganda and 6% in Tanzania are slightly or heavily degraded (Table 1).

CONCLUSIONS

The integration of old field data, legacy soil and proxy maps, the coverage of confirmed organic soils and proxy layer, many also extensively in digital form, can serve as the backbone of our approach. But the overall coverage is very poor and the drainage details largely missing. Only the very abrupt changes of the drainage status is easily detected. For example, the transition from highly drained organic soils to very wet peat soils is not revealed by the approach, whereas it is very obvious in high resolution aerial imagery. This situation remains as the major limitation of our approach. Thethreat and urgency is in the need for comprehensive and high resolution digital database in the context of the rapid changes of the drainage status.

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Feeding the Nile River, sustaining a fast growing and widely poor population and already facing climatic changes, the organic soils of the Lake Victoria catchment are partially under heavy threat. Considering the key role of organic soils (incl. peatlands) for water provision and regulation and their rapid deterioration after drainage, our inventory open perspectives for specific organic soil protection and rewetting actions.

Table 1: Extent of organic soils according to their degradation status. Included are only polygons with the the reliability classes ‘confirmed organic soil’ and ‘probable organic soil’. Also aggregated soil units are displayed that differ in organic soil proportions.

<table>
<thead>
<tr>
<th>Degradation Status</th>
<th>Burundi</th>
<th>Rwanda</th>
<th>Uganda</th>
<th>Tanzania</th>
<th>Kenya</th>
<th>Zambia</th>
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<tr>
<td></td>
<td>km²</td>
<td>%</td>
<td>km²</td>
<td>%</td>
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<tr>
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<td>11</td>
<td>115</td>
<td>10</td>
<td>126</td>
<td>3</td>
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<tr>
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<td>80</td>
<td>437</td>
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<td>1,201</td>
<td>100</td>
<td>4,111</td>
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</tr>
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</table>

Figure 1: Schematic illustration of the peatland and organic soil mapping process.

Figure 2: Estimation of the drainage and degradation status based on visually analysis of the drainage schemes via satellite and aerial images.

Figure 3: Organic Soil Map for the Lake Victoria region and Zambia. Shown is the coverage of confirmed organic soils, probable organic soils and possible organic soils. Also aggregated soil units are displayed that differ in proportions of organic soil.

Figure 4: Schematic illustration of the peatland and organic soil mapping process.