Report on

Soil Erosion Processes in the Nile Basin

Consultancy within the framework of the FRIEND/Nile Project supported by

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By

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1. INTRODUCTION

The Nile Basin is undergoing severe soil erosion that has led to a deterioration of soil and water resources mainly due to a loss of soil fertility on the hill slopes and an excessive transport of sediment in the rivers. The latter has caused a reduction of water storage in reservoirs so that irrigated land of the Nile valley is threatened. These problems have high economic costs both for the governments and for the population; therefore it is primordial to study the sediment production and transport processes within the Nile Basin in order to enhance water resource management.

Six countries that are part of the Nile Basin now participate actively in a research project, FRIEND/Nile. One of the components of this project focuses at the management of sediment and watershed in the basin. After a successful first phase of four years, the FRIEND/Nile Project built good baseline knowledge on the processes of sediment transport and its implications on watershed management in the Nile Basin. Based on the results of the first phase, a second phase was launched with the overall scientific aims to study the effect of the implementation of soil conservation measures and to provide guidelines to improve watershed management. During the first phase of the FRIEND/Nile project, the team mainly focused on sediment transport and management in streams, and did not include all components of sediment production and transfer within the Nile Basin. To achieve the goals proposed by the FRIEND/Nile Project, the team should not only focus on sediment transport but also on the identification of sources and sinks of sediment so that the most relevant erosion and deposition processes can be included.

Before undertaking detailed research on erosion for specific case-studies, basic information on overall soil erosion processes within the Nile Basin should be gathered. For this purpose, an overall soil erosion map is primordial. During the workshop held in Mekelle, the research group of the Erosion, Sediment Transport and Watershed Management Component of the FRIEND/Nile Project decided to elaborate an actual erosion map of the Nile Basin based on a previous global assessment of soil erosion by ISRIC: the Global Assessment of Soil Erosion (GLASOD) map.
Given the timeframe of the FRIEND/Nile project, it was not possible to produce an actual erosion map of the entire Nile Basin. The teams have decided to work on specific ‘erosion risk’ zones. Based on data from soil erosion measurements, complementary information on land use, precipitation, soil type and expert judgment, the different teams realized an update of the Glasod map.

During the workshop in Nairobi, each team presented his actualization of the erosion map for his specific ‘erosion risk’ zone. As the maps from the various teams presented major inconsistencies with respect to the legend, coordinate system and setup of the attribute table, homogenization was necessary. The objective of this consultancy was to (i) homogenize and standardize all erosion risk information that was compiled for the erosion risk zones, and (ii) compare these results from this research activity from the FRIEND/Nile project with existing soil erosion information from literature.

2. Methodology

The soil erosion maps that are presented in this report are based on the information that was collected by the ESTWM team of the FRIEND/Nile project. This team of international scientists has worked for two years on an update and regionalization of the Glasod erosion map for the Nile Basin. In 1987, the United Nations Environment Programme (UNEP) and the International Soil Reference and Information Centre (ISRIC) executed a project entitled “Global Assessment of Soil Degradation” (Glasod). The output of this project was the elaboration of world map on the status of human-induced soil degradation at a scale of 1:10 M (Oldeman et al., 1990). A topographic map was the base to display the different continents and create mapping units which were then related to climate, soil, vegetation and land use to elaborate the Global Assessment of Soil Erosion map. This map is a qualitative assessment, and is largely based on expert judgment.

The six erosion risk zones selected within the FRIEND/Nile Project were grouped into three zones: (i) the lower Nile catchment (Egypt), (ii) the Blue Nile catchment (Sudan and Ethiopia) and (iii) the lake Victoria region (Kenya, Uganda and Tanzania). For each zone, three erosion maps were elaborated. They represent the
erosion type, its extent and its degree (see Annexes). These maps are actualizations of the Glasod erosion map, as they contain all modifications that are made to the Glasod map within the framework of the FRIEND/Nile Project. Below, an overview map is shown to highlight the location of the erosion risk zones within the Nile basin.
As mentioned before, the erosion maps that were compiled for the six erosion risk zones showed major inconsistencies. These errors and inconsistencies were resolved according to the following methodology:

1. Homogenization of the legend with usage of the categories of erosion type, extent and degree as proposed by ISRIC. They existed large differences in the legend that was used for the different maps, which made regionalization of the results impossible. It is important to note that the erosion categories are now in accordance with the original legend of the Glasod map. For this study, it was preferred to display the entire legend instead of the symbols and numbers that are used in the Glasod map. Gaps and zero values in the table of attributes were represented on the legend as “no data”.

2. Georeferencing of all erosion maps within a similar coordinate system. As the different teams used different (or unknown) coordinate systems to display the maps, it was impossible to automatically combine the results of the different research teams. One common georeference system was selected, and all maps were reprojected into this coordinate system. As the erosion map of Sudan lacked any coordinate system, the entire map had to be re-digitised.

3. Reorganisation of all erosion data into one common spatial database. After homogenization of the legend, the erosion data of all research teams were combined into one common spatial database. This database now contains all information on erosion for the different erosion risk zones.

Below are listed all symbols and numbers with their respective denomination as they were used by ISRIC to compile the Glasod map. This categorization was followed in this study.

1. Map of soil degradation types
   - Wt: sheet erosion
   - Wd: gully erosion
   - Et: loss of topsoil by wind
   - Eo: overblowing by wind
   - Cn: loss of nutrients and organic matter
   - Cs: salinization
   - A: desert
   - D: active dunes
   - M: arid mountains
   - SN: stable terrain under natural conditions
2. Map of the extent of soil degradation
   - 0: no data
   - 1: infrequent
   - 2: common
   - 3: frequent
   - 4: very frequent
   - 5: dominant

3. Map of the degree of soil degradation
   - 0: no data
   - 1: light
   - 2: moderate
   - 3: strong
   - 4: extreme
3. ACTUALIZATION OF THE EROSION MAP FOR SIX EROSION RISK ZONES

LOWER NILE

The actualization of the erosion map for Egypt was limited to the area within the water divide of the Nile basin. The maps in the annexes clearly indicate the type, degree and extent of soil erosion as identified by the Egyptian research team. The valley from Aswan dam to the delta of Nile river is frequently affected by soil degradation, but the degree of soil degradation can generally be considered as ‘light’ with the exception of the area around the delta of the Nile River where moderate soil degradation is found. The main human-induced soil degradation types are related to salinization (Cs) which is a major problem in the Nile valley from Aswan dam to Cairo. Natural or semi-natural erosion processes affect other areas. Notably, the following degradation features are observed: an arid mountain region (M) located around the Aswan High Dam reservoir, active dunes (D) present in the north-east and desert (A) covering the surroundings of the Nile valley.

The Egyptian team has realized modifications to the Glasod map based on information from published erosion records. It should be mentioned that a lot of this documentation on erosion processes is patchy and anecdotal, and that regional assessments of soil degradation are lacking. The following changes were made:

Type of soil degradation:
- The Egyptian research team identified a section of the Nile River that is prone to ‘Sand encroachment’. This area was delineated with an additional polygon in ArcGIS, and corresponds to the area between Aswan and Isna Barrage. The area that is affected by sand encroachment is about 30 km in length. To homogenize the legends of the erosion maps, this new polygon was given the symbol of Eo (Overblowing).

Degree of soil degradation:
- The Egyptian researchers highlighted that the Nile Valley between Aswan dam to Cairo is not affected by high levels of soil erosion. They changed accordingly the degree of soil degradation of this area from ‘moderate’ to ‘light’.
The area that is affected by overblowing (Eo), is given an erosion level of moderate.

Extent of soil degradation:
- The area of the delta beach from Alexandria to El-Arish is now affected frequently by erosion. The attribute of this polygon has been changed accordingly (‘frequent’ instead of ‘dominant’).
- The area of overblowing (Eo) is given an erosion extent of ‘frequent’.

BLUE NILE RIVER
Two research teams have worked together on different sections of the Blue Nile catchment. The Sudanese research team has focused on the Sudanese part of the Blue Nile catchment, DS of the Ethiopian border, while the Ethiopian team worked on the Ethiopian side of the Blue Nile (Abbey) catchment. To enhance the regionalization of the results, the data from both teams were compared and homogenized. From the figures in the annexes, it is clear that the soil degradation map of Sudan contains more detailed than the map from Ethiopia.
As there was a major issue with the georeferencing of the Sudanese erosion map, this map had to be digitised completely. This was done in ArcGIS.

Blue Nile River: Sudanese Side
The soil degradation map that exists for the Sudanese side of the Blue Nile catchment from ISRIC (Glasod map) is very coarse, and does not contain information on soil degradation for a large part of the territory. The Sudanese research team has made a major effort in updating this soil degradation map. Notably, the polygons that existed in the Glasod map were further subdivided into 16 ‘soil degradation’ polygons. These polygons were all related to soil degradation information. All voids or zero values were replaced by a soil degradation category. As this soil degradation map is a thorough reworking of the original Glasod map, we only mention the actual soil degradation processes here as indicated by the Sudanese research team.

As there were some major inconveniences due to the lack of any information on coordinate systems for the Sudanese map, and due to some mismatch in the organisation of the attribute tables, the soil degradation information had to be re-
digitised and the information on the attributes had to be entered into a spatial database. Three new ‘soil degradation’ fields were added in the attribute table (type, extent and degree) to represent the different types of soil degradation for all 16 polygons. Based on these new fields, soil degradation maps were generated. Based on expert knowledge and some sporadic information from erosion studies in Sudan, the Sudanese research team indicates that sheet erosion (Wt) is predominant in the basin. Gully erosion (Wd) is limited to very small area located in the centre, and is indicated as polygons 13 and 16 in the attribute table. Although this area of gully erosion is relatively small, the degree of erosion is strong. It has been reported that these areas are heavily affected by gullies, and that agricultural activities are now impossible in these areas. Additionally, the loss of topsoil by wind (Et) is predominant in the most northern part, and is indicated as polygon 1 in the attribute table.

**Blue Nile/Abbey River: Ethiopian Side**

The Ethiopian team has realized the update of the Glasod map for the Abbay River basin based on reports (Abbey River Basin Integrated Master Plan), land use/cover maps, erosion plots and expert knowledge. As detailed information is available from soil erosion plots, this information was used as a major input source for the updates. It should be noted that these erosion plot data are often representative for only a small area (50 to 100m²), and that extrapolation of these erosion measures to larger scales might be problematic.

Soil degradation in the Abbay River basin is mainly caused by water erosion. Sheet erosion (Wt) is the main type of water erosion and is covering the entire study area. There are some strong regional differences in the extent and degree of soil degradation. Soil degradation is most severe and frequent in the Eastern and Southern part of Abbay River Basin. Moderate levels of water erosion are occurring in the lake Tana region, while the Western and Central parts of the Abbay basin are less affected by water erosion.

The Ethiopian experts have made several changes to the soil degradation classification as proposed in the Glasod map. The major modifications are linked to the degree and extent of soil degradation. No changes were made to the type of soil
degradation. As such the main composition of the soil degradation map and its attribute table is very similar to the one proposed by the ISRIC team.

Concerning the degree of soil degradation, some modifications were made:

- Two polygons covering the western part of the Abbay basin with the degree of soil degradation of ‘moderate’ are replaced by ‘light’.
- Two polygons covering the southeastern and eastern part of the Abbay basin with soil degradation degree ‘strong’ are now replaced by ‘extreme’.

Concerning the extent of soil degradation, the following changes were made:

- The polygon around lake Tana and a small polygon in the northwestern part of the Abbay basin with extent of soil degradation ‘frequent’ are replaced by the extent of degradation ‘common’.
- A small polygon in the southeast with indication of the extent of degradation ‘infrequent’ is replaced by ‘common’.
- A polygon located in the southwest with indication of ‘very frequent’ extent of degradation is replaced by ‘common’.
- Two polygons in the southern part of the Abbay basin with indication of ‘very frequent’ extent of soil degradation are replaced by ‘dominant’ extent of degradation.

LAKE VICTORIA BASIN

Three research teams (Kenya, Uganda, and Tanzania) have worked on soil degradation around Lake Victoria. The size of the area that is covered by the different research teams is highly variable. The Ugandan and Tanzanian team worked on relatively large areas: the Ugandans districts that are part of the Lake Victoria basin and the Tanzanian part of the Lake Victoria basin respectively. The Kenyan team limited their efforts to the Nyando basin, which is very small compared to the other study areas. It is questionable if this area is representative for the Kenyan part of the Lake Victoria basin. In the future, the soil degradation should be extended so that it includes the entire Kenyan part of the Lake Victoria basin.

The main problems related to soil degradation are caused by water erosion. Sheet erosion is very common in most of the Lake Victoria basin, and is threatening agricultural production as a lot of fertile topsoil is being lost. The enhanced levels of water erosion by sheet wash are causing increased levels of sediment transport in
streams, and may contribute to further deterioration of the environmental quality of Lake Victoria. In some specific areas in Uganda, loss of nutrients and organic matter is a real soil degradation problem. Gully erosion is limited to some specific regions. It has been observed in several catchments in the Kenyan side of the Lake Victoria basin, and was documented by the Kenyan team for the Nyando catchment.

**Kenya**

The Kenyan team focused their efforts on the Nyando catchment as some basic information on soil degradation processes was collected in the past for this drainage basin. As the legend of the Kenyan soil degradation map was not conform with the Glasod standards, homogenisation of the attribute tables and legend was necessary. Two major soil degradation types caused by water erosion are identified: sheet and gully erosion.

For the Nyando catchment, three different zones of soil degradation were identified, corresponding with the lower, middle and upper catchment. According to the Glasod map, sheet erosion (Wt) is the dominant soil degradation process in the catchment. However, recent studies indicate that the middle part of the Nyando catchment is undergoing gully erosion (Wd) due to deforestation, removal of natural vegetation and agricultural activities. Therefore, the Kenyan team decided to add an extra polygon and replace the soil erosion type ‘sheet erosion (Wt)’ by gully erosion (Wd) for the middle part of the Nyando catchment.

**Tanzania**

The Tanzanian soil erosion experts used quantitative information on sediment yields for the major streams draining into Lake Victoria for the update of the Glasod map. As this information from the Tanzanian National Water Quality Synthesis Report is much more detailed than the scale of the Glasod map, the Tanzanian team did adapt the soil degradation map accordingly. Some information on sediment yields for the Tanzanian part of the Lake Victoria Basin was added to the attribute table of the Glasod map. As no information was added on the types, extent and degree of soil degradation in the attribute table of the partitioned map, it was not possible to update the soil degradation map. In this report, the maps of the soil degradation types, extent
and degree are created based on the original information of Glasod map as no further partitioning was done by the Tanzanian erosion experts.

According to expert judgment and some quantitative information on sediment yields, the main processes of soil degradation are linked to water erosion by sheet erosion. There is one natural area where human-induced soil degradation is not existing. From the maps, it is clear that the degree and extent of the erosion problems in Tanzania are much smaller than in Uganda and Kenya. So, in general, this information seems to indicate that soil degradation is less an issue in Tanzania than in Uganda or Kenya. It is likely that regional differences in population and cattle density among these countries can explain these differences in soil degradation degree and extent.

Uganda

The Ugandan erosion experts used published information on soil erosion rates as basic information to update the Glasod map. This information is available at the level of the districts. The Glasod map was then combined with the map of the district boundaries of Uganda to further partition the map units. Expert judgment was important to translate the quantitative information on soil rates and/or degradation status of each district into the Glasod legend.

The main types of soil degradation in Uganda are related to water erosion by sheet wash (Wt) and by deterioration of soils by loss of nutrients and organic matter (Cn). Soil erosion in Uganda is generally moderate with dominant extent. Some strong degree of soil erosion is found in the Eastern part of the country. Soil erosion is mainly linked to areas with steep topography and high population density in rural areas.

Based on soil erosion data, the following modifications were made to the Glasod map: For the districts of Iganga, Busia and Tororo, the main modification is related to the degree of soil degradation. Regions for which ‘extreme’ soil degradation was mentioned on the Glasod map were changed to ‘moderate’ degree of soil degradation. The degree of soil degradation of the polygons that are covering the districts of Pallisa, Kumi and Soroti and lower parts of Mbale (Lake Kyoga districts) were
changed to the level of ‘moderate’. The districts of Mbale and Kapchorwa are mainly composed by strong degrees of soil degradation.

4. COMPARISON OF EROSION MAP WITH EROSION DATA PUBLISHED IN LITERATURE

A literature review has been done on soil erosion and sediment yield in the Nile Basin to compare the outputs of the soil degradation map with existing or published data. Although there is a general awareness of the negative effects of soil erosion on soil and water resources in the Nile basin (Wasson, 2002), very few studies have been carried out to quantify soil degradation in the region. Most erosion studies have focused at very small plot scale experiments, which are often difficult to extrapolate to larger regional units.

From the published records on sediment yield and erosion, it seems that Ethiopia is one of the best-documented countries of the Nile Basin. Only marginal information is found for other countries. This is particularly true for Sudan and Egypt where wind and water erosion might affect agricultural production. Table 1 and 2 summarize the information found in the literature for Ethiopia on soil erosion and sediment yield, whereas table 3 summarizes some data on sediment yields for Tanzania. All values of soil erosion from literature were converted into the same unit, t/km²/year in order to have comparable numbers. It is clear that these tables on soil erosion rates for the Nile Basin are far from being complete, but they give a first estimation of soil erosion values based on information that is publicly available. In the future, this database should be further elaborated with information on sediment yields from gauging stations and from reservoir sites from all around the Nile Basin.

In order to validate the regional assessment of soil degradation that was made by the different research teams, the information that is given on the regional soil degradation maps was compared with the spatial patterns in erosion rates from the literature review. First, a spatial database of soil erosion rates was compiled from the review. Second, this information on soil erosion was then compared with the information displayed on the updated soil degradation map by overlaying the geographical coordinates of the two databases. For each data on soil erosion that was found in
literature, the respective information from the soil degradation map was extracted. This information is given in Table 1, 2 and 3 (see last columns: type, degree and extent of soil degradation). This comparison not only allows validating and homogenizing the information on soil degradation, it also allows providing some quantitative information on erosion rates for the different regions within the Nile basin.

Table 1 shows information on erosion rates that are compiled from plot erosion studies. These studies are typically done based on small-scale experiments. It has often been discussed that the erosion rates that are derived from such experiments are not representative for the overall sediment export from large basins. However, some basic information on local soil erosion rates can give us some indication of regional patterns in erosion. The data that are compiled in Table 1 clearly show that soil erosion is highly variable in the Abbay basin ranging from \( \sim 0 \) to 28200 ton/km²/yr. It is clear that the erosion rates that are measured on these erosion plots are often very high, with extreme values of more than 10,000 ton/km²/year of soil eroded. When we compare this information on erosion rates with the spatial patterns of erosion on the regional soil degradation map, some major inconsistencies become clear. In general, grass and cultivated land present soil erosion rates lower than 7800 ton/km²/yr and occur mainly in soils such as Luvisol, Vertisols, Nitisols and Phaeozems. These results slightly agree with the soil degradation map that indicates that these areas are prone to moderate soil erosion by sheet erosion (Table 1). The main inconsistencies between the regional soil degradation map and the erosion rates are observed for the high to very high erosion rates. For several basins, we observe very high erosion rates (\( > 10,000 \) ton/km²/year) for regions that are indicated as having a ‘light’ degree of soil erosion.

There might be two reasons for these differences.

1. Soil erosion measures from soil erosion plots tend to over-estimate the overall soil erosion in a certain region. This observation has been made for several regions worldwide, where it has been ascertained that soil erosion plots tend to be installed on steep slopes with shallow soils, and seem not to be too representative of the overall erosion problems of a region.
(2) The soil degradation map is far to capture all processes of soil degradation, and erosion experts tend to focus mainly on sheet erosion as the dominant erosion problem. It is known that some smaller erosion features such as gullies, or badlands might be limited in space but very important for the overall erosion rates.

For the Abbay basin, there is probably a combination of these two reasons that explains why the regional patterns of the soil degradation map do not correspond with the observed spatial patterns in erosion rates from erosion plots.
Table 1
Soil erosion in Ethiopia (Only measured soil erosion data is given below, N.A.=not available)

<table>
<thead>
<tr>
<th>Basin</th>
<th>Source</th>
<th>Land use</th>
<th>Soil type</th>
<th>Measured data</th>
<th>Regional soil degradation map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbay</td>
<td>Tolcha 1991,</td>
<td>Grass</td>
<td>Luvisols, vertisols</td>
<td>~0 to 7200</td>
<td>Erosion type: Sheet erosion; Degree: Moderate; Extent: Common</td>
</tr>
<tr>
<td></td>
<td>Hurni 1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abbay</td>
<td>Tolcha 1991,</td>
<td>Teff</td>
<td>Leptosols, Cambisols and Vertisols</td>
<td>~ 28200</td>
<td>Erosion type: Sheet erosion; Degree: Moderate, strong and extreme; Extent: Frequent, very frequent and dominant</td>
</tr>
<tr>
<td></td>
<td>Hurni 1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abbay</td>
<td>Tolcha 1991,</td>
<td>Cultivated</td>
<td>Nitosols, Vertisols</td>
<td>~13900</td>
<td>Erosion type: Sheet erosion; Degree: Light; Extent: Common</td>
</tr>
<tr>
<td></td>
<td>Hurni 1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abbay</td>
<td>Tolcha 1991,</td>
<td>Cultivated</td>
<td>Nitisols, Phaeozems</td>
<td>7800 – to 21800</td>
<td>Erosion type: Sheet erosion; Degree: Light and moderate; Extent: Common</td>
</tr>
<tr>
<td></td>
<td>Hurni 1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gilgel Abbay</td>
<td>MOWR, 1989</td>
<td>N.A.</td>
<td>N.A.</td>
<td>&gt; 10000</td>
<td>Erosion type: Sheet erosion; Degree: Moderate; Extent: Common</td>
</tr>
<tr>
<td>Gumara</td>
<td>MOWR, 1989</td>
<td>N.A.</td>
<td>N.A.</td>
<td>3000 to 2000</td>
<td>Erosion type: Sheet erosion; Degree: Moderate; Extent: Common</td>
</tr>
<tr>
<td>Abay at Bahir Dar</td>
<td>MOWR, 1989</td>
<td>N.A.</td>
<td>N.A.</td>
<td>5000 to 4000</td>
<td>Erosion type: Sheet erosion; Degree: Moderate; Extent: Common</td>
</tr>
<tr>
<td>Ardi</td>
<td>MOWR, 1989</td>
<td>Cultivated</td>
<td>N.A.</td>
<td>2500 to 4000</td>
<td>Erosion type: Sheet erosion; Degree: Strong; Extent: Frequent</td>
</tr>
</tbody>
</table>
As the data from the erosion plots might be affected by locally extreme erosion rate measurements, we also compiled information on sediment yields from publicly available information. These measures are given in Table 2 (Humphreys et al., 1997). They are representative of the overall catchment-wide erosion rates for larger catchments that vary in size from a few km² to a few thousands of km². On average, these data are representative for the Abbay River basin in Ethiopia. The data indicate that about 80% of the land of all catchments is composed by herbaceous crops or cultivated land, 19% by tress and only 1% by bare soil. Annual rainfall ranges between 885 and 1539 mm and the mean slope gradient between 6 and 22%.

Sediment yield in the Abbay Basin varies from 4 to 1405 ton/km²/yr (Table 2). Catchments with the lowest mean slopes present values of sediment yield lower than 100 ton/km²/yr. Sediment yield measured at the outlet of the catchment represents all erosion processes in the system such as hillslope erosion, transport and sediment deposition, but also bank erosion along the rivers and landslides. The Glasod map was mainly developed to represent hillslope erosion where cultivated land and rangeland are the main land use classes. Relating data on sediment yield to the types of soil degradation on the Glasod map can be inappropriate because only land degradation on hillslopes is represented. However, we can assume that the majority of sediment from these agricultural catchments comes from the hillslopes and is produced by water erosion.

On the regional soil degradation map, sheet erosion was identified as the dominant type of soil degradation. It is probable that gully erosion is also important in some of these areas because farmed land with scarce vegetation cover can be very prone to undergo soil erosion with the contact of the rain drops. This indeed occurs as the region is rather humid with annual precipitation over 900 mm. Heavy rains can cause severe gully erosion and shallow landslides. From the data presented in Table 2, it is clear that the regional soil degradation assessment is incapable of representing local detailed information on the complexity of soil degradation processes, and is mainly constrained to the major erosion types in the region.

When comparing the map of the degree of soil degradation with the data on sediment yield, we observe some agreement between the two datasets. The degree of soil
degradation in the Abbay Basin roughly corresponds with the regional pattern in sediment yield data. However, there are some inconsistencies: as for example, values of sediment yield of 911 and 704 ton/km²/yr are giving a level of light degree of soil degradation while an area that is characterised by a value of sediment yield of 4 ton/km²/yr is given an extreme degree of soil degradation. Similar inconsistencies are observed for the extent of soil degradation. Thus, although the information on the regional soil degradation map roughly corresponds with the sediment yield measures, it becomes clear that the soil degradation map should be used as a first qualitative overall assessment.
<table>
<thead>
<tr>
<th>Basin</th>
<th>Station</th>
<th>Sediment yield (ton/km²/yr)</th>
<th>Mean slope</th>
<th>Land use (%)</th>
<th>Mean annual rainfall (mm)</th>
<th>Regional Soil Degradation Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbay</td>
<td>Bahir Dar (lake Tana)</td>
<td>143</td>
<td>8</td>
<td>89 9 2</td>
<td>1048</td>
<td>Sheet erosion  Moderate Common</td>
</tr>
<tr>
<td>Abbay</td>
<td>Mota</td>
<td>253</td>
<td>11</td>
<td>88 11 1</td>
<td>885</td>
<td>Sheet erosion  Moderate Common</td>
</tr>
<tr>
<td>Abbay</td>
<td>Bichena</td>
<td>266</td>
<td>20</td>
<td>89 7 4</td>
<td>894</td>
<td>Sheet erosion  Strong Frequent</td>
</tr>
<tr>
<td>Abbay</td>
<td>Dembecha</td>
<td>552</td>
<td>20</td>
<td>86 14 0</td>
<td>1010</td>
<td>Sheet erosion  Strong Frequent</td>
</tr>
<tr>
<td>Abbay</td>
<td>Debre Marcos (l.chemoga)</td>
<td>1252</td>
<td>16</td>
<td>81 18 1</td>
<td>939</td>
<td>Sheet erosion  Strong Frequent</td>
</tr>
<tr>
<td>Abbay</td>
<td>Debre Marcos (u.chemoga)</td>
<td>162</td>
<td>15</td>
<td>84 14 2</td>
<td>971</td>
<td>Sheet erosion  Strong Frequent</td>
</tr>
<tr>
<td>Abbay</td>
<td>Jiga</td>
<td>106</td>
<td>13</td>
<td>89 11 0</td>
<td>1081</td>
<td>Sheet erosion  Strong Frequent</td>
</tr>
<tr>
<td>Abbay</td>
<td>Finote Selam</td>
<td>932</td>
<td>22</td>
<td>88 12 0</td>
<td>1028</td>
<td>Sheet erosion  Strong Frequent</td>
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</table>

Table 2: Sediment yield data for the Blue Nile Basin (HC: herbaceous crops, T: trees and BS: bare soil)
Some data were available on sediment yields for Rivers that are draining into Lake Victoria (Myanza, 2005 and Table 3). Sediment yield in Tanzania varies from 8 to 179 ton/km²/yr. It is clear that the sediment yields for the Tanzanian part of the Lake Victoria Basin are much smaller than the ones that were observed for Ethiopia. Roughly speaking, we observe that the sediment yield values for selected sub-catchments within the Abbay basin are about 5 to 10 times larger than the ones reported for the Tanzanian part of the Lake Victoria Region.

The information in the regional soil degradation map for Tanzania roughly coincides with the measures of sediment yield. Most of the measures of sediment yield are taken from areas that are subject to light degree of sheet erosion, and have relatively low to moderate sediment yield values. It becomes increasingly clear that the soil degradation map is available to depict large regional differences in soil degradation, but is not capable of explaining local degradation problems.

**Table 3**: Sediment yield data for Tanzania

<table>
<thead>
<tr>
<th>Basin</th>
<th>Source</th>
<th>Sediment yield ton/km²/yr</th>
<th>Soil degradation types</th>
<th>Degree of soil degradation</th>
<th>Extent of soil degradation</th>
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<td>Isanga and eastern shore streams</td>
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<td>21.97 – 41.98</td>
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<td>Common and very frequent</td>
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<td>Common</td>
</tr>
</tbody>
</table>
5. References

Annual Sediment study in Aswan High Dam Reservoir, Nile Research Institute (NRI) reports, National Water Research Center (NWRC), Cairo, (1998- 2002).


6. Annexes

Soil degradation types of the Blue Nile Catchment

Legend
- Loss of topsoil by wind
- Gully erosion
- Sheet erosion

Kilometers

0 65 130 260

N  O  E  W
Extent of soil degradation of the Blue Nile Catchment

Legend
- Infrequent
- Common
- Frequent
- Very frequent
- Dominant

Kilometers
Degree of soil degradation of the lake Victoria region

Legend
- No data
- Light
- Moderate
- Strong

0 55 110 220 Kilometers

30°00'E 35°00'E
Soil degradation types of the lower Nile catchment

Legend
- Desert
- Salinization
- Active dunes
- Overblowing by wind
- Arid mountains

N

30°00'E

35°00'E

N.0.06

30°00'S

N.0.06

0 65 130 260 Kilometers
Extent of soil degradation of the lower Nile catchment

Legend
- No data
- Frequent
Degree of soil degradation of the lower Nile catchment

Legend
- No data
- Light
- Moderate