EROAHI

DEVELOPMENT OF AN IMPROVED METHOD FOR SOIL AND WATER CONSERVATION PLANNING AT CATCHMENT SCALE IN THE EAST AFRICAN HIGHLANDS

PROGRESS REPORT
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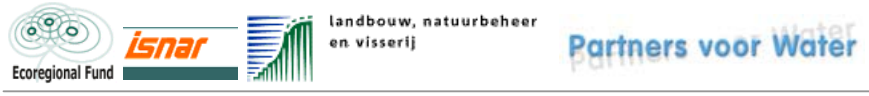

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Development of an improved method for soil and water conservation planning at catchment scale in the East African Highlands

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CONTENTS

1 PROJECT PROPOSAL AND OBJECTIVES

The overall goal of the EROAHI Project is to improve the Catchment Approach, a methodology for participatory soil conservation planning currently applied in the East African Highlands Eco-region. Anticipated improvements are: semi-quantification of soil and productivity loss using farmers' knowledge, simple ex ante economic cost-benefit analysis of proposed scenarios and moving up the SWC planning from farm level to catchment scale.

The project goal is to be achieved by realising the following objectives (EROAHI Management Document 1, 2000):

To develop field-scale indicators of erosion and sedimentation based on indigenous knowledge of soil and vegetation characteristics;

1. To attach quantitative values of erosion, sedimentation and/or productivity to the developed indicators, based on field scale measurements;
2. To quantify erosion, sedimentation and soil productivity at catchment scale using the developed indicators and compare the estimates with a detailed model study to develop simple 'rules of thumb' for erosion assessment;
3. To develop a methodology for economic impact assessment of planned soil and water conservation measures at farm level;
4. To further develop a specific methodology for catchment scale soil and water conservation planning in the East African Highlands using a participatory approach.

The project is extended with additional activities in the framework of the Program Partners in Water (sub-program Water for Food), financed by several Dutch Ministries, and co-ordinated by the Ministry of Agriculture, Nature Management and Fisheries.

This report covers the activities carried out for the EROAHI-project in the period of 1 January to 30 September 2002.

1.1 References

EROAHI Management Document 1, 2000. Development of an improved method for soil and water conservation planning at catchment scale in the East African Highlands. Project Inception Document. Ed.: H. van den Bosch, Alterra. Wageningen, August 2000, 45 p.

2 PROJECT COORDINATION

2.1 Presentation of project results to ISAC

Alterra presented the results of the EROAHI project to the International Scientific Advisory Committee (ISAC) of the Eco-regional Fund at the 11th meeting of ISAC in Nairobi, on 1 May 2002. A presentation and poster were prepared (downloads on the EROAHI web site: www.alterra.dlo.nl/websites/eroahi). ISAC evaluated the presentation of results positively and provided useful comments. The comments were discussed in the 3rd EROAHI workshop, on 27 August 2002 (see Report 3rd EROAHI/SWCP workshop, Van Dijck, 2002a).

2.2 Final application for funding by the Water for Food Program

In November 2000, Alterra applied for additional funding of the EROAHI project by the Water for Food Program, financed by the Dutch Ministry of Agriculture, Nature and Fisheries. Though by necessity, part of the equipment for the EROAHI project had already been advanced from the Water for Food budget by Alterra, the application was only definitively granted in January 2002. Alterra submitted a new project proposal, an overview of expenditures in 2000 and 2001, and a project budget in March 2002. Information on the Water for Food Program, available budgets and expenditures were presented at the EROAHI workshop (27 August 2002).

2.3 3rd EROAHI Workshop

The 3rd EROAHI workshop was held at Alterra in Wageningen, from 26 through 29 August 2002. The program included:

- Presentation of work done between September 2001 and August 2002 by the project partners;
- Evaluation of the project by ISAC in the 11th ISAC meeting, Nairobi, 1 May 2002;
- Communication between project partners and relationships with AHI and RELMA;
- Granting of application for the Water for Food program;
- Web site;
- Working program 2003;
- Financial state of affairs.

The workshop was extended with a seminar "Collective Action for Farmers in Natural Resource Management". Four extension officers from Kenya (Soil & Water Conservation Branch) and Tanzania (Lushoto District Extension) attended the EROAHI workshop and the seminar. They reacted to the presentations given in the seminar and contributed to the group discussion. The workshop was closed with a writing shop, where paper subjects and some paper outlines were defined. A full report of the EROAHI workshop was sent to ISNAR and the Working Group Water for Food (EROAHI Management Document 9; Van Dijck, 2002a).

2.4 Transfer of project co-ordination Alterra

Rik van den Bosch will take over the project co-ordination for Alterra again from Simone van Dijck from 1 October until 31 December 2002. Possible changes in project co-ordination by Alterra after this period will be communicated in good time.

2.5 References

Van Dijck, S.J.E. 2002a. Report of the 3rd EROAHI/SWCP workshop. EROAHI Management Document 9. Alterra, Wageningen, The Netherlands, 26-29 August 2002. 20 p.

3 OVERVIEW OF PROJECT RESULTS

An overview of project results achieved from the start of the project (1 July 2000) till 30 September 2002 is given below. The overview is structured according to the work packages defined in the project proposal. The five work packages comply with the respective five project objectives (chapter 1). Detailed information on results achieved before the period covered by this progress report can be found in previous progress reports (EROAHI Management Documents 2-9).

3.1 Work package 1: Identification of indigenous erosion indicators

In Work package 1, two catchments were selected in the Highlands of Kenya and Tanzania at the target size of the Catchment Approach. The catchments were typical for soil degradation in the East African Highlands in the two countries with respect to morphology, land use and ethnic and socio-economic conditions. The selected catchments are the Gikuuri catchment in the Embu District of Kenya (5 km2) and the Kwalei catchment in the Lushoto District of Tanzania (3 km2). Selection criteria for the catchments as well as listings of available baseline information with respect to soil and water conservation in the areas were given in previous progress reports.

Participatory Rural Appraisals (PRA) were carried out in both catchments (the PRA in the Kwalei catchment had already been carried out by AHI in 1998) in order to:

1. characterise existing soil and water management systems
2. understand farmers' perceptions on management of the systems, and
3. evaluate socio-economic parameters, like off-farm income, land ownership, major financial transactions and household characteristics.

The PRAs were reported in separate project reports (Lyamchai et al., 1998; Ouma and Okoba, 2000).

Based on this information, farmers' meetings and field visits and household surveys were organised to gather information on farmers' perception of soil erosion, expressed in terms of erosion indicators. Related farmers' estimates of soil loss, nutrient loss and yield reduction were collected, as well as their perceptions of suitable SWC strategies, including land use and management.

National and international literature on farmers' indicators was screened and reported in separate project reports (Karanja and Van Dijck, 2001; Horstman, 2002). Work package 1 was finished in 2001.

3.2 Work package 2: soil erosion at field level

Work package 2 aims at the qualification of soil erosion at the field level by farmers and the quantification of soil erosion by measurements.

In both catchments, farmers identified erosion prone fields. Farmers' mentioned erosion indicators for the selected fields, and estimated soil loss levels and yield reduction. This activity is finished in the Tanzanian site (chapter **Fout! Verwijzingsbron niet gevonden.**), and still going on in the Kenyan site. In the Kenyan site farmers' perception of the effect of crop cover on erosion indicators was recorded at several positions along hillslope transects in addition to the selected fields. Farmers also estimated erosion severity along the transects. Farmers attributed the estimated erosion severity along the hillslope transects rather to slope steepness and slope length than to crop cover. Erosion was perceived most severe in mid-slope sections (chapter **Fout! Verwijzingsbron niet gevonden.**).

Farmers' indicators and farmers' estimates of soil loss and yield reduction for the selected fields are currently quantified by field measurements. In the Kenyan site, grain and biomass yield and nutrient status were measured in 4*4 m2 plots in 17 fields with high, moderate and low soil loss levels. Differences in yield between fields with high and low soil losses corresponded to differences in yield as estimated by farmers. Yields and nutrient levels were also measured in 12 fields showing past erosion damage (testified by e.g. gullies, rock exposure) in 3*3 m2 plots, and in control plots showing no signs of past erosion damage in the same fields (chapter **Fout! Verwijzingsbron niet gevonden.**).

In the Tanzanian site, farmers' indicators were quantified in 16 fields through measurable parameters (e.g. soil shear stress for indicator "hard soil"). Farmers' estimated erosion classes for each field appeared to relate to soil colour, top soil depth and organic carbon and total nitrogen contents.

Farmers' estimates of yield loss in the Tanzanian site correlated with the remaining top soil depth (Ap horizon) and estimated erosion classes (chapter **Fout! Verwijzingsbron niet gevonden.**). Farmers' estimates of yield will be compared to measured yields over the rainy season of October-December 2002.

Literature reviews were carried out on relationships between soil erosion, nutrient loss and yield reduction (Karanja and Van Dijck, 2002; Horstman, 2002). As part of the literature study, maize yield was modelled as a function of nutrient loss through soil erosion using the QUEFTS and WOFOST models (Horstman, 2002).

The effectiveness of SWC measures was assessed by field measurements, in order to:

1. obtain a list of the most promising SWC measures with their effects on soil and water loss quantified, and
2. assess the effects of SWC measures on crop yields

In the Kenyan site, runoff and soil erosion were measured from 5 fields with SWC measures in ditches (chapter **Fout! Verwijzingsbron niet gevonden.**). In the Tanzanian site, the following measurements were carried out on fields with SWC measures and control fields (chapter **Fout! Verwijzingsbron niet gevonden.**):

- soil and water loss (Gerlach troughs and "flying runoff plots") (chapter **Fout! Verwijzingsbron niet gevonden.**)
- soil moisture content
- organic carbon content
- limiting nutrients (NPK)
- soil and nutrient loss
- soil (surface) properties (bulk density, texture, water retention characteristic, shear strength)
- crop performance and yield

Some results of measurements of soil and water loss are presented in chapter **Fout! Verwijzingsbron niet gevonden.**.

3.3 Work package 3: Soil erosion at the catchment level

In this work package, catchment maps are created by researchers and farmers, showing farmers' indicators, actual soil loss and yield reduction, using the results from work package 2. In parallel, the Limburg Soil Erosion Model (LISEM) and the Morgan, Morgan & Finney model (MMF) will be applied to both catchments to estimate soil loss and sedimentation for all mapping units (fields). LISEM and MMF are applied to bridge the gap between the field-scale indicators of farmers and erosion and sedimentation patterns at catchment scale. Comparing the maps of farmers' indicators in each field to the outputs of the catchment models gives the possibility to scale up relationships between farmers' indicators and soil loss, nutrient loss and yield reduction at field level to the catchment level. Moreover, insight is gained in the scale effect of erosion and sedimentation processes in the catchments.

A catchment map of farmers' indicators is currently created for the Tanzanian site (chapters **Fout! Verwijzingsbron niet gevonden.** and **Fout! Verwijzingsbron niet gevonden.**). For the Kenyan site, results of the inventory of farmers' indicators along the hilllslope transects were translated into catchment maps showing erosion indicators and farmers' estimates of erosion severity and yield reduction (chapter **Fout! Verwijzingsbron niet gevonden.**).

Measurements of soil, soil surface and vegetation properties(e.g. soil texture, hydraulic conductivity, soil cohesion, leaf area index) were performed in both catchments by the project site coordinators, the PhD students and students sent by Alterra and the Wageningen University. These measurements are used to parameterise the catchment erosion models. Databases of these properties are currently available for both catchments. Digital elevation models, land use and soil maps were created for both catchments to provide catchment descriptions to the models. An extensive soil survey was carried out in the Tanzanian site.

Farmers' fields serve as the target units in the comparison of farmers' indicators and estimates to model outputs, and in the construction of soil and water conservation scenarios in the final stage of the project. A map of farmers' fields was created for the catchment in Kenya (chapter **Fout! Verwijzingsbron niet gevonden.**), and remains to be created for the catchment in Tanzania.

The performance of the catchment erosion models is currently checked using (1) catchment maps of actual erosion and sedimentation rates, (2) distributed observations of infiltration and overland flow rates and (3) measurements of stream flow discharge and sediment concentration at the catchment outlet. Maps of actual erosion and sedimentation

rates were prepared using the ACED method in both sites. In the Tanzanian site, surveys were carried out in autumn 2001 and spring 2002 (chapter **Fout! Verwijzingsbron niet gevonden.**). 34% of the surveyed area was classified as having "high" and "very high" erosion rates. This area was mainly covered by annual crops. Dominant erosion forms were sheet and interrill erosion. Erosion was also monitored using mesh bags and splash cups, but the results were unreliable due to disturbance by hoeing. In the Kenyan site, the ACED survey was carried out in topographical elements with uniform flow directions. Erosion and sedimentation measurements were carried out using erosion-sedimentation pins along transects, cutting through several topographical flow elements (chapter **Fout! Verwijzingsbron niet gevonden.**).

Distributed observations of infiltration and overland flow were collected in a 6 ha part of the Kwalei catchment (Tanzania) during 11 rain events between March and May 2002 (chapter **Fout! Verwijzingsbron niet gevonden.**) . Overland flow detectors, piezometers and blackboard sticks were used for these measurements.

Stream flow discharge, sediment concentration and rainfall intensity have been measured at the outlet of the Tanzanian catchment since September 2001. Rainfall is currently also collected from 3 other rain gauges, distributed over the catchment. Up till present, no major events occurred (peak discharge <60 l/s). Runoff coefficients for the Tanzanian catchment were very small: 0.5% on average. Also, 2-minute rainfall intensities of about 100 mm/h were observed, as well as several storms with 20-30 mm rainfall. This indicates that the larger part of the rainfall is retained within the catchment. For the Kenyan catchment, manual measurements of stream flow discharge and sediment concentration are available for a number of rain events during the short-rain season of 2001. Automated measurements of stream flow discharge and sediment concentration started in the spring of 2002. Unfortunately, the ultrasonic water level sensor at the flume outlet was washed away during a big storm on 22 April 2002. In addition, the solar panels and battery, providing power to the automated flume equipment, were stolen in July 2002, while the watch man was threatened.

3.4 Work package 4: Development of a tool for economic assessment of SWC technologies

Work package 4 aims to provide a tool (model, spreadsheet or set of decision rules) to enable quick economic assessment of SWC technologies in an area. Returns on investment in SWC technologies calculated with the tool are compared to returns on investment in other ventures. Special attention will be paid to the economic effects of off-farm erosion management like gully development along roads and erosion of communal lands. The economic tool is currently developed for the Tanzanian project site, and applied to both sites.

Inputs and boundary conditions for the tool are:

- socio-economic parameters
- the physical effectiveness of different soil and water conservation measures (a.o. the degree of soil erosion with and without SWC technologies)
- inputs and outputs from soil and water conservation activities
- costs and prices of all inputs and outputs
- evaluation criteria for soil and water conservation from different actors in the area

Results of the socio-economic survey in the Tanzanian site include household characteristics, resource availability, perception of soil erosion problems and farmers' opinions on SWC issues (Tenge et al., 2002). Factors determining adoption of SWC technologies are currently analysed. A format for the socio-economic survey was developed by the Tanzanian project group and provided to the Kenyan group for data collection in the Kenyan site. Most of these data are already available at the Kenyan site, except for farming operation activities. These data will be collected in the next rainy season (Q3-Q4 2002).

Cost-benefit analysis (CBA) and Multi Criteria Analysis (MCA) are used in the economic tool to evaluate the efficiency of different SWC options. Evaluation criteria and weights attributed by farmers and the government were inventoried (chapter **Fout! Verwijzingsbron niet gevonden.**). Farmers put larger weights to the maximisation of soil fertility and easy tillage than the government, and less to minimisation of material input.

International papers on economic impact assessment of SWC technologies were compiled and presented in readers (De Graaff and Fleskens, 2001; Smaling et al., 2001).

3.5 References

Graaff, J. De & L. Fleskens (eds.), 2001. Impact assessment of land and water management, Reader.
ESWC group, Wageningen University.

Horstman, H., 2002. Erosion indicators and related soil productivity changes in the East African Highlands. EROAHI Content Report 2, June 2002. 35 p. excl. appendices.

Karanja, G.M. and Van Dijck, S.J.E. 2001. Literature study for the EROAHI project. EROAHI Content Document 1. Ed. S.J.E. van Dijck, Alterra, Wageningen, The Netherlands. 27 p.

Lyamchai, C., Owenya, M., Ndakidemi, P. and Massawe, N. 1998. Participatory Rural Appraisal in Kwalei Catchment, Lushoto District, Tanzania. Eds.: S.D. Lyimo and R.V. Ndondi. African Highlands Initiative, Selian Agricultural Research Institute, Arusha, Tanzania. 79 p.

Ouma, J.O. and Okoba, B.O. 2000. Report of Focussed Participatory Rural Appraisal on Farmers Perceptions of Soil Erosion Indicators and Soil and Water Management Systems. Gikuuri Catchment - Embu District, Kenya. EROAHI-Embu Report No. 1, October 2000. 32 p.

Smaling, E.M.A., J. de Graaff and R. Ruben (eds.), 2001. Land degradation and economic development, Reader. Department of Environmental Sciences

Tenge, A.J., Hella, J. and De Graaff, J., 2002. Identification of social economic factors for adoption of soil and water conservation measures in Kwalei catchment, Lushoto, Tanzania. EROAHI Content Report 3, 35 p.