



Tanzania Land Evaluation Tool

Trans-SEC Interactive Modelling Tool

An online tool for evaluating Land Use Suitability for Maize in Tanzania



Land Evaluation Tool - Overview

- Web based modeling tool to evaluate Land Use Suitability for growing maize in Tanzania, part of Web-GIS module
- GIS module is part of larger project **Trans-SEC**
Innovating Strategies to safeguard Food Security using Technology and Knowledge
- One of several on-line tools developed in Trans-SEC
- **Work in Progress, to be finished in September 2016**

Land Evaluation Tool - Goals

- to support planning efforts for ensuring food security in Tanzania and beyond
- to help strengthen sustainable development in the affected Countries

Part of the Trans-SEC project



The image shows the header and main content area of the Trans-SEC website. The header is a dark blue banner with the Trans-SEC logo on the left, which consists of a green plant growing from a white outline of Africa. To the right of the logo, the text "Trans-SEC" is written in large white letters, followed by the tagline "Innovating pro-poor Strategies to safeguard Food Security using Technology and Knowledge Transfer" in smaller white text. Below the header is a wide photograph of a maize field in Tanzania, with a person standing in the middle ground. Below the photo is a dark blue bar with a row of seven white dots. Underneath this is a white navigation bar with links: Home, Structure, Products, CPM, Capacity Building, Press, and Intranet. The main content area has a white background. On the left, the text "Trans-SEC" is displayed. On the right, a small text block states "Trans-SEC is sponsored by BMBF and co-financed by BMZ". In the center, a large blue text block reads: "... to contribute to innovate strategies to safeguard food security through the use of science, technology and knowledge transfer".

Trans-SEC
Innovating pro-poor Strategies to safeguard Food Security using Technology and Knowledge Transfer

Home Structure Products CPM Capacity Building Press Intranet

Trans-SEC

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... to contribute to innovate strategies to safeguard food security through the use of science, technology and knowledge transfer



Federal Ministry
of Education
and Research



Federal Ministry
for Economic Cooperation
and Development

**An online tool for evaluating Land Use Suitability
for Maize in Tanzania and beyond**



TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS

Trans-SEC project

Natural Resources

1. Rainwater harvesting (tie-ridges, infiltration pits)
2. Fertiliser micro-dosing ("deep fertiliser placement")
3. Optimised weeding

Crop Production

Processing Waste Management Bioenergy

1. Crop byproducts for bioenergy
2. Improved processing (trainings, business models for purchasing machines)
3. Improved on-farm wood supply (tree planting/integration)
4. Improved cooking stoves

Markets Income Generation

1. New product development (horizontal and vertical coordination, high value crops, surplus cereals, and livestock products)
2. Optimised crop storage (profitable, market oriented, reducing PH losses)
3. Poultry-crop integration (for enhanced rural income and food security)
4. Market access system (m-IMAS, mobile based)

Consumption

1. Household nutrition education
2. Kitchen gardens (indigenous fruits and vegetables for dietary diversification)

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Trans-SEC Web GIS - Overview

Welcome Map Viewer Land Evaluation Tool Tanzania Food Security Monitor

Natural Resource Data Base Communication tool box

Trans-SEC Web-GIS for Tanzania

2015

Welcome to this exciting new tool


This Web-GIS tool is created in order to speed up exchange of data and information in and about Tanzania. This way it is thought to enable faster development particularly in the agricultural sector.

The Trans-SEC Web-GIS consists of four major components:


1. A static map viewer
2. A land evaluation tool
3. The „Tanzanian Food Security Monitor“
4. A natural resource database

Additionally, a communication tool box is provided.


The whole Trans-SEC Web-GIS environment is open source-based. Please explore its functionality and contribute with your wisdom to knowledge generation in Tanzania!



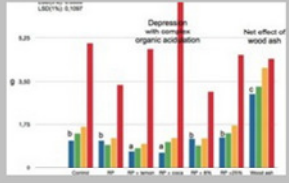
The **map viewer** provides static maps included from various sources.



You can use the **land evaluation tool** for your own purposes!



The **Tanzanian Food Security Monitor** provides scenarios of the actual potential biomass productivity and is updated every ten days.



From the **Natural Resource Data Base** you can download data and statistics on crops, climate, land and soil for various purposes including modeling.

Online Map Viewers

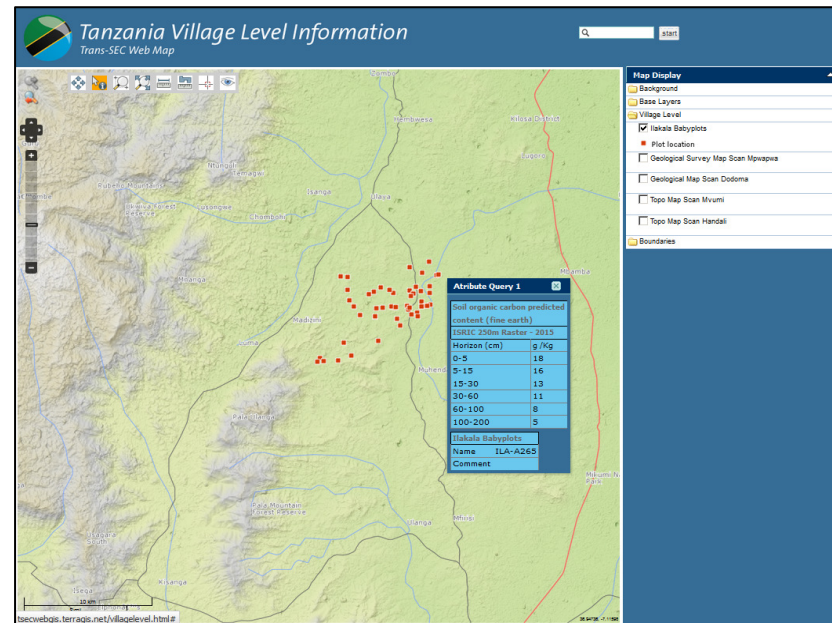
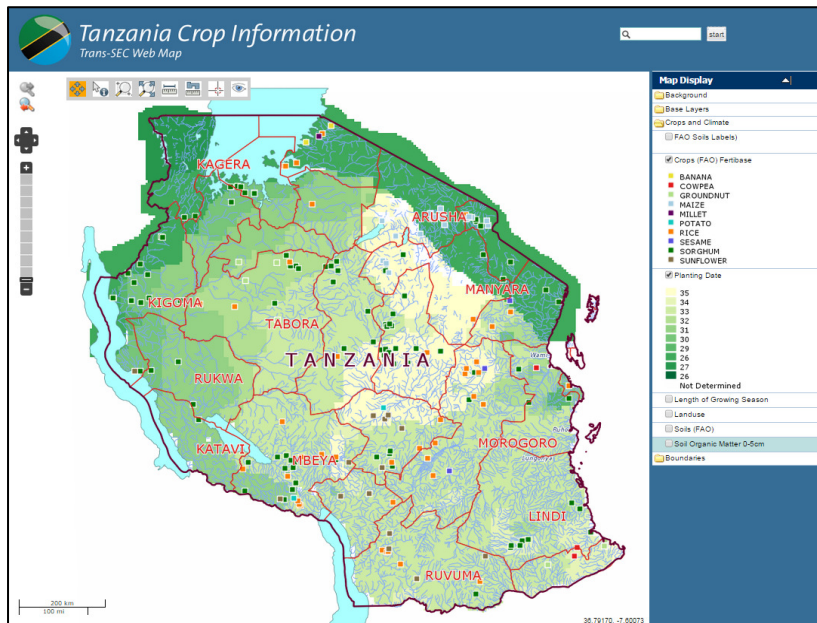
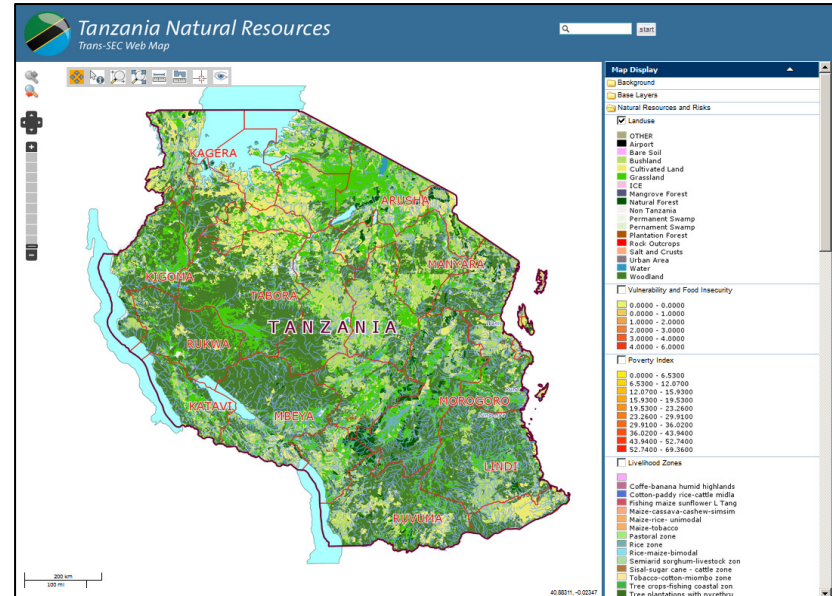
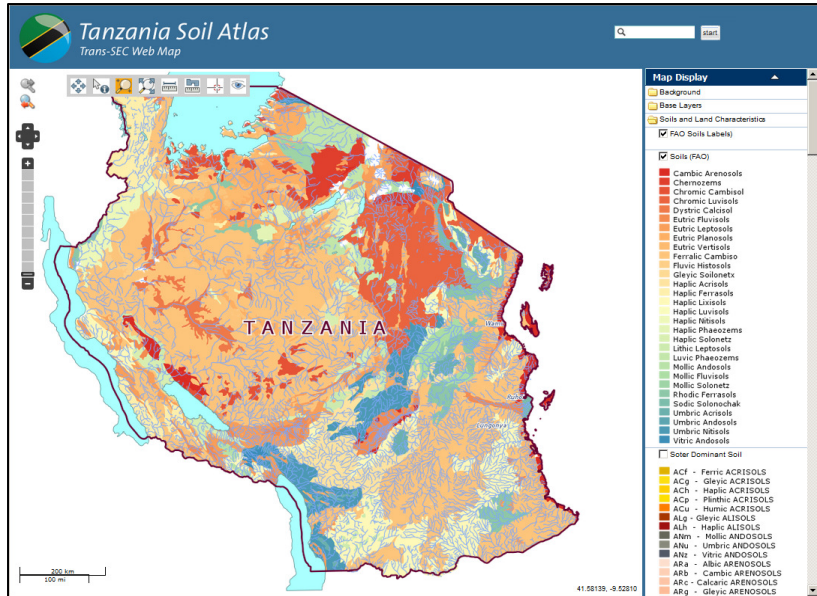
- Tanzania Soil Atlas
- Natural Resources
- Crops and Climate
- Village/Local level maps

Land Evaluation Tool

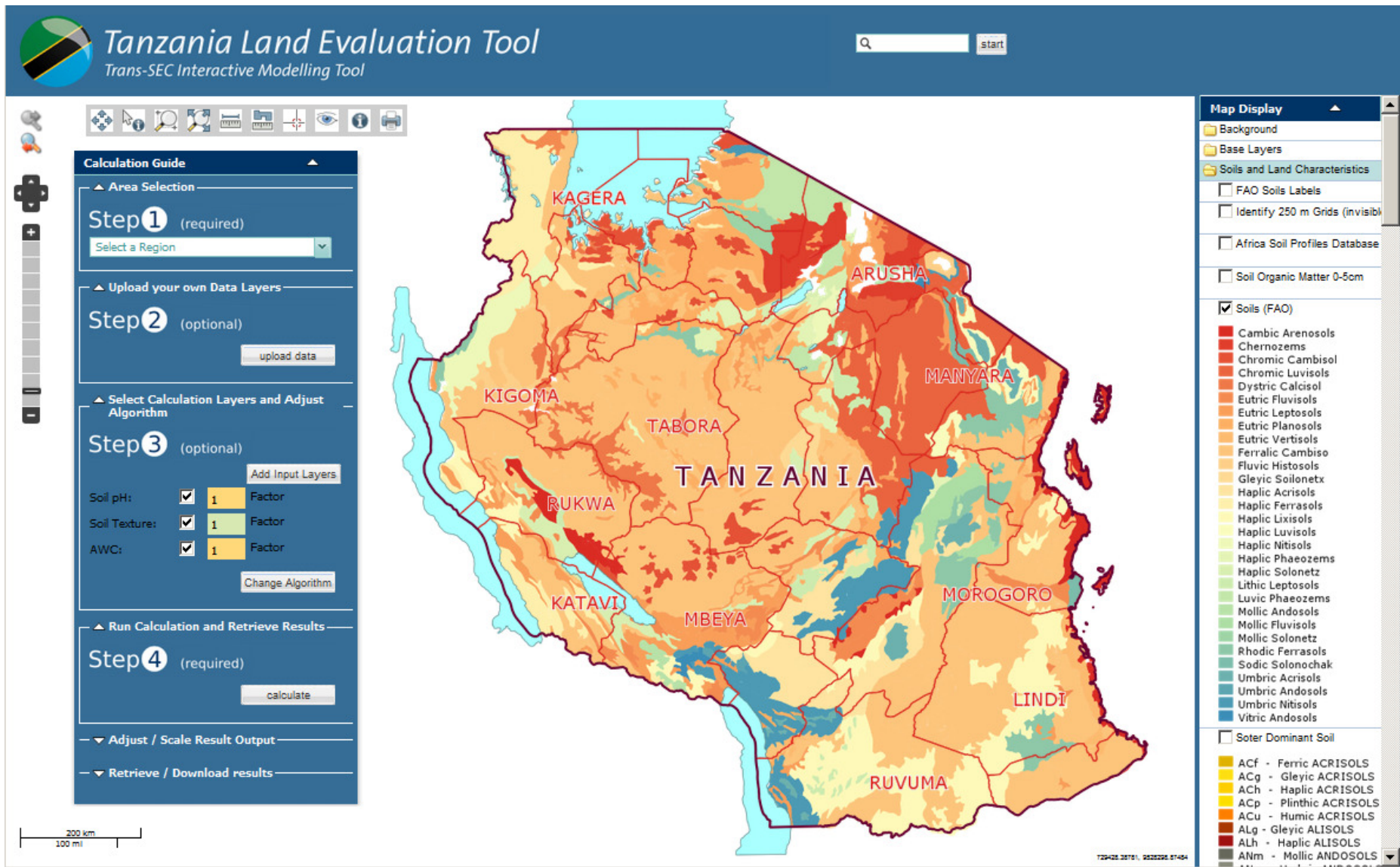
Tanzanian Food Security Monitor

Natural Resource Database

Online Map Viewers



Land Evaluation Tool



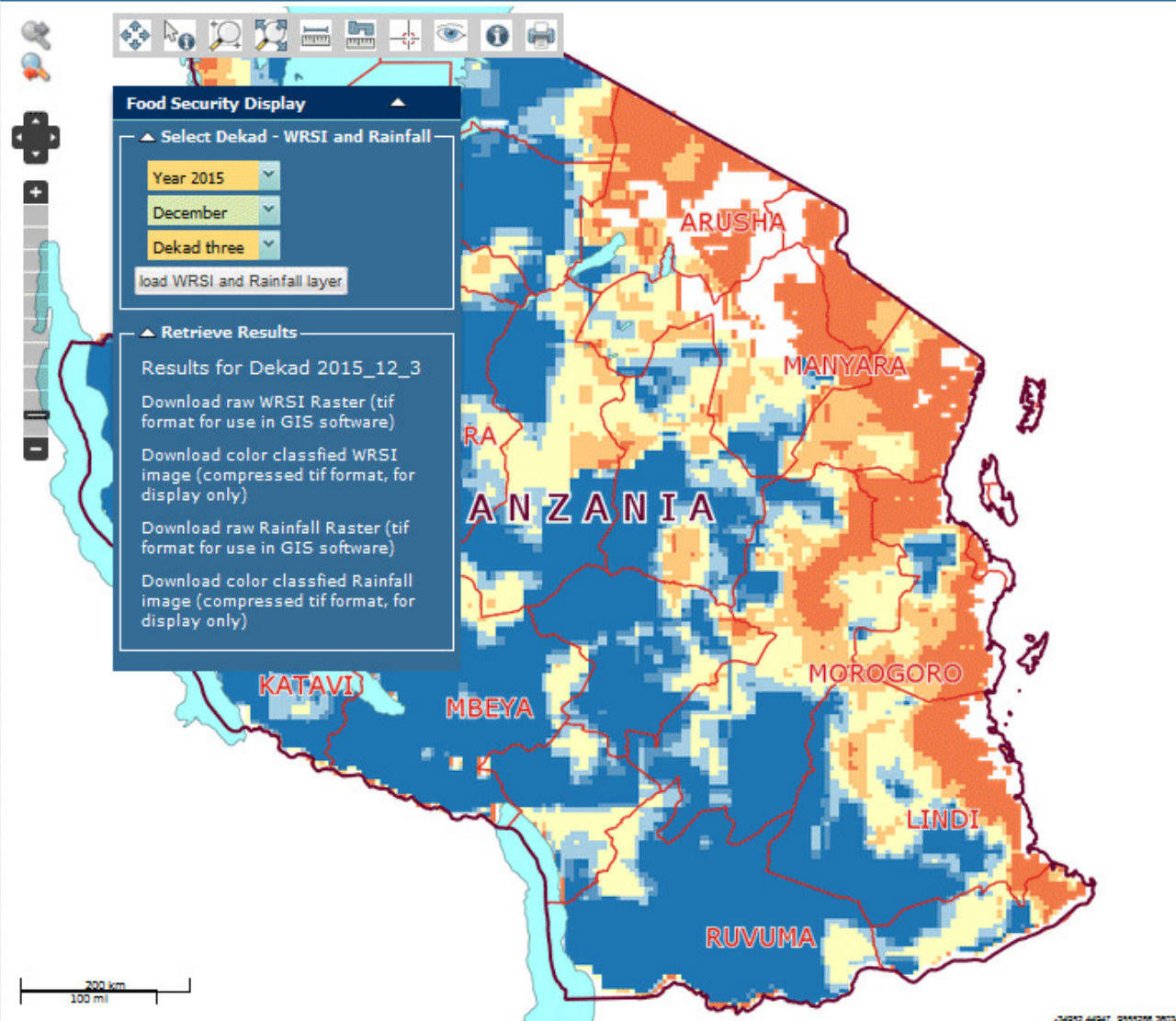
Food Security Monitor



Tanzania Food Security Monitor

Trans-SEC Interactive Modelling Tool

Q start



Map Display

Background

Base Layers

Food Security

☒ WRSI - Dekad 2015-12-3

0 - 50%

50 - 60%

60 - 80%

80 - 95%

95 - 99%

99 - 100%

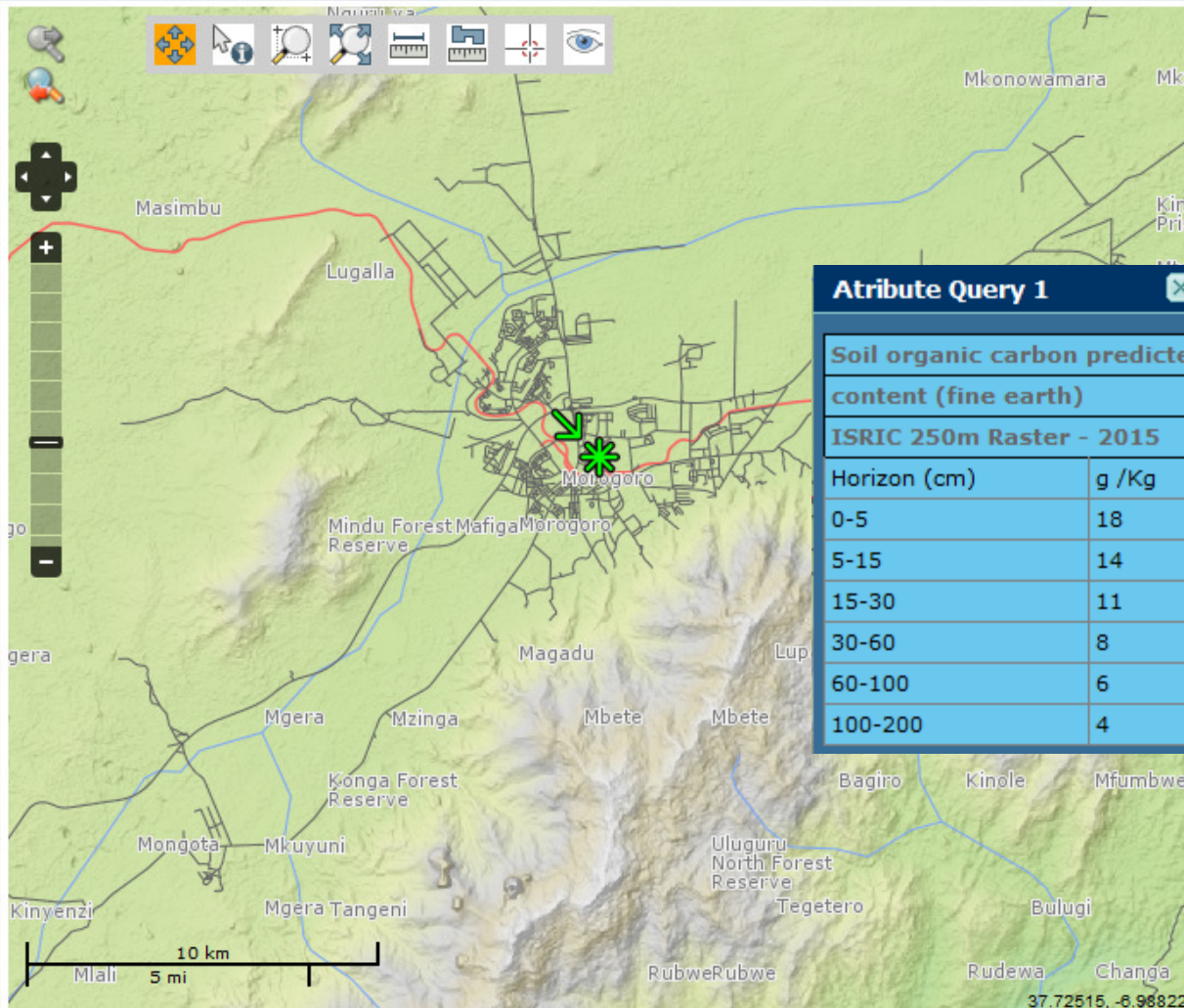
☐ Rainfall - Dekad 2015-12-3

Boundaries

Soil Atlas - Interactive Map Viewer



Tanzania Soil Atlas
Trans-SEC Web Map



Attribute Query 1

**Soil organic carbon predicted
content (fine earth)**

ISRIC 250m Raster - 2015

Horizon (cm)	g /Kg
0-5	18
5-15	14
15-30	11
30-60	8
60-100	6
100-200	4

Map Display

- ☐ Background
- ☐ Base Layers
 - ☐ Place names
 - ☒ Place names (Text only)
 - ☒ Roads
 - ☒ Railways
 - ☒ Lakes
 - ☒ Rivers
 - ☐ Forests
 - ☐ Game Reserves
 - ☐ Protected Areas
 - ☒ Hillshade
 - ☒ Slopesshade
 - ☒ Colour Relief
- ☐ Soils and Land Characteristics
- ☐ Boundaries

Example: Soil Atlas - Layers

Background

☐ Topo 1:500K (russian)

☐ Topo 1:2Mio

☐ Satellite Image 1:8Mio

☒ No Background

Base Layers

☐ Place names

☒ Place names (Text only)

☒ Roads

☐ Roads

☐ Railways

☒ Railways

☒ Lakes

☐ Lake

☒ Rivers

☐ River

☐ Forests

☐ Game Reserves

☐ Game reserve

☐ Protected Areas

☐ Protected Area

☒ Hillshade

☒ Slopeshade

☒ Colour Relief

Boundaries

☐ Tanzania Boundary

☒ International Border

☐ Regions

☒ Region Boundary

☐ Districts

☒ District Boundary

☐ Wards 2002

☒ Ward Boundary

Soils and Land Characteristics

☐ FAO Soils Labels

☒ Identify 250 m Grids (invisible)

☒ Africa Soil Profiles Database

☒ Soil Organic Matter 0-5cm

☐ Soils (FAO)

☐ Soter Dominant Soil

☐ Soter Lithology

☐ Soter Landform

☐ Soils of Tanzania

☒ Soils of Tanzania Map 7

☐ Soils of Tanzania Map 5

☐ Soil Topography

☐ Soil Stoniness

☐ Soil Phase

☐ Soil colour

☐ Relief and physical Features

☐ Hydrology

☐ Landuse

Attribute Query 1

Main FAO Soil Type	Ferralic Cambiso
Code	CMo9

Soil organic carbon predicted content (fine earth)

ISRIC 250m Raster - 2015	
Horizon (cm)	g /Kg
0-5	15
5-15	13
15-30	10
30-60	9
60-100	7
100-200	5

Soil and Terrain (SOTER)

Dominant Soil type	Chromi-Ferralic Cambisols (CMo)
Landform	LP
Lithology	IA1

Landuse type Woodland

Relief and Physical Features

Rainfall	1000-1500
----------	-----------

Soil Colour Gray

Soil Phase Deep soil

Soil Stoniness Soil without stone

Topography Type Moderate topography

Soil Description 2 Young alluvium

Soil Description 3 Alluvial lacustrin origin soils

Soil Description 1 Clay with imperfect drainage

Attribute Query 2

Africa Soil Profiles Database2

ISRIC, 2014, version 1.2

Soil Profile No. TZ 13514W3_0136

ISRIC 250m Raster - 2015

predicted soil values

Soil parameter	units	value
Soil pH in H2O	pH * 10	62
Coarse fragments volumetric	%	0
Soil texture fraction sand	%	81
Soil texture fraction silt	%	7
Soil texture fraction clay	%	12
Bulk density	kg/m3	1500
Cation Exchange Capacity	cmolc/kg	7
Total nitrogen	g/kg	0.41
Aluminium concentration	ppm	588
Exchangeable acidity	cmolc/kg	0.221
Exchangeable Calcium	cmolc/kg	10.2
Exchangeable Magnesium	cmolc/kg	3.5
Exchangeable Sodium	cmolc/kg	1.1
Sum of exchangeable bases	cmolc/kg	15
Drainage class (FAO)	class	5
Depth to bedrock	cm	136
Available soil water capacity	%	5
Electrical conductivity ECN	dS/m	0.28400001

Natural Resource Layers



Trans-SEC Web Map Viewer

Innovating Strategies to safeguard Food Security using Technology and Knowledge Transfer





Attribute Query 1

Agroecological Zone	Plateaux
Lithology/Geology	Granites migmatites and associated acid gneiss

Mean Annual Rainfall 800-1000 mm

Landuse type Cultivated Land

Main FAO Soil Type Chromic Cambisol
Code CMx3

Livelihood Mwanza-Shinyanga-Mara
Cotton, Livestock, Cassava,

Hazards primary Inadequate rainfall

Hazards secondary Crop pests and diseases

Hazards tertiary Livestock diseases

Livelihood Cotton-paddy rice-cattle
midla

Code II

Region Tabora

District NYANG'WALE

Region Geita

Poverty Level Low

Poverty % 5.13

District NYANG'WALE

Region Geita

12_13 0

Total 0

Map Display

Background

Base Layers

Natural Resources and Risks

☐ Relief and Physical

☐ Hydrology

☐ Vulnerability and Food Insecurity

☐ Poverty Index

☐ Livelihood Zones

☐ Crop and Livestock Hazards

☐ Soils (FAO)

☐ Landuse

☐ Mean Precipitation

☐ Lithology

☒ Agroecological Zones

- ☒ Central
- ☒ Islands
- ☒ Isolated Granitic Mountains
- ☒ Kilombero
- ☒ Northern
- ☒ Rufiji
- ☒ South Eastern
- ☒ South Western
- ☒ Southern
- ☒ Usangu
- ☒ Wami
- ☒ Western

Boundaries

200 km
100 mi

34.76624, -5.88854

Land Evaluation Tool - Overview

- Technically is based on **a set of open source software tools:**
OpenLayers, MapServer, PostGIS and GDAL
- **provides web-GIS functionality** mainly for the ex-ante assessment of growing maize (land suitability)
- The tool is based on the FAO framework for land evaluation and applies the **Storie index** in order to derive **land suitability classes**
(in combination with specifications from Sys et al 1991 + 1993)

Intended User Audience Land Evaluation Tool

- Scientists and students, Universities
- International organizations, research centers e.g. CGIAR
- NGOs
- Governmental organizations in Tanzania and the neighboring region

Open Source Web GIS technically based on

MapServer – Rendering Engine



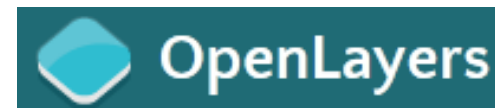
- Map Display and rendering functionalities

PostGIS - Database

- Unified data storage and retrieval
- GIS functionalities



OpenLayer – Map Viewer



- Object-oriented JavaScript library

Storie Index – evaluating soil characteristics

■ Method of soil rating

based on soil characteristics related to

- land's use potential & productivity capacity
- independent of other physical or economic factors

■ Simple evaluation method

4-5 parameters evaluated e.g.

- A: Soil depth and texture
- B: Soil permeability
- C: Soil chemical characteristics
- D: Drainage, Surface runoff
- E: Climate

■ Index is multiplication of parameters

$$\text{Sindex} = A \times B \times C \times D \times E$$

[Wikipedia about Storie index](#)

Land Suitability Calculation *technically based on*



GDAL (Raster) and OGR (Vector)

- reading, writing and processing of raster and vector data sets
- important for many Desktop GIS e.g. ArcGIS
- long list of supported GIS formats

■ **gdal_calc.py**

- a Python script included in GDAL installation
- command line raster calculator

■ **gdaldem color-relief**

- command to create - 3 RGB band - tif output

Land Suitability Calculation

■ gdal_calc.py - command line raster calculator

Example command line use:

gdal_calc.py

-A 1_landeval_ph.tif -B 1_landeval_tx.tif -C 1_landeval_cl.tif

--outfile=1_landeval_result_eval.tif

--type=Float64

--NoDataValue=0

--calc=

'1 * (40*(logical_or(A < 52, A > 85)))+(60*(logical_or(logical_and (A >= 52, A < 55),logical_and(A >= 82, A < 85)))+(85*(logical_or(logical_and(A >= 55, A < 58),logical_and (A >= 70, A < 82)))+(100*(logical_and(A >= 58, A < 70))) * 0.01 * (100*(B < 15)+(85*(logical_and(B >= 15, B < 35)))+(60*(logical_and(B >= 35, B < 55)))+(40*(B >= 55))) * 0.01 * (40*(C < 400)+(60*(logical_and (C >= 400, C < 800)))+(85*(logical_and(C >= 800, C < 1200)))+(100*(C >= 1200))) * 0.01 * 100'

Input Data

- Maximum of layers that can be selected
- List of input data layers for model calculations
 - **site characterization** data
 - **soil parameters** based on 250m soil raster data sets provided by ISRIC (2015)

Climatic requirements

Length of growing cycle

Average temperature growing season (1979-2012)
 Average minimum temperature growing season (1979-2012)
 Average maximum temperature growing season (1979-2012)
 Average absolute minimum temperature growing season (1979-2012)
 Average absolute maximum temperature growing season (1979-2012)

Landscape and soil requirements

Slope %
 Flooding areas
 Drainage class
 Soil Texture
 Coarse fragments
 Soil depth in cm
 CEC
 CEC per Kg clay
 Base saturation
 Sum of basic cations
 Exchangeable Na
 Exchangeable Mg
 Exchangeable Ca
 Exchangeable Al
 pH(H₂O)
 Organic carbon %
 Total nitrogen
 EC
 AWC
 bulk dens kg/m³

Calculation Steps - Land Evaluation Tool

- **Area Selection**
- *Upload of your own data layer (optional)*
- **Select calculation layers and adjust Algorithm**
- **Run Calculation and View Results**
- *Adjust / Scale Result Output (optional, not implemented yet)*
- **Retrieve / Download result layer**

Land Evaluation Tool - Steps

The screenshot displays the 'Tanzania Land Evaluation Tool' interface. The main map shows the outline of Tanzania with regional boundaries. A large orange rectangular area is selected over the Morogoro and Lindi regions, labeled 'Area Selection'. The interface includes a 'Calculation Guide' on the left with three steps: Step 1 (required) 'Select a Region', Step 2 (optional) 'Upload your own Data Layers', and Step 3 (optional) 'Select Calculation Layers and Adjust Algorithm'. Step 3 shows 'Soil pH', 'Soil Texture', and 'AWC' each set to a factor of 1. A 'Map Display' panel on the right lists layers: Background, Base Layers, Soils and Land Characteristics, and Boundaries. Under Boundaries, 'Tanzania Boundary', 'Regions', and 'Ward Boundary' are checked. A scale bar at the bottom left indicates 100 km and 100 miles. A search bar and 'start' button are at the top right.

Tanzania Land Evaluation Tool
Trans-SEC Interactive Modelling Tool

Calculation Guide

Step 1 (required)
Select a Region

Step 2 (optional)
upload data

Step 3 (optional)
Add Input Layers

Soil pH: ☒ 1 Factor
Soil Texture: ☒ 1 Factor
AWC: ☒ 1 Factor

Change Algorithm

Run Calculation and Retrieve Results
Adjust / Scale Result Output
Retrieve / Download results

Map Display

- Background
- Base Layers
- Soils and Land Characteristics
- Boundaries
 - ☒ Tanzania Boundary
 - ☒ International Border
 - ☒ Regions
 - ☒ Region Boundary
 - ☐ Districts
 - ☐ Wards 2002
 - ☒ Ward Boundary

Area Selection

100 km 100 miles

771536 39925 9254483 95233

An online tool for evaluating Land Use Suitability
for Maize in Tanzania and beyond

Land Evaluation Tool - Steps

Tanzania Land Evaluation Tool
Trans-SEC Interactive Modelling Tool

Search: start

Calculation Guide

Step 1 (required)
Area Selection
Select a Region

Step 2 (optional)
Upload your own Data Layers
upload data

Step 3 (optional)
Select Calculation Layers and Adjust Algorithm

Soil pH: ☒ 1 Factor
Soil Texture: ☒ 1 Factor
AWC: ☒ 1 Factor

Add Input Layers
Change Algorithm

Run Calculation and Retrieve Results
Adjust / Scale Result Output
Retrieve / Download results

Upload Raster data set

Display Name: distance to market
Your Notes:
Note that only tif Raster images (.tif file name extension) in geographic map projection are accepted for upload (maximum of 3).
File Upload: r3.tif Browse...
Upload Raster data

Map Display

- Background
- Base Layers
- Soils and Land Characteristics
- Boundaries
 - ☒ Tanzania Boundary
 - ☒ International Border
 - ☒ Regions
 - ☒ Region Boundary
 - ☐ Districts
 - ☐ Wards 2002
 - ☒ Ward Boundary

100 km 100 mi

7/2025 15/23 9103593 45578

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for Maize in Tanzania and beyond



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Land Evaluation Tool - Steps

Tanzania Land Evaluation Tool
Trans-SEC Interactive Modelling Tool

Calculation Guide

- Step 1 (required)**
Area Selection:
- Step 2 (optional)**
Upload your own Data Layers:
- Step 3 (optional)**
Select Calculation Layers and Adjust Algorithm
 - Soil pH: ☒ 1 Factor
 - Soil Texture: ☒ 1 Factor
 - AWC: ☒ 1 Factor
 - distance to market: ☒ 1 Factor
-
-
-

Upload Raster data set

Display Name:

Your Notes:

Note that only tif Raster images (.tif) in geographic map projection are supported.

File Upload:

Reported values are:
 Minimum: 14.450
 Maximum: 60.000
 Mean: 23.426
 StdDev: 15.086
 Projcs: Arc 1960 / UTM zone 37S
 Geogcs: Arc 1960
 Datum: Arc_1960
 Extent: 113516.622694,9114361.93342,169159.084
 CellX: 249.51776775
 CellY: -250.156565204

Update selected calculation extent to match the uploaded raster layer: ☒

Map Display

- Background
- Base Layers
 - ☒ Extent of Land Calculation
 - ☒ Uploaded Raster 1 Extent
 - ☐ Place names
 - ☒ Place names (Text only)
 - ☒ Roads
 - ☐ Roads
 - ☒ Railways
 - ☐ Railways
 - ☒ Lakes
 - ☐ Lake
 - ☒ Rivers
 - ☐ River
 - ☐ Forests
- OREST
 - ☐ Game Reserves
 - ☐ Game reserve
 - ☐ Protected Areas
 - ☐ Protected Area
 - ☐ Hillshade
 - ☐ Slopeshade
 - ☐ Colour Relief
- Soils and Land Characteristics
- Boundaries
 - ☒ Tanzania Boundary
 - ☐ International Border
 - ☒ Regions
 - ☐ Region Boundary
 - ☐ Districts

close info window and proceed

100 km 100 mi

tsecwebgis.terragis.net/land_evaluation_tool.html#

632773.95327, 9328287.34545

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Land Evaluation Tool - Steps

Calculation Guide

Step 1 (required)
Select a Region

Step 2 (optional)
Upload your own Data Layers
upload data

Step 3 (optional)
Select Calculation Layers and Adjust Algorithm
Add Input Layers

Soil pH: ☒ 1 Factor
Soil Texture: ☒ 1 Factor
AWC: ☒ 1 Factor
distance to market: ☒ 1 Factor
Change Algorithm

Step 4 (required)
Run Calculation and Retrieve Results
calculate

Step 5
Adjust / Scale Result Output
adjust output

Step 6
Retrieve / Download results

Adjust Algorithm

Algorithm

Layer Classification

	Class 4		Class 3		Class 2		Class 1	
	min >	max <=	min >	max <=	min >	max <=	min >	max <=
Soil pH (*10):	0	52	52	55	55	58	58	70
Soil pH (*10):	85	140	82	85	70	82		
Soil texture:	not suitable		marginally suit		suitable		very suitable	
Soil texture:	0	15	15	35	35	55	55	100
Soil texture:	very suitable		suitable		marginally suit		not suitable	
AWC (mm):	0	400	400	800	800	1200	1200	2000
AWC (mm):	not suitable		marginally suit		suitable		very suitable	
distance to market:	14	18.5	18.5	23	23	41.5	41.5	60
distance to market:	not suitable		marginally suit		suitable		very suitable	

Map Display

Background
Base Layers

Protected Areas
Protected Area
Hillshade
Slopesshade
Colour Relief
Soils and Land Characteristics
Boundaries

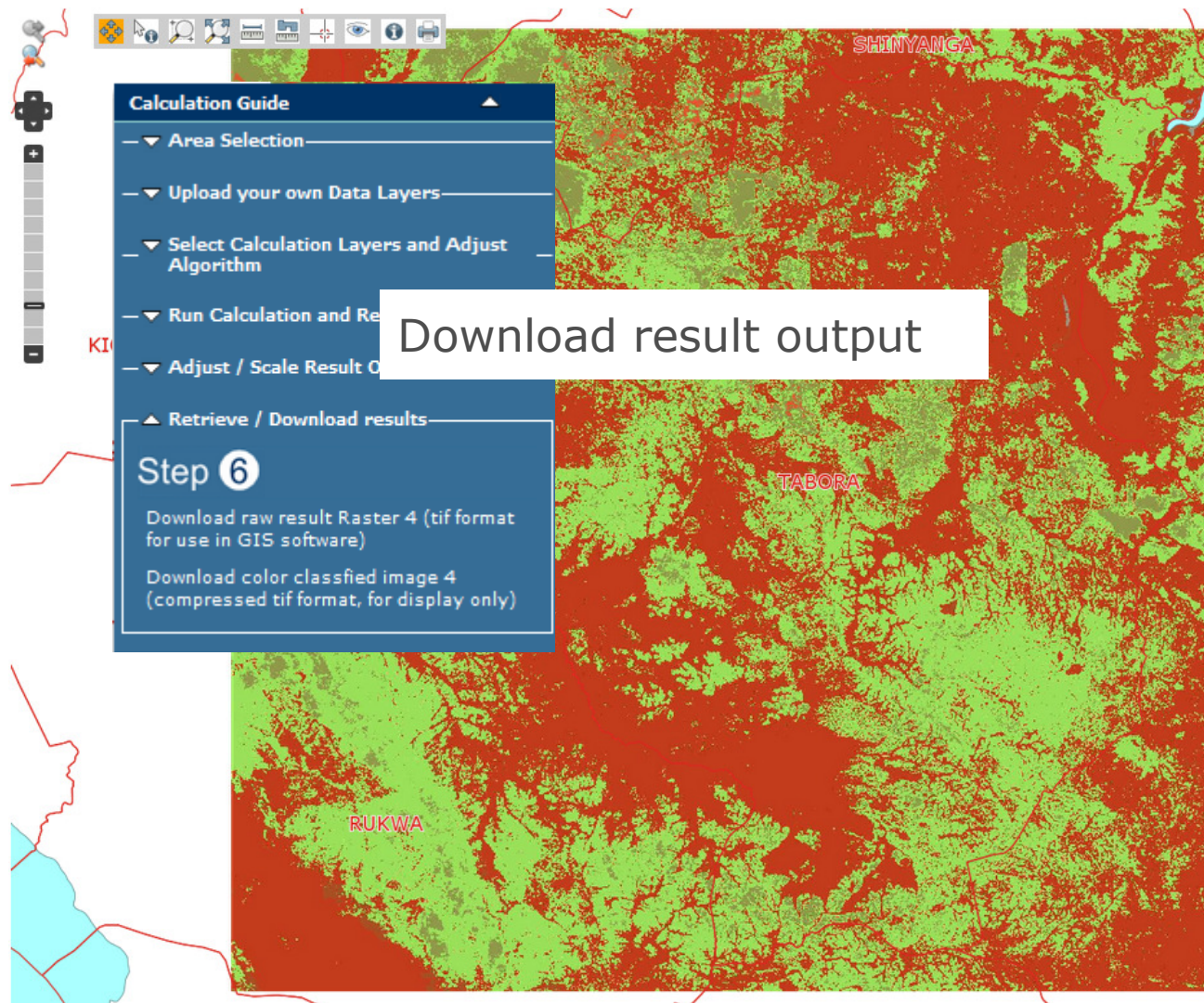
MBEYA

20 km

tsecwebgis.terragis.net/land_evaluation_tool.html#

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Land Evaluation Tool – output



Land Evaluation Tool – Results

- Raster output: download tif file format
- Two versions
 - “raw” tif - raster cells having the calculated output
 - RGB colored tif (3 bands)
representing interpolated color scheme used
in the web GIS (calculated result not included)
- for further processing in GIS
the “raw” tif version can be used
- output raster resolution is 250 m
(that of the input soil layers)

References - Land Evaluation Tool

■ Storie Index

- *R.E.Storie. Storie Index Soil Rating. 1978. Division of Agricultural Science, University of California*

■ SYS model for land evaluation

- *Sys, C., E. Van Ranst and J. Debaveye, 1991. Land evaluation, Part I: Principles in land evaluation and crop production calculations. International Training Centre for Post-Graduate Soil Scientists, University Ghent, Belgium, pp: 265.*
- *Sys, C., E. Van Ranst and J. Debaveye, F. Beernaert, 1993. Land evaluation part III crop requirements. Agricultural publications General Administration for Development Cooperation, Belgium*

■ Gdal – [Geospatial Data Abstraction Library](#) [gdal_calc.py](#)

A command line raster calculator – using numpy syntax

Conclusions

- Land Evaluation Tool output based on simple map algebra
FAO *Storie Index* and *Sys et al* publication
- Usage highly flexible
 - non – soil - maize based evaluations possible by uploading your own *subject specific* tif data layers
 - multiple adjustment levels available
- User has to calibrate / interpret output according to their own rules - results can not be predicted
- Future use in teaching *Land Evaluation and GIS*
 - ⇒ Stand alone version on virtual machine
 - Live DVD – USB stick* planned

Thank you



Asante Sana !



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