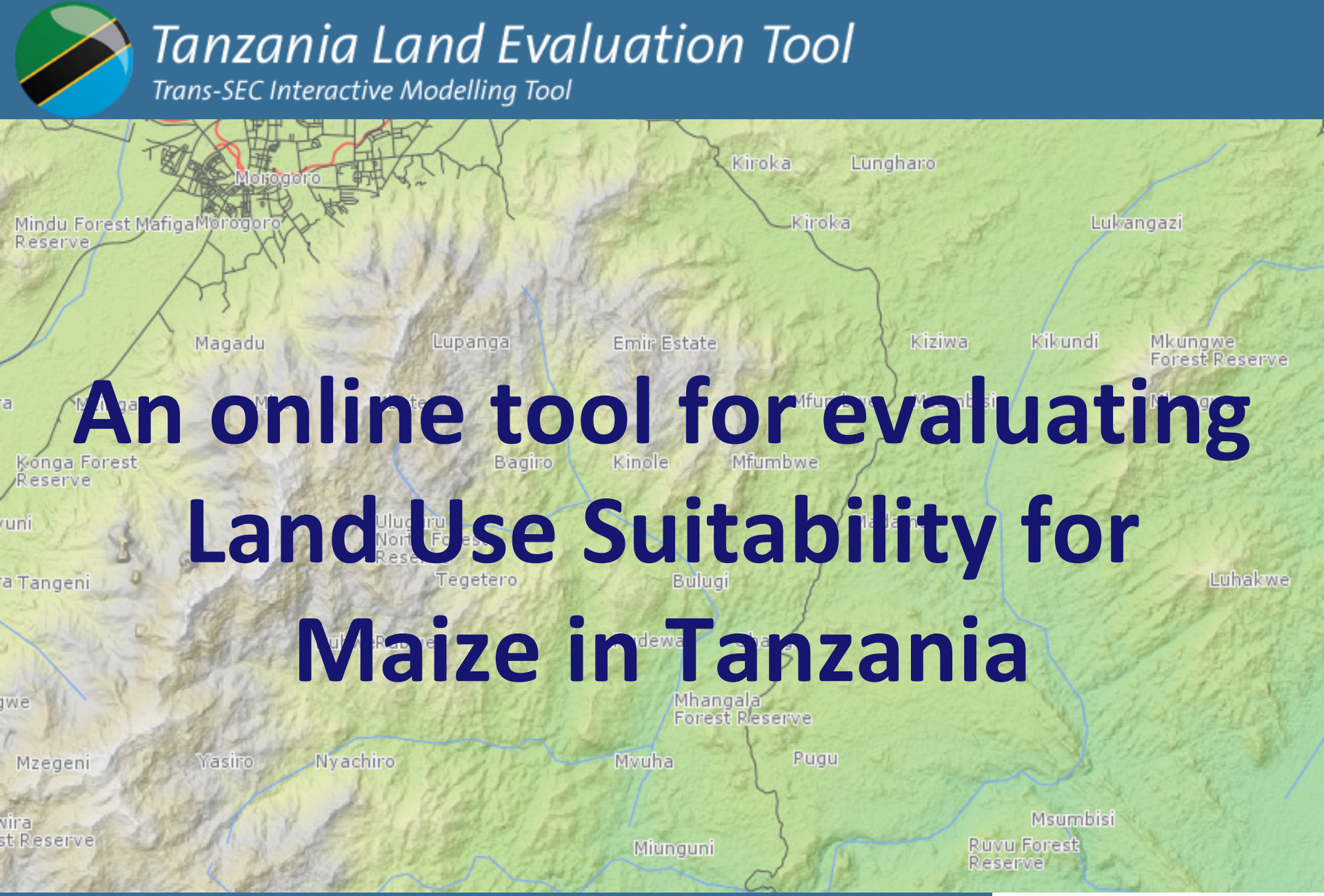


An online tool for evaluating Land Use Suitability for Maize in Tanzania

Karsten Vennemann, Seattle

TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS

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

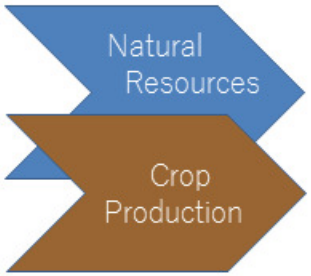
Federal Ministry of Education and Research

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



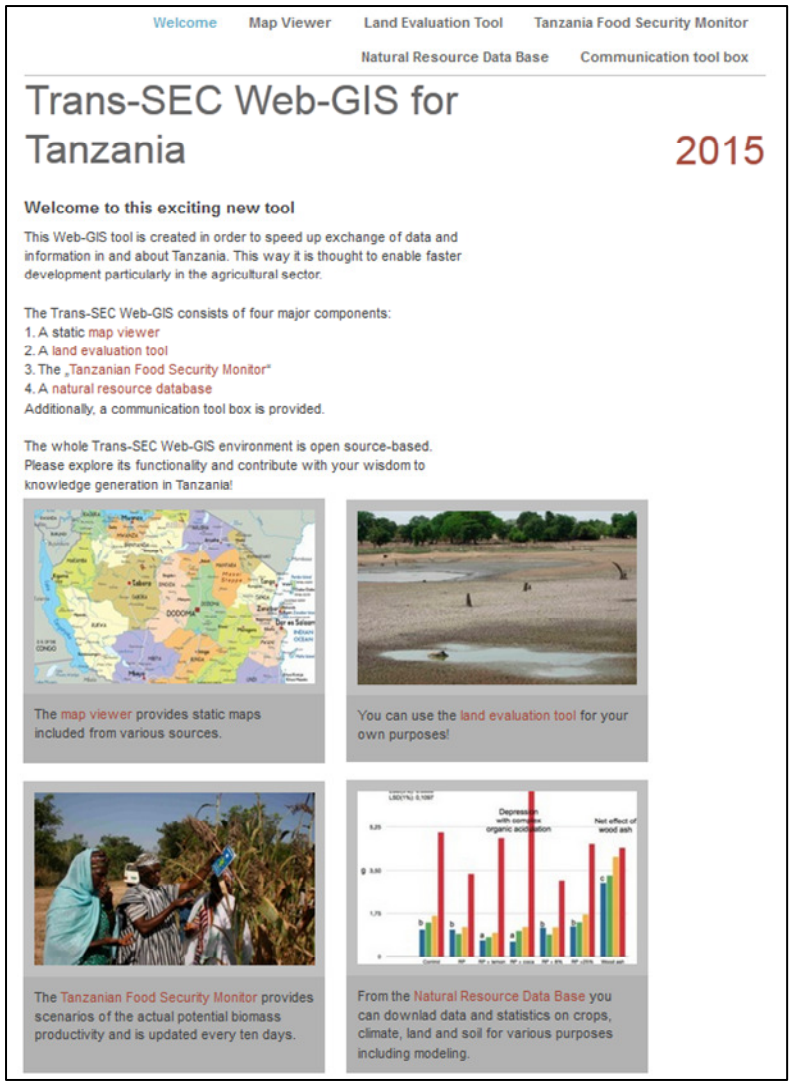
1. Rainwater harvesting (tie-ridges, infiltration pits)
2. Fertiliser micro-dosing ("deep fertiliser placement")
3. Optimised weeding

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

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)

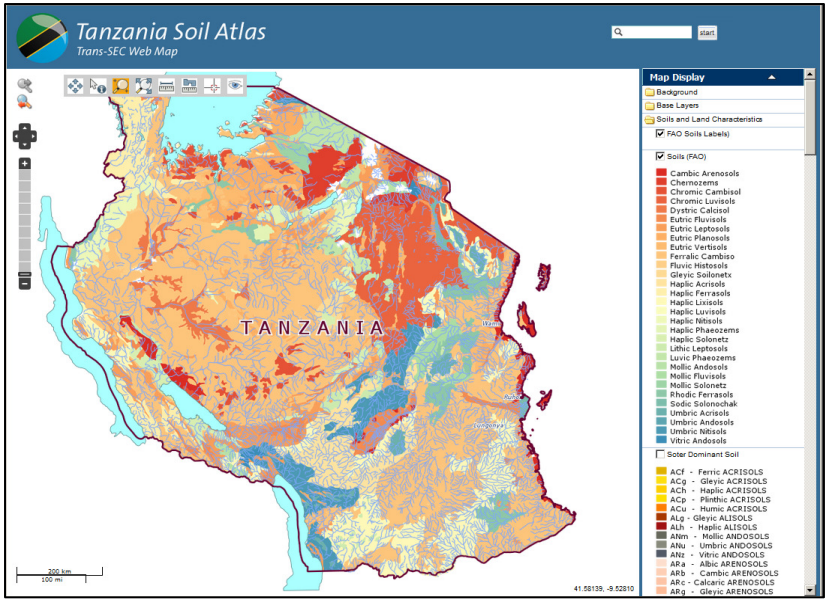
1. Household nutrition education
2. Kitchen gardens (indigenous fruits and vegetables for dietary diversification)

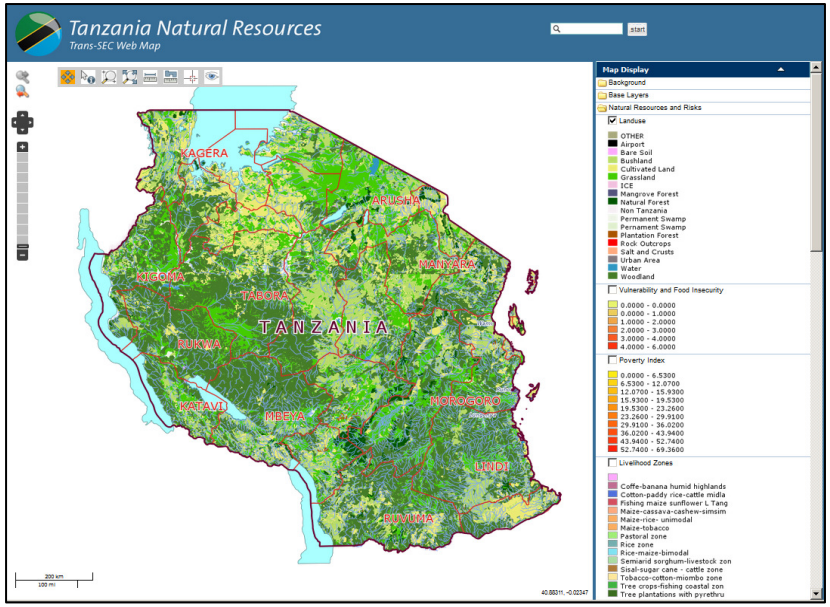
Trans-SEC Web GIS - Overview

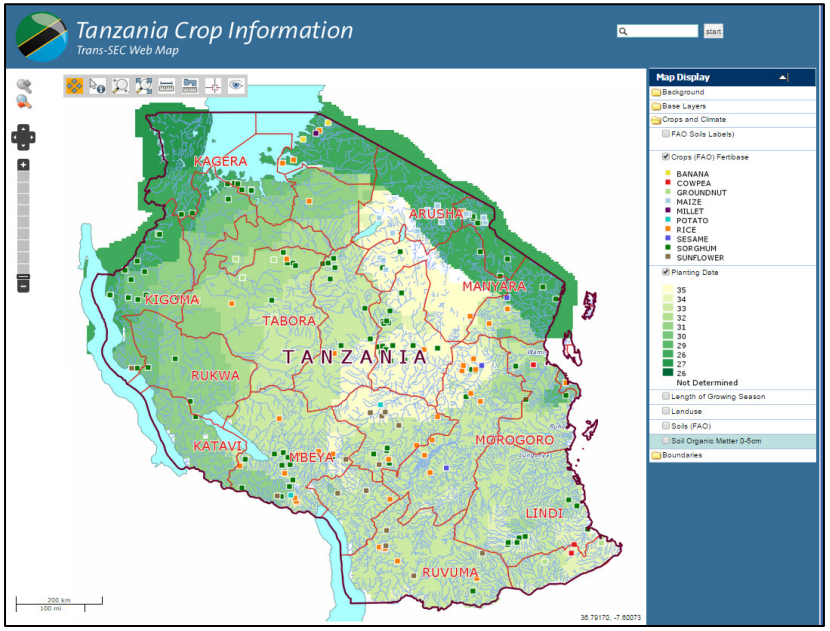


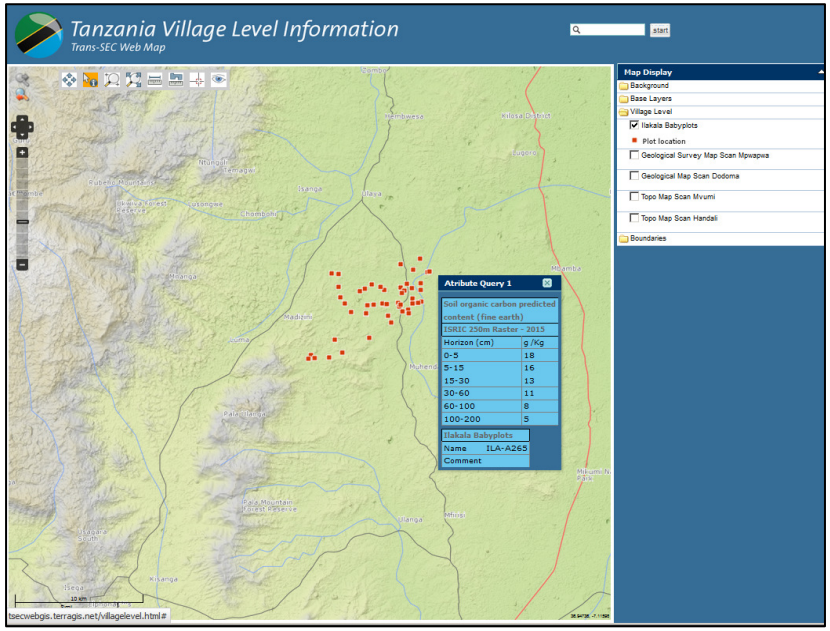
- **Online Map Viewers**
  - Tanzania Soil Atlas
  - Natural Resources
  - Crops and Climate
  - Village/Local level maps
- **Land Evaluation Tool**
- **Tanzanian Food Security Monitor**
- **Natural Resource Database**

Online Map Viewers

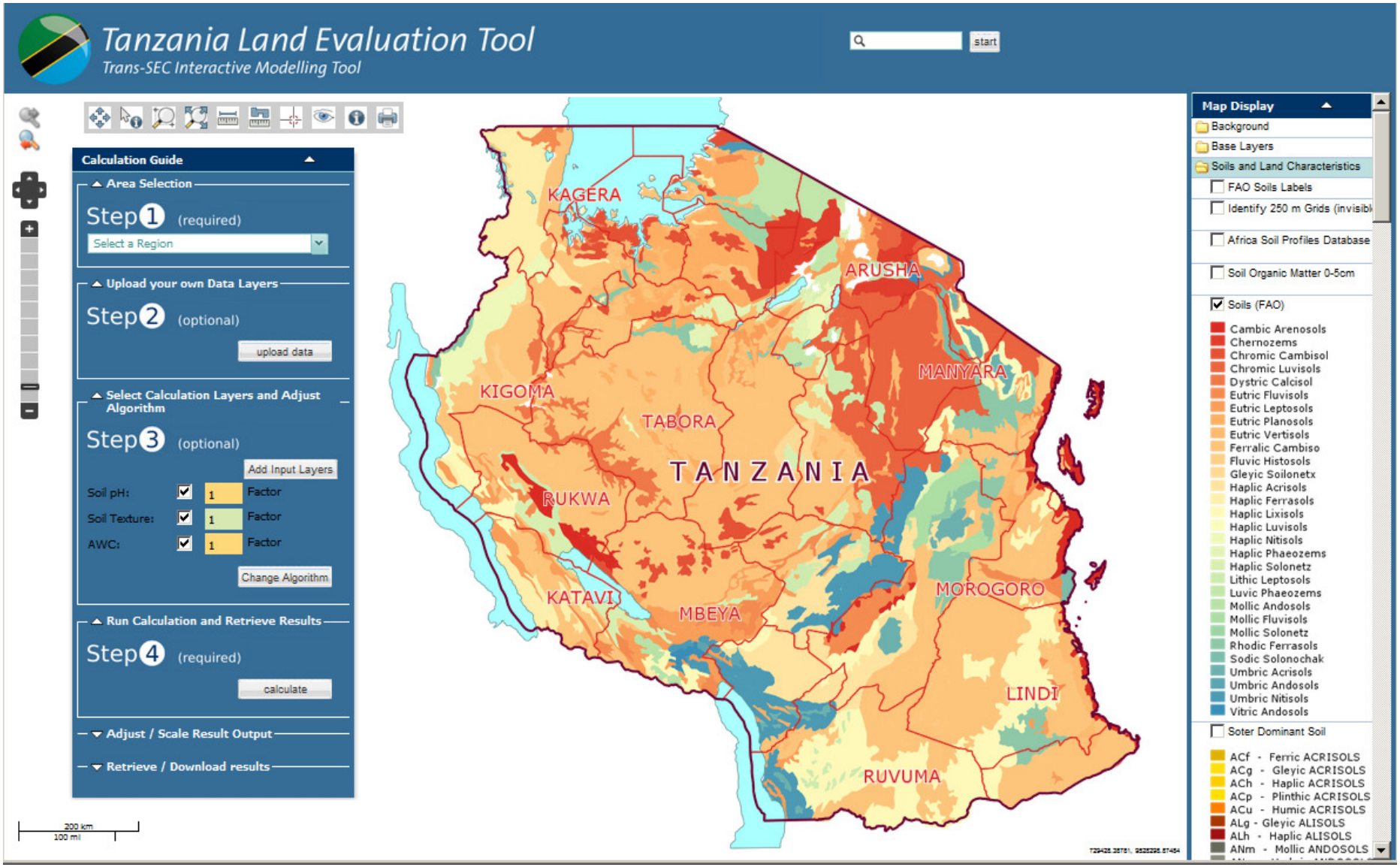




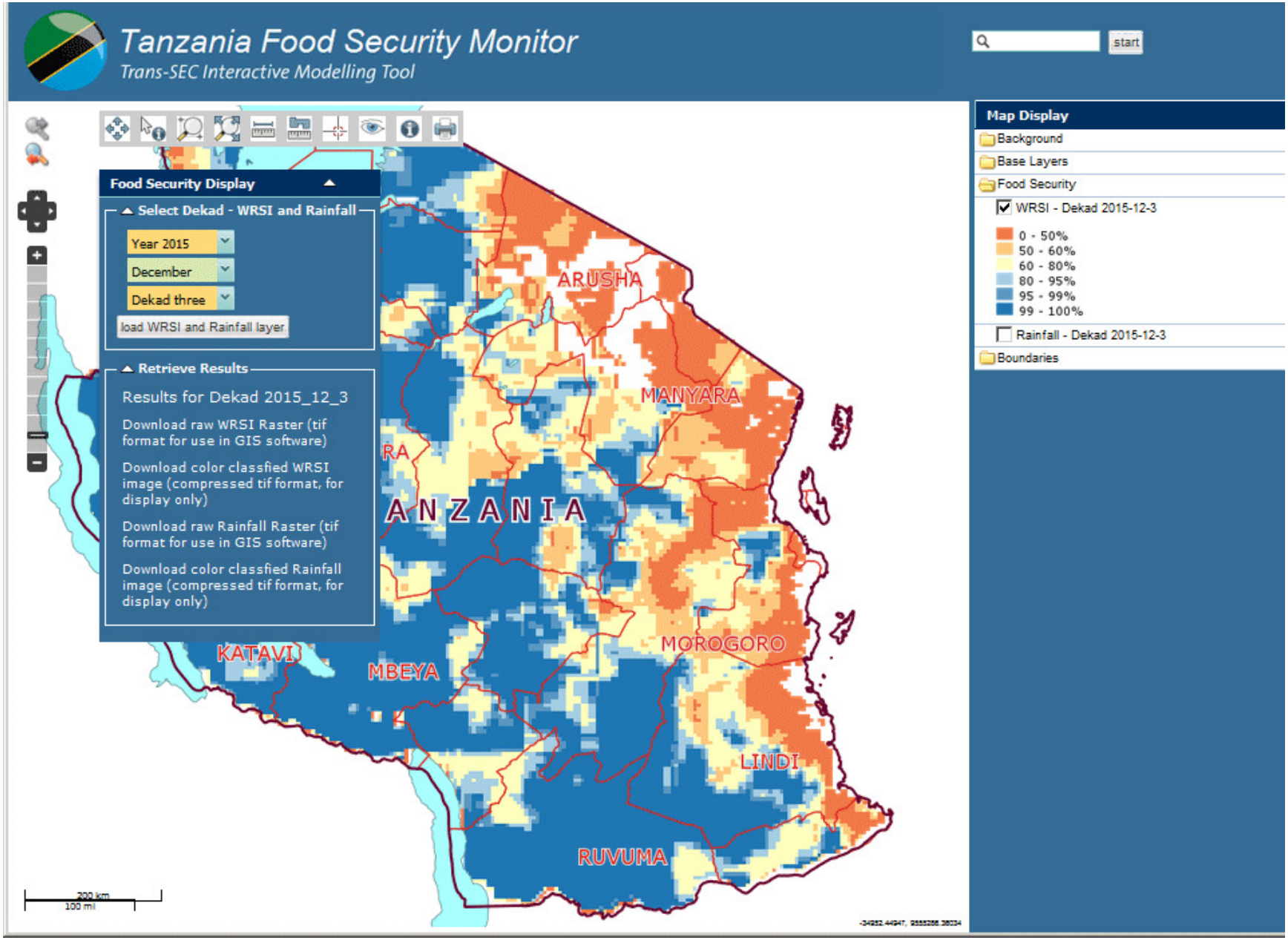




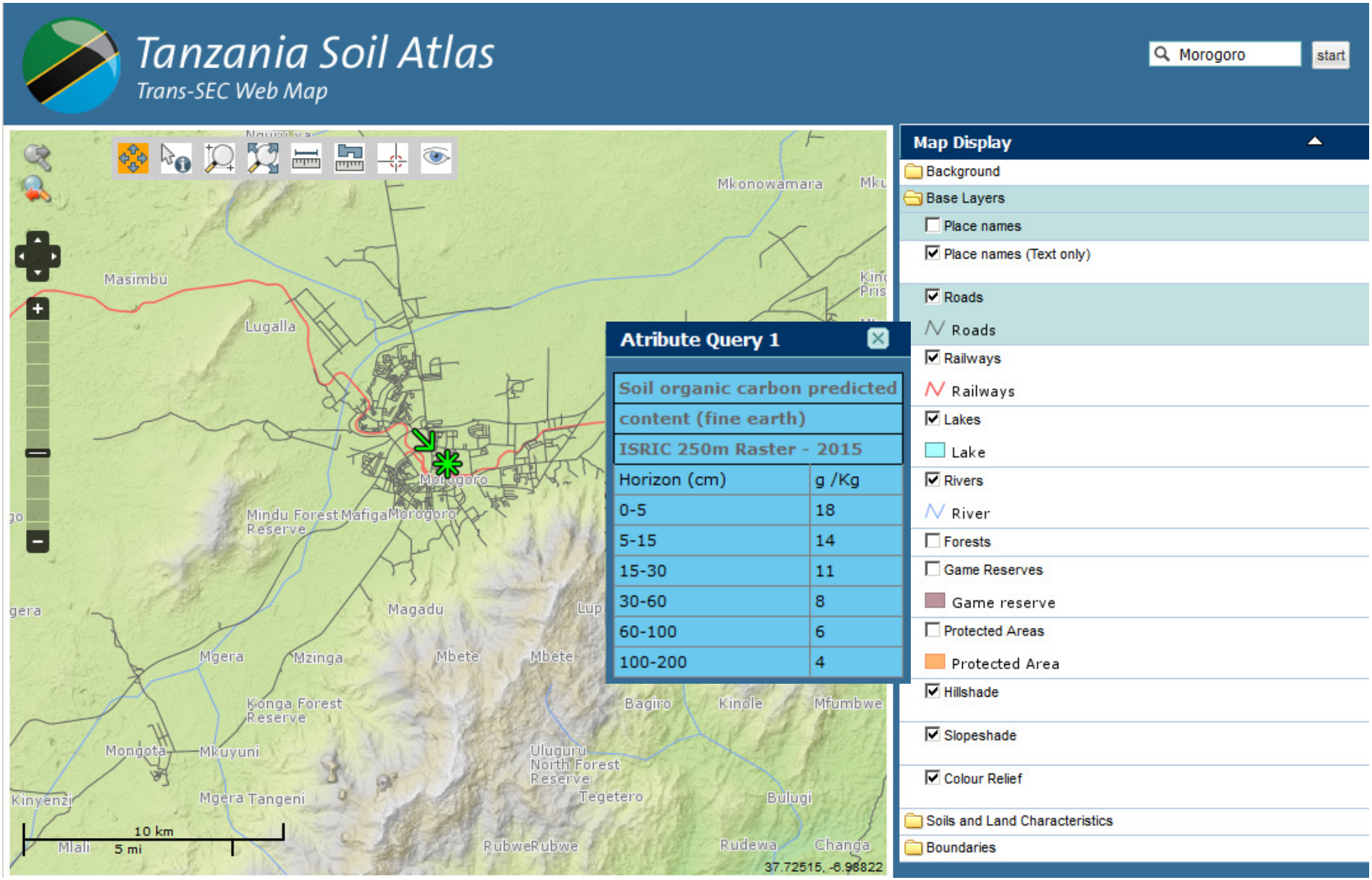
Land Evaluation Tool



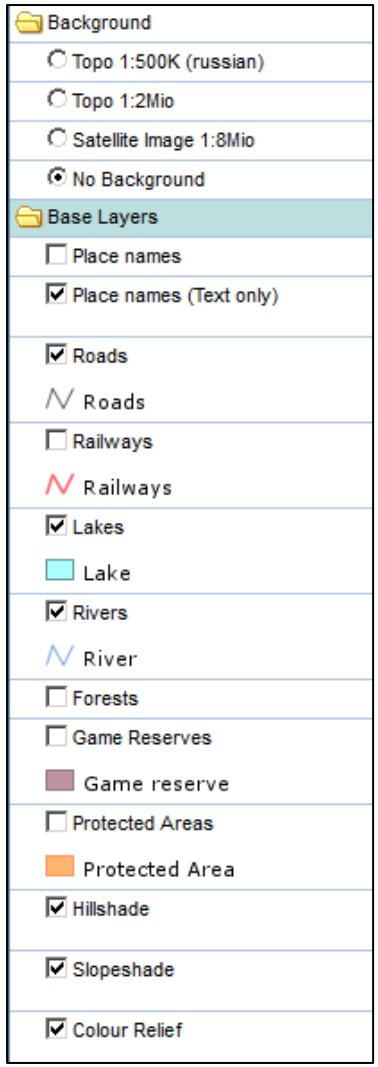
Food Security Monitor

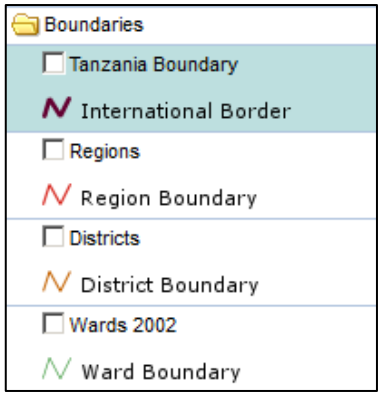


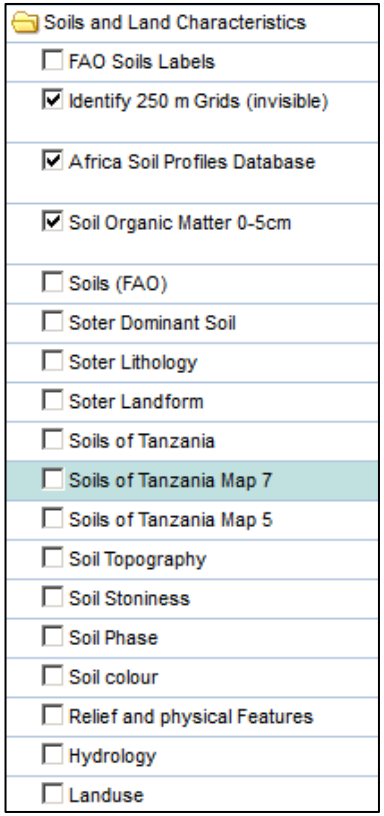
Soil Atlas - Interactive Map Viewer



Example: Soil Atlas - Layers







Atribute 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

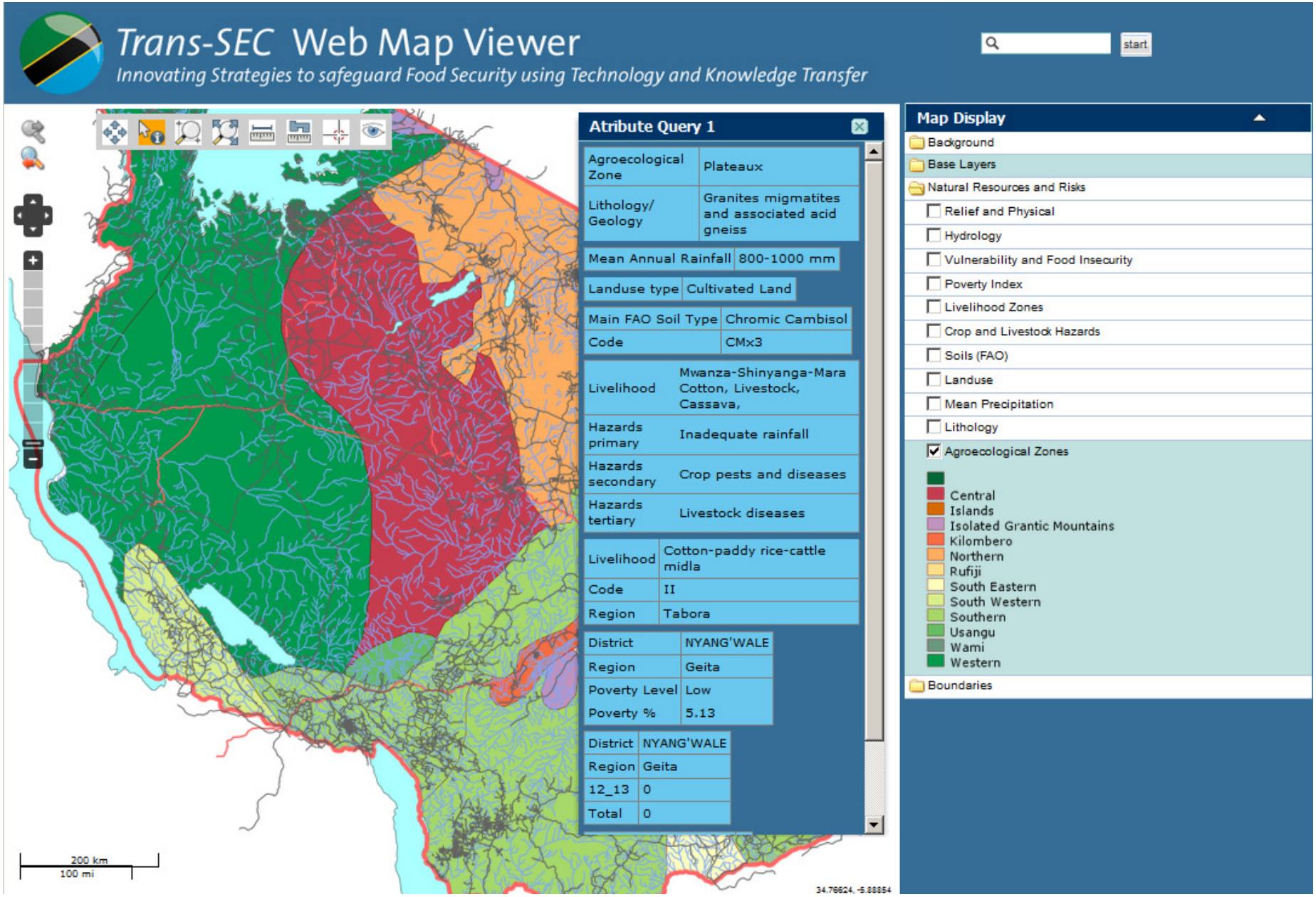
Soil Colour	Gray
Soil Phase	Deep soil
Soil Stoniness	Soil without stone
Topography Type	Moderate topography
Soil Description 2	Young alluvium
Soil Description 3	Alluvial lacustrin origin soils
Soil Description 1	Clay with imperfect drainage

Atribute 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 condutivity ECN	dS/m	0.28400001

Natural Resource Layers



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 all 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*

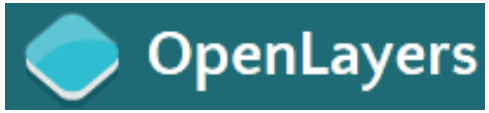
MapServer – Rendering Engine

- 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
  Sindex = A x B x C x D x 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

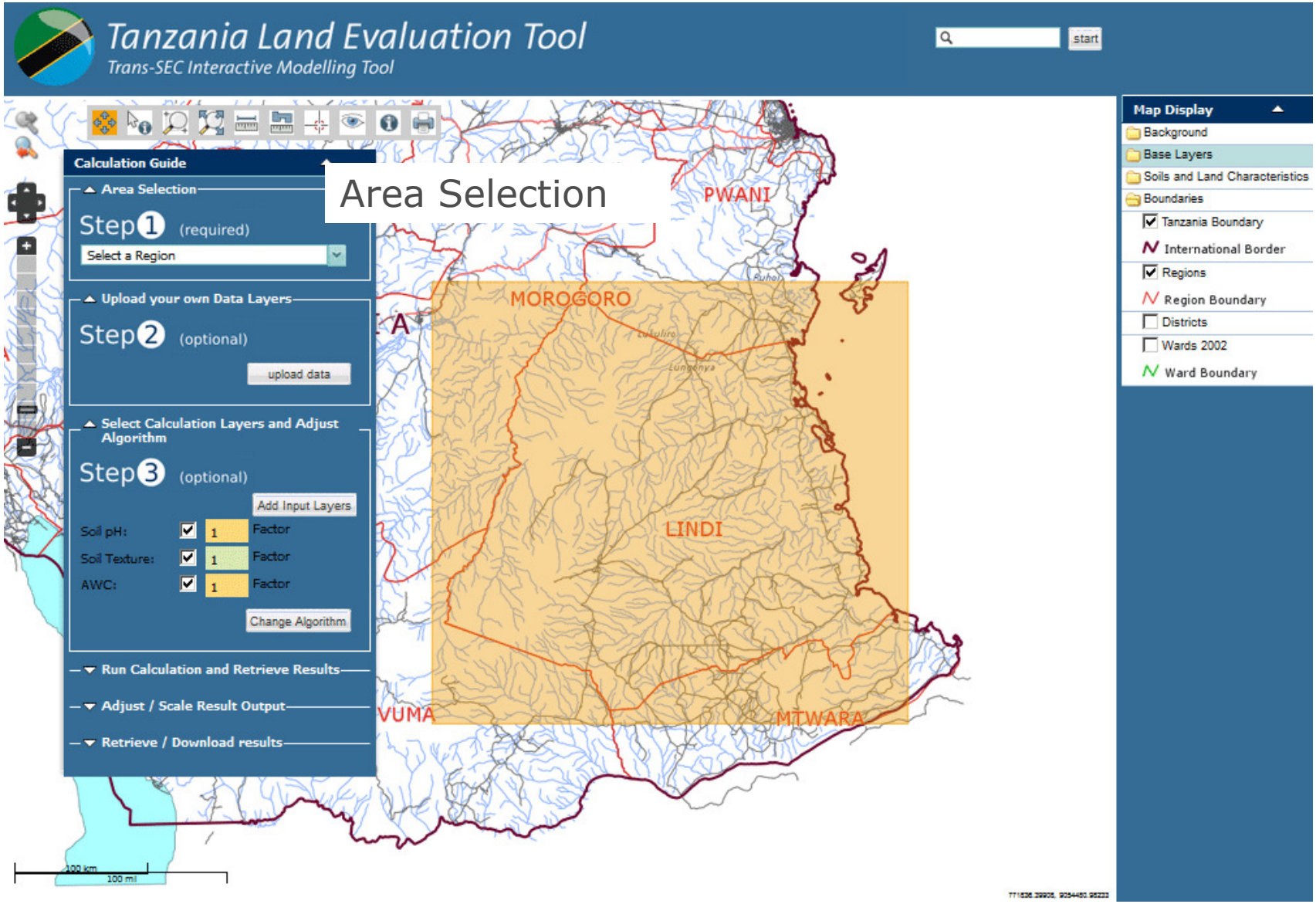
- Maximum of layers that can be selected
- List of input data layers for model calculations
  - site characterization data
  - soil parameters based on 250m soil raster data sets provided by ISRIC (2015)

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 requirments	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



An online tool for evaluating Land Use Suitability

for Maize in Tanzania and beyond

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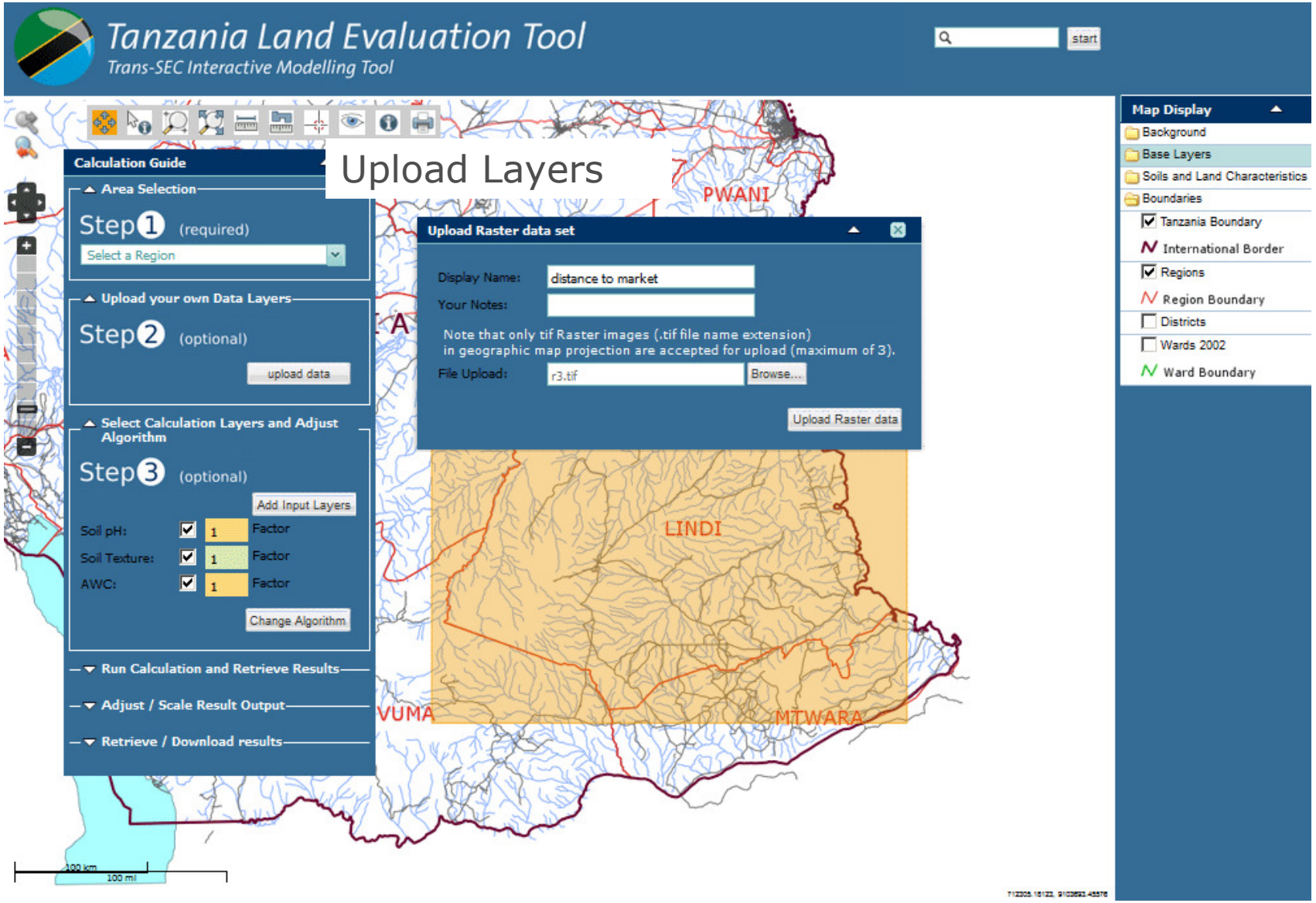
Land Evaluation Tool - Steps



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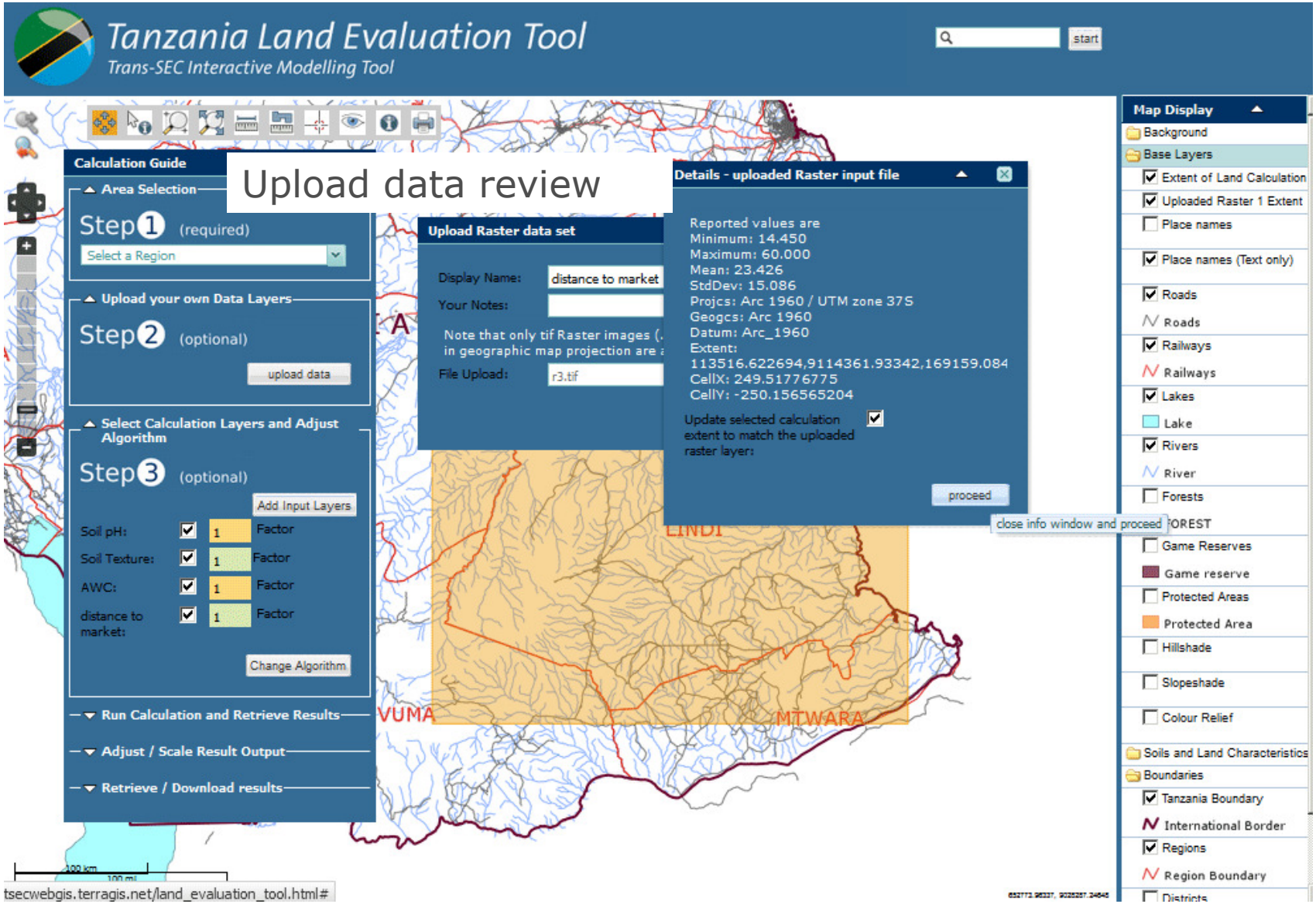

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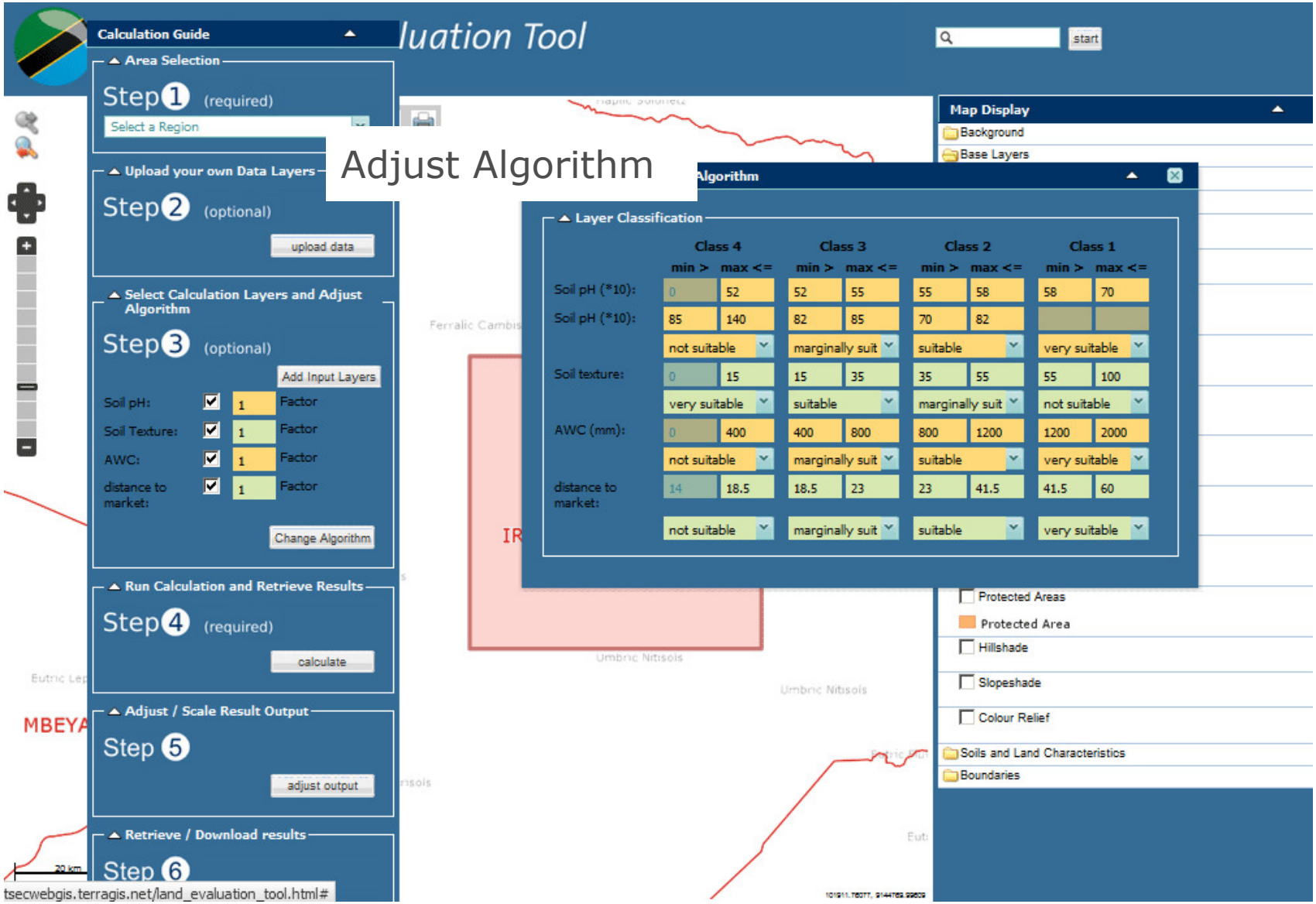

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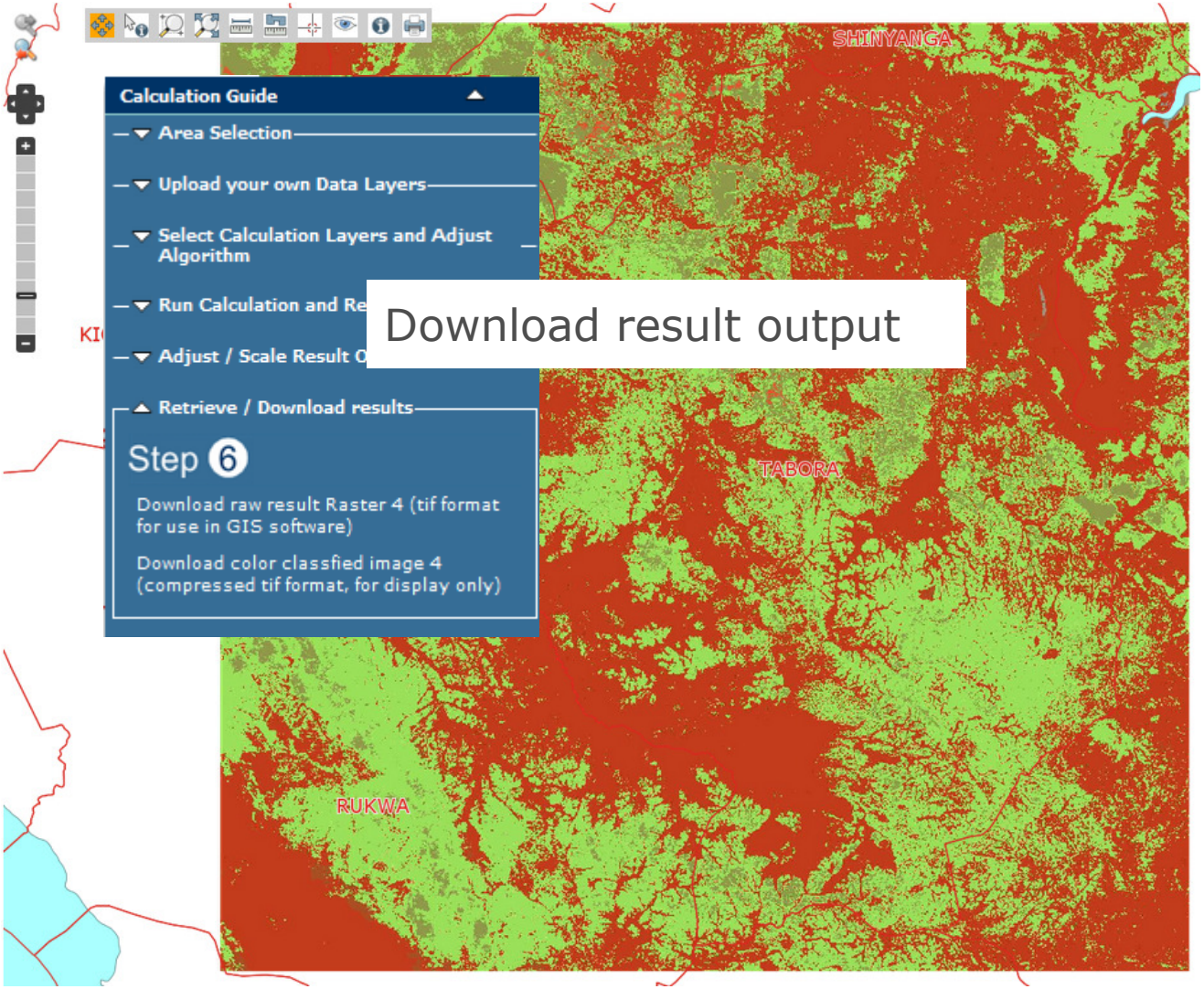
Land Evaluation Tool – output



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 all* publication
- Usage highly flexibile
  - 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

TERRA GIS
TERRESTRIAL ENVIRONMENT REGIONAL ANALYSIS