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ESTIMATION OF EVAPOTRANSPIRATION IN MINAS GERAIS STATE, BRAZI

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developed in the framework of the DevCoCast project

ITC

FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

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~~**Introduction**~~

Objective of the application

Methodology

Input data

Local / regional (in-situ) data

Data from GEONETCast-DevCoCast

Data analysis

Data pre-processing steps required

- Import LSA SAF products
- Import Spot Vegetation products
- Submap of the Minas Gerais State and resampling other maps
- Change of units for LST and ALBEDO of the MG Sub Maps
- Calculate Emissivity, Solar Zenith Angle, derive downward solar radiation and Julian day number
- Import table and processing of in situ data

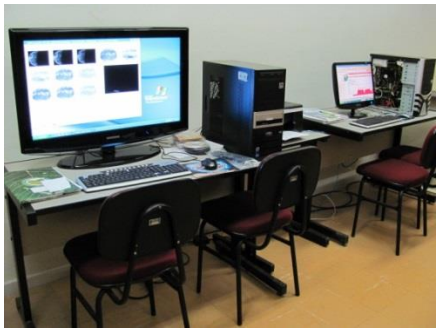
Running SEBS in ILWIS

Derive statistical information aggregating Minas Gerais state and center pivot area

Conclusions

FEDERAL UNIVERSITY OF LAVRAS 21°13’ 43.98’’ S, 44°58’ 30.30’’ W, 921 m
Minas Gerais State, Brazil

http://www.ufla.br/en/



Introduction

Evapotranspiration (ET) is the term used to describe the amount of water which is effectively lost from the earth surface to the atmosphere by soil surface evaporation and plant transpiration.

ET is mainly:
-an important component of the water cycle
-necessary for calculation of the soil water balance,
-input variable in crop yield models or study of ecosystem or study of regional climate, among others.

There are 3,789 center pivots in Minas Gerais State until 2011.
The estimation of evapotranspiration from data obtained by remote sensing is an alternative in the determination of water required by crops, especially for large areas, since the traditional methods using data collected using meteorological ground observations, represents only points in geographic space.

Objective of the application

The objective of this application is to estimate daily Evapotranspiration (ET) using the Surface Energy Balance System (SEBS) Model to know the ET pattern over irrigated areas by center pivots, in MG State, Brazil using ILWIS and the GEONETCast Toolbox with data obtained through GEONETCast and DevCoCast. Since the Land Surface Analysis Satellite Application Facility (LSA SAF) also provides an ET product (SAF ET), the estimated ET calculated using the SEBS model and the SAF ET product are also compared.

Methodology

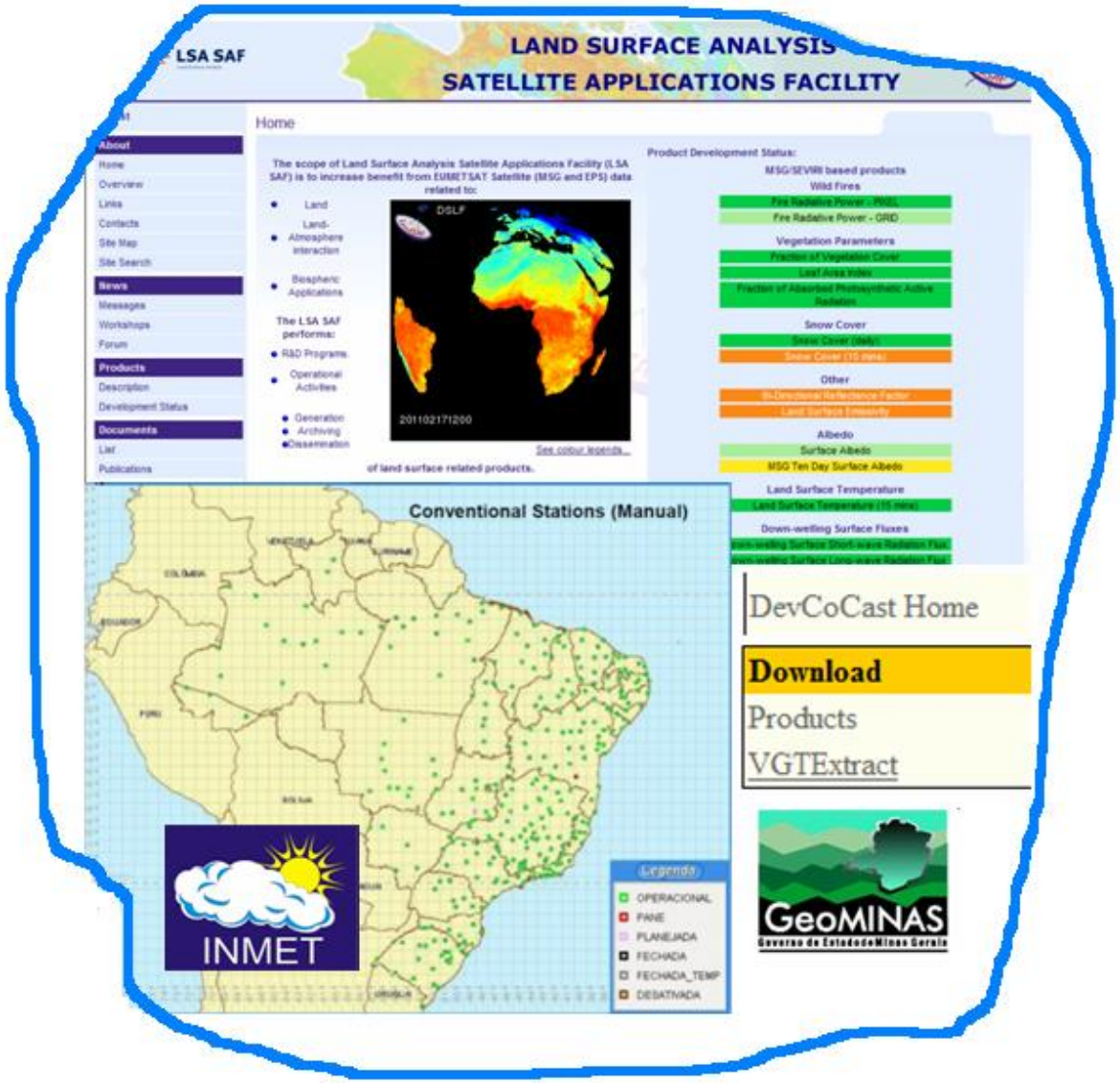
The SEBS model (Su 2002) was developed to estimate surface energy fluxes and the evaporative fraction using remotely sensed data in combination with meteorological information at scales that are dependent on the forcing data.

SEBS consists of several separate modules to estimate the net radiation and soil heat flux and to partition the available energy (=Rn-G0) into sensible and latent heat fluxes, as presented the equation :

$$Rn - G0 = H + \lambda E$$

Where: Rn: the net radiation;
G0: the soil heat flux;
H: the sensible heat flux;
λ E: the latent heat flux.
SEBS estimates the net radiation based on the radiative energy balance.

Input data


LSA SAF
LAND SURFACE ANALYSIS
SATELLITE APPLICATIONS FACILITY
Home
About
Home
Overview
Links
Contacts
Site Map
Site Search
News
Messages
Workshops
Forum
Products
Description
Development Status
Documents
List
Publications
The scope of Land Surface Analysis Satellite Applications Facility (LSA SAF) is to increase benefit from EUMETSAT Satellite (MSG and EPS) data related to:
Land
Land-Atmosphere interaction
Biospheric Applications
The LSA SAF performs:
R&D Programs
Operational Activities
Generation
Archiving
Dissemination
of land surface related products.
DSLF
201102171200
See colour legends...
Product Development Status:
MSG/SEVIRI based products
Wild Fires
Fire Radiative Power - PIXEL
Fire Radiative Power - GRID
Vegetation Parameters
Fraction of Vegetation Cover
Leaf Area Index
Fraction of Absorbed Photosynthetic Active Radiation
Snow Cover
Snow Cover (daily)
Snow Cover (15 mins)
Other
Bi-Directional Reflectance Factor
Land Surface Emissivity
Albedo
Surface Albedo
MSG Ten Day Surface Albedo
Land Surface Temperature
Land Surface Temperature (15 mins)
Down-welling Surface Fluxes
Down-welling Surface Short-wave Radiation Flux
Down-welling Surface Long-wave Radiation Flux
Conventional Stations (Manual)
Legenda
OPERACIONAL
PANE
PLANEJADA
FECHADA
FECHADA_TEMP
DESATIVADA
INMET
DevCoCast Home
Download
Products
VGTExtract
GeoMINAS
Governo do Estado de Minas Gerais

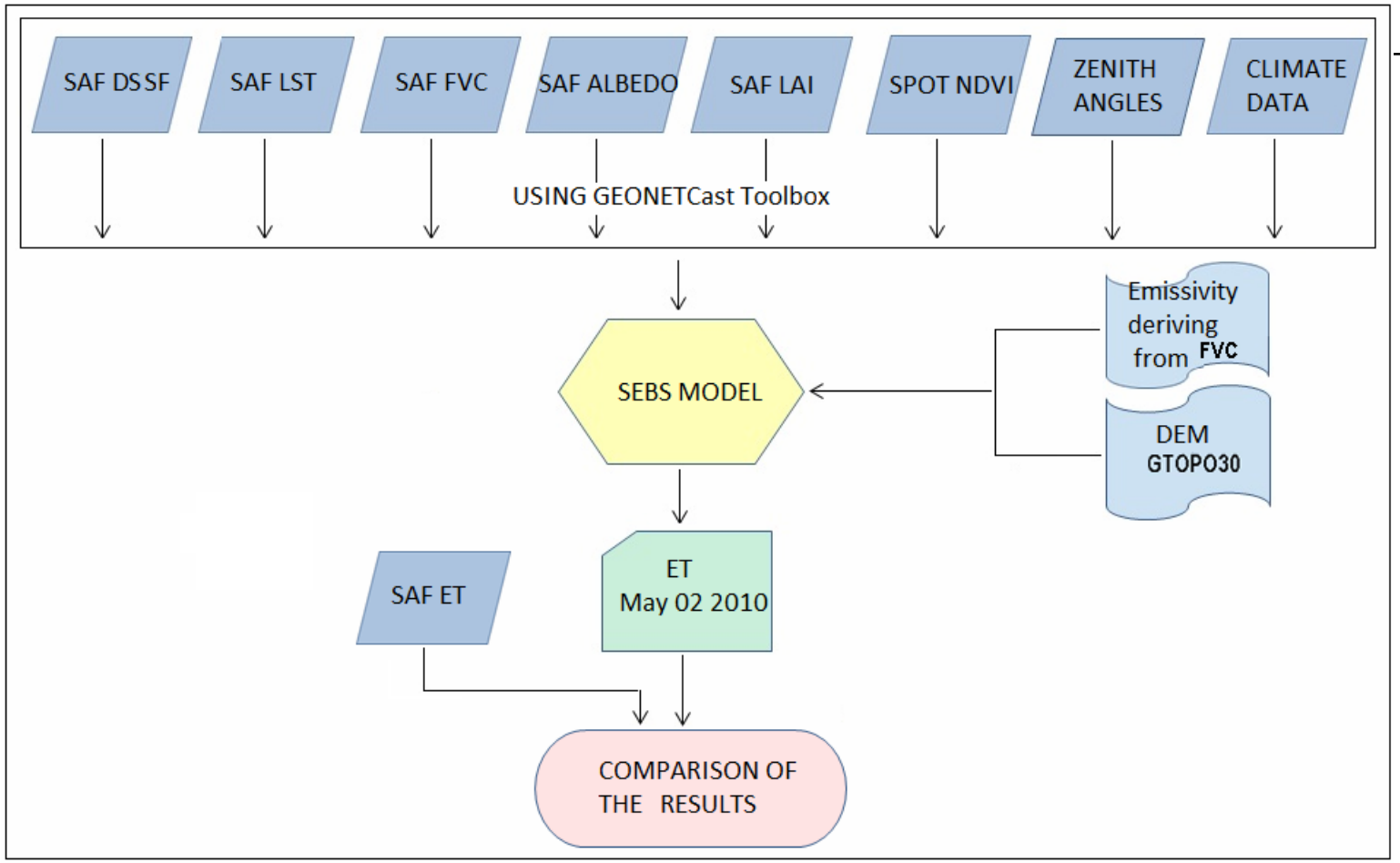
Local / regional (in-situ) data

DEM (http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/gtopo30_info)
Data of Climatological Ground Stations of MG State (https://www.inmet.gov.br)
Boundary (ILWIS map layer) (http://www.geominas.mg.gov.br/)
Municipalities (ILWIS map layer) (http://www.geominas.mg.gov.br/)
pivots_MG (ILWIS map layer) (made by the authors of this application)

Data from GEONETCast-DevCoCast

Landsaf products (https://landsaf.meteo.pt/):
S-LSA_-HDF5_LSASAF_MSG_ALBEDO_SAme_201005020000.bz2
S-LSA_-HDF5_LSASAF_MSG_FVC_SAme_201005020000.bz2
S-LSA_-HDF5_LSASAF_MSG_LAI_SAme_201005020000.bz2
S-LSA_-HDF5_LSASAF_MSG_DSSF_SAme_201005021500.bz2
S-LSA_-HDF5_LSASAF_MSG_LST_SAme_201005021500.bz2
ET_Minas_geo (ILWIS map layer)
SPOT Vegetation product (http://www.devcocast.eu/):
V2KRNS10__20100501_NDVI__S-America.ZIP

The flowchart



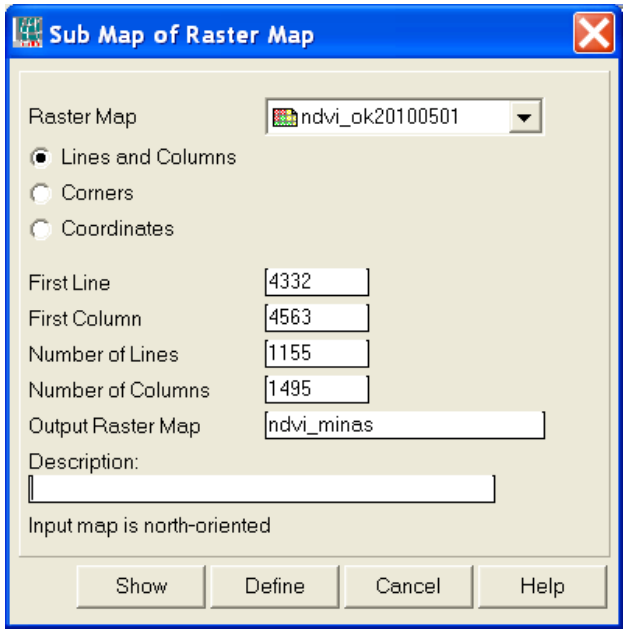
Data analysis

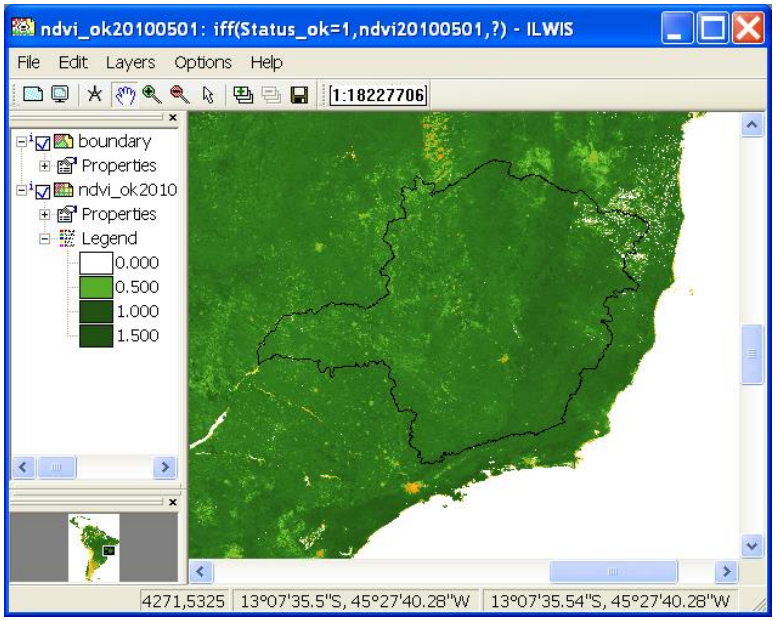
Data pre-processing steps required

Import LSA SAF products

Import Spot Vegetation products

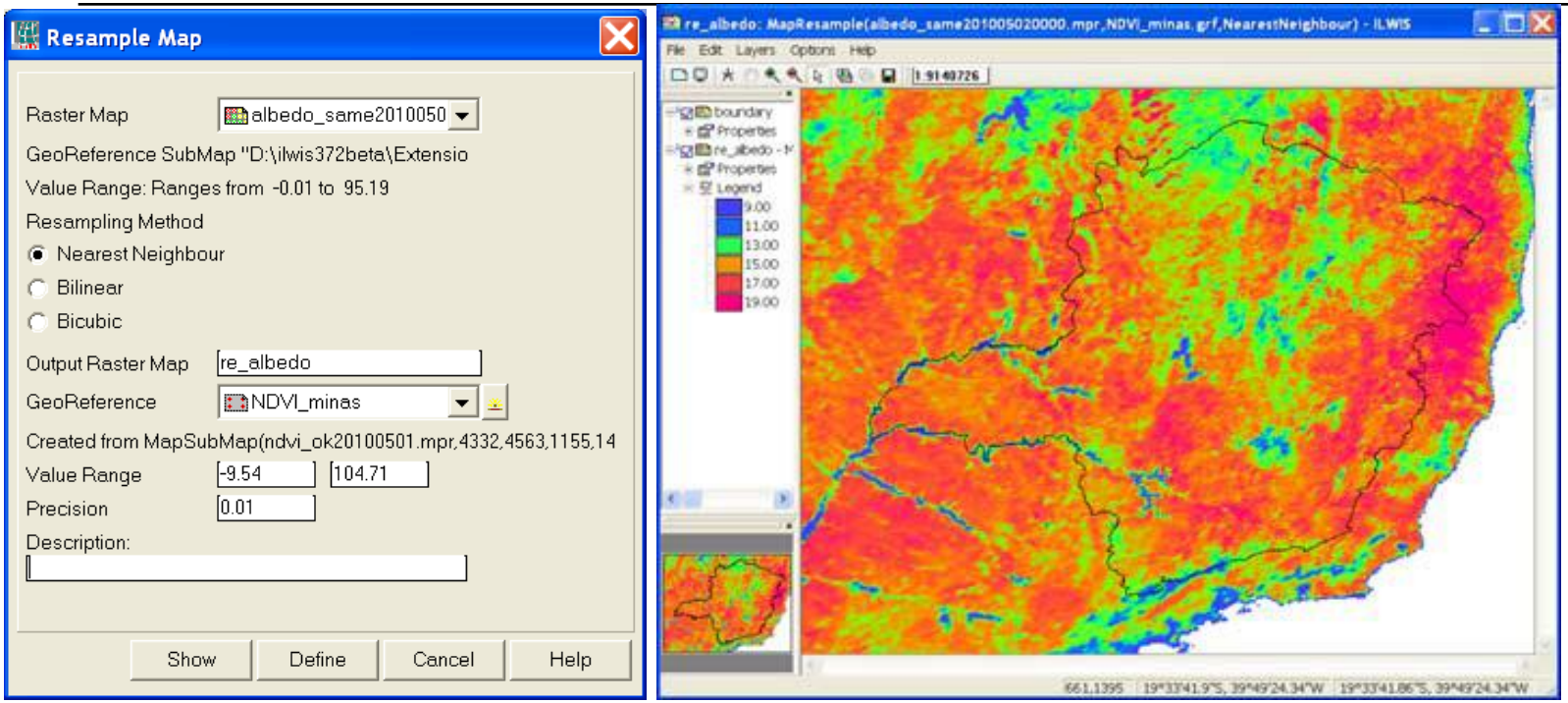
Submap of the Minas Gerais State and resampling other maps





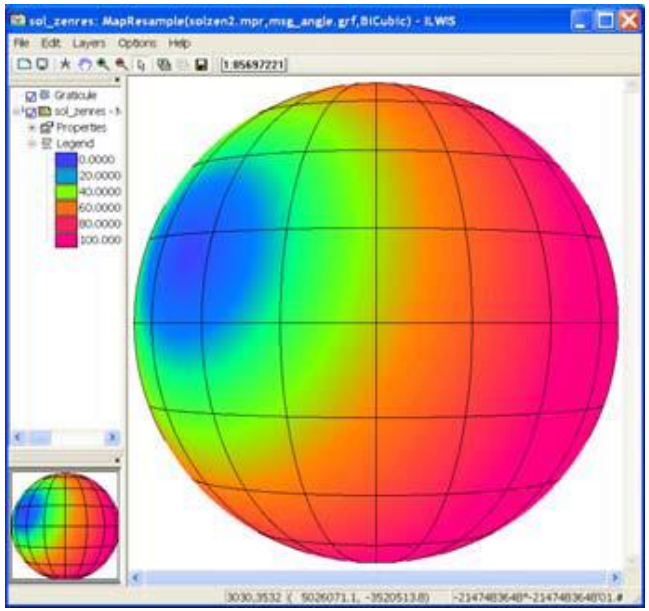
Creating a sub map of SPOT VGT4 NDVI for MG State and sub map details

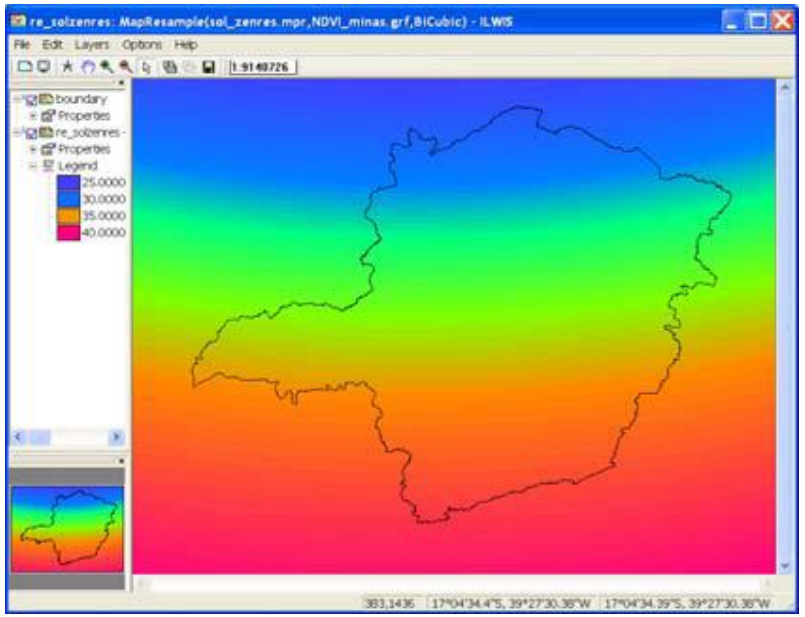
4.5.1.4. Change of units for LST and ALBEDO of the Minas Gerais Sub Maps



Resampling settings and the resulting Albedo sub map

Calculate Emissivity, Solar Zenith Angle, derive downward solar radiation and Julian day number





Solar zenith angle of MSG for the full disk and resampled to the Minas Gerais georeference

Table with “in-situ” data of meteorological ground stations for Minas Gerais

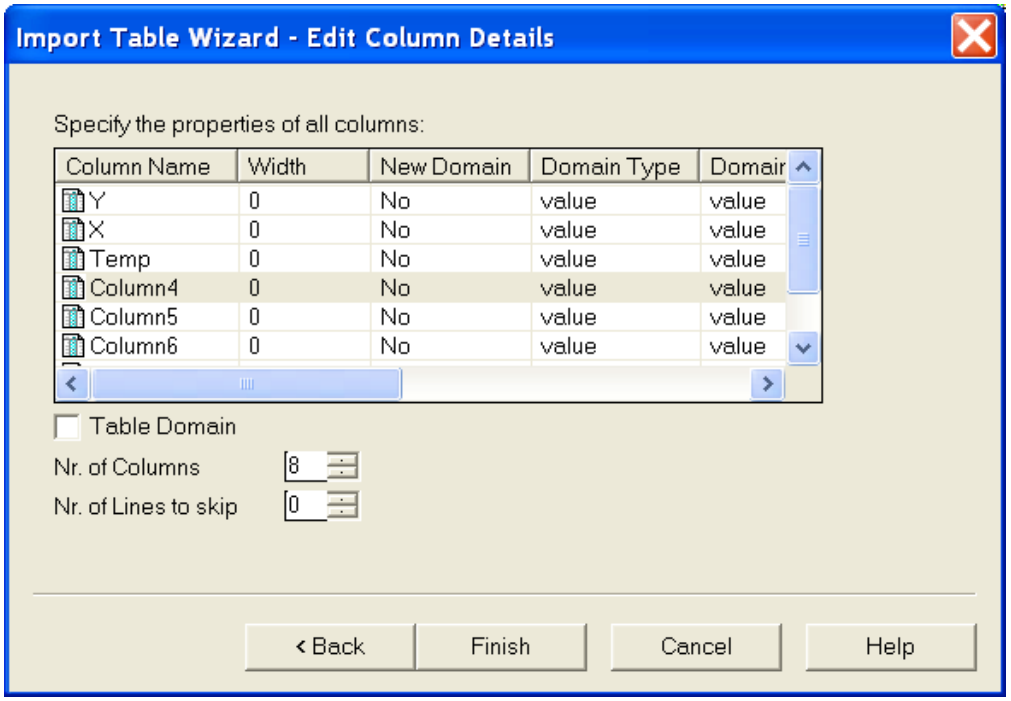
Table "Station_MG" - ILWIS

File Edit Columns Records View Help

	Y	X	Temp	HumidityRel	Pressure	Mix_ratio	Ins_hrs	Windspeed
1	-16.83	-42.05	22.8	72.3	98000	0.013	5.92	1.00
2	-19.60	-46.93	18.7	77.3	90230	0.012	7.43	1.96
3	-20.03	-46.00	18.2	83.2	93870	0.012	7.27	1.10
4	-21.25	-43.76	16.3	82.1	89100	0.011	6.25	1.36
5	-19.93	-43.93	19.6	72.5	91870	0.011	7.65	1.36
6	-21.91	-46.38	15.9	81.3	88340	0.010	6.74	1.48
7	-21.85	-45.30	17.3	71.4	91200	0.010	7.63	0.68
8	-18.71	-49.55	21.5	77.5	94560	0.013	8.12	1.00
9	-19.80	-42.15	19.4	83.3	94830	0.012	6.55	2.13
10	-21.38	-42.68	21.1	78.8	99650	0.012	6.39	1.02
11	-19.01	-43.43	18.6	80.3	94120	0.011	6.20	0.65
12	-21.56	-43.25	19.3	80.8	96840	0.012	5.89	0.92
13	-18.75	-44.45	20.9	69.6	93900	0.011	7.22	0.71
14	-18.25	-43.60	16.9	78.4	87280	0.011	6.87	1.20
15	-14.91	-42.85	23.5	59.6	94940	0.011	7.97	2.07
16	-19.88	-44.41	17.7	74.7	93110	0.010	7.46	2.34
17	-18.85	-41.93	22.3	76.0	99170	0.013	5.88	0.82
18	-20.01	-44.05	18.2	78.4	92530	0.011	6.48	1.27
19	-17.01	-42.85	18.4	81.4	89710	0.012	5.93	1.53
20	-15.85	-44.36	23.0	67.8	96040	0.012	8.17	1.90
21	-19.45	-43.11	19.0	81.9	91990	0.012	6.06	0.97
22	-17.83	-46.16	21.7	69.4	93000	0.012	8.39	1.73
23	-21.70	-43.35	17.6	83.3	91240	0.011	5.46	2.46
24	-21.76	-45.00	17.4	77.4	91530	0.010	7.17	1.68
25	-21.75	-45.90	17.5	74.5	91900	0.010	6.34	1.10
26	-16.65	-43.83	21.1	65.3	94290	0.011	7.68	1.74
27	-20.63	-44.81	17.9	78.2	91050	0.011	7.82	1.13
28	-22.38	-44.96	16.2	76.3	91630	0.010	7.55	1.80
29	-18.51	-46.43	19.4	69.1	90910	0.011	7.78	1.37
30	-16.00	-41.28	21.4	76.2	94000	0.013	6.42	1.98
31	-17.35	-44.91	21.5	74.6	95740	0.012	8.69	1.76
32	-19.21	-45.00	20.1	78.4	93780	0.012	7.23	1.09
33	-16.16	-42.30	21.4	74.8	96060	0.012	5.34	1.51
34	-21.30	-44.26	17.4	74.7	91260	0.010	6.52	1.37
35	-22.10	-45.01	16.2	79.9	91900	0.010	6.46	0.47
36	-19.40	-44.25	19.0	72.3	93090	0.011	8.33	1.20
37	-17.85	-41.50	21.6	81.3	97590	0.013	5.66	0.62
38	-19.73	-47.95	19.8	74.6	93290	0.012	8.15	1.50
39	-20.75	-42.85	17.2	83.3	93820	0.011	6.69	1.15
Min	-22.38	-49.55	15.9	59.6	87280	0.010	5.34	0.47
Max	-14.91	-41.28	23.5	83.3	99650	0.013	8.69	2.46
Avg	-19.38	-44.28	19.3	76.2	93266	0.011	6.97	1.36
StD	2.00	1.77	2.1	5.4	2798	0.001	0.90	0.49
Sum	-755.88	-1726.77	753.0	2972.2	3637360	0.445	271.76	53.13

Column "Windspeed"

Import table and processing of in situ data



Editing first column of each line with appropriate column name

Import table and processing of in situ data

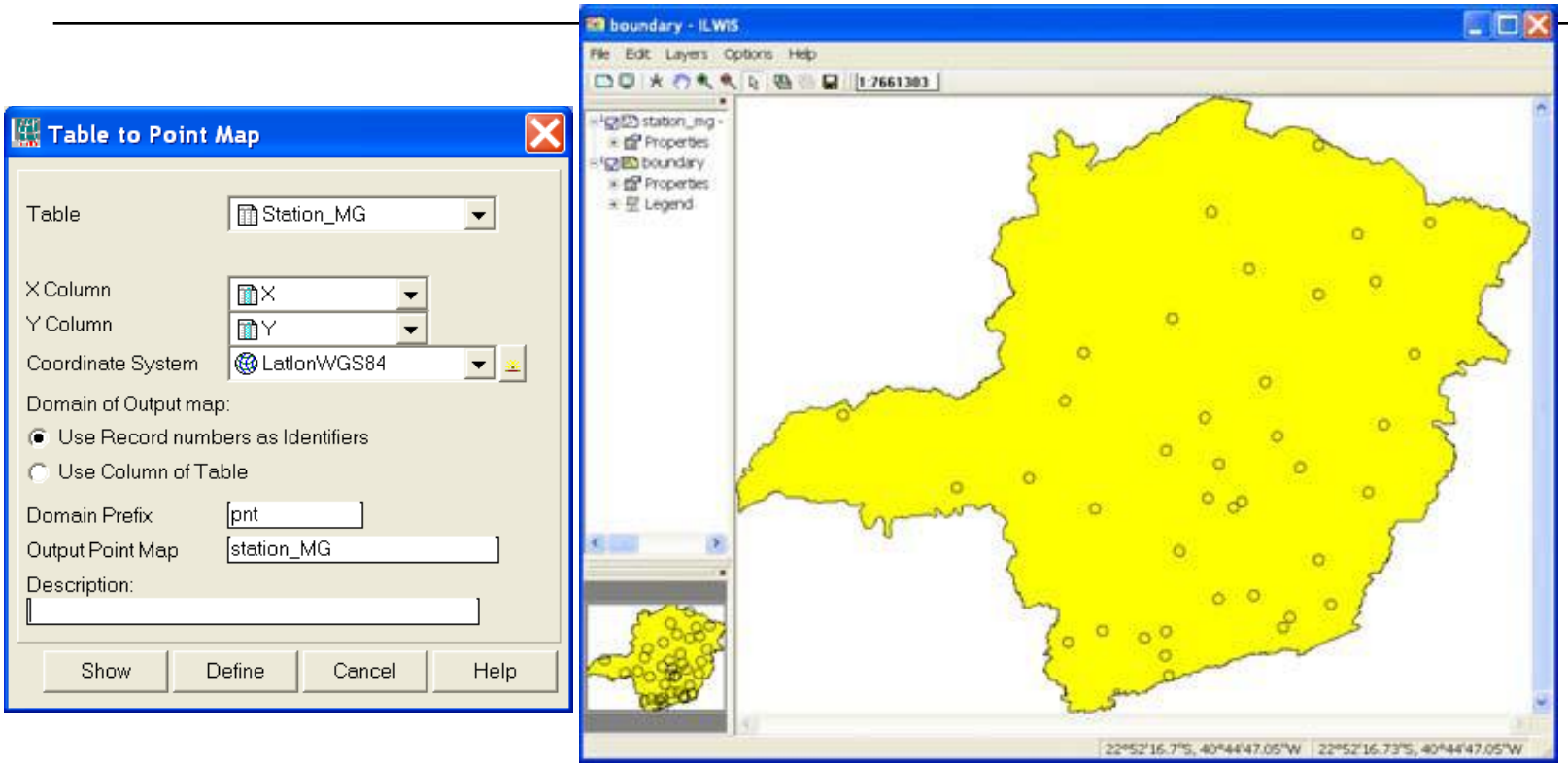
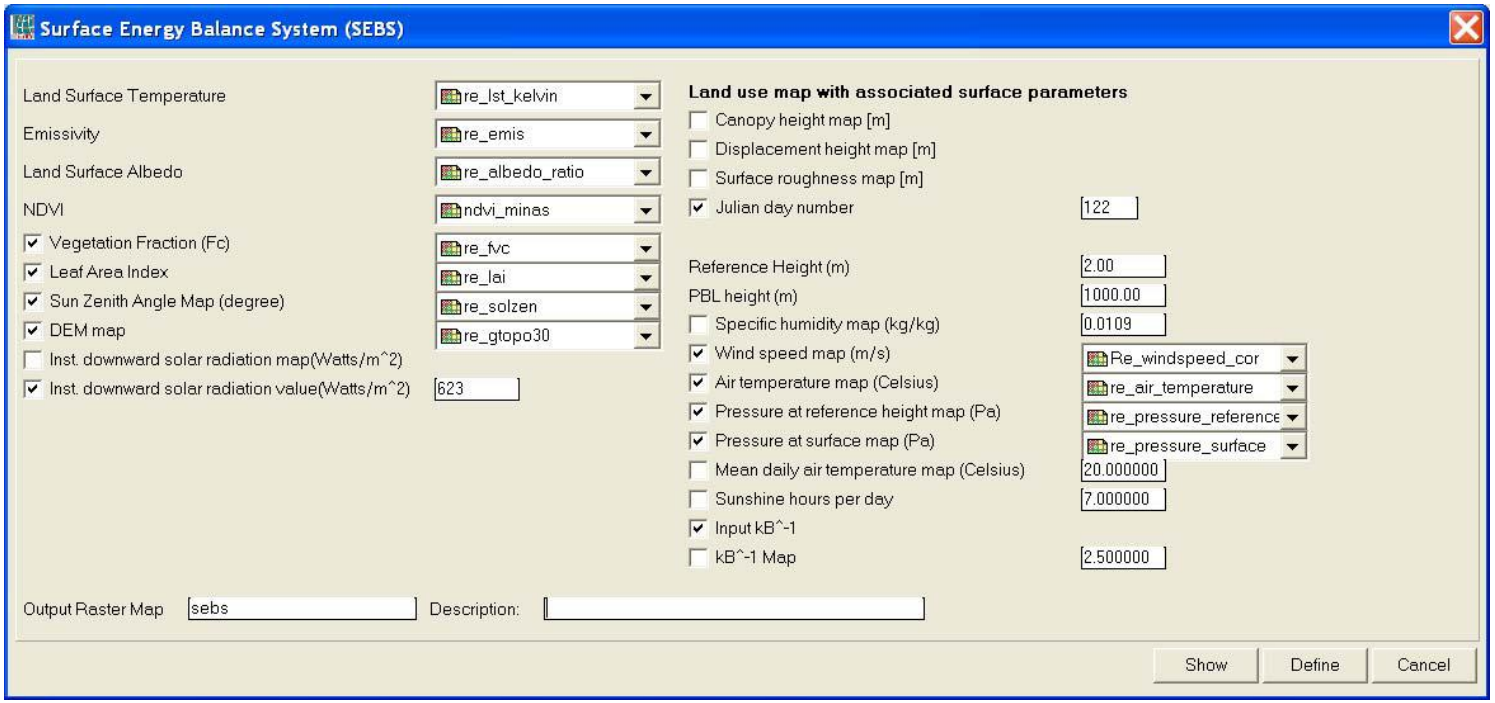


Table to point map conversion and INMET ground stations distribution

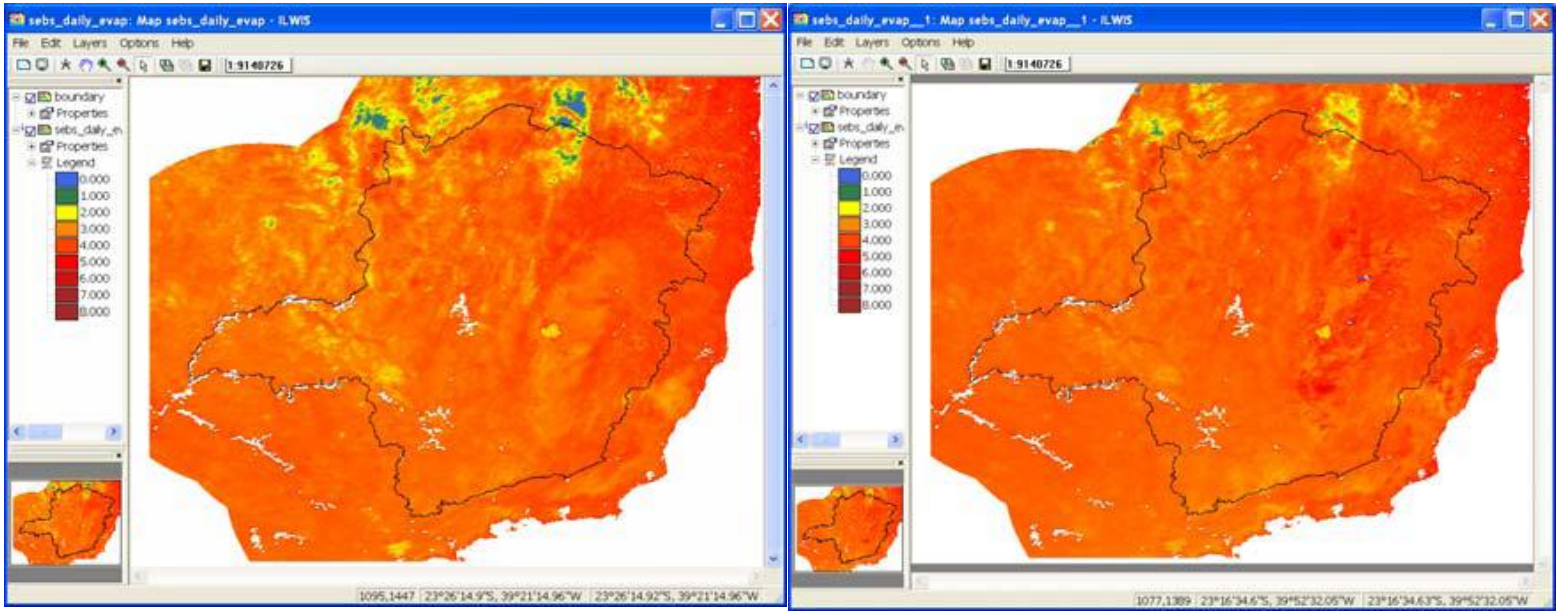
Running SEBS in ILWIS



SEBS data entry form in ILWIS

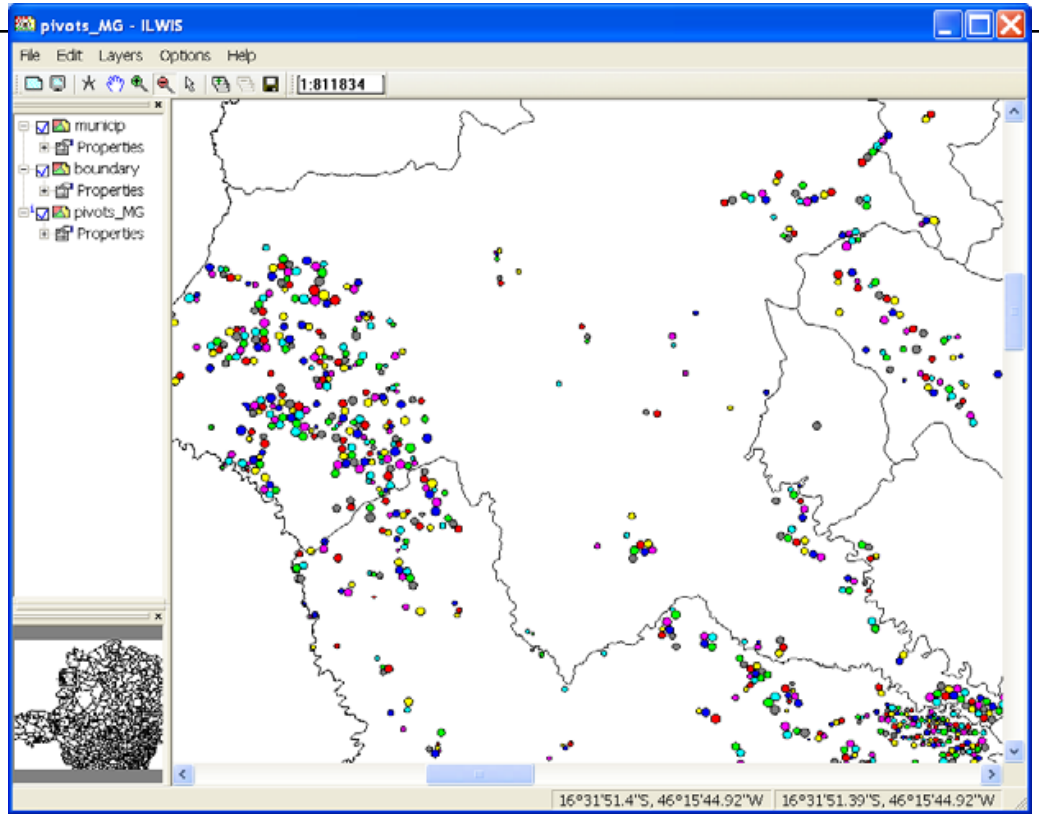
Running SEBS in ILWIS

SEBS daily ET (mm/day)



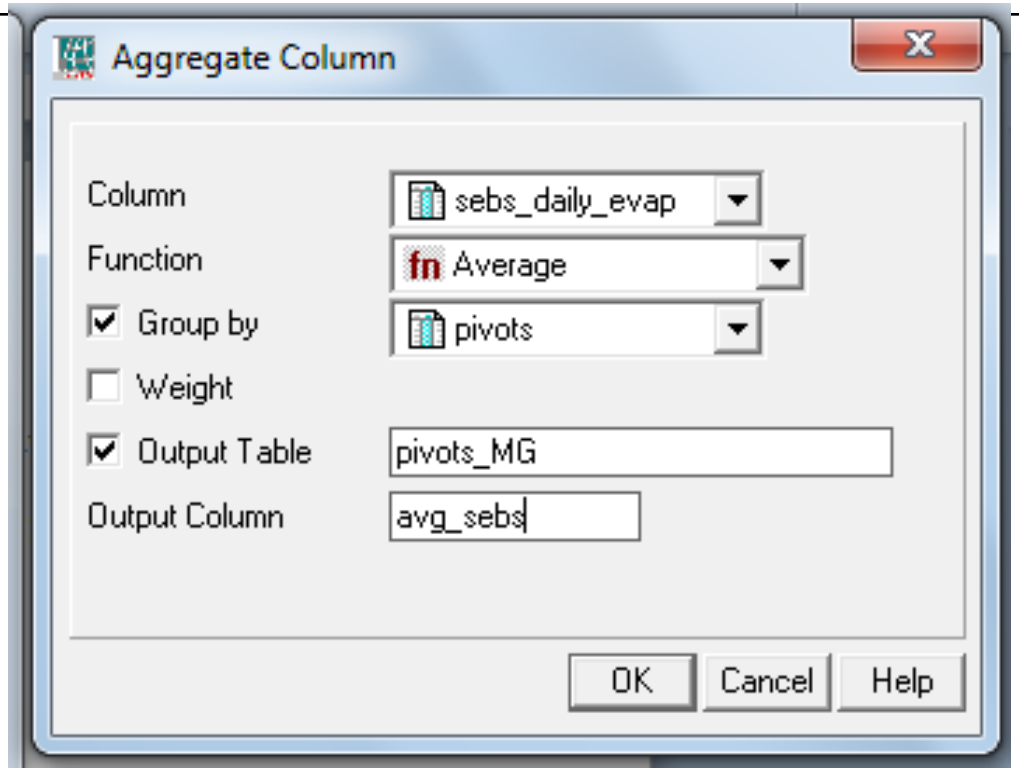
Using single downward solar radiation value Using LSA SAF DSSF map

Derive statistical information aggregating Minas Gerais State and center pivot area



Map detail showing various vector layers of irrigated areas by center pivots

Derive statistical information aggregating Minas Gerais State and center pivot area



Aggregating the daily evapotranspiration from SEBS to pivots areas

Conclusions

The SEBS model was used to estimate the daily evapotranspiration for the 2nd of May 2010. The results show an ET ranging from 2.063 to 4.321 mm/day in the Minas Gerais State using a single instantaneous solar downward radiation value and an ET ranging from 2.633 to 4.560 mm/day using the LSA SAF DSSF product (using 0.5 % cutoff interval).

More detailed statistics, like mean, standard deviation and median reveal that the overall results look quite comparable despite the fact that the last ET estimation is slightly higher as a single time step noon image (local time) was used. The daily aggregated ET LSA SAF product gives ET values in the range of 0.01 to 4.21 mm/day, showing a larger difference between the SEBS ET estimation (both runs) and the one obtained from the LSA SAF.

Considering that for the SEBS model runs a lot of local climatological - meteorological in situ input data was used, we consider that ET estimated using SEBS are more realistic compared to those from the ET LSA SAF and that the
last one is slightly underestimating the ET. Further validation is required using local in situ ET observations. It is important to consider that a number of input layers used in the SEBS model are actually derived from other LSA SAF products, also used in the computation of the ET LSA SAF product.

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THE END

THANK YOU

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