

SPIRITS

Software for the Processing and Interpretation of Remotely sensed Image Time Series



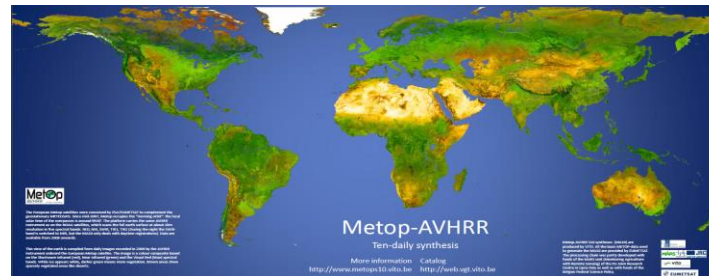
Software for Processing and Interpreting Remote Sensing Image Time Series

Felix Rembold, Carolien Tote, Herman Eerens, Dominique Haesen,
Sven Gilliams, Lieven Byderkerke



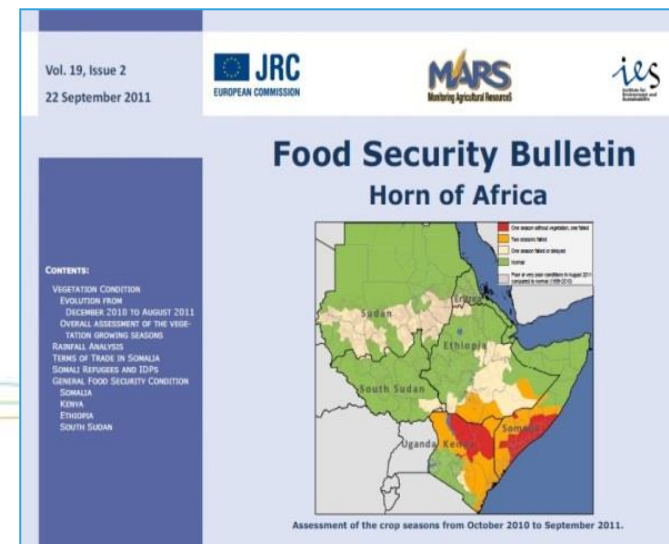
Why SPIRITS?

- » Large availability of free remote sensing data, but:
- » Remote sensing and processing software not specifically designed for time series processing
- » Food security analysts are usually not software programmers
- » Tools developed in the past are no longer updated (e.g. WINDISP)
- » Online platforms don't allow high degree of customization (e.g. Crop explorer, Decision Support Interface (DSI), MARS Viewer)



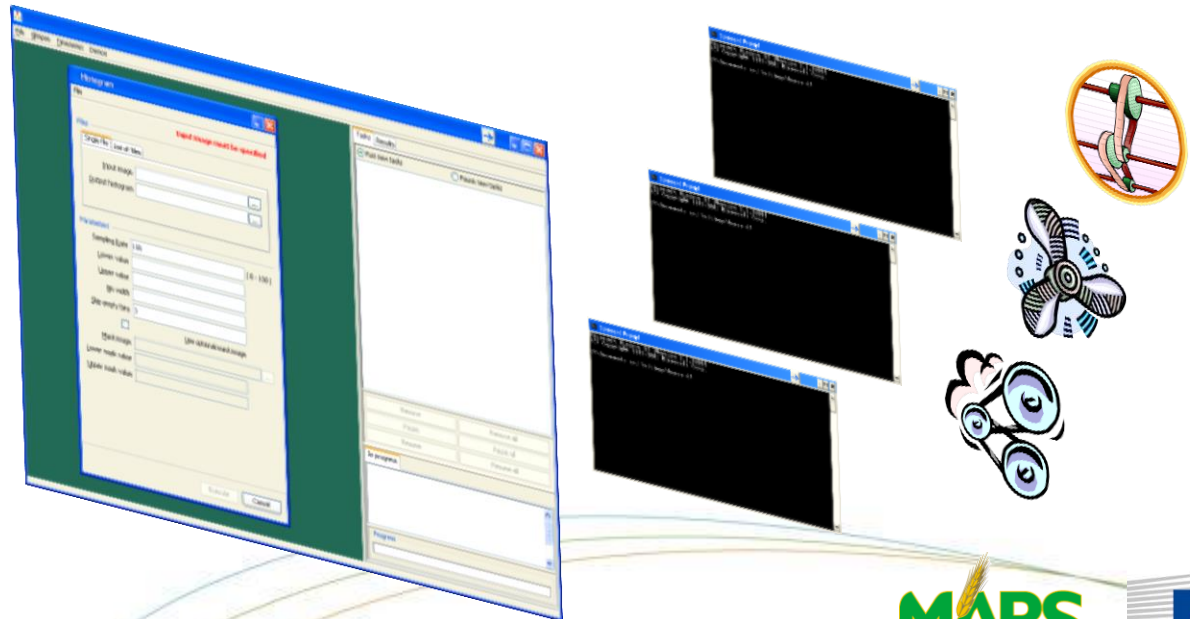
What is SPIRITS?

- » An integrated modular software for raster image time series processing for:
 - » producing information and facilitating analysis normally needed for **crop monitoring bulletins**
 - » strengthening **early warning systems** in food insecure countries
 - » automation of repetitive time series processing steps
 - » other uses like environmental monitoring
- » Complementary to other environmental analysis software (**E-station**) or drought monitoring systems (**ASIS**)



What is SPIRITS?

- » SPIRITS is a **Graphical User Interface** written in **Java** and based on GLIMPSE (previously developed set of C programs)
 - » controlling/using/launching/ in-built executables
 - » includes open source libraries (GDAL, HSQLDB...)
 - » can also run external executables



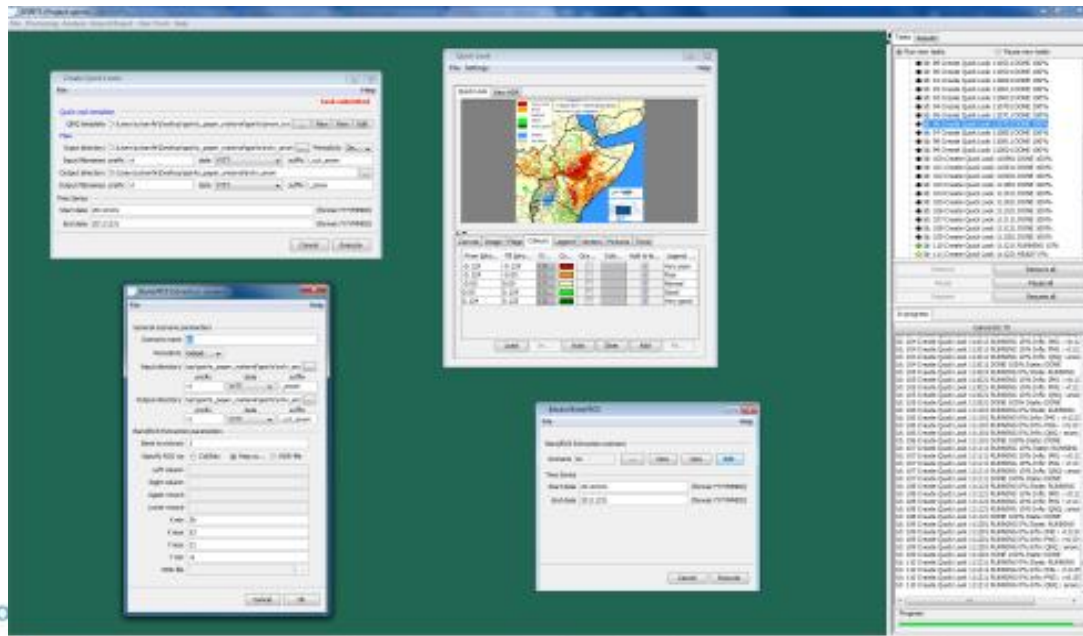
Who are the users?

- » Agricultural monitoring experts (e.g. Ministries of Agriculture and Forestry, Rural Development projects, FAO, WFP, etc...)
- » Remote sensing experts in research or government organizations
- » GIS experts with need to process remote sensing time series
- » E-station users focusing on agricultural monitoring
- » Other experts working with spatial data (food security, environment...)



SPIRITS information

- » Software developed by VITO for the MARS Unit of the Joint Research Centre (MARSOP contracts)
- » Version 1.0 November 2012, complete with manual and tutorials
- » Currently Version 1.1.1
- » Scientific paper accepted by «Environmental Modelling & Software»
- » WEBSITE to be finalized



Active since 2.30 pm today!

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European Commission

SPIRITS

Institute for Environment and Sustainability

European Commission > JRC > IES > Spirits

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SPIRITS
Software for the Processing and Interpretation of Remotely sensed Image Time Series

An integrated and flexible software environment for analyzing satellite derived image time series in crop and vegetation monitoring. With this toolbox, you can process time series from data source such as SPOT-Vegetation and MODIS, compute vegetation indexes and anomalies and extract aggregated statistics that can be used to automatically generate maps and graphs for analysts and decision makers.

[Download it!](#) [See what you can do](#) [Learn how to do it](#)

News

6/11/2013 Spirits official launch

20/10/2013: Paper "SPIRITS: An image time series processing software for agriculture monitoring" has been accepted for publication in Environmental Modelling & Software.

6/11/2013 Global Geospatial Conference Addis Ababa, Ethiopia

NOVEMBER 2013

M	T	W	T	F	S	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

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<http://spirits.jrc.ec.europa.eu/>

A dedicated website to:

» Disseminate Spirits

- Download the latest release
- Download the tutorial and the training data set
- Download data in Spirits format

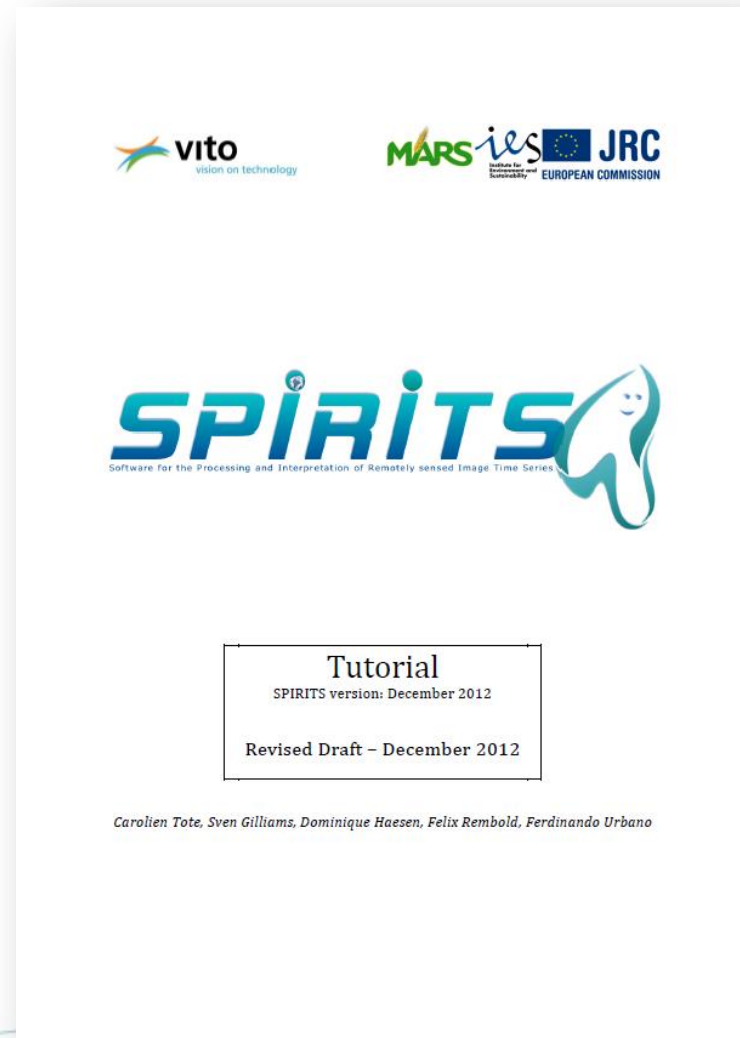
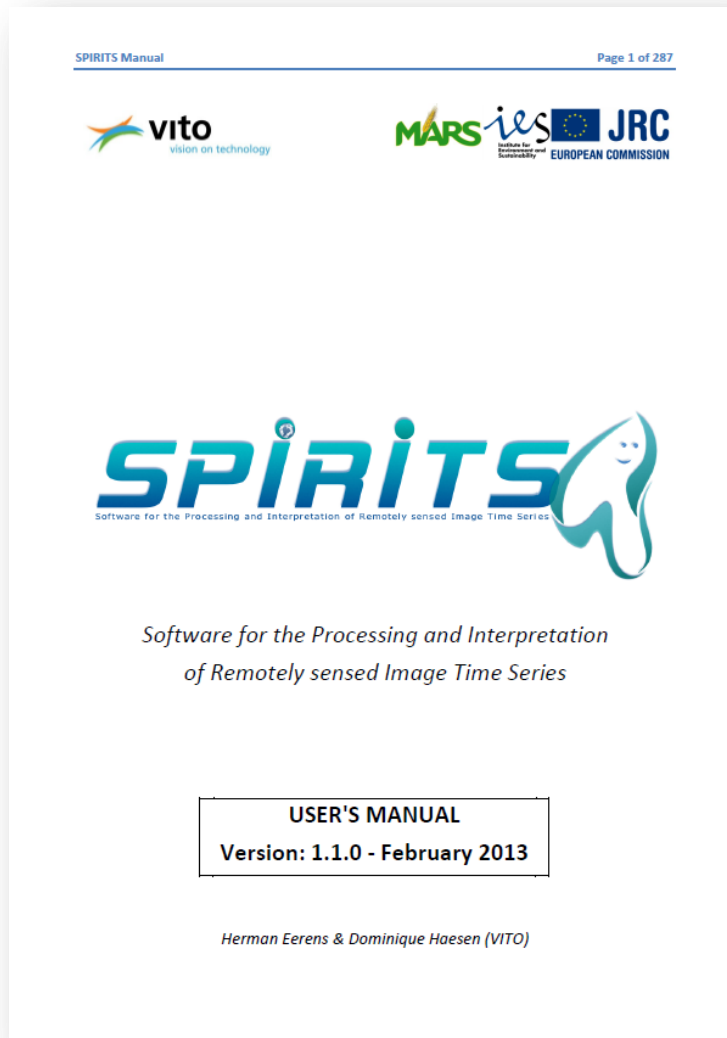
» Support users

- Wiki, FAQ, Video tutorial

» Involve users

- Wish list, Mailing list, Forum, News, Calendar

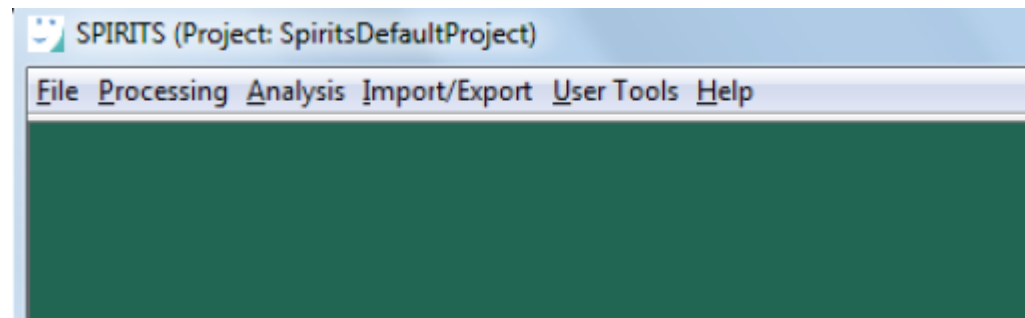
SPIRITS documentation



SPIRITS FUNCTIONALITIES

The SPIRITS menu

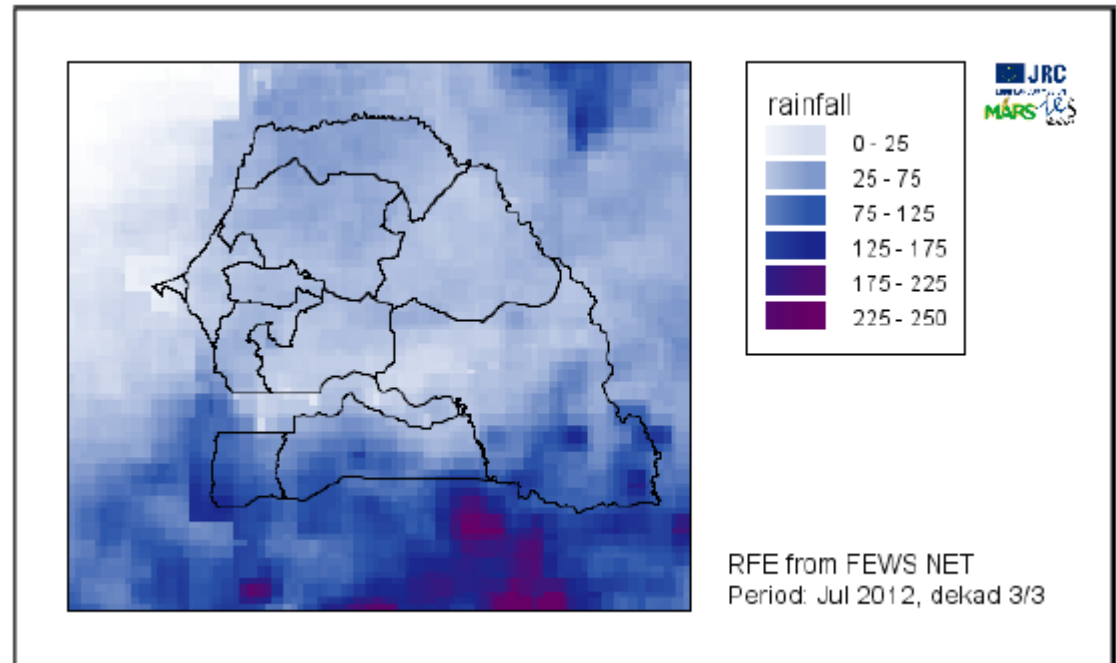
- » File
 - » File and project definitions, renaming etc...
- » Processing
 - » Image processing modules for single images (tools) or on a time-series of images
- » Analysis
 - » Produce maps, browse database, create charts... can be automated
- » Import/Export
 - » format conversions
 - » rasterization
- » User tools
 - » Runs external or internal executables on time series



Main functionalities (1/5)

Import and export external data formats

- » Image importer: all formats supported by GDAL
- » Vector to raster conversion
- » File renamer
- » Image exporter



Main functionalities (2/5)

Spatial processing operations

- » Region of interest (ROI) extraction
- » Resampling
- » Area fraction image generation
- » Low pass filters



input IMG: map info = {Geographic Lat/Lon, 1.5, 1.5,
-180, 90, 2.7778e-003, 2.7778e-003}

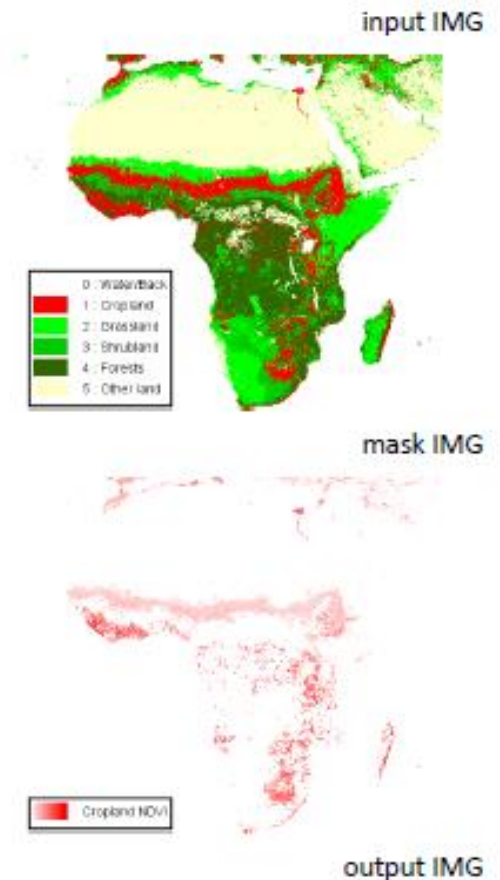


output IMG: map info = {Geographic Lat/Lon, 1, 1,
-26.066964, 38.0669643, 0.1875, 0.1875}

Main functionalities (3/5)

Thematic processing operations

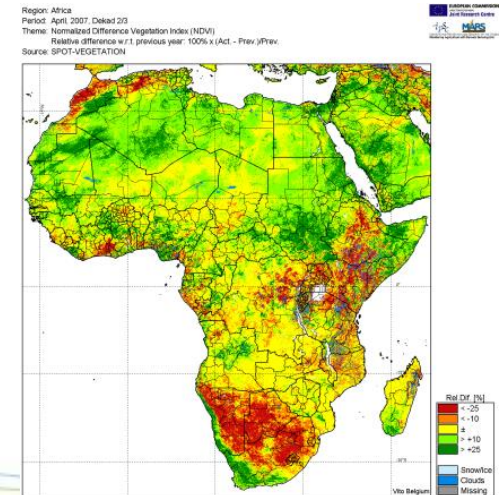
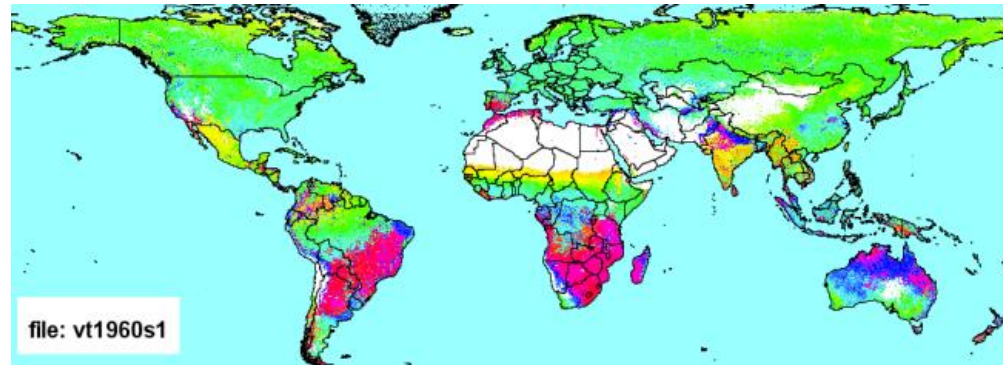
- » Rescaling
- » Index
- » Masking
- » Flagging
- » DMP (Dry matter production)
- » Clustering



Main functionalities (4/5)

Temporal processing operations

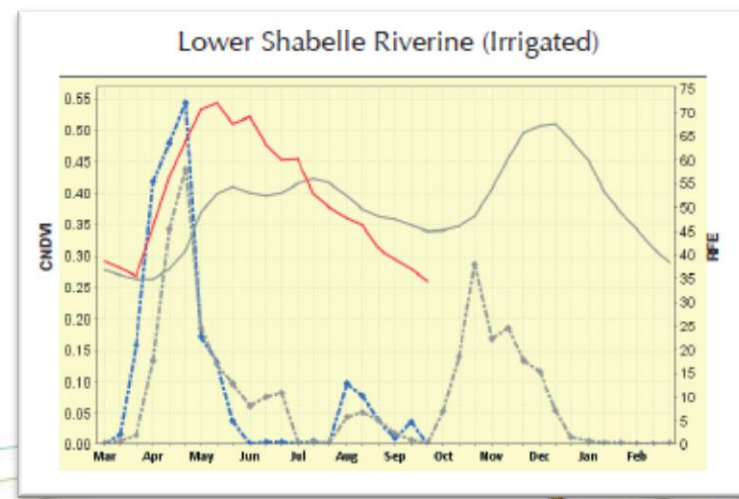
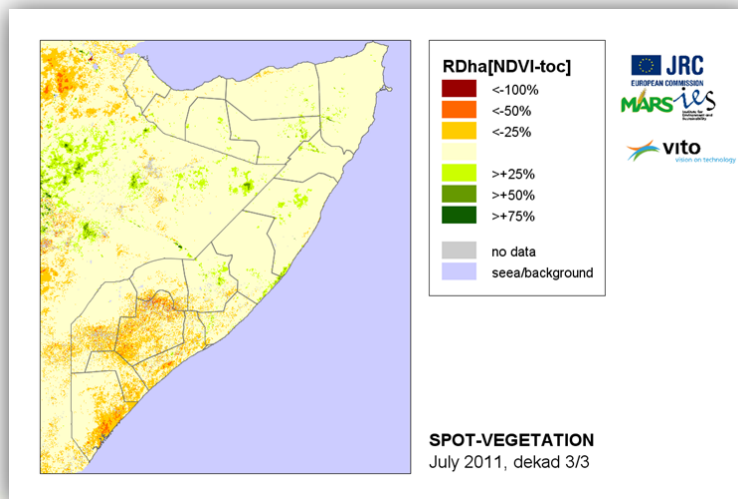
- » Smoothing
- » Compositing
- » Averaging
- » Cumulating
- » Phenology
- » Phenological averaging or cumulating
- » Long term statistics
- » Anomalies
- » Similarity analysis
- » Similarity based yield assessment



Main functionalities (5/5)

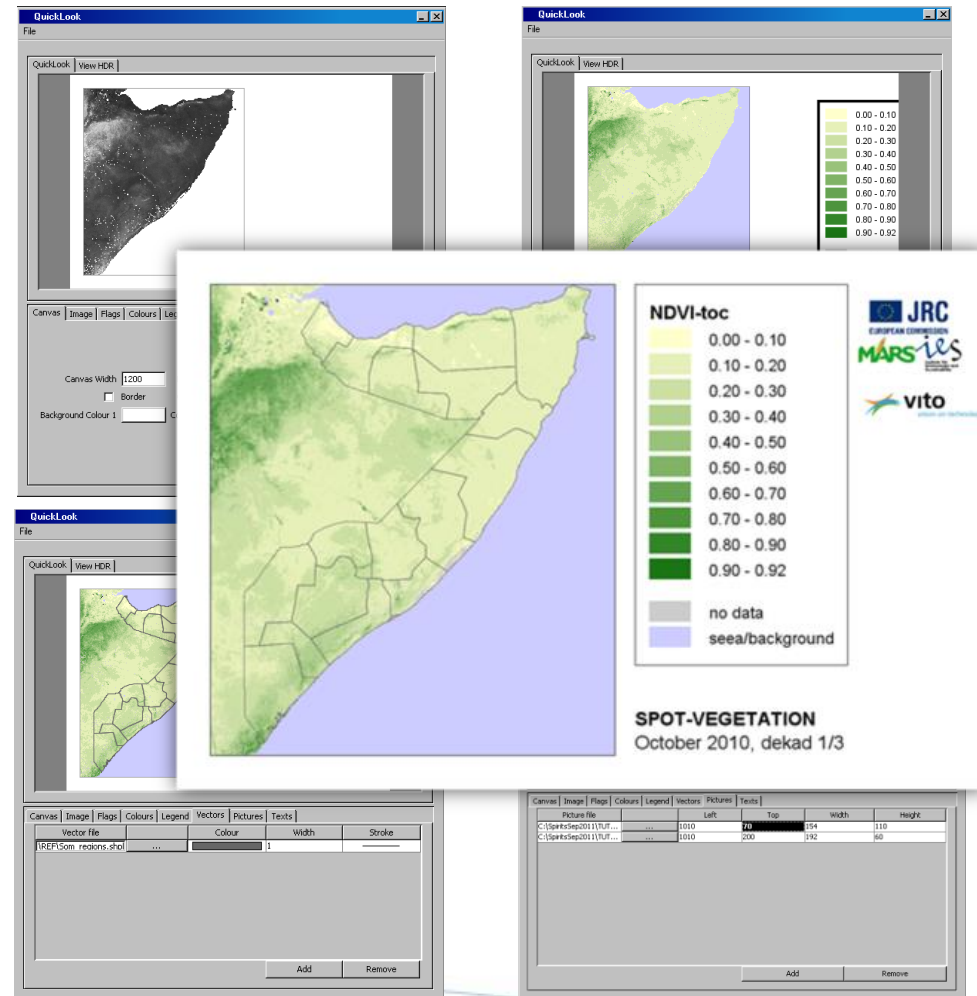
Analysis tools

- » Map composer
- » Database with regionally and thematically aggregated statistics
- » Graph composer
- » User tool



Map composer

- » Create image maps
 - » Choose frame and background extension and properties
 - » Overlay vector files
 - » Edit legends
 - » Label features
 - » Add logos
 - » Copy directly into a report
 - » Export as PNG



Maps – Time Series

The image shows a 'Create Quick Looks' dialog box in the foreground, overlaid on a file explorer window. The dialog box is titled 'Create Quick Looks' and has a blue header. It contains several sections:

- File**: Quick Look template: QNQ template with buttons for '...', 'New', 'View', and 'Edit'.
- Files**: Input directory: with a '...' button and 'Periodicity' set to 'Dekad'. Input filenames: prefix , date , suffix . Output directory: with a '...' button. Output filenames: prefix , date , suffix .
- Time Series**: Start date: (format YYYYMMDD). End date: (format YYYYMMDD).

At the bottom of the dialog are 'Cancel' and 'Execute' buttons. A green arrow points from the dialog box to a file explorer window in the background. The file explorer shows a grid of 32 map files named 'FAPAR9813a.png' through 'FAPAR9901a.png'. A tooltip over one of the maps displays: 'Dimensions: 600 x 400', 'Type: PNG Image', 'Size: 22,2 KB'. The file explorer's status bar shows '373 objects (Disk free space: 18,6 GB)' and '8,04 MB My Computer'.

Aggregated statistics extraction and visualization

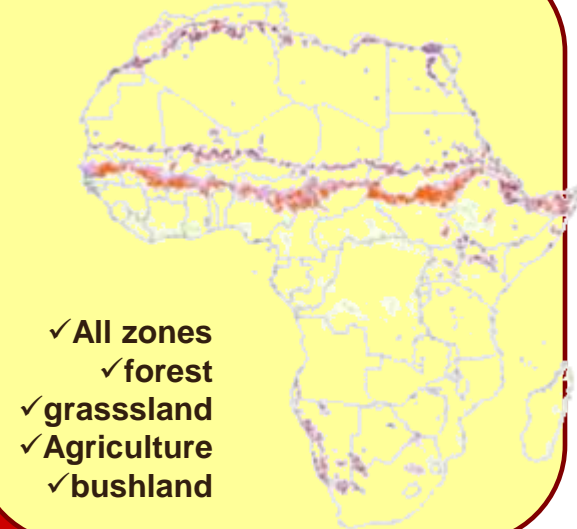
Administrative boundaries



SPOT-VGT images



Landcover



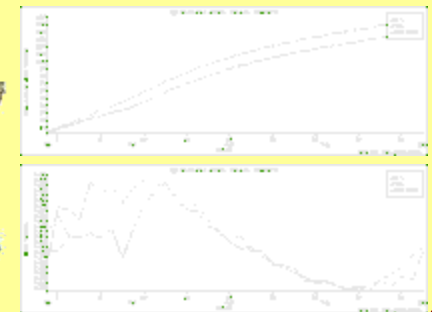
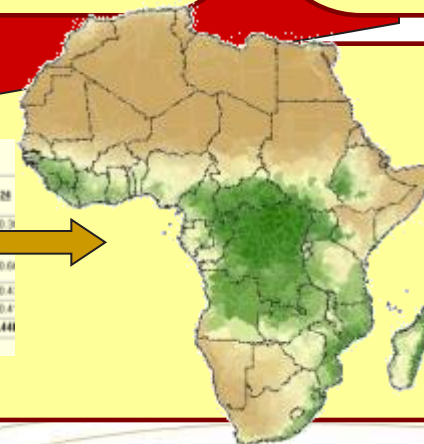
“RUM” database – regional unmixed

Statistics for : 2003, RW, Northern

Figures indicate the dry matter productivity in kg/ha/yr. Column 1-30 indicate decade 1 to decade 30.

Country	ADMIN LEVEL_1	ADMIN LEVEL_2	ADMIN LEVEL_3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
Malawi	Northern	Chipiwa		0.40	0.87	0.84	0.84	0.60	0.70	0.74	0.84	0.61	0.62	0.55	0.52	0.83	0.69	0.60	0.90	0.48	0.42	0.51	0.44	0.48	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	
Malawi	Northern	Karanga		0.55	0.70	0.85	0.60	0.65	0.72	0.72	0.83	0.60	0.62	0.60	0.60	0.88	0.84	0.64	0.61	0.95	0.52	0.46	0.49	0.45	0.49	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
Malawi	Northern	Nkato-Diy		0.62	0.74	0.83	0.48	0.71	0.73	0.74	0.83	0.56	0.64	0.55	0.82	0.76	0.74	0.63	0.74	0.47	0.59	0.49	0.52	0.81	0.51	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Malawi	Northern	Phungu		0.47	0.99	0.88	0.60	0.66	0.75	0.78	0.88	0.57	0.70	0.62	0.85	0.76	0.70	0.65	0.87	0.48	0.50	0.51	0.47	0.53	0.43	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
Malawi	Northern	Mzimba		0.43	0.83	0.58	0.47	0.63	0.67	0.97	0.53	0.51	0.63	0.61	0.82	0.83	0.63	0.59	0.59	0.44	0.46	0.45	0.43	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	
Mean				0.51	0.89	0.82	0.55	0.64	0.72	0.73	0.81	0.57	0.64	0.59	0.82	0.77	0.68	0.61	0.65	0.47	0.48	0.49	0.46	0.51	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44		

* 1 decade is a ten-days synthesis of the dry matter productivity values



Time series analysis charts

The screenshot displays the SPIRITS (Project: NewMarch) interface. The 'Databases' menu is highlighted. The 'Browse RUM database' section shows search criteria: Regions Set: GLD, Region: *ALL*, Classes Set: GLC2000, Class: *ALL*, Sensor: SPOT-VGT, Variable: FAPAR, Periodicity: *ALL*, Method: *ALL*. A table lists search results with columns: Type, Region, Class, Method, Threshold, Sensor, Variable. A red box labeled 'Available' highlights a row in this table. Below the table, a 'table preview' window shows a data table with columns 'Date' and 'Mean'. A red box labeled 'Values' highlights the 'Mean' column. A 'table preview' window also shows a time series plot of 'FAPAR' values over time, with a red arrow pointing from the 'Mean' column in the table to the plot.

Example of SPIRITS Graph

The 'Example of SPIRITS Graph' window shows a line chart with multiple data series representing different years (1998-2007) and a smoothed trend line. The Y-axis is labeled 'FAPAR' and ranges from 0.000 to 0.250. The X-axis shows months from Jan to Oct. A legend lists the series: SPOT-VGT 1998, SPOT-VGT 2000, SPOT-VGT 2001, SPOT-VGT 2002, SPOT-VGT 2003, SPOT-VGT 2004, SPOT-VGT 2005, SPOT-VGT 2006, SPOT-VGT 2007, SPOT-VGT Avg. 1998-2007, SPOT-VGT Min. 1998-2007, and SPOT-VGT Max. 1998-2007.

Task List

- Id: 786 RUM to Database
- Id: 788 Extract RUM 060211
- Id: 791 Extract RUM 060221
- Id: 794 Extract RUM 060301
- Id: 793 Extract RUM DOM
- Id: 795 RUM to Database
- Id: 797 Extract RUM 060311
- Id: 800 Extract RUM 060321
- Id: 803 Extract RUM 060401
- Id: 806 Extract RUM 060411

Buttons: Remove, Remove all, Pause, Pause all, Resume, Resume all.

In progress

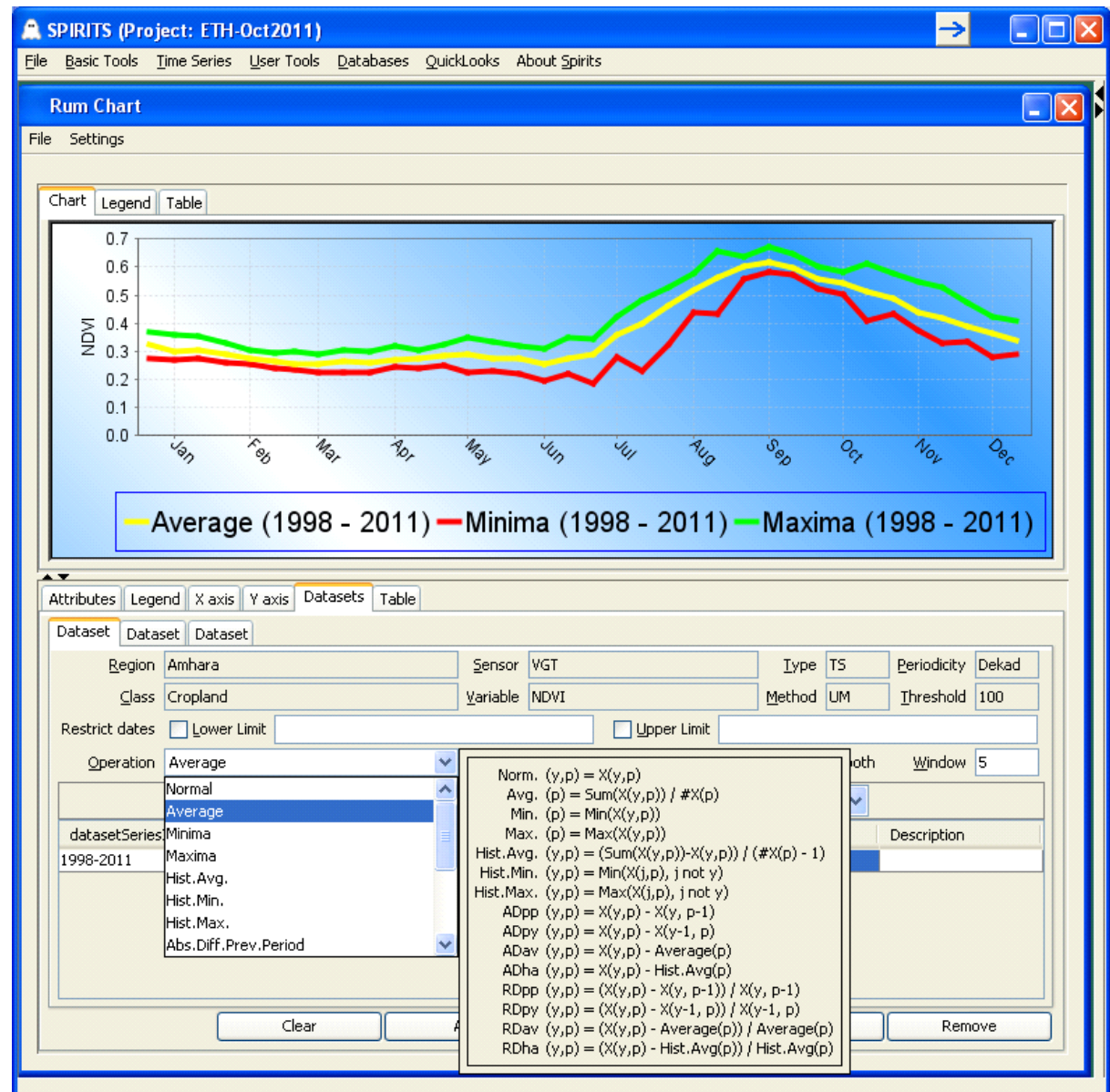
- Id: 1100 Extract RUM 090101 DONE 11
- Id: 1103 Extract RUM 090111 RUNNIN
- Id: 1102 Extract RUM RUNNING 0% St
- Id: 1102 Extract RUM DONE 100% St

Progress bar: [Progress indicator]

*Database browser:
selected series
can be sent to
a chart*

Chart operations

- » Normal
- » Average
- » Minimum
- » Maximum
- » Historical Average
- » Historical Minimum
- » Historical Maximum
- » Absolute Difference
 - » previous period
 - » previous year
 - » average
 - » historical average
- » Relative Difference
 - » previous period
 - » previous year
 - » average
 - » historical average



Charts – time series

RUM Chart series

File Task submitted

RUM Chart template

CNC template: M\Bay_rainfed.cnc ... New View Edit

Regions

Select Regions Ref. Region: BAY - Set: Reg

Select	Id	Abbreviation	Name
<input checked="" type="checkbox"/>	16	L_SHABELLE	L_SHABELLE
<input type="checkbox"/>	9	MUDUG	MUDUG
<input type="checkbox"/>	18	M_JUBA	M_JUBA
<input checked="" type="checkbox"/>	14	M_SHABELLE	M_SHABELLE
<input type="checkbox"/>	7	NUGAL	NUGAL
<input type="checkbox"/>	2	SANAG	SANAG
<input type="checkbox"/>	6	SOOL	SOOL

Classes

Select Classes Ref. Class: cont - Set: AFRI

Select	Id	Abbreviation	Name
<input type="checkbox"/>	0	CA_0	CN_0
<input type="checkbox"/>	4	clus_s	clus_s
<input checked="" type="checkbox"/>	1	cont	cont
<input type="checkbox"/>	3	f_irrig	f_irrig
<input type="checkbox"/>	6	herb_som	herb_som
<input type="checkbox"/>	2	irr_s	irr_s
<input type="checkbox"/>	8	onsh_som	onsh_som

Output files

Output directory: C:\X_Data\SOM\Graphs ...

Filename pattern: Region_%0_Class_%3 .png Filename Parameters

Cancel Execute

XP (C:) > X_Data > SOM > Graphs

Search Graphs

Share with Slide show Burn New folder

The figure displays six time series charts arranged in a 3x2 grid. Each chart is titled 'Bay_rainfed' and shows two data series: CNDM (left y-axis, 0.0 to 0.4) and Rain (mm) (right y-axis, 0 to 150 or 200). The x-axis represents time from 01/01/2011 to 01/01/2012. The charts are labeled as follows:

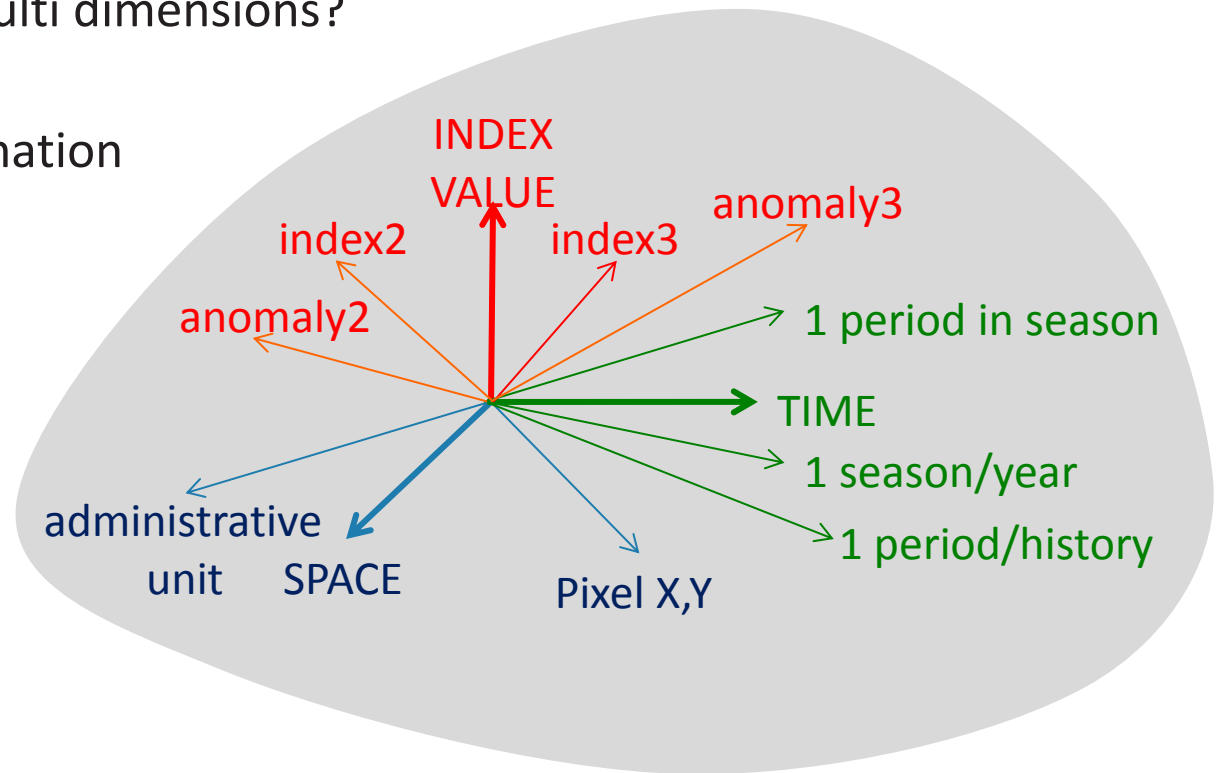
- Region_11_Class_1.png
- Region_12_Class_1.png
- Region_14_Class_1.png
- Region_15_Class_1.png

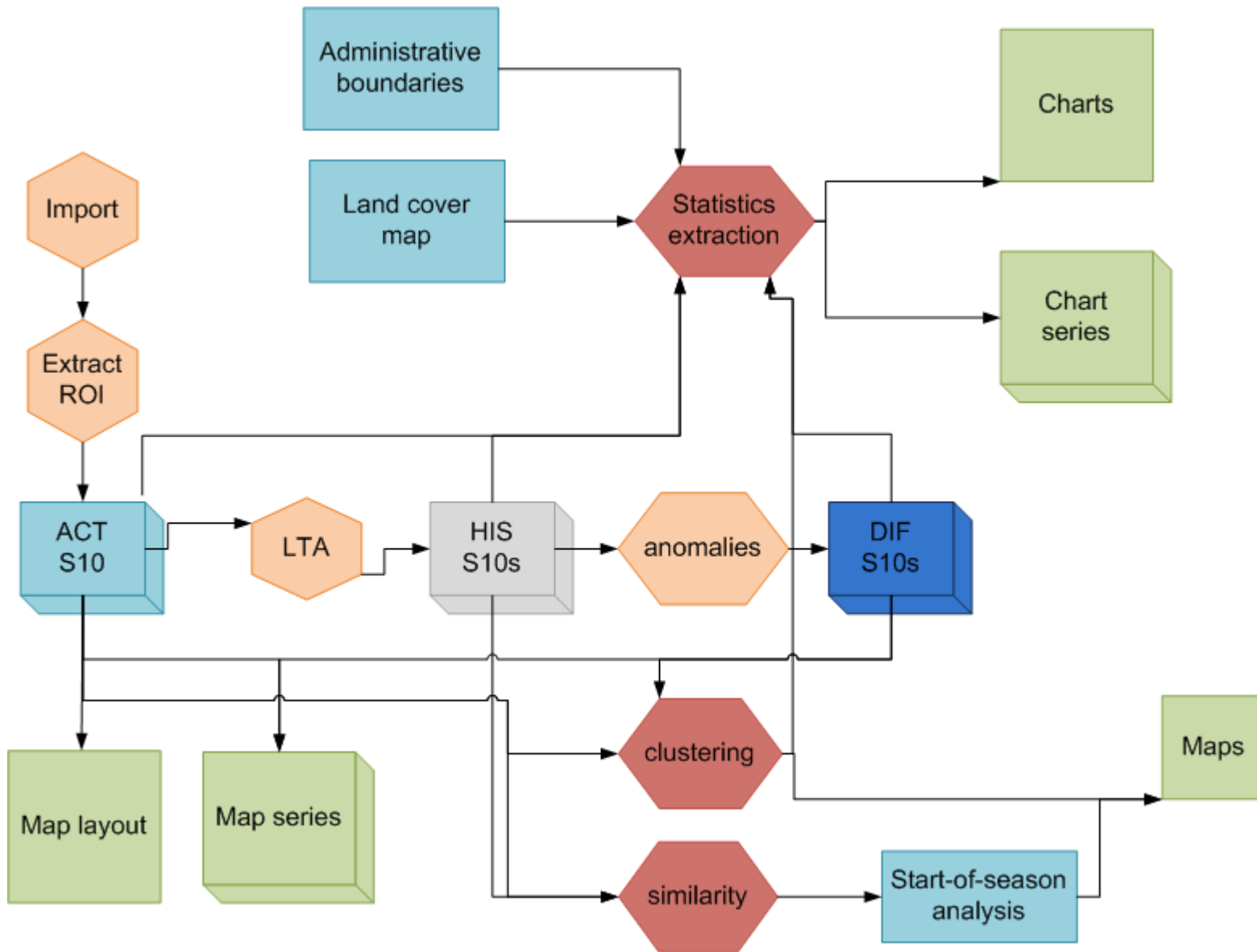
Each chart shows a blue line for Rain and a red line for CNDM. The Rain series exhibits sharp peaks, while the CNDM series shows a smoother trend with a significant peak around mid-2011.

SPIRITS ANALYSIS METHODS

The challenge of information analysis

- » A lot of information to analyze in space and time!
- » How to interpret multi dimensions?
- » Get an overview and combine information

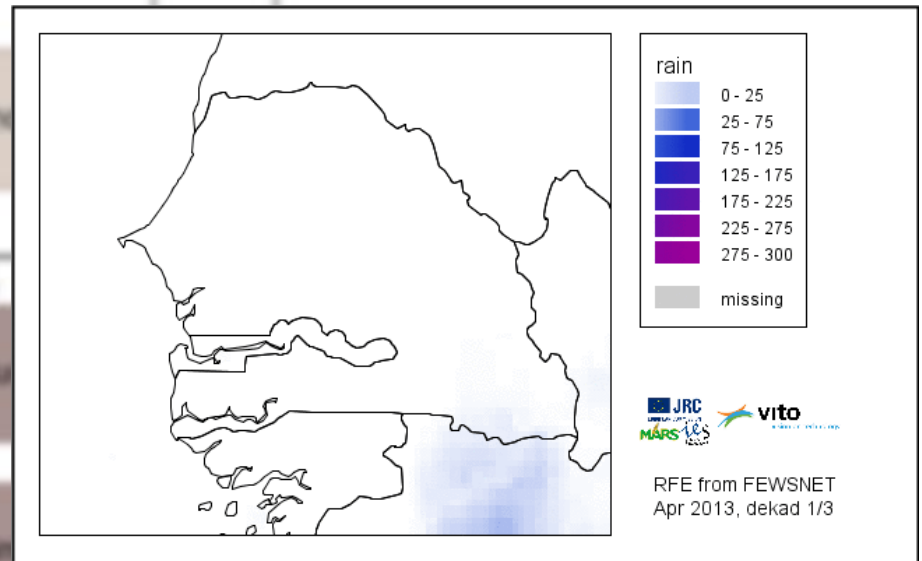
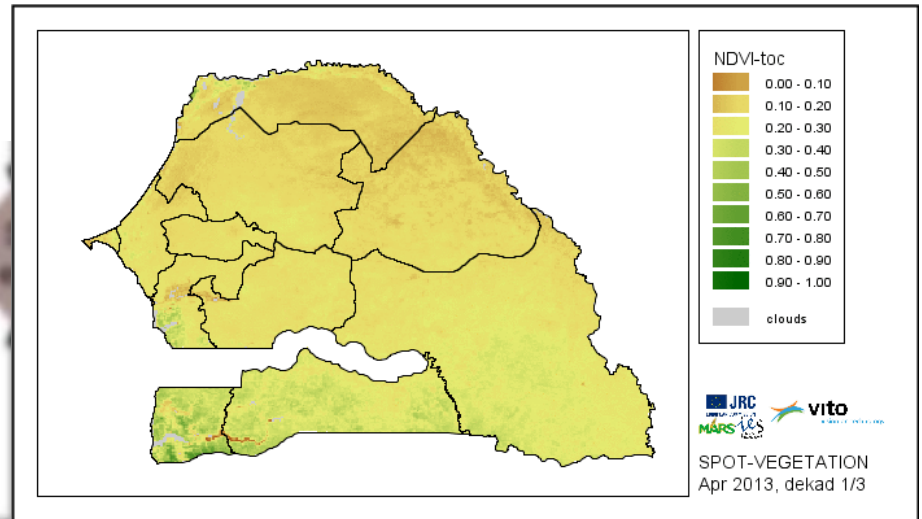
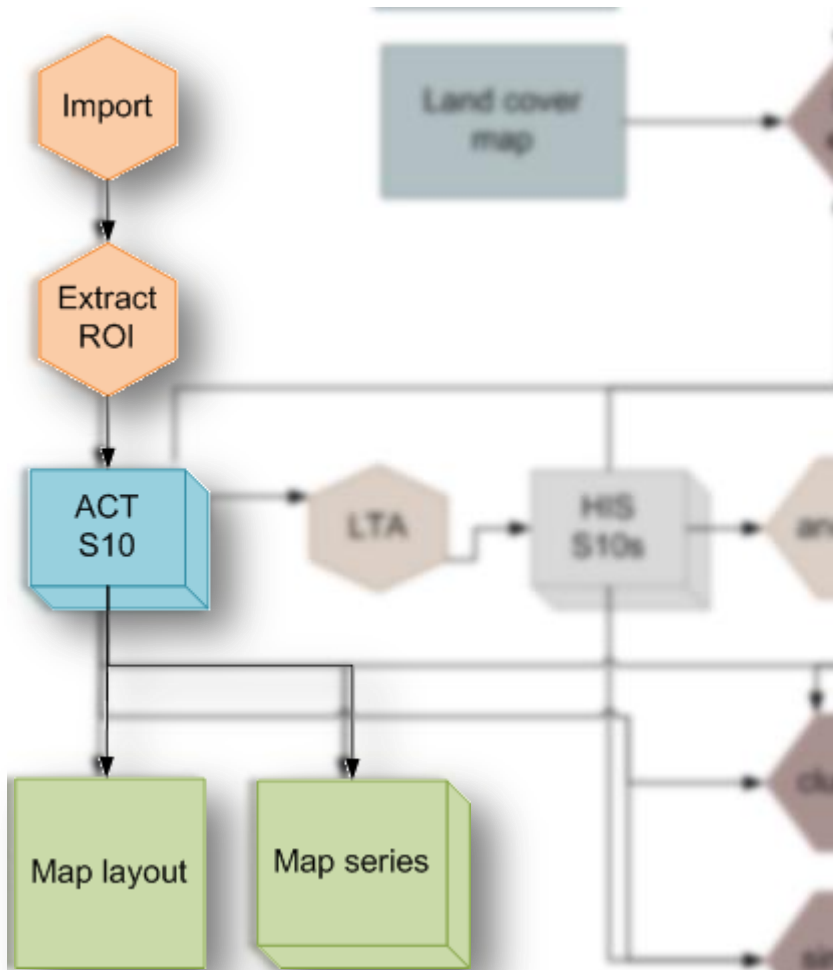




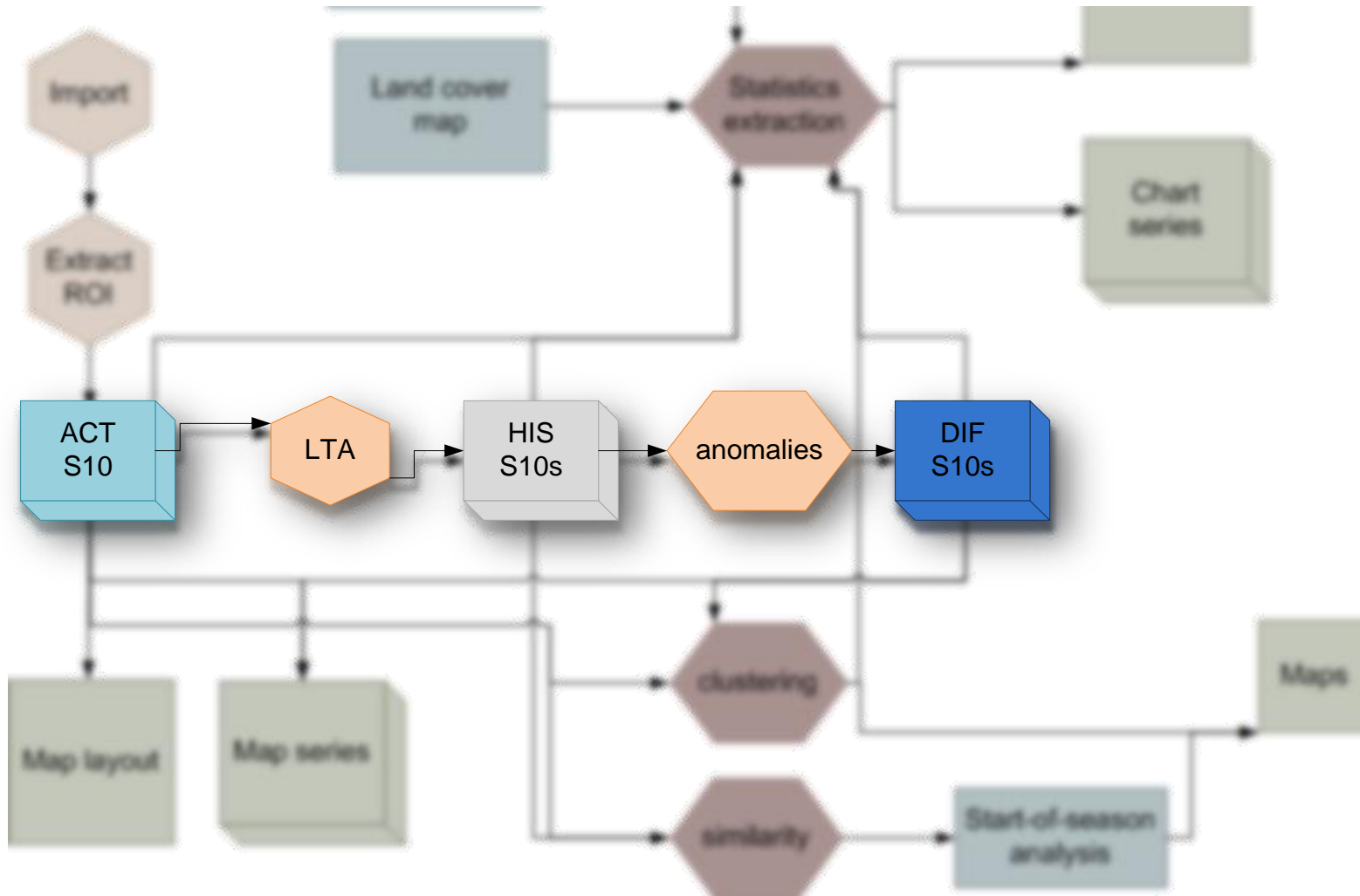
SPIRITS OUTPUT

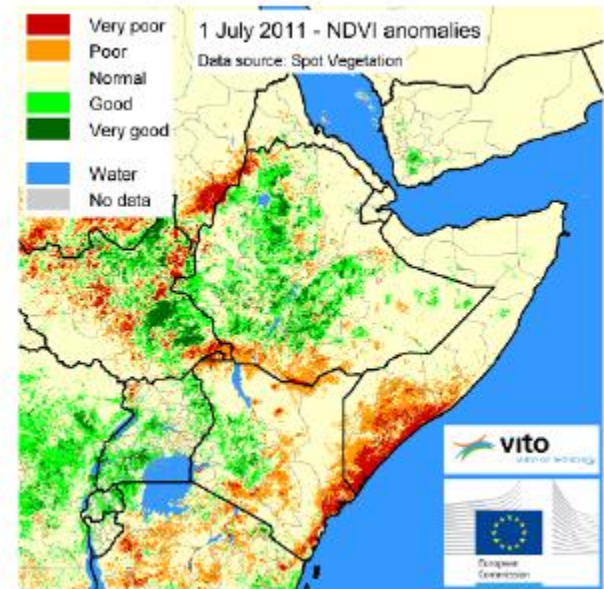
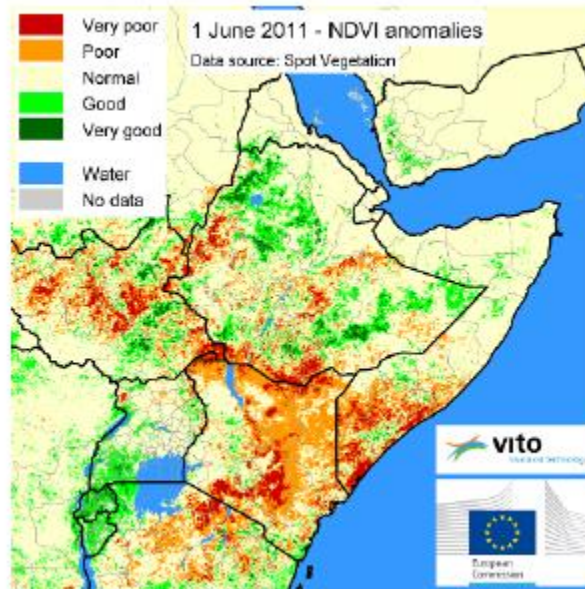
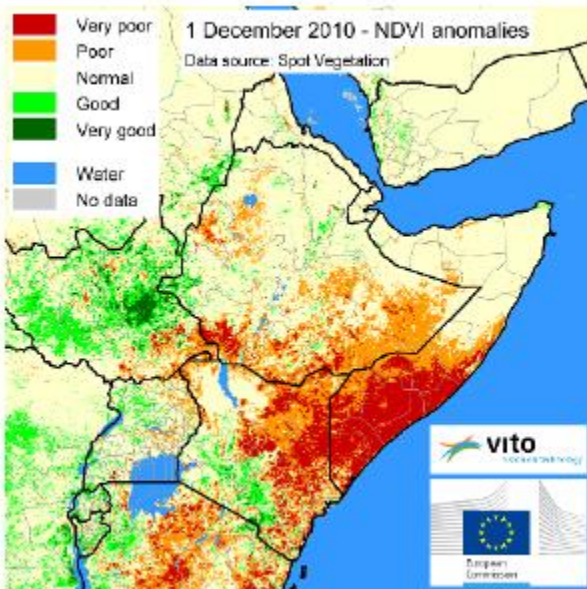
- » Map series based on a layout
- » Long term averages
- » Anomalies
- » Graphs for multiple variables
- » Clustering
- » Start-of-season shift
- » ...

Map series



Long term averages and anomalies





2010/2011 drought, Horn of Africa

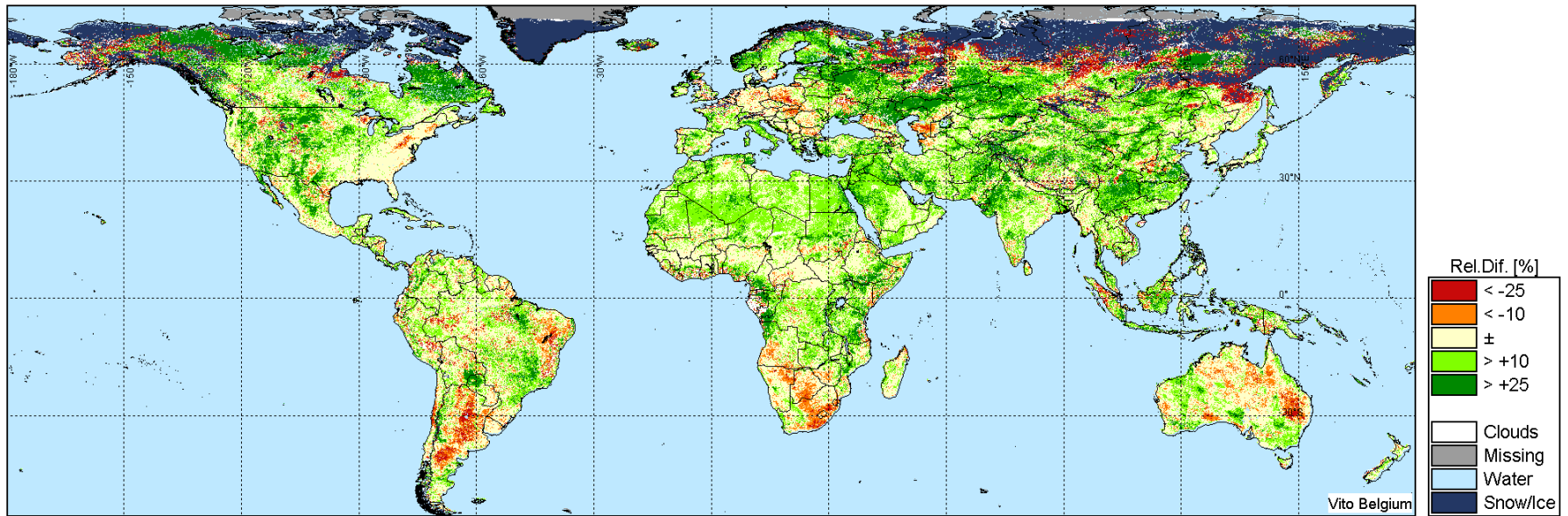
Region: The GLOBE

Period: Oktober, 2013, Dekad 2/3

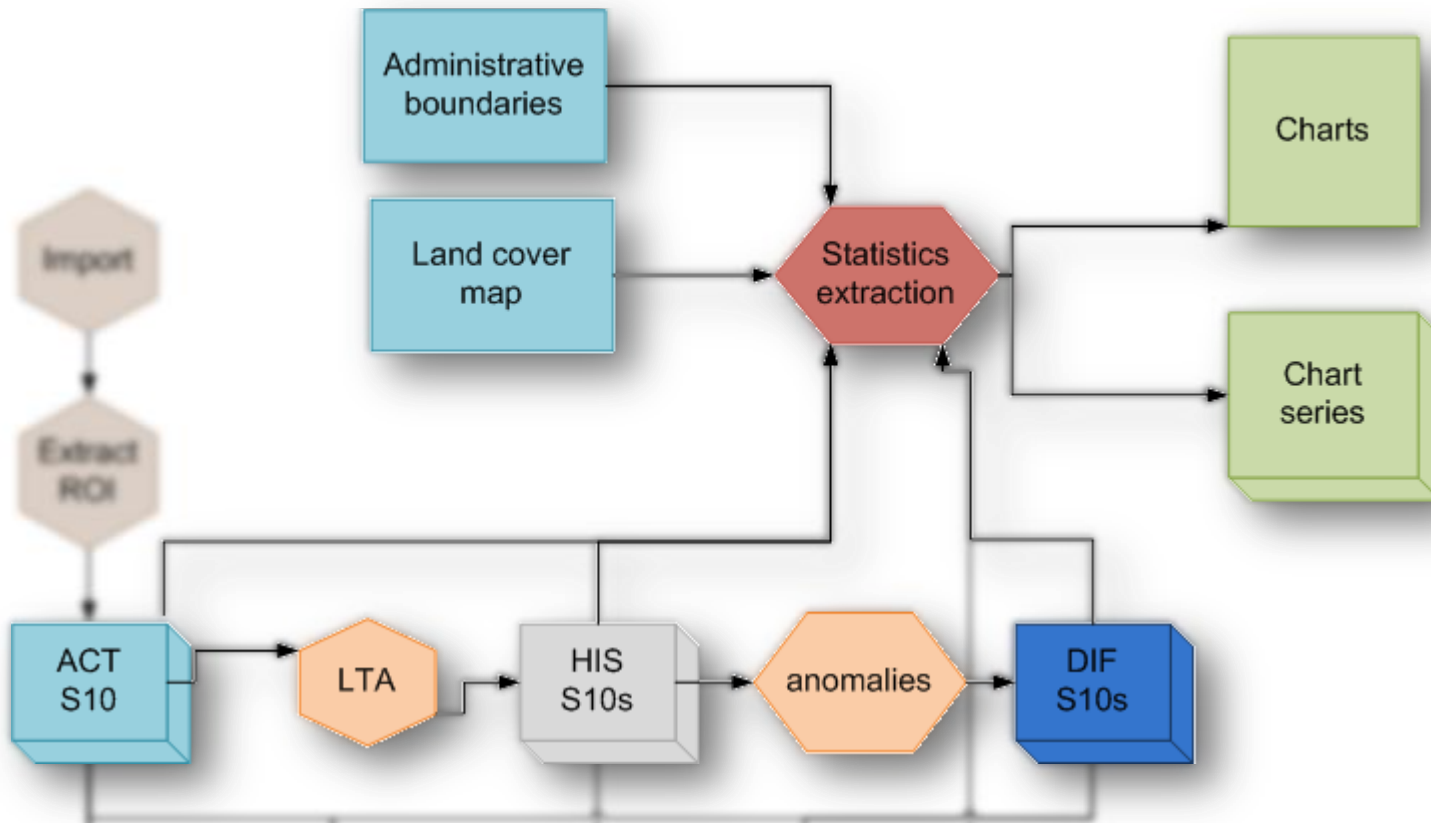
Theme: Normalized Difference Vegetation Index (NDVI)

Relative difference w.r.t. historical mean: $100\% \times (\text{Act.} - \text{Hist.})/\text{Hist.}$

Source: SPOT-VEGETATION

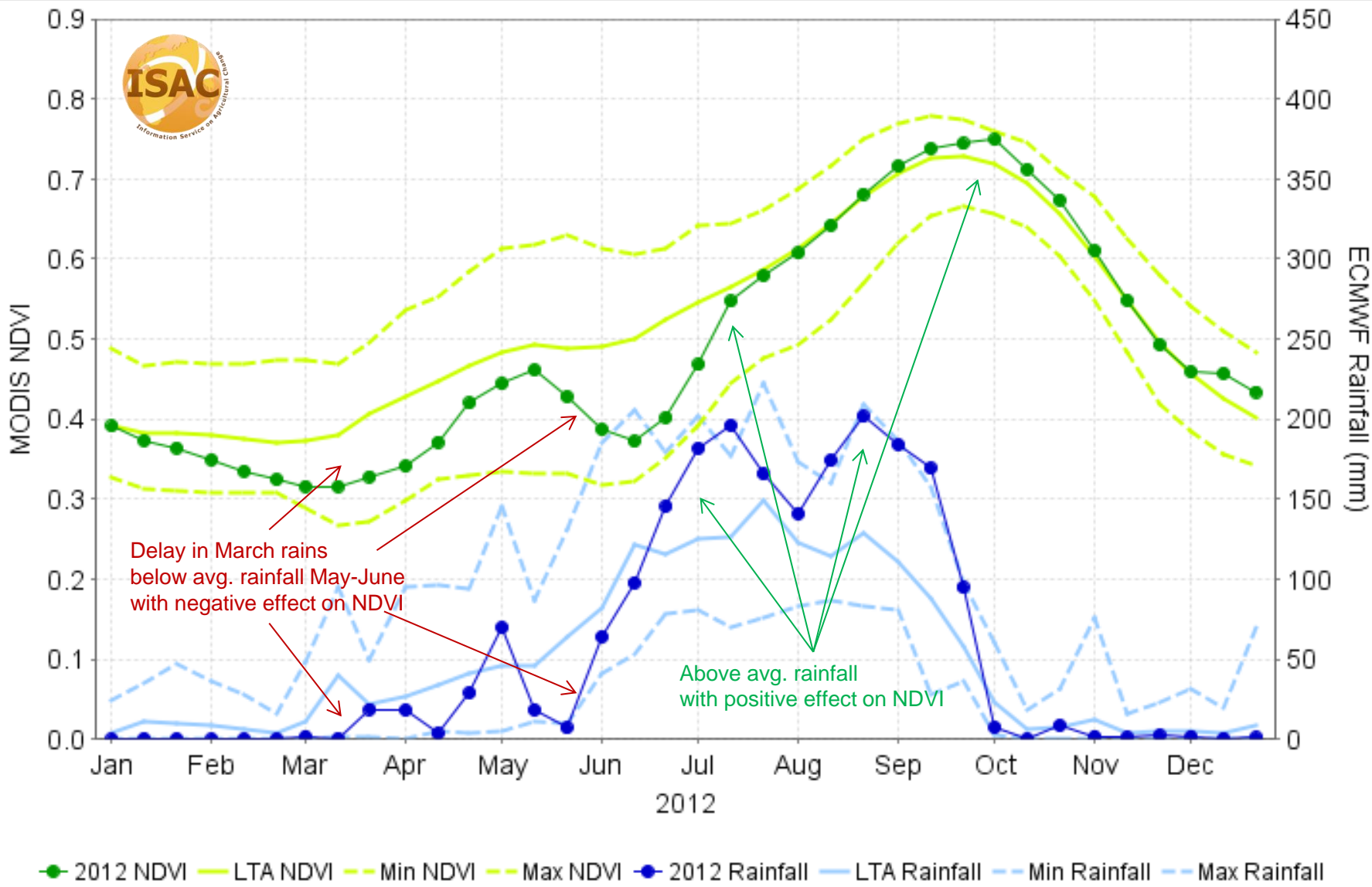


Current global situation



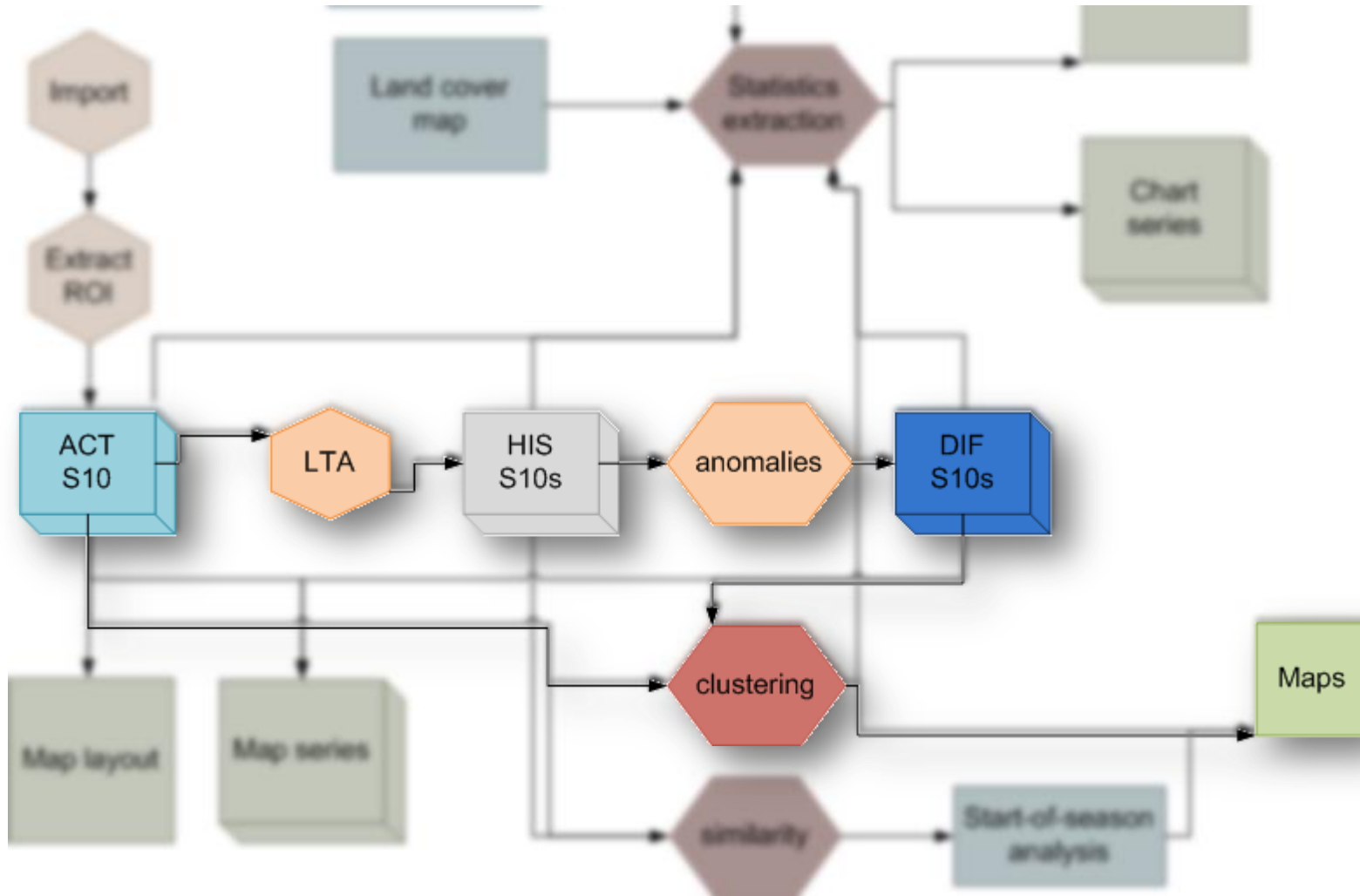
Statistics extraction and graphs



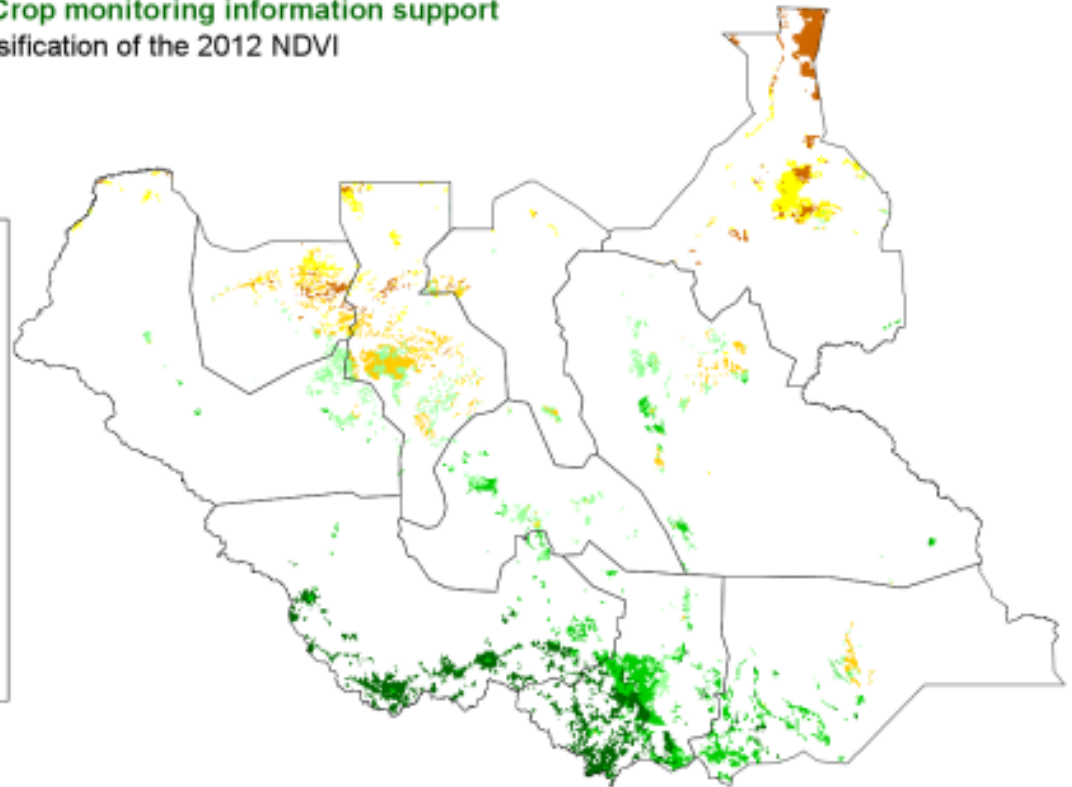
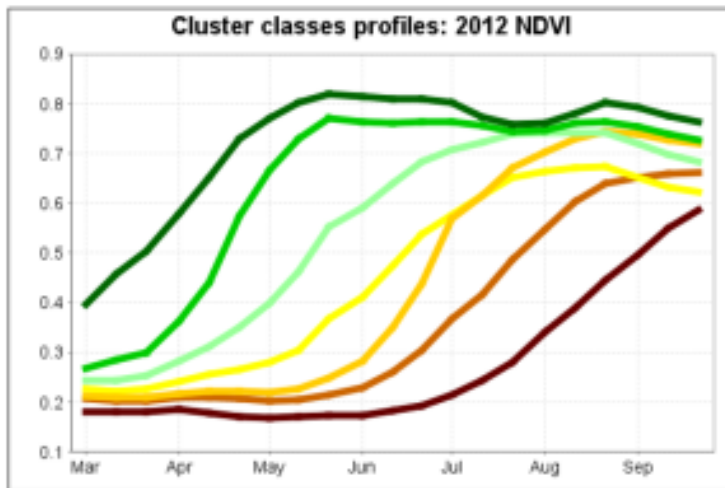


2012 Meher season, West-Shewa, Ethiopia

Clustering



SOUTH SUDAN - Crop monitoring information support
 Cluster classification of the 2012 NDVI



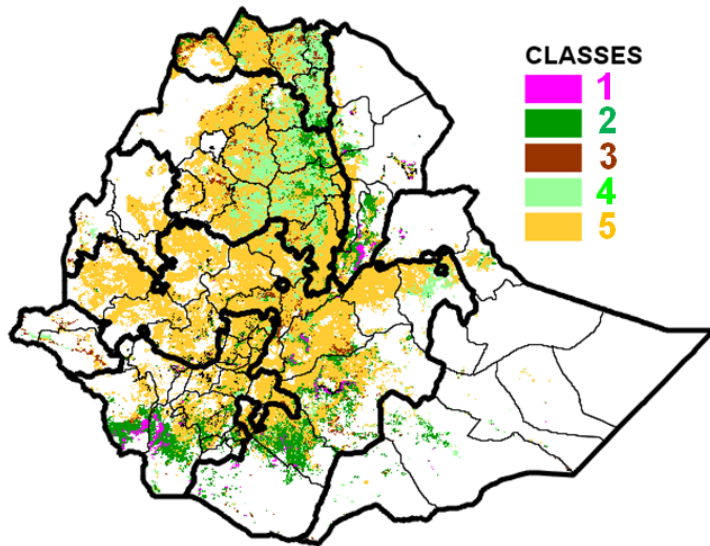
Sources: 1) CLASmaxi - 2) Vectors from FAO-GAUL, level 2 - 3) Produced per FAO GIEWS/GMFS
 Projection: Geographic Lat/Lon - Resolution: 1km

2012 crop season, South Sudan

ETH - Relative NDVI anomalies classification

Period: February to December 2012

Focus on main agriculture area



CLASSES



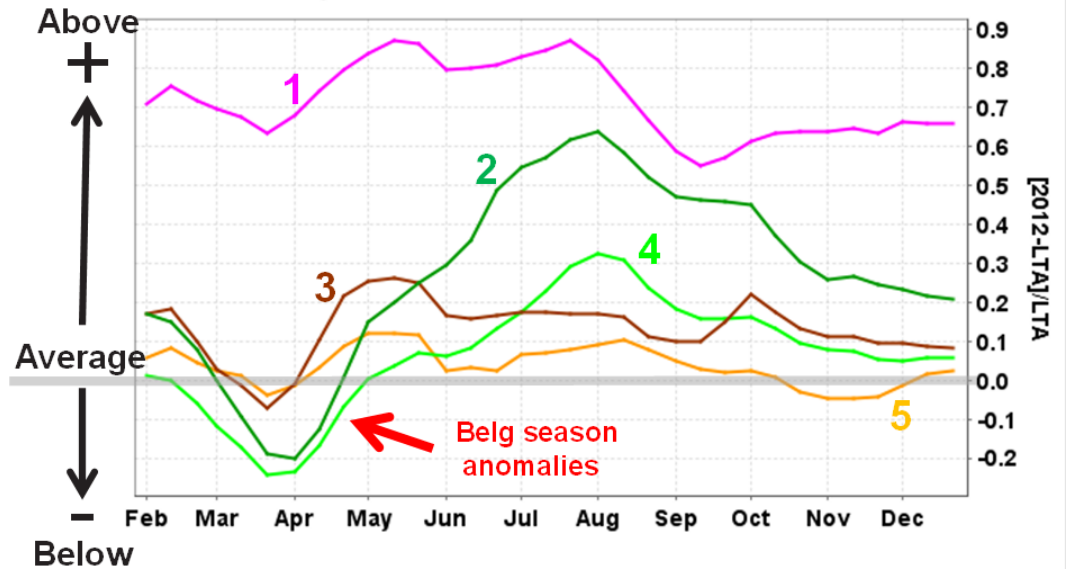
*LTA: Long Term Average 1999-2011

Map: Geographic, WGS 84 - Resolution: 1km

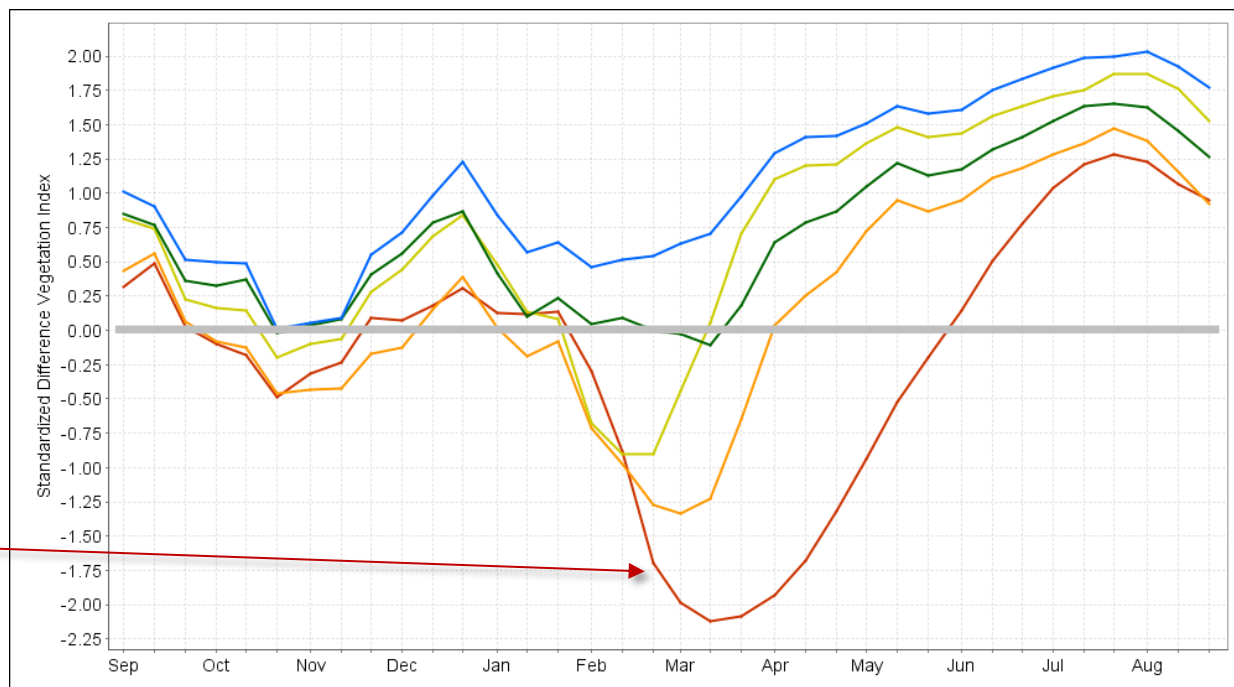
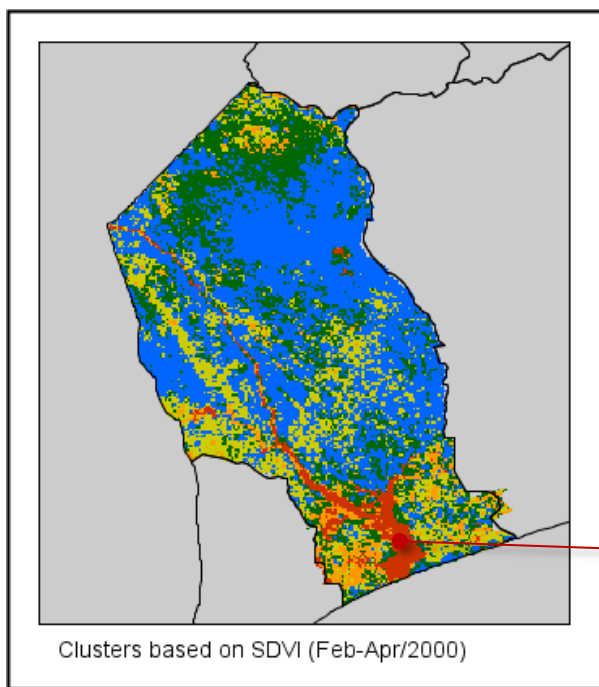
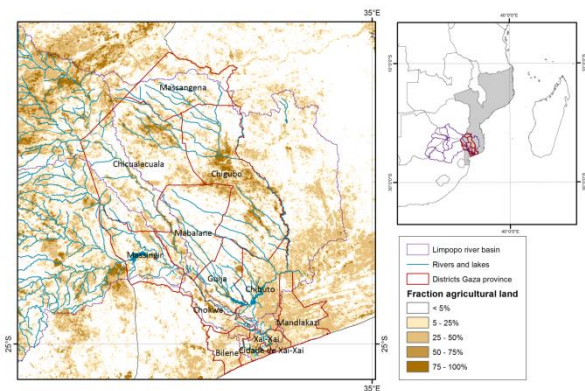
Images : SPOT/VGT - Vectors from FAO Gaul



Clusters profiles of relative NDVI anomalies classification

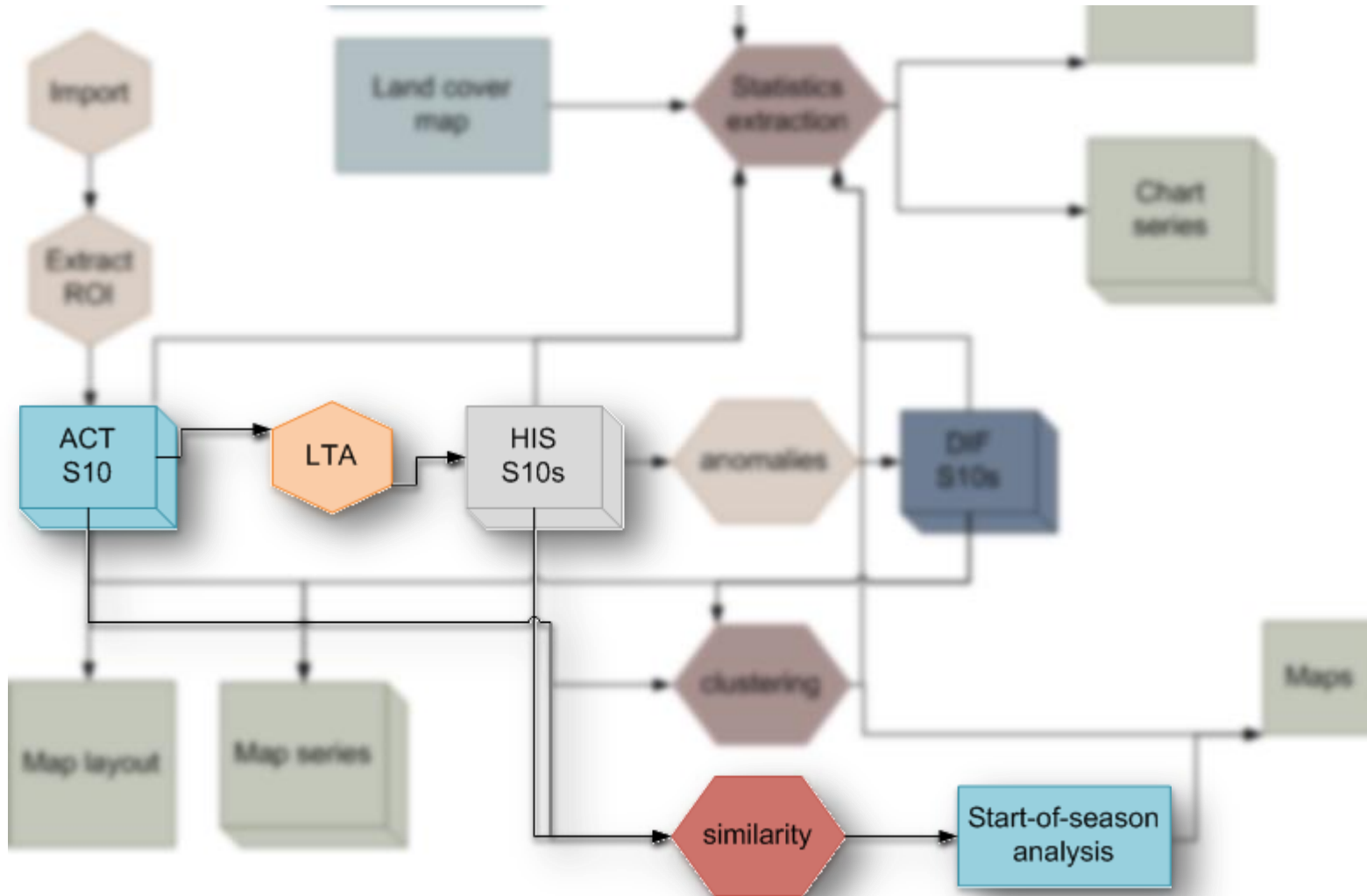


2012 Belg - Meher crop seasons, Ethiopia

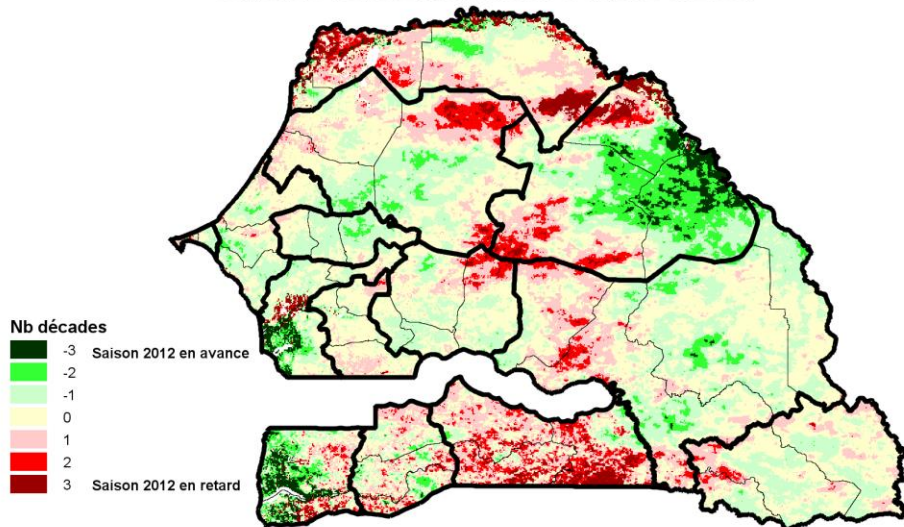


2000 Flood of Limpopo River, Gaza, Mozambique

Similarity for start-of-season analysis

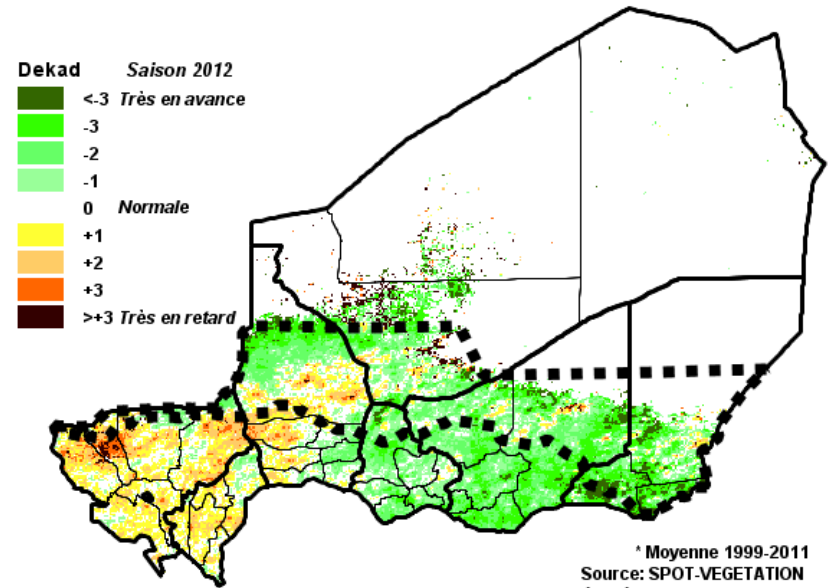


SENEGAL - Elements d'analyse de la campagne agro-pastorale
 Anomalies de démarrage de la saison du 01/05/2012 à 31/07/2012
 Comparaison des profils NDVI: 2012 avec la moyenne 1999-2011



Projection: Geographic Lat/Lon - Grid size: 1km
 Sources: 1)Analyse de données SPOT VGT- 2) Vecteurs de FAO-GAUL level 2 - 3) Produit par GMFS

Début de la saison 2012 par rapport à la moyenne*
 Période d'avril à juillet 2012



* Moyenne 1999-2011
 Source: SPOT-VEGETATION
 Réalisé par AGRHYMET/GMFS

2012 Start-of-season shift compared to long term average (Senegal, Niger)

Growing user community

SPIRITS users/contributors

INAM (Institut National de l'Élevage et de Médecine Vétérinaire)
FAO (Organisation des Nations Unies pour l'alimentation et l'agriculture)
CMES (Centre de Suivi Écologique)
MARS (Méthode d'Analyse de Réponse Spatiale)
United Nations World Food Programme
UNIVERSIDADE EDUARDO MONDLANE



CENTRE DE SUIVI ÉCOLOGIQUE

Suivi de la campagne agro-pastorale 2013

BILAN A MI-PAROURS DE LA SAISON DES PLUIES

BULLETIN N°30 SEPTEMBRE 2013 - BILAN A MI-PAROURS

Suivi des cultures et des pâturages au Niger bilan à la fin du mois de septembre 2012

Dans les autres pages :

Prévision des rendements du mil et du sorgho	2
Profils comparés	3
Validation	5
Protocoles d'analyse GMFS	6

La situation agro-pastorale, telle qu'elle se présente en fin septembre 2012, laisse présager des meilleures conditions de vie au cours des mois à venir pour les agriculteurs et les pasteurs nigériens. Plus de 90% des zones agricoles et pastorales présenteront des productions comparables ou supérieures à la moyenne des 14 dernières années, moins de 10% des surfaces sont déficitaires. Il faut signaler qu'en plus des conditions de mauvais déroulement de la campagne (Pause pluviométrique et retard d'installation) les inondations dans la vallée du fleuve ont causé beaucoup de dommages ayant entraîné une diminution voire la perte totale des productions envisagées sur les 3/5 des zones traversées par le fleuve niger au Niger (figure1).



RÉSUMÉ

Sommaire

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Le bilan à mi-parcours de la campagne agro-pastorale fait l'état des lieux sur le comportement de la végétation au niveau des différentes zones agro-écologiques du Sénégal de mai à août. Pour cette année 2013, le mois de septembre a été inclus dans le bilan à mi-parcours pour mieux ressortir l'incidence des pluies de la troisième décennie du mois d'août, souvent très pluvieuse, sur le comportement des cultures.

La campagne agro-pastorale 2013-2014 est marquée, à l'échelle nationale, par un retard quasi global, du début de croissance de la végétation, sauf au niveau des régions de Ziguinchor et de Sédiou qui ont enregistré une avance de plus de 3 décades par rapport à la moyenne 1999-2012. Ces régions ont bénéficié d'un début de saison des pluies précoce mais ont par la suite connu une situation similaire au reste du pays.

À la première décennie du mois de septembre 2013, les conditions de croissance de la végétation (VCI) ont été défavorables dans les départements de Fatick, Matam, Kaolack, Louga, Boudioune, Sédhiou et le nord de Vélingara. Certaines zones ont ainsi été classées à risque en attendant les missions de terrain du Groupe de Travail pluridisciplinaire (GTP) qui pourra mieux cibler les zones à visiter avec l'analyse du VCI.

Cette situation par endroit défavorable laisse présager une baisse des rendements des cultures et de la production herbacée pour l'alimentation animale si les pluies du mois de septembre ne permettent pas de combler le déficit de croissance de la végétation dans les zones à risque.

SENEGAL - Indice de Condition de la Végétation (VCI) Décade du 19/2013

Figure 1 : Anomalies de croissance de la végétation (VCI) à la première décennie de septembre 2013

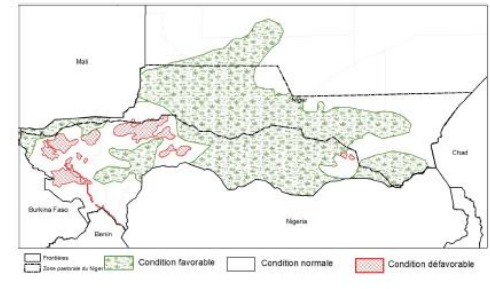


Figure 1 : Situation de la campagne agropastorale au 30 septembre 2012

Le Rouge montre les zones à situation défavorable. C'est-à-dire les zones dans lesquelles les conditions pluviométriques n'ont pas été du tout propices à une bonne croissance et à un développement important de la végétation laissant craindre des mauvaises à très mauvaises perspectives de production agropastorale.

Le Blanc se rapporte aux zones à situation moyenne car comparable à la moyenne enregistrée au cours des 14 dernières années. On peut espérer une production agropastorale tout au moins égale à la moyenne de 1998 à 2011.

Le Vert représente les zones à situation favorable. C'est-à-dire les zones dans lesquelles les conditions pluviométriques ont permis une bonne croissance ainsi qu'un développement favorable de la végétation, laissant espérer une bonne à très bonne production agropastorale.





Strengths

- » Advanced TS processing, unique tool for crop monitoring
- » Modular structure
- » Fast computation
- » Automation of complex data processes
- » Automation of outputs on multiple time/space objects
- » Freely available
- » Growing community of practice (website and training)
- » Complete documentation: manual and tutorial

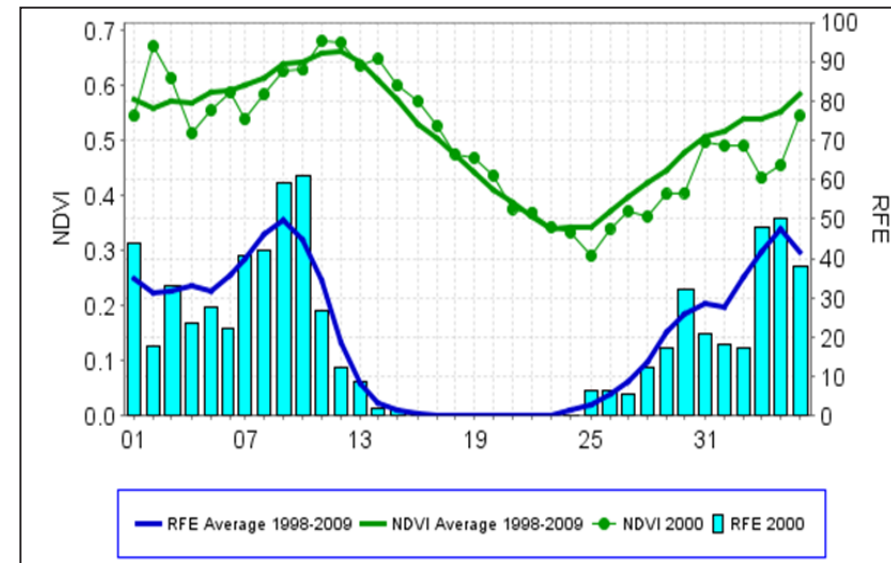


Weaknesses

- » SPIRITS-specific standards
 - » File format (modified ENVI)
 - » Contents of HDR file
 - » File name structure
 - » Flagging of no data values
- » Not open source
- » No real user support service yet
- » Initial steep learning curve

Future activities

- » **Technical developments** planned for 2013-2014
 - » Import/export: HDF5 format
 - » Smoothing: Witthaker smoother
 - » Anomaly indicators: SPI (Standard precipitation index)
 - » Database operations: Standard deviation and Z-scores
 - » Projection: reprojection from other projections to Geographic Lat/Long
- » Finalization of the **website** and **user forum** for better user support
- » **Training workshops** planned in 2014
 - » AGRICAB regional workshops and follow up training workshops
 - » MARS trainings follow up: South Sudan, Kenya, Botswana
 - » Others to be identified, e.g. China



Summary: in a nutshell...



“SPIRITS is a tool that simplifies and speeds up a growing number of time series data processing and analysis steps”

Remote sensing background required and initial training recommended

Powerful and complete solution for working with time series when no programming skills are available

Thank you!

