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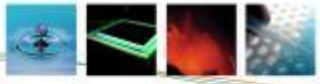


SPIRITS
Software for the Processing and Interpretation of Remotely sensed Image Time Series

Software for Processing and Interpreting Remote Sensing Image Time Series

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

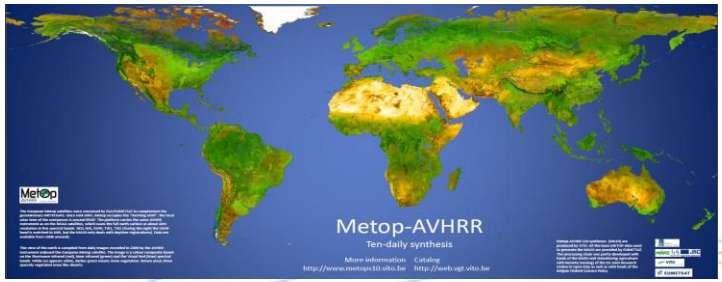
MARS

European Commission

SPIRITS Launch
AfricaGIS 2013/GSDI 14, Addis Ababa, Ethiopia November 4-8, 2013

Why SPIRITS?

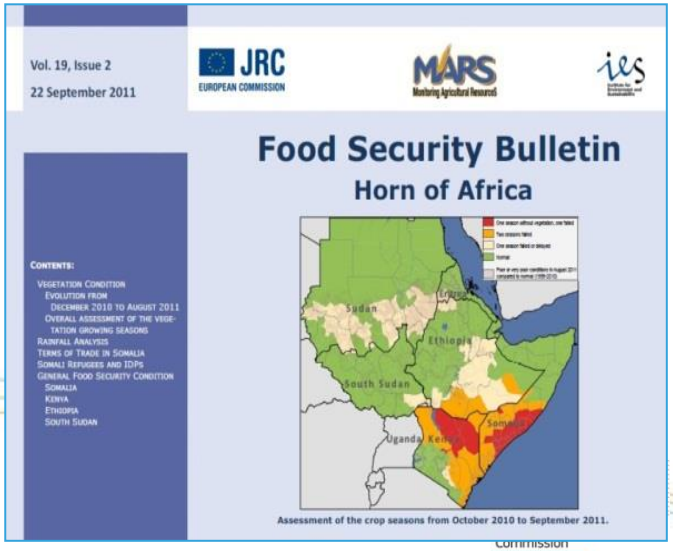
- Large availability of free remote sensing data, but:
- Remote sensing and processing software not specifically designed for time series processing
- Food security analysts are usually not software programmers
- Tools developed in the past are no longer updated (e.g. WINDISP)
- Online platforms don't 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**)



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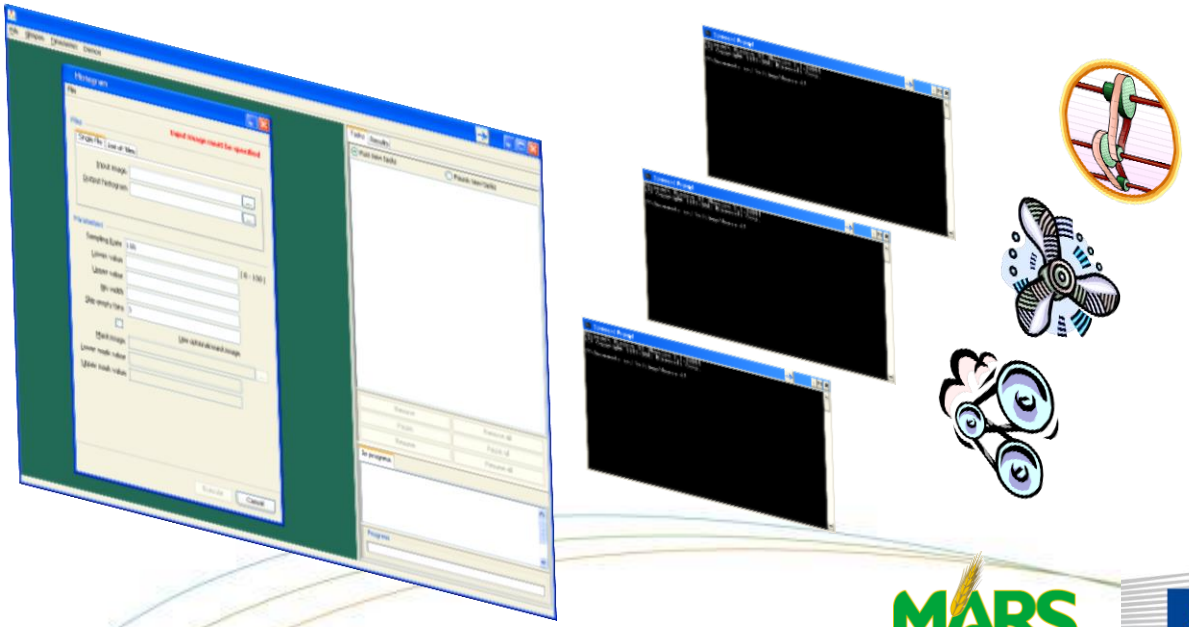
What is SPIRITS?

- 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

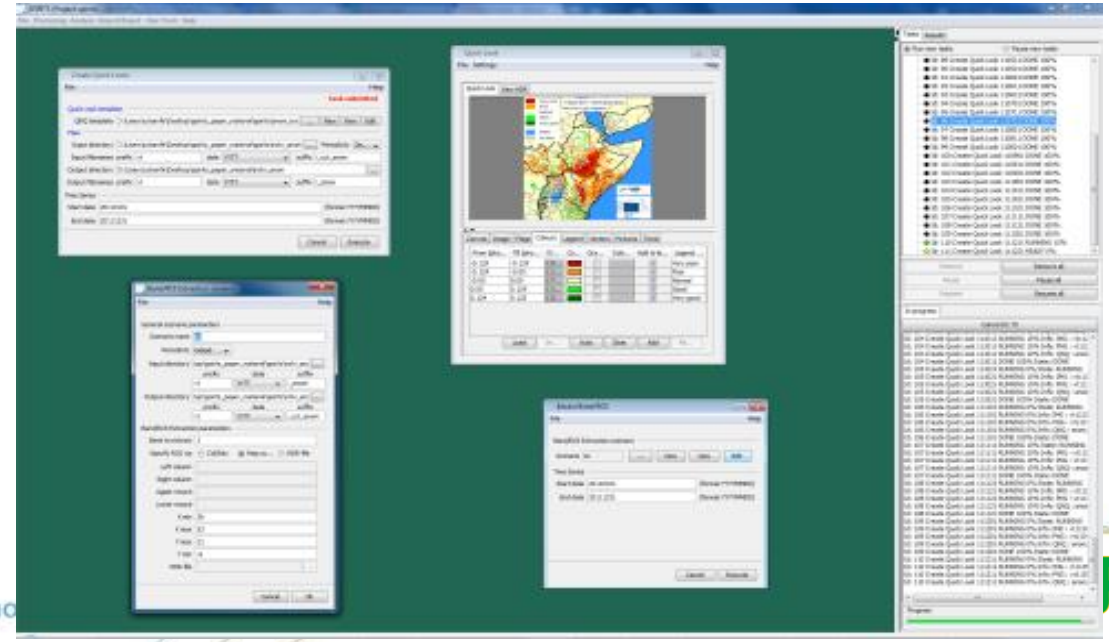


Who are the users?

- 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



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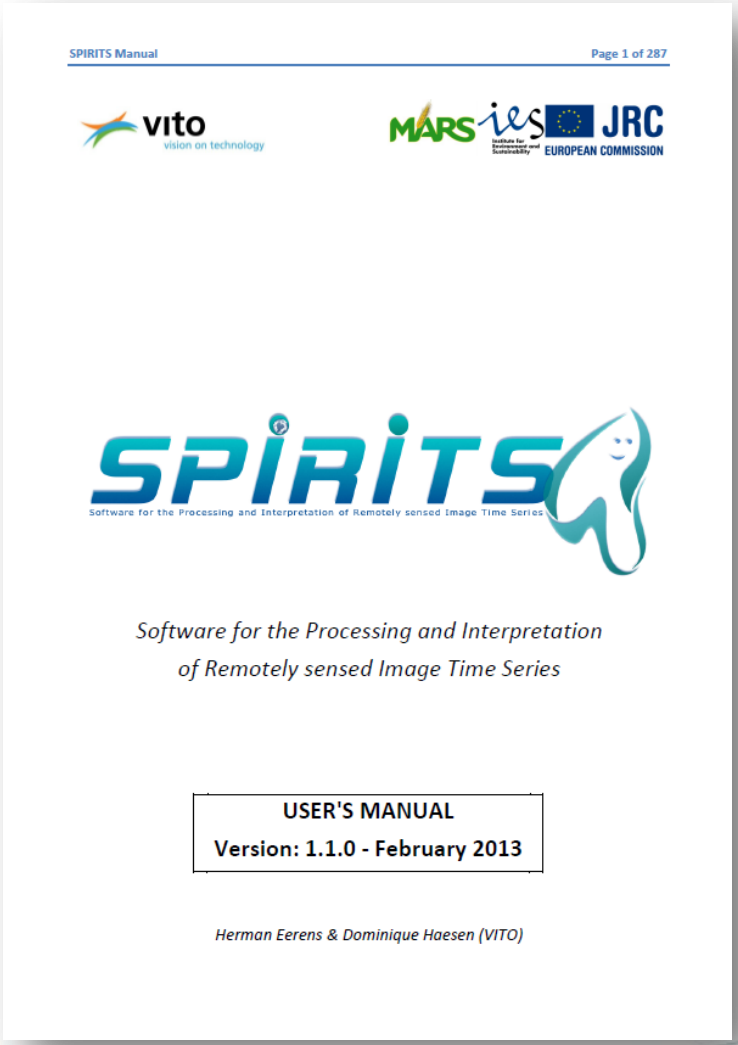
Active since 2.30 pm today!

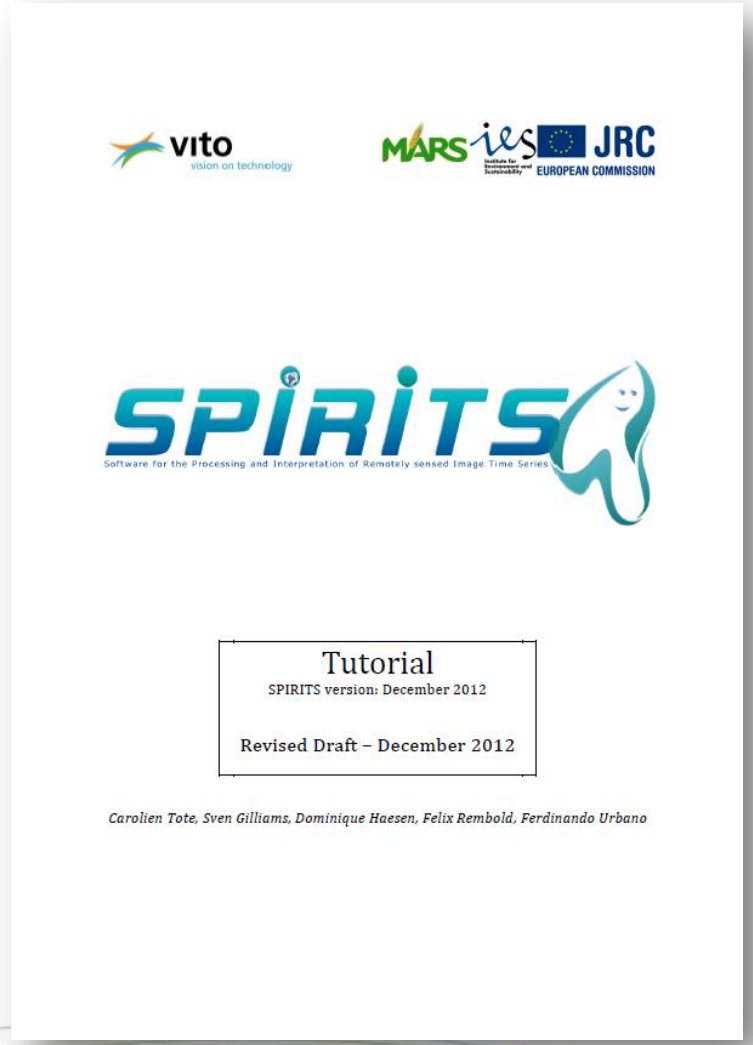
http://spirits.jrc.ec.europa.eu/

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

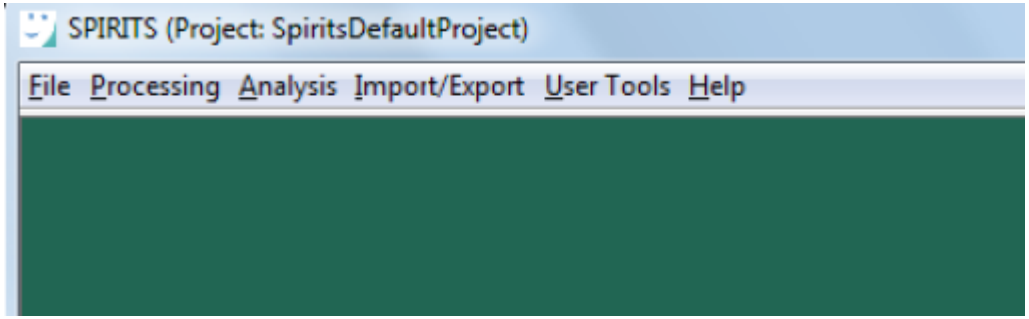




SPIRITS FUNCTIONALITIES

The SPIRITS menu

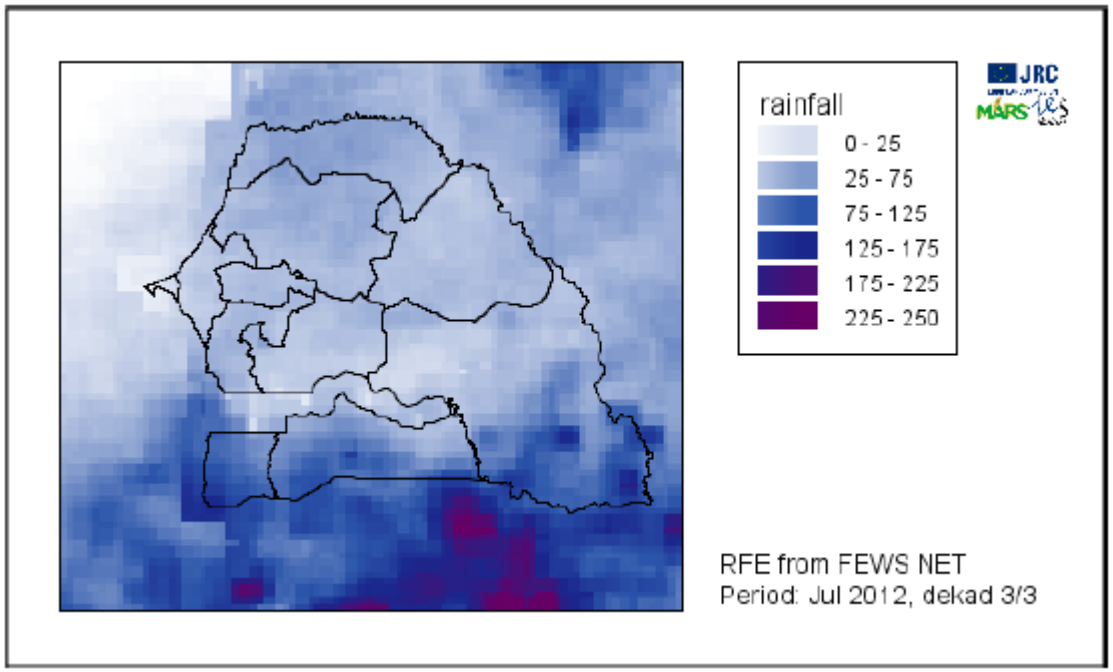
- File
  - File and project definitions, renaming etc…
- Processing
  - Image processing modules for single images (tools) or on a time-series of images
- Analysis
  - Produce maps, browse database, create charts… can be automated
- Import/Export
  - format conversions
  - rasterization
- User tools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

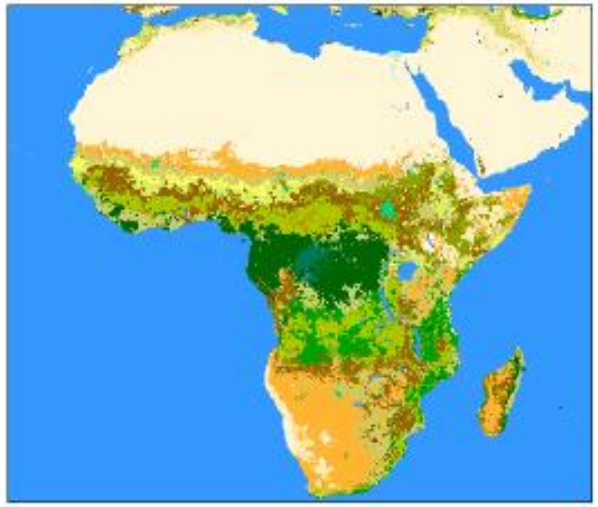


Main functionalities (2/5)

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}

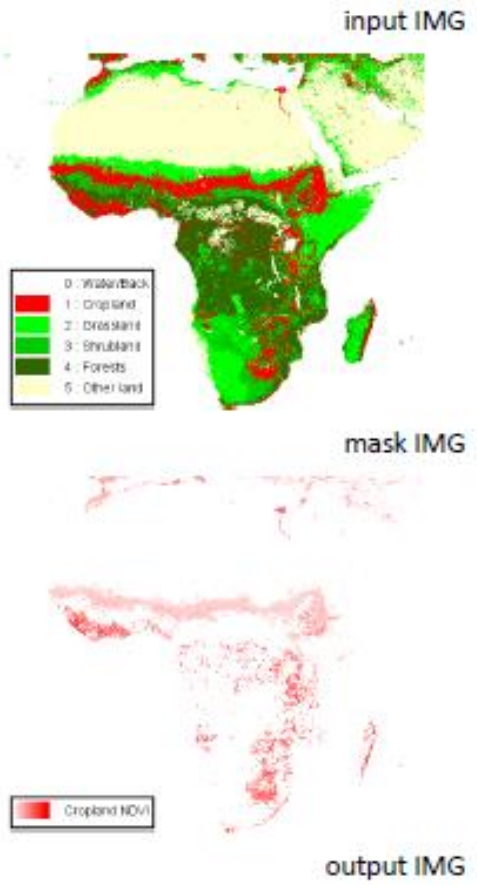


output IMG: map info = {Geographic Lat/Lon, 1, 1, -26.066964, 38.0669643, 0.1875, 0.1875}

Main functionalities (3/5)

Thematic processing operations

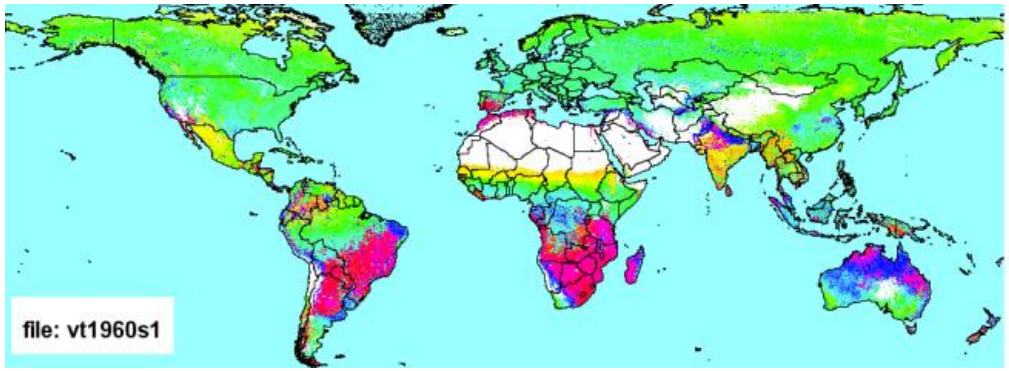
- Rescaling
- Index
- Masking
- Flagging
- DMP (Dry matter production)
- Clustering

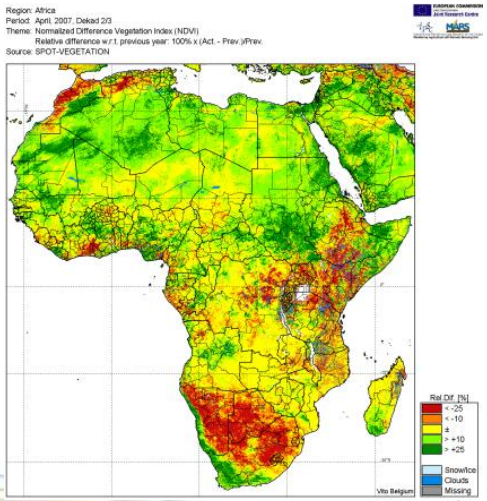


Main functionalities (4/5)

Temporal processing operations

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

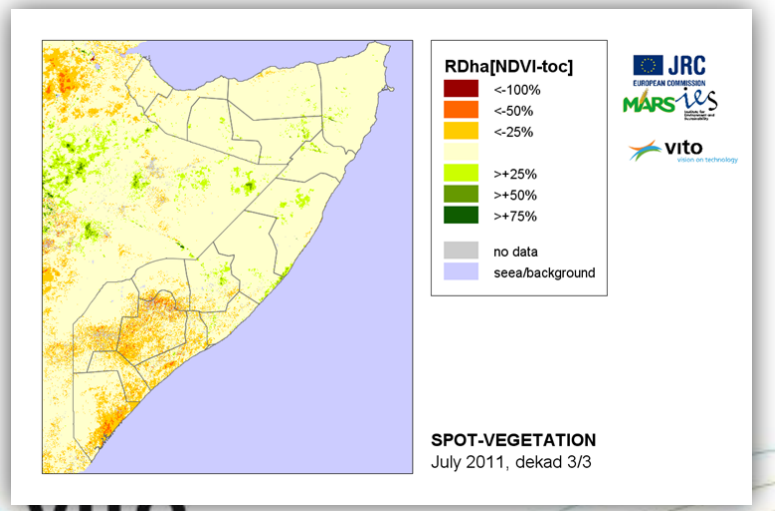


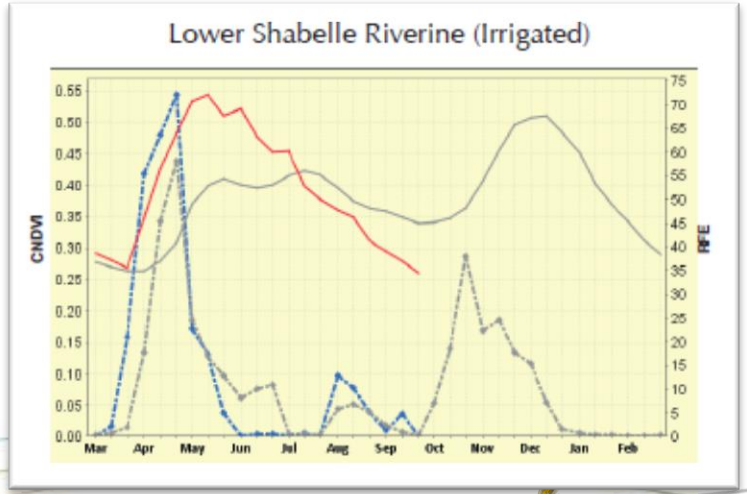


Main functionalities (5/5)

Analysis tools

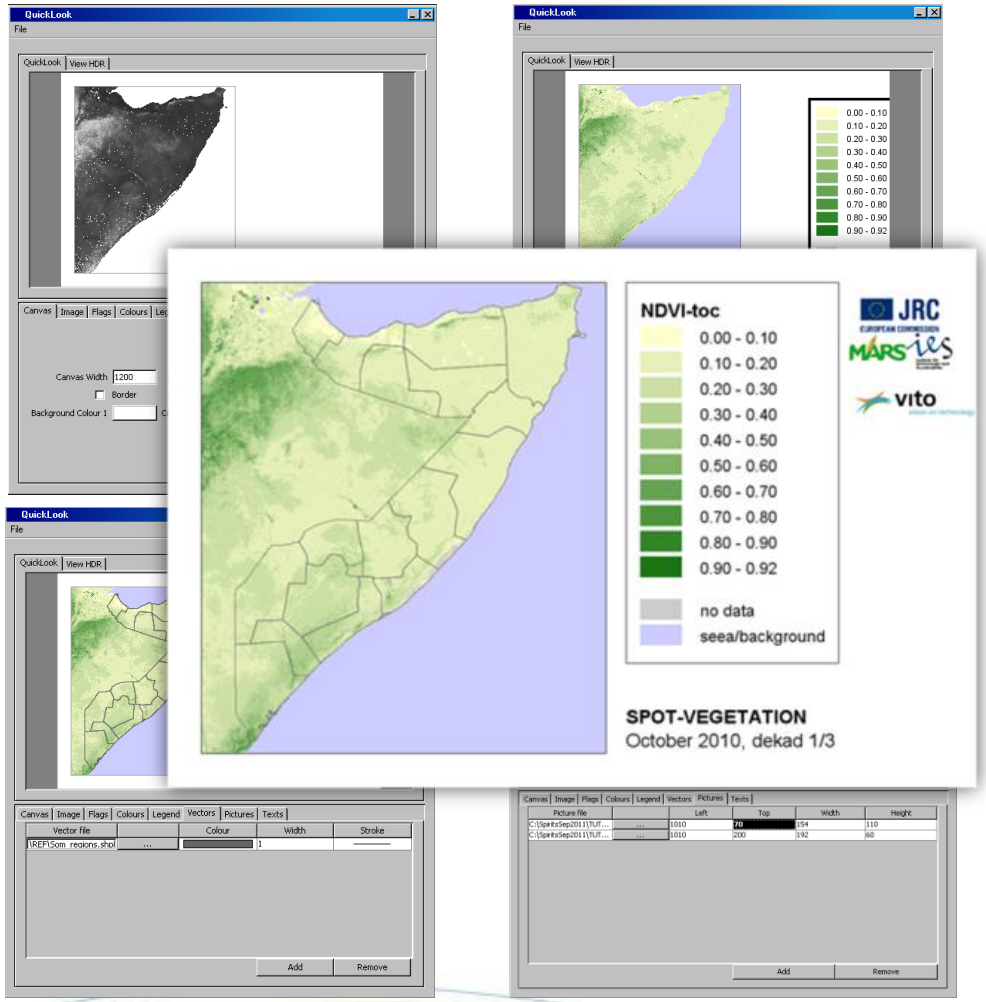
- Map composer
- Database with regionally and thematically aggregated statistics
- Graph composer
- User tool



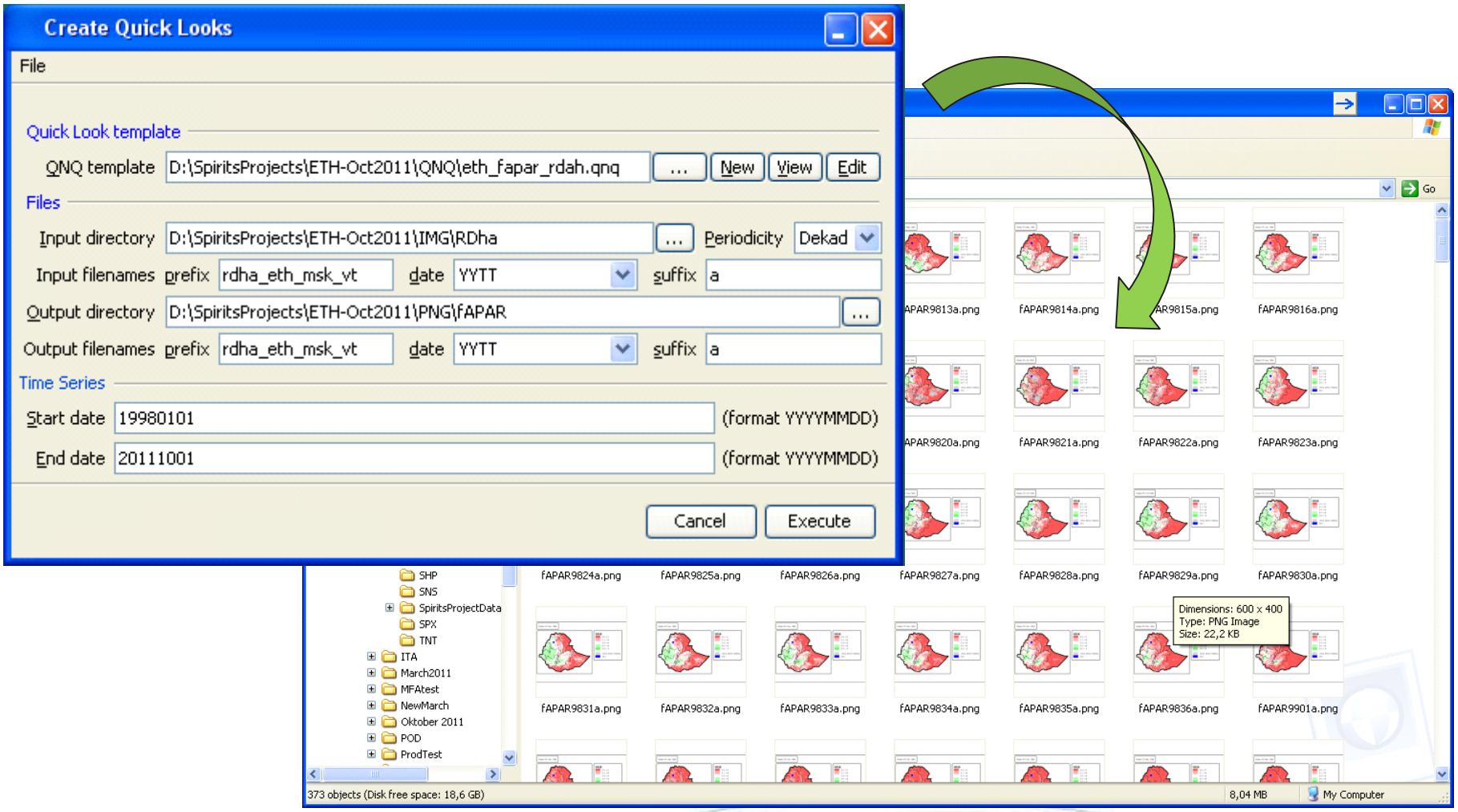


Map composer

- 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



Aggregated statistics extraction and visualization

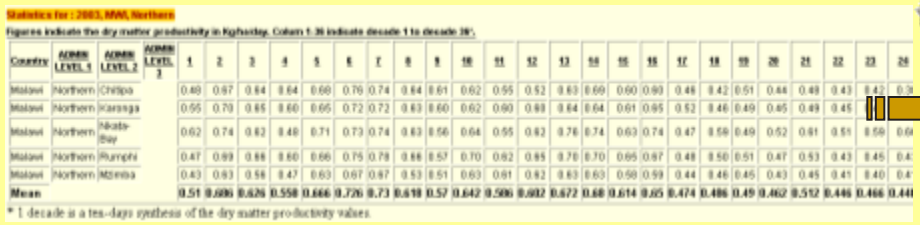
Administrative boundaries

SPOT-VGT images

Landcover

- ✓All zones
- ✓forest
- ✓grasssland
- ✓Agriculture
- ✓bushland

“RUM” database – regional unmixed

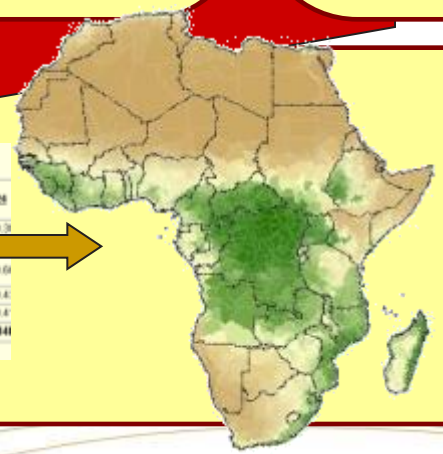


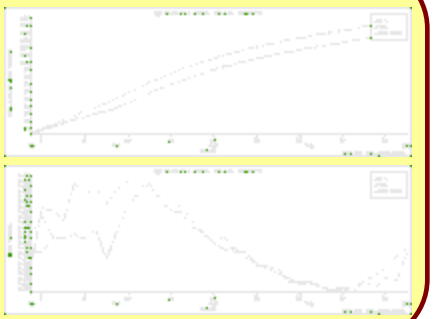
Statistics for : 2003, MWI, Northern

Figures indicate the dry matter productivity in Kg/ha/day. Colum 1-36 indicate decade 1 to decade 36*.

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
Malawi	Northern	Chitipa		0.48	0.67	0.64	0.64	0.68	0.76	0.74	0.64	0.61	0.62	0.55	0.52	0.63	0.69	0.60	0.60	0.48	0.42	0.51	0.44	0.48	0.43	0.42	0.3
Malawi	Northern	Karonga		0.55	0.70	0.65	0.60	0.65	0.72	0.72	0.63	0.60	0.62	0.60	0.60	0.64	0.64	0.61	0.65	0.52	0.46	0.49	0.45	0.49	0.45		
Malawi	Northern	Nkata-Bay		0.62	0.74	0.62	0.48	0.71	0.73	0.74	0.63	0.56	0.64	0.55	0.62	0.76	0.74	0.63	0.74	0.47	0.59	0.49	0.52	0.61	0.51	0.59	0.6
Malawi	Northern	Rumphi		0.47	0.69	0.66	0.60	0.66	0.75	0.78	0.66	0.57	0.70	0.62	0.65	0.76	0.70	0.65	0.67	0.48	0.50	0.51	0.47	0.53	0.43	0.45	0.4
Malawi	Northern	Mzimba		0.43	0.63	0.58	0.47	0.63	0.67	0.67	0.53	0.51	0.63	0.61	0.62	0.63	0.63	0.59	0.59	0.44	0.46	0.45	0.43	0.45	0.41	0.40	0.4
Mean				**0.51**	**0.686**	**0.626**	**0.558**	**0.666**	**0.726**	**0.73**	**0.618**	**0.57**	**0.642**	**0.586**	**0.602**	**0.672**	**0.68**	**0.614**	**0.65**	**0.474**	**0.486**	**0.49**	**0.462**	**0.512**	**0.446**	**0.466**	**0.44**

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





Time series analysis charts

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

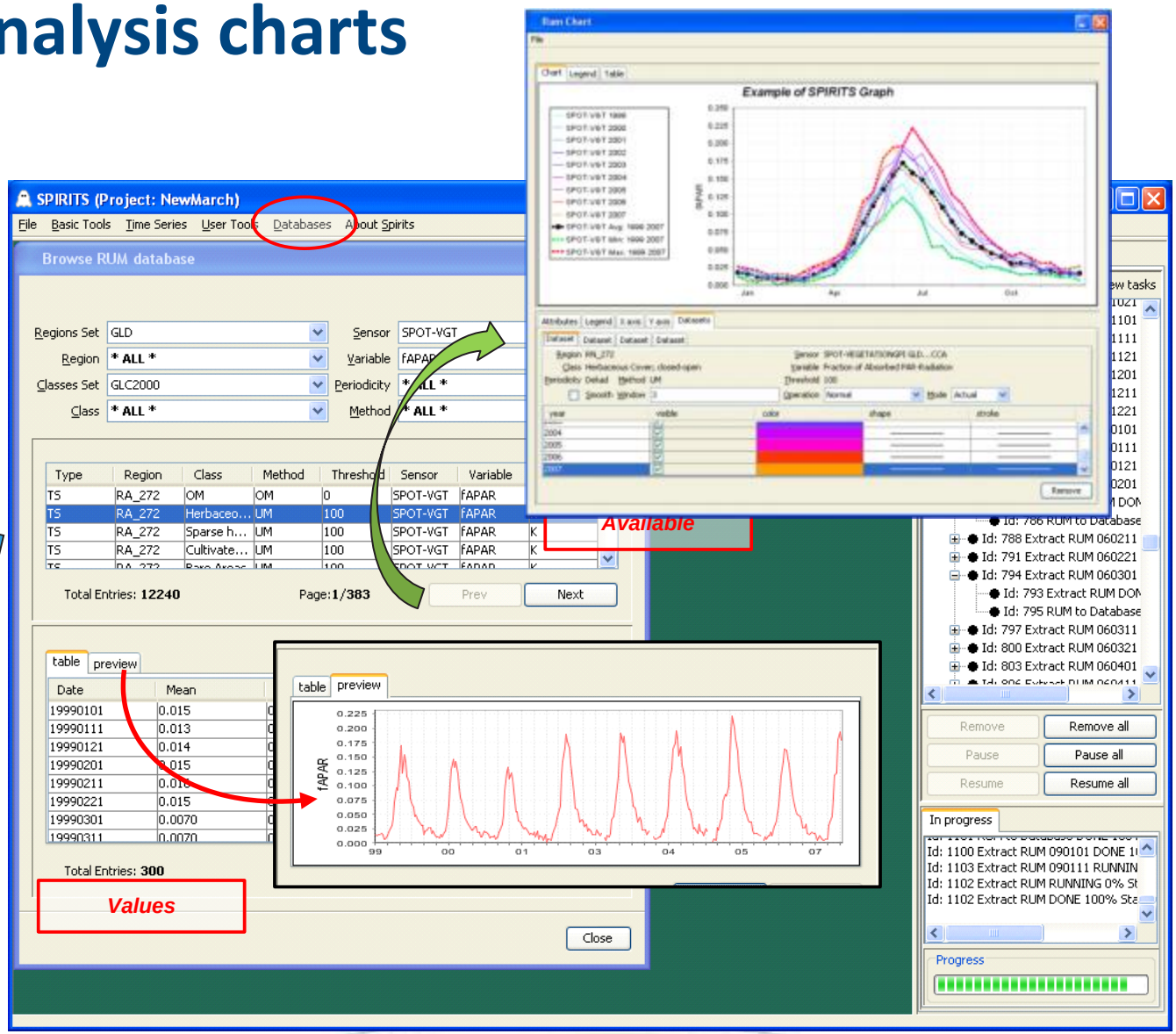
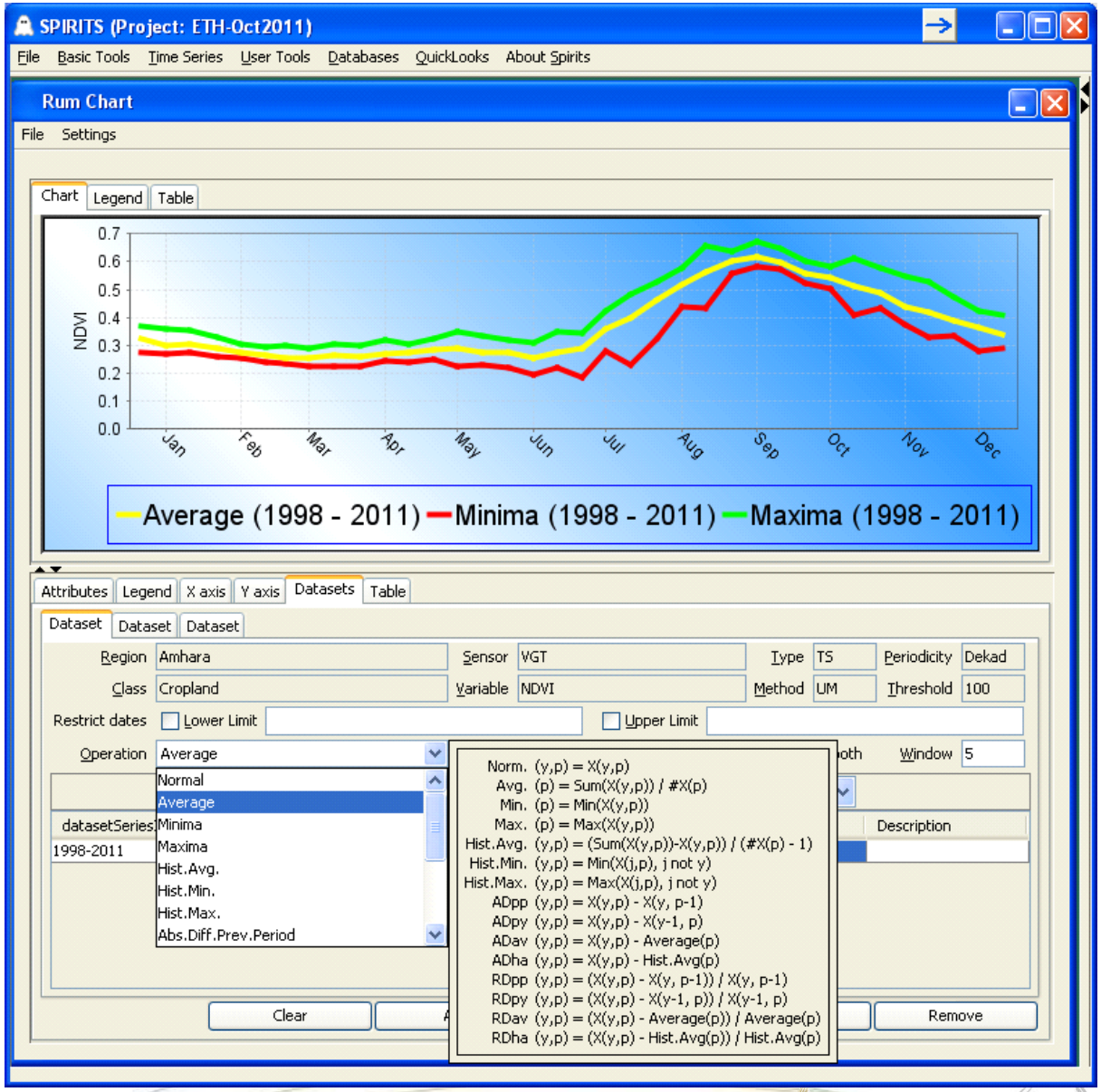
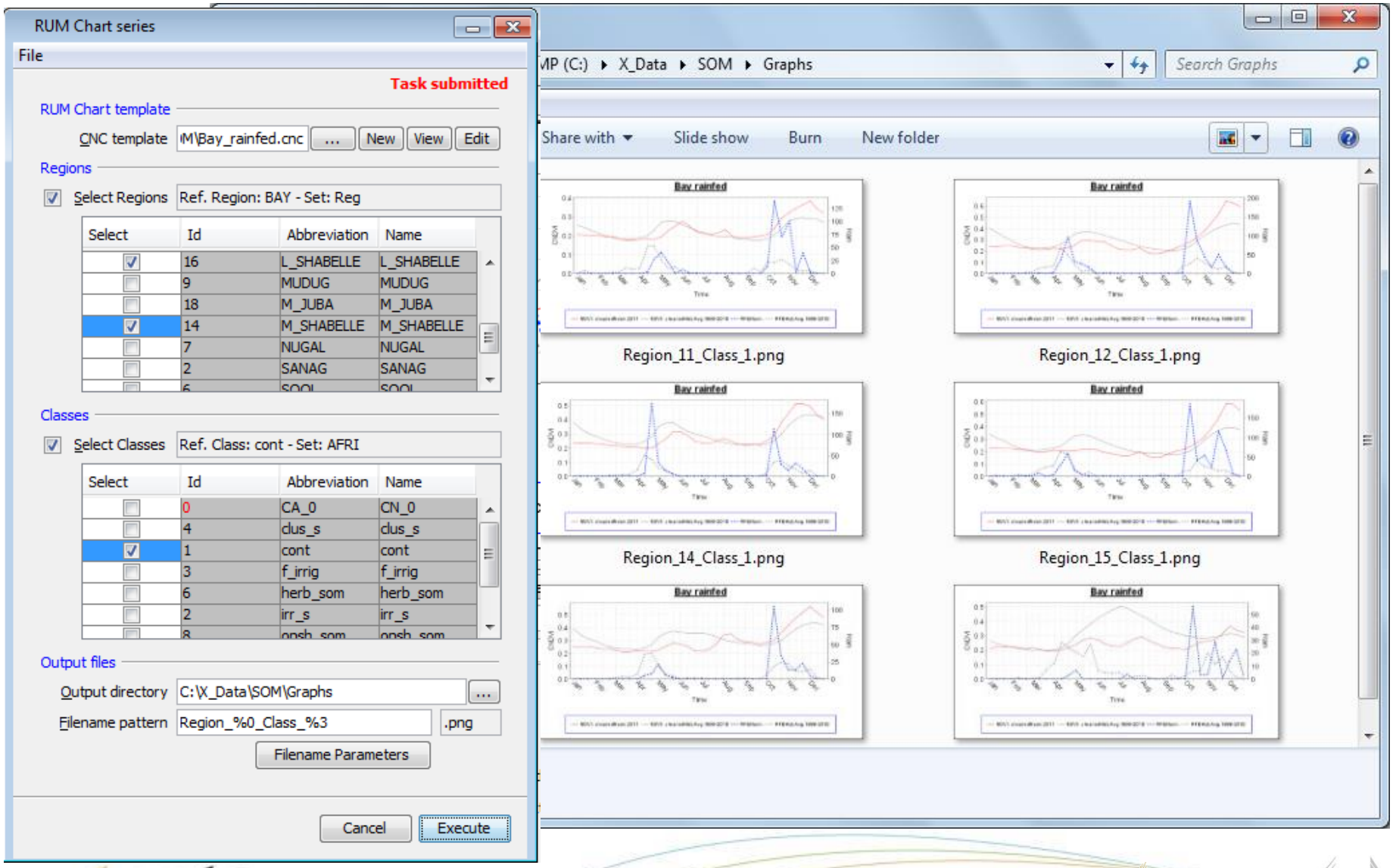


Chart operations

- 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



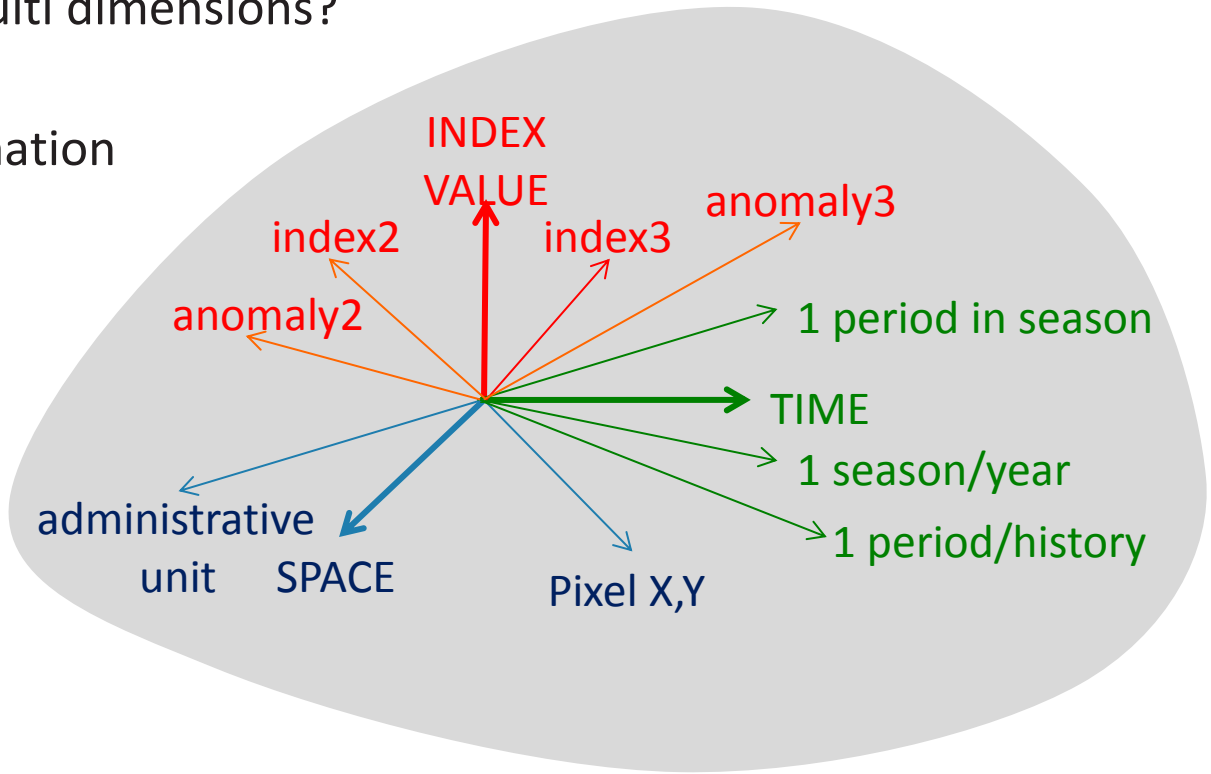
Charts – time series

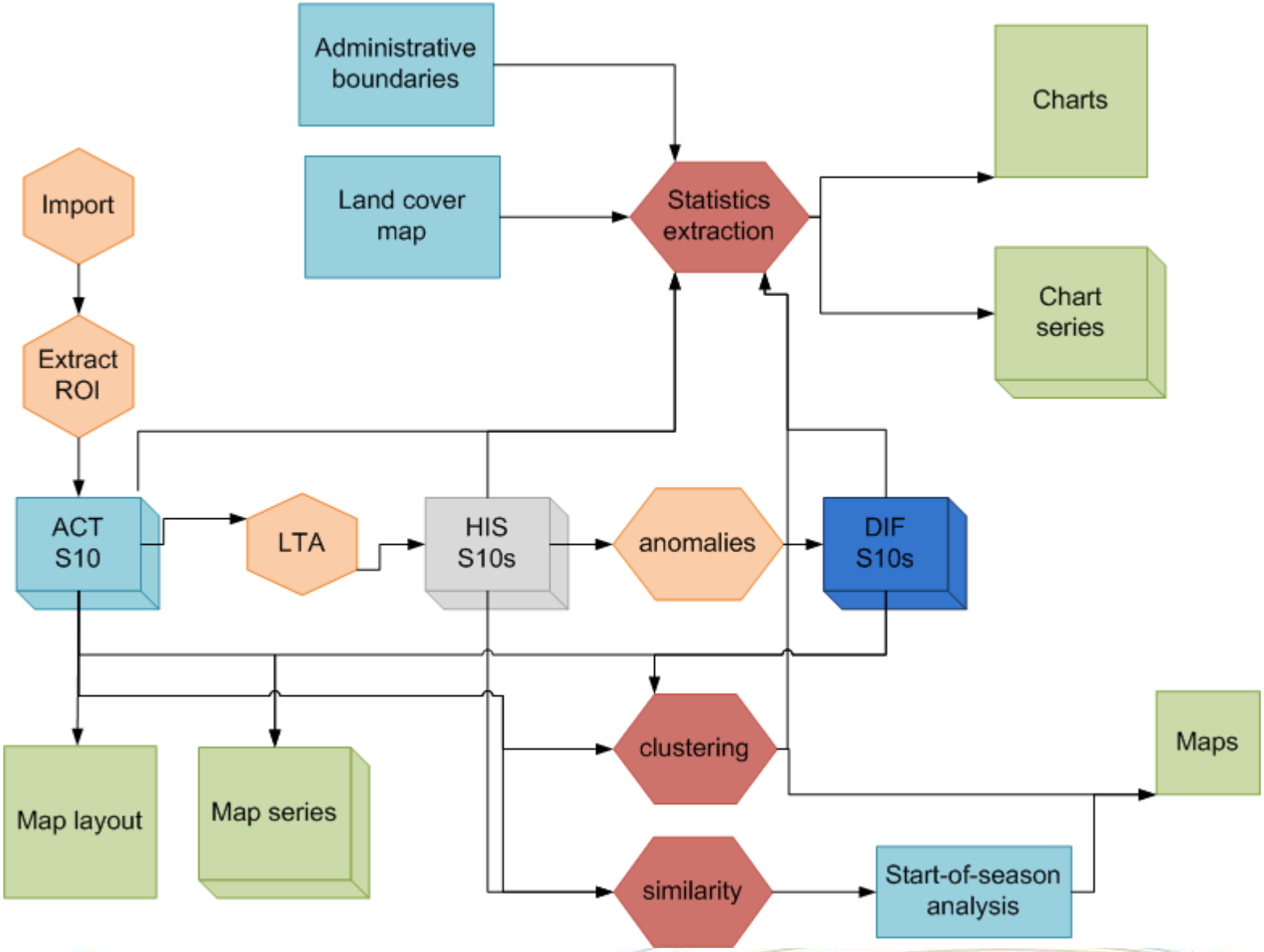


SPIRITS ANALYSIS METHODS

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

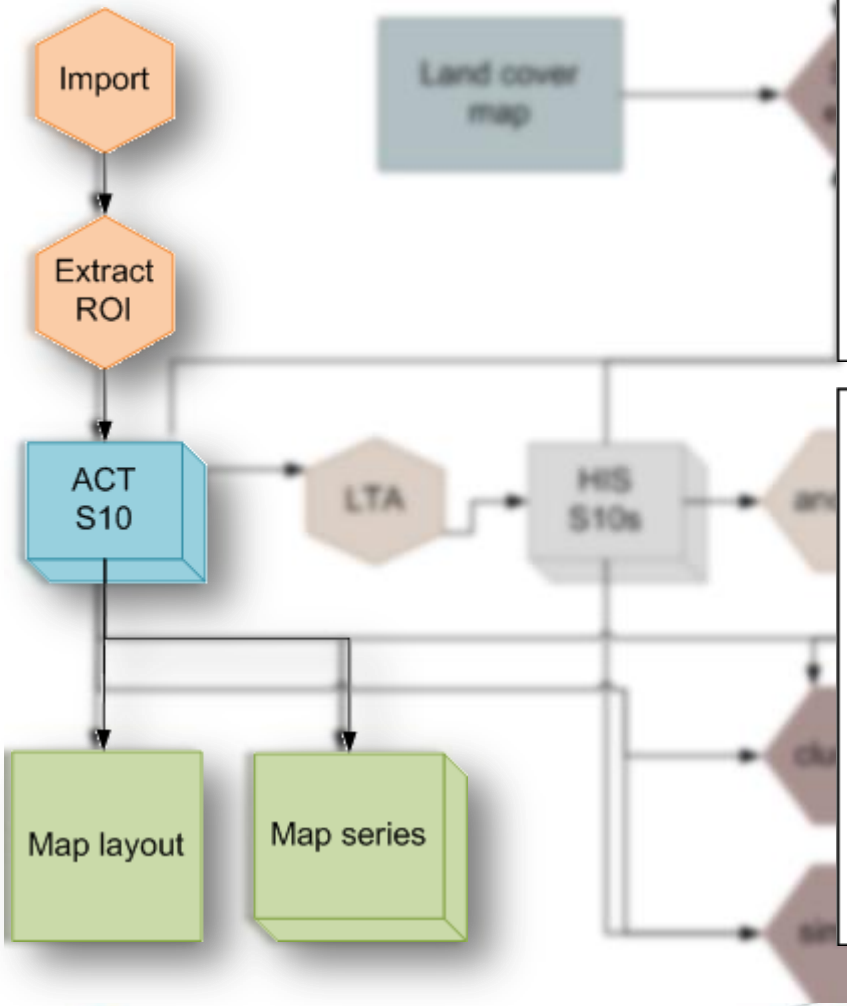


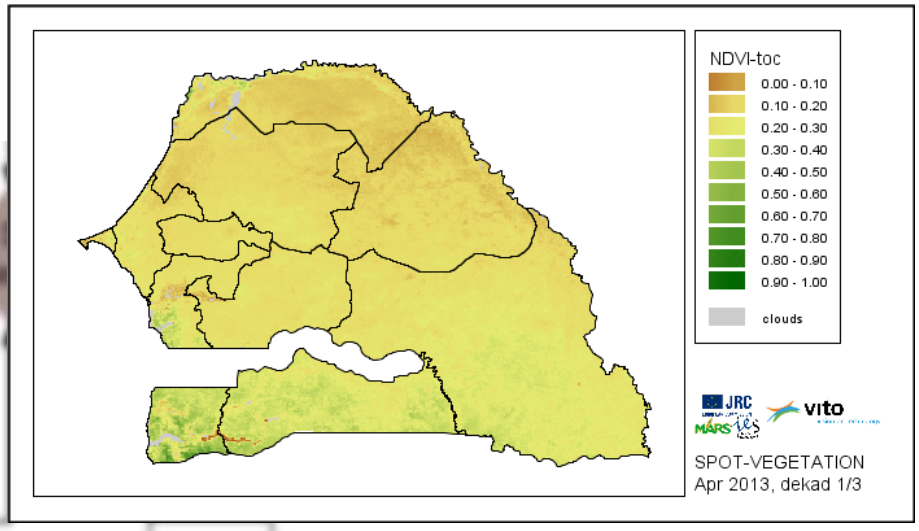

Administrative boundaries
Land cover map
Statistics extraction
Charts
Chart series
Import
Extract ROI
ACT S10
LTA
HIS S10s
anomalies
DIF S10s
Map layout
Map series
clustering
Maps
similarity
Start-of-season analysis

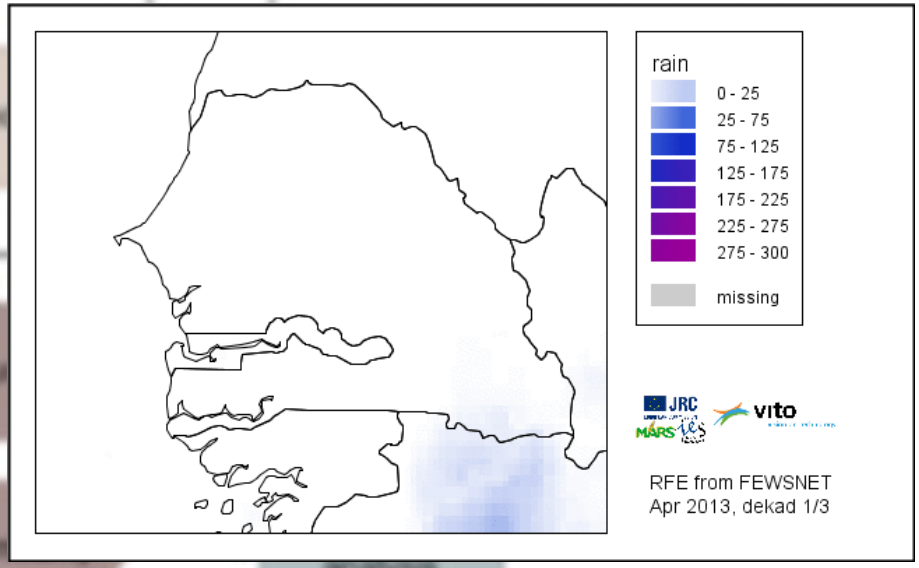
SPIRITS OUTPUT

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

Map series







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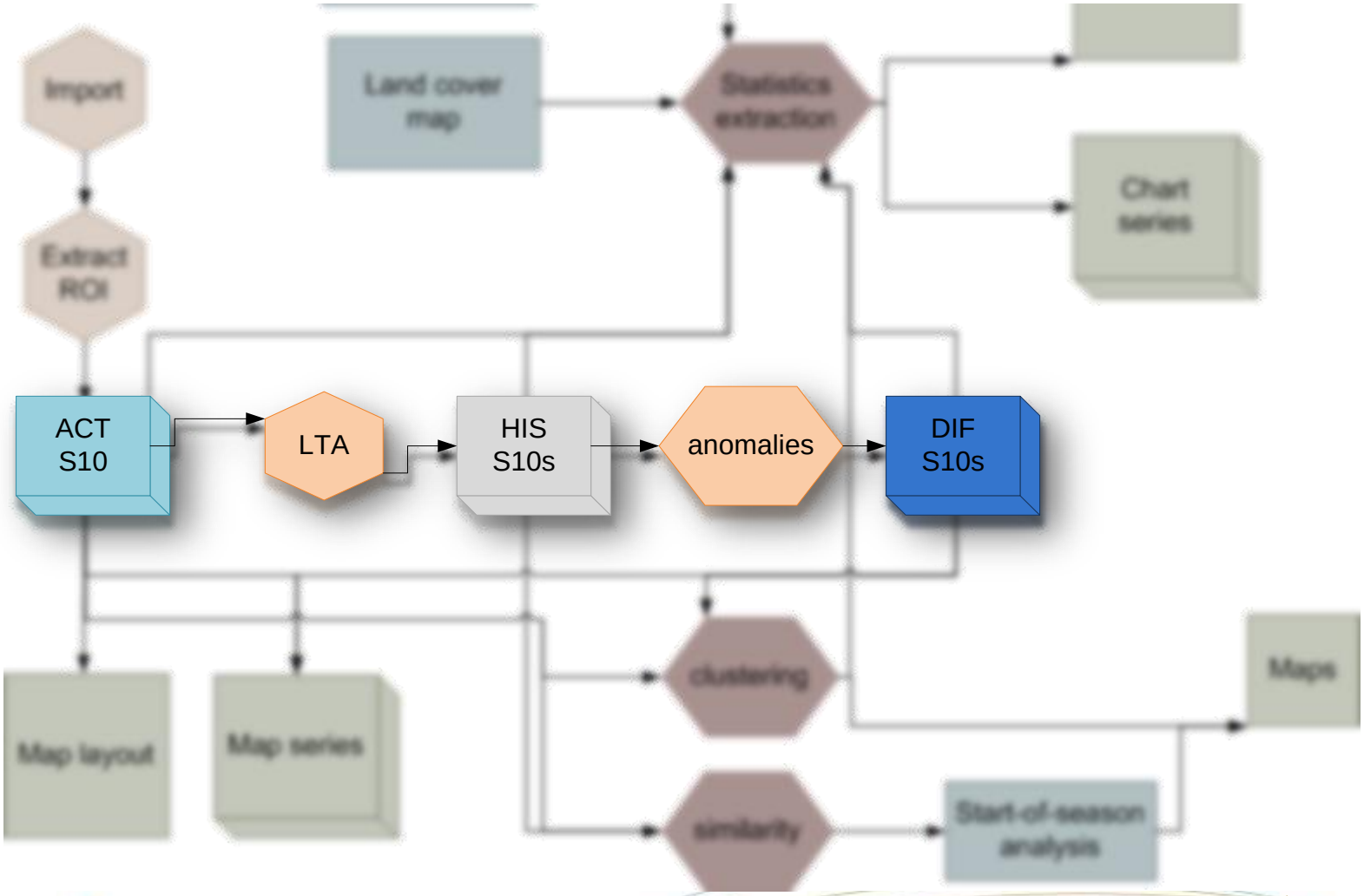
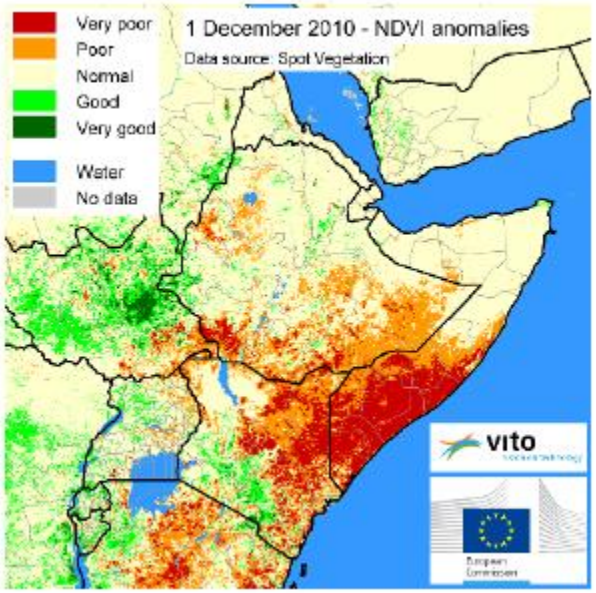
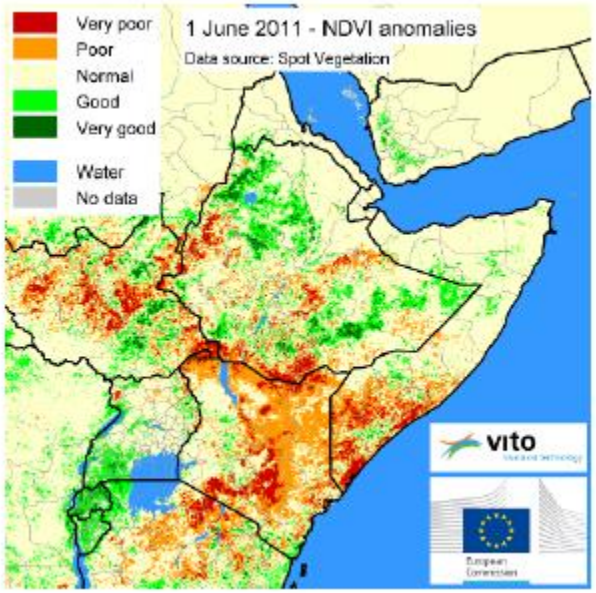
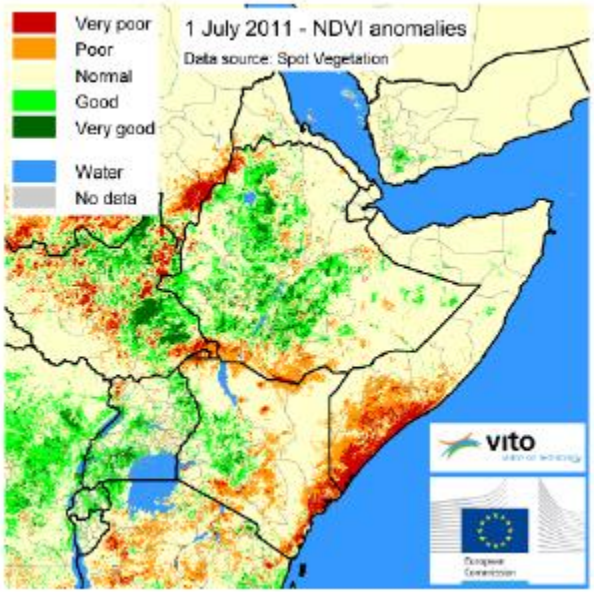
Long term averages and anomalies



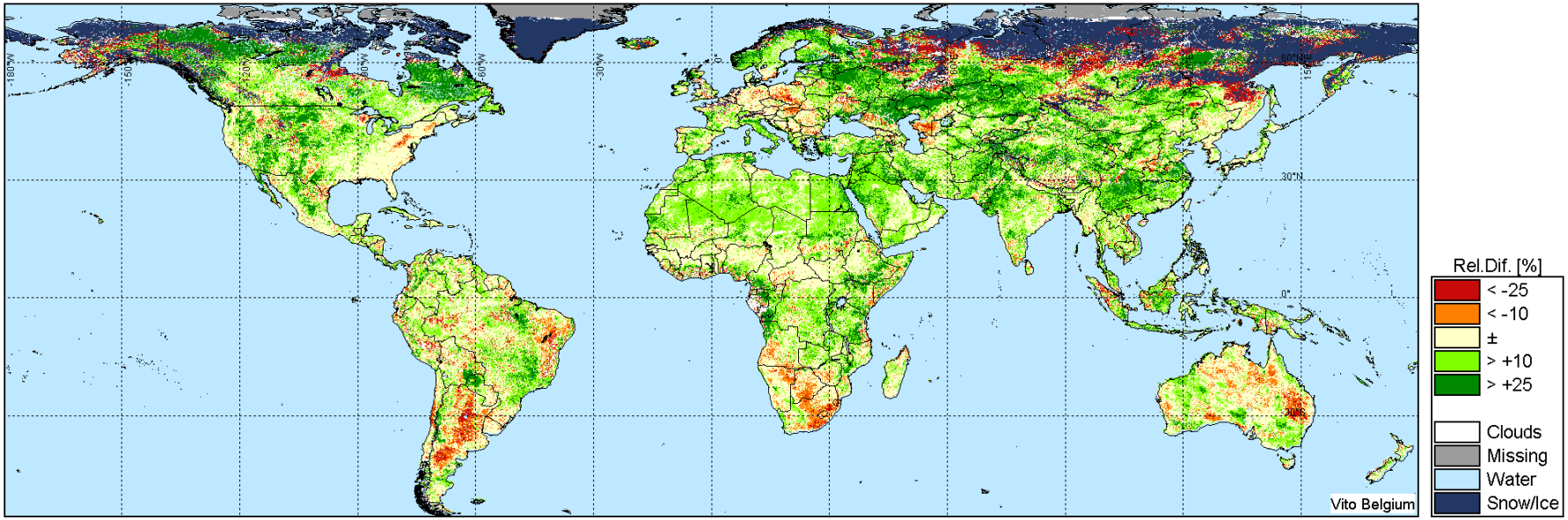




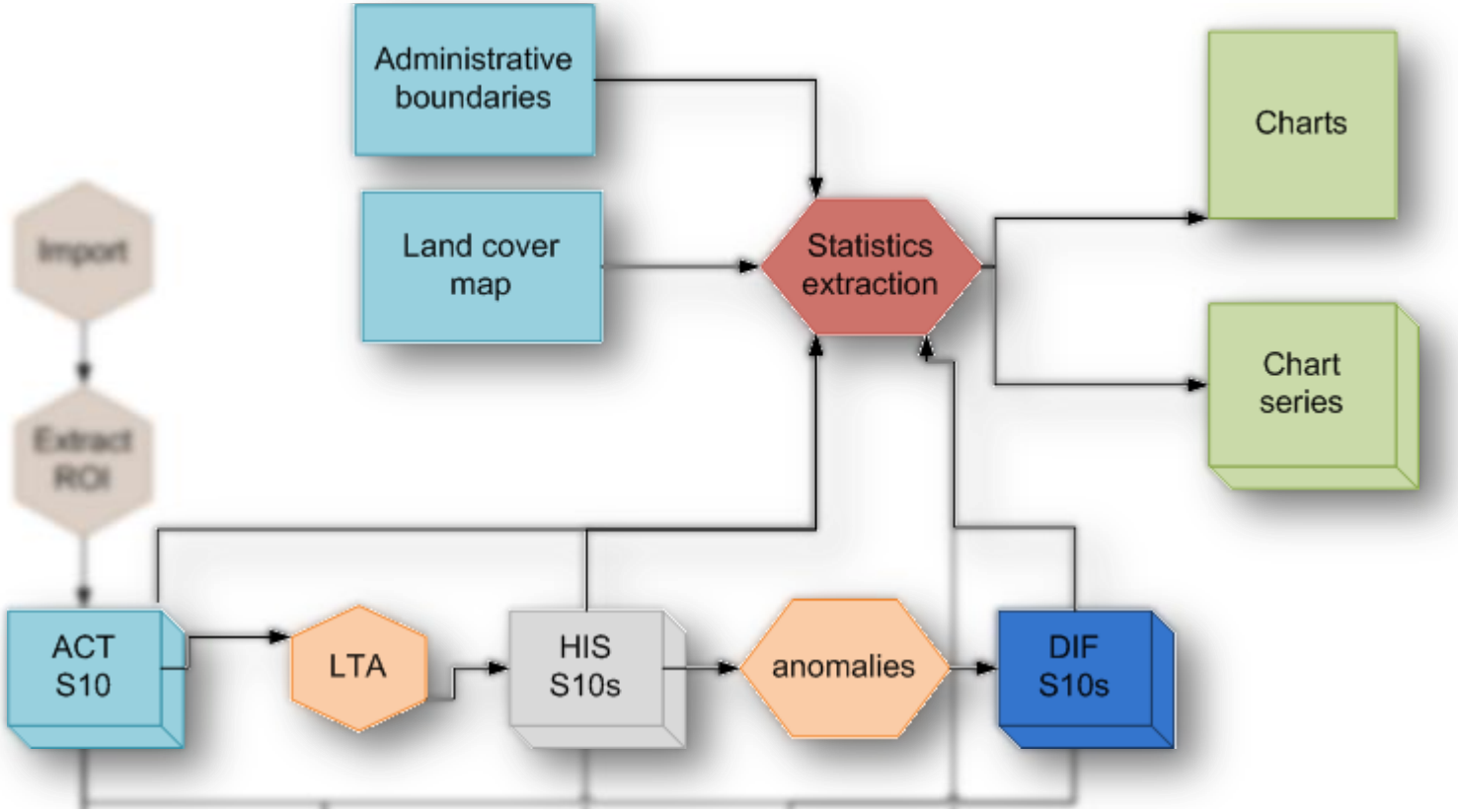


2010/2011 drought, Horn of Africa

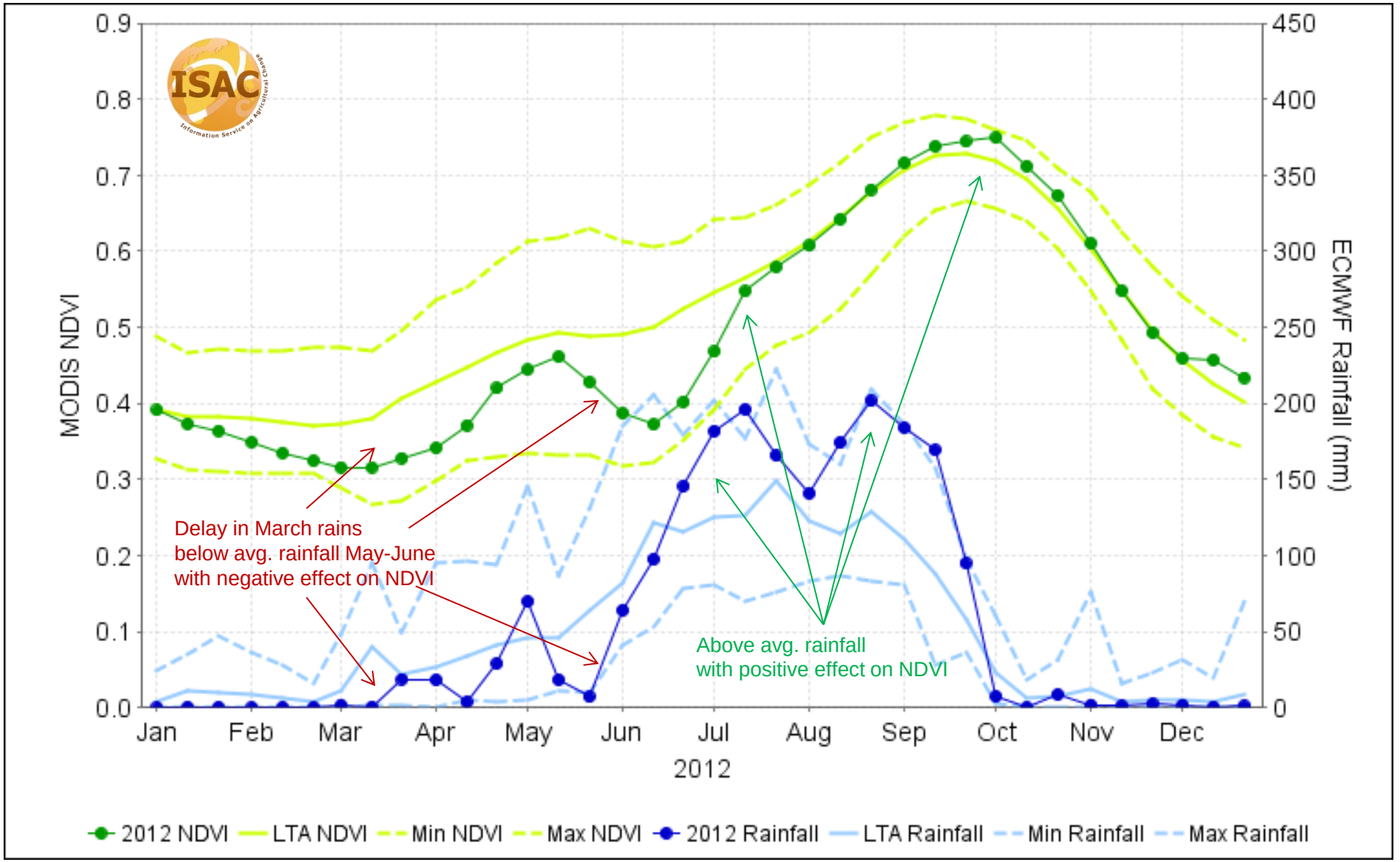
Region: The GLOBE
Period: Oktober, 2013, Dekad 2/3
Theme: Normalized Difference Vegetation Index (NDVI)
Relative difference w.r.t. historical mean: 100% x (Act. - Hist.)/Hist.
Source: SPOT-VEGETATION



Current global situation

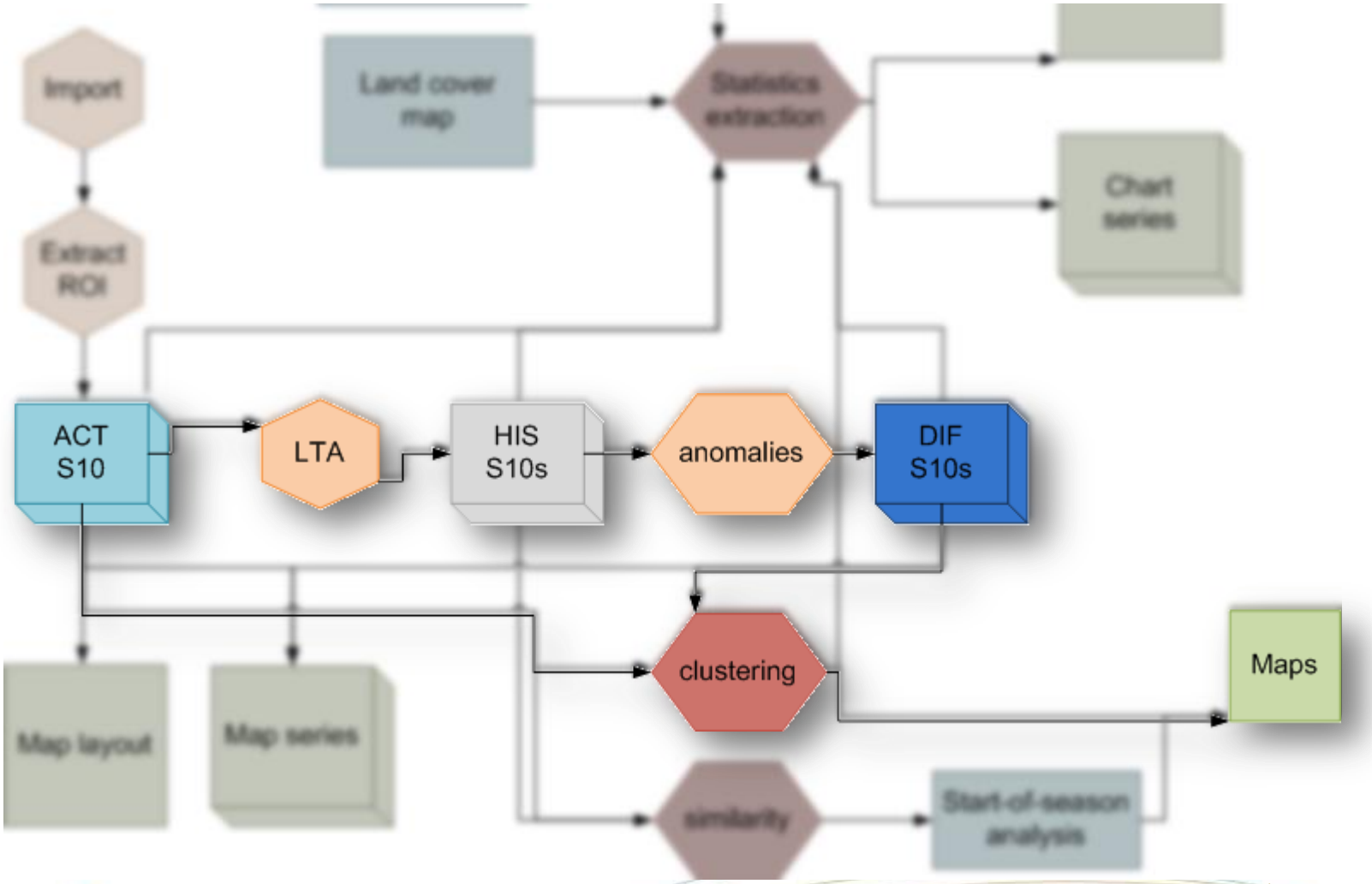


Statistics extraction and graphs



2012 Meher season, West-Shewa, Ethiopia

Clustering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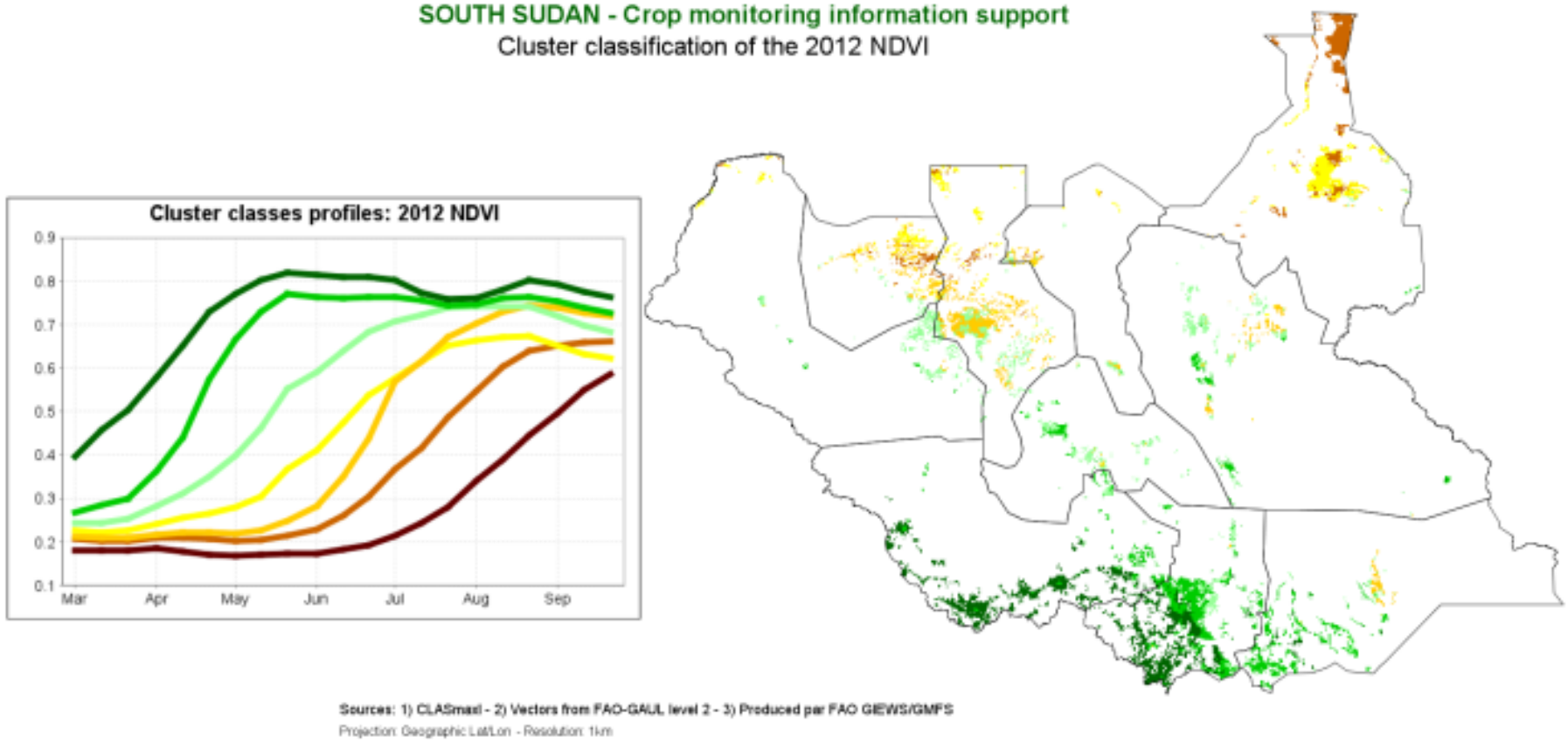
Start-of-season analysis

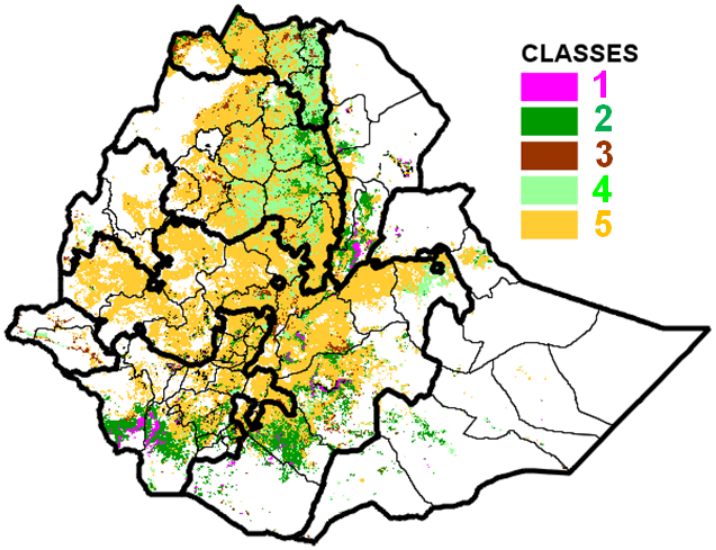


2012 crop season, South Sudan

ETH - Relative NDVI anomalies classification

Period: February to December 2012

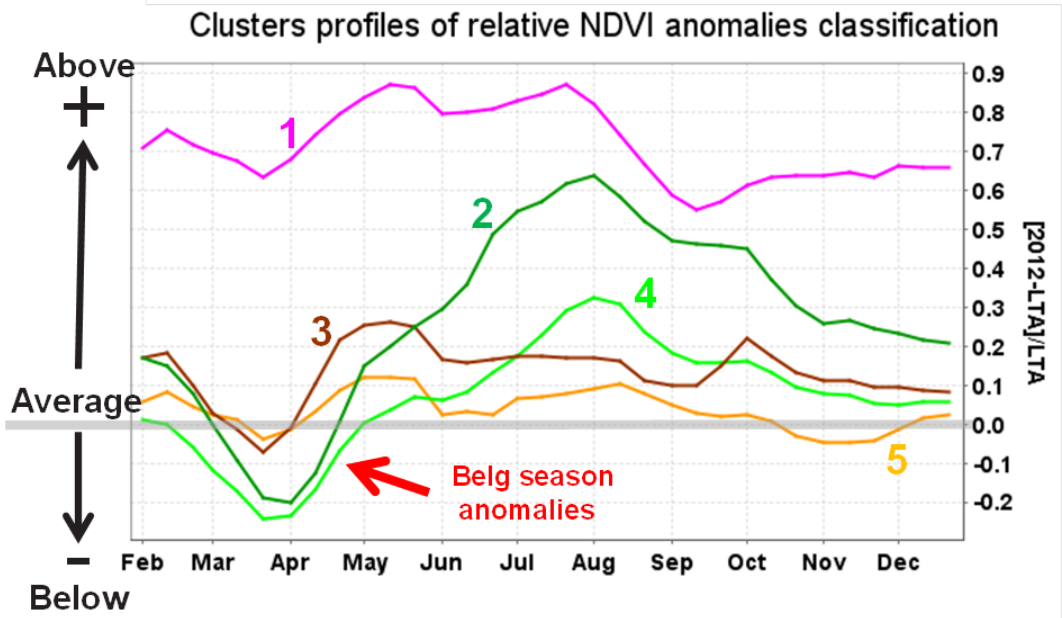
Focus on main agriculture area



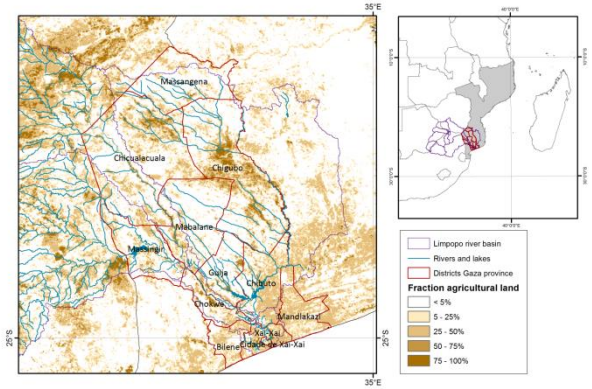
*LTA: Long Term Average 1999-2011

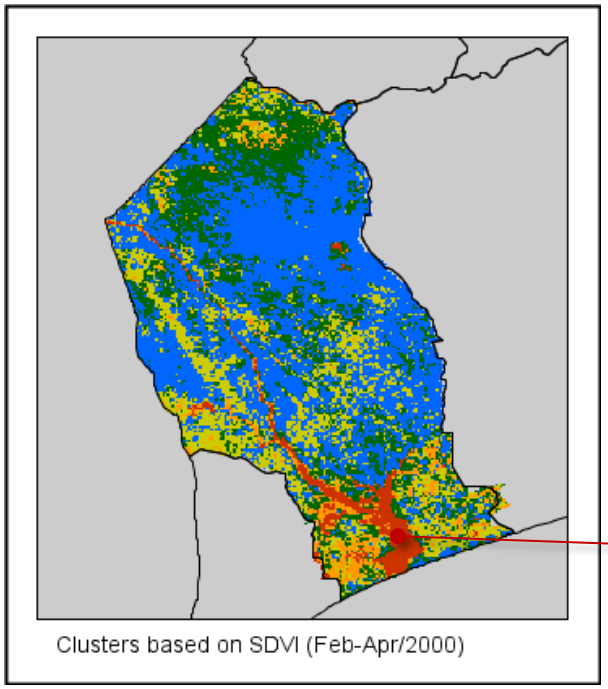
Map: Geographic, WGS 84 - Resolution: 1km

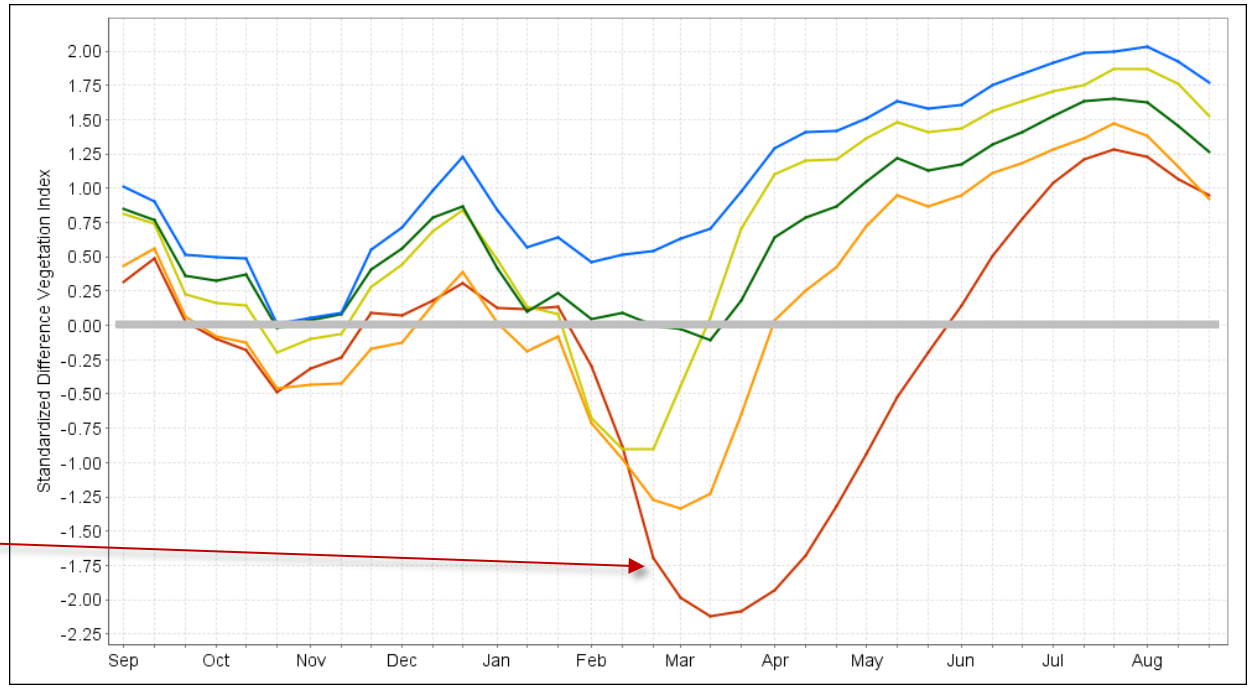
Images : SPOT/VGT - Vectors from FAO Gaul



2012 Belg - Meher crop seasons, Ethiopia







AGRICAB

2000 Flood of Limpopo River, Gaza, Mozambique

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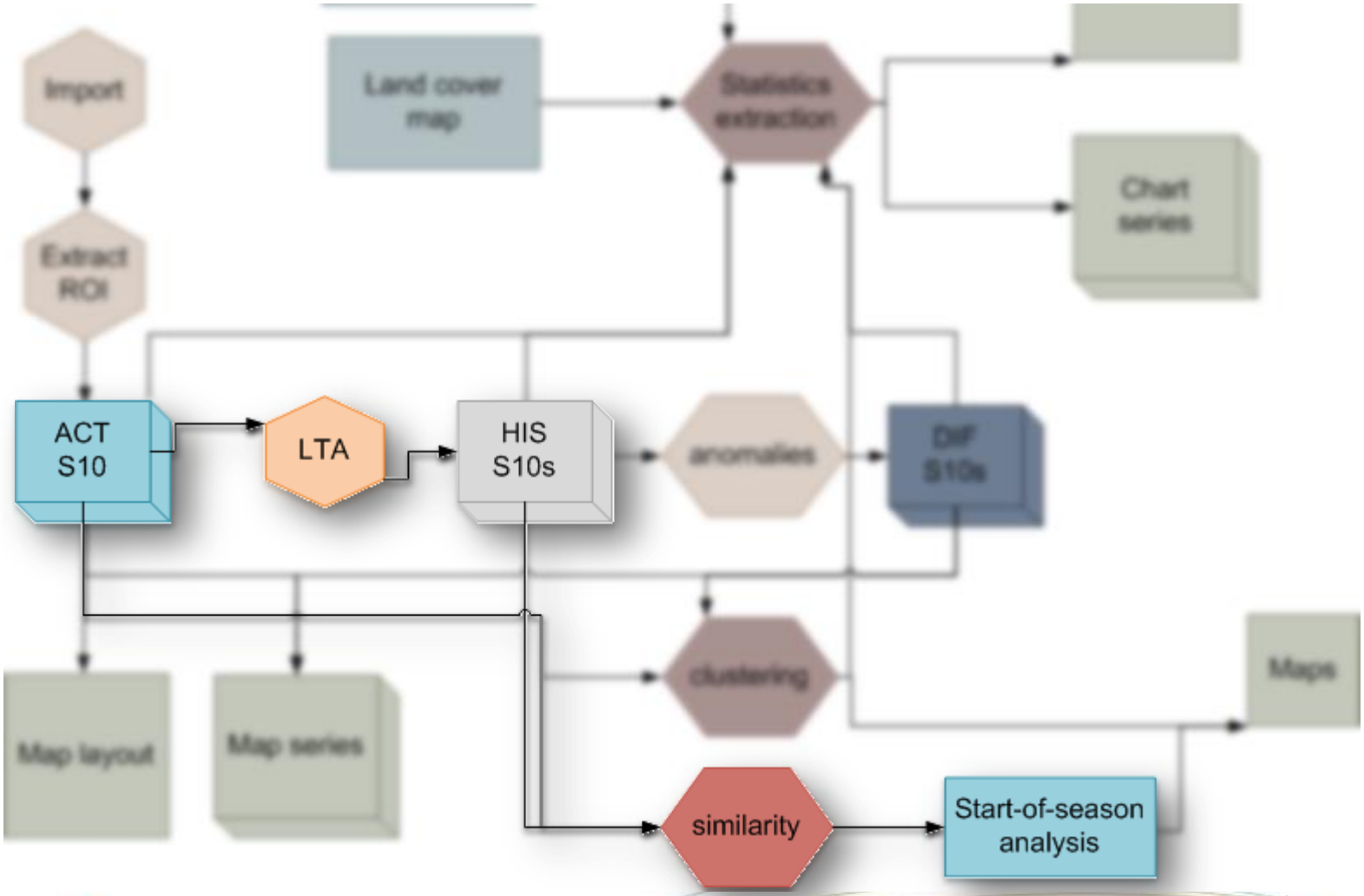
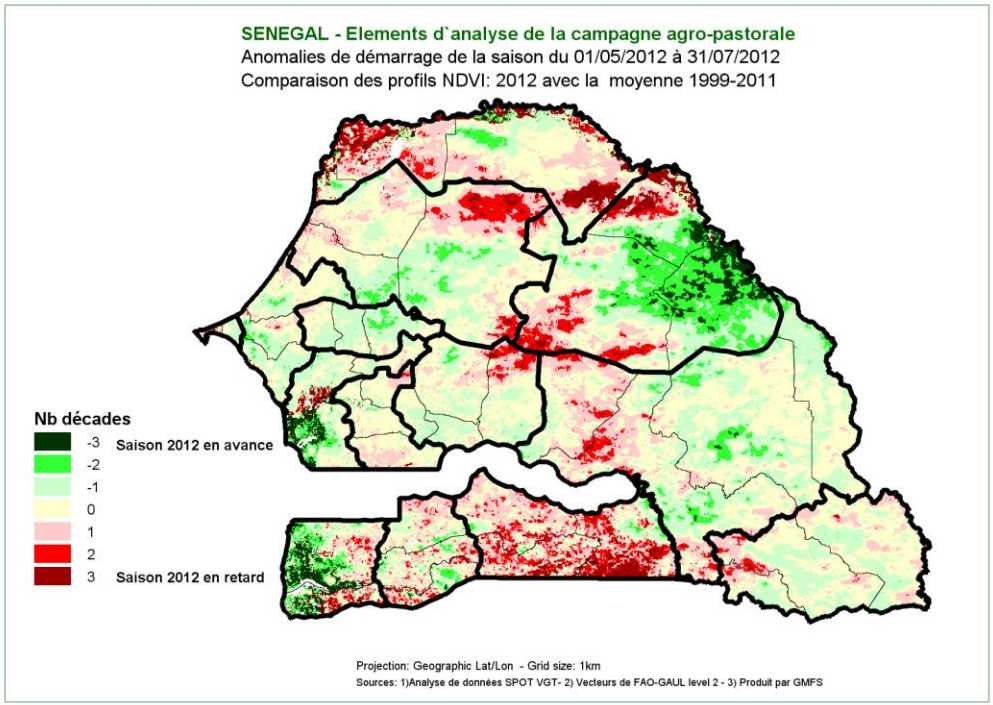
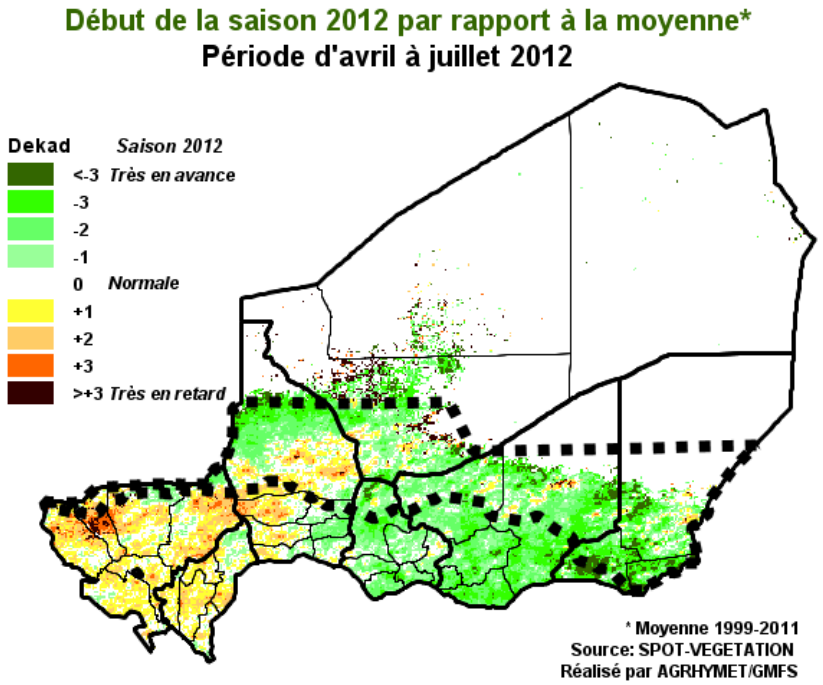
Similarity for start-of-season analysis



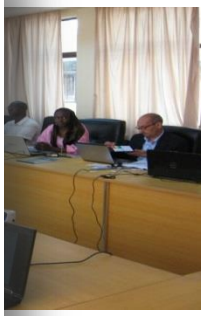




2012 Start-of-season shift compared to long term average (Senegal, Niger)

Growing user community

SPIRITS users/contributors



CENTRE DE SUIVI ECOLOGIQUE

CSE

Suivi de la campagne agro-pastorale 2013

BILAN A MI-PARCOURS DE LA SAISON DES PLUIES

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

RÉSUMÉ

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 décade 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 végetation, sauf au niveau des régions de Ziguinchor et de Sédhiou qui ont enregistré une avance de près de 3 décades par rapport à la moyenne 1999-2012. Ces regions ont bénéficié d'un début de saison des pluies précoce mais ont par la suite connu une situation similaire au reste du pays.

A la première décade du mois de septembre 2013, les conditions de croissance de la végétation (VCI) ont été défavorables dans les départements de Foundiougne, Matam, Ranérou, Louga, Bounkiling, Sedhiou 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 déficitaire 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.

Sommaire

SENEGAL - Indice de Condition de la Végétation (VCI)
Décade du 1/9/2013

VCI (%)
0-10
11-20
21-40
41-60
61-80
81-100
Sup 100

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

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

GMFS

Dans les autres pages :

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 pluviométriques 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 de des zones traversées par le fleuve niger au Niger (**figure1**).

Mali
Burkina Faso
Benin
Nigeria
Chad

Frontières
Zone pastorale du Niger
Condition favorable
Condition normale
Condition défavorable

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.*

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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

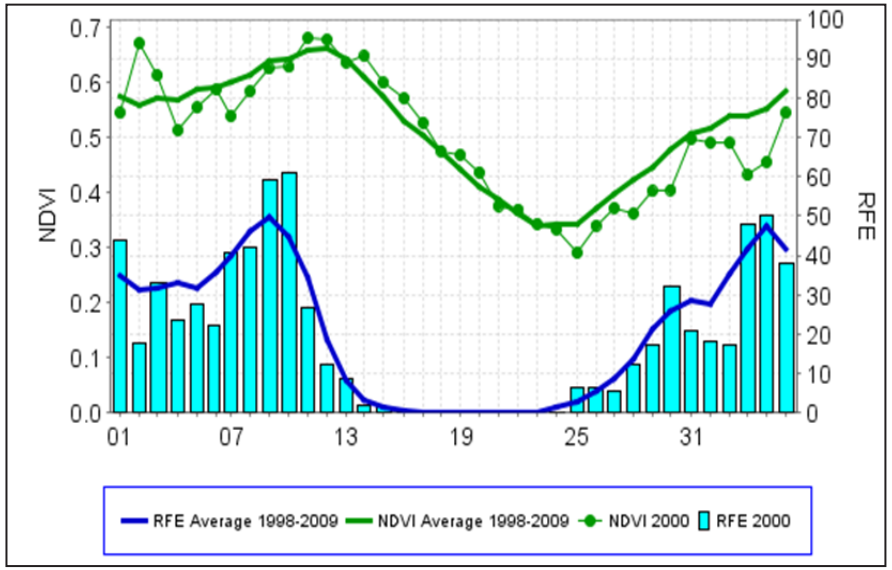
- SPIRITS-specific standards
  - File format (modified ENVI)
  - Contents of HDR file
  - File name structure
  - Flagging of no data values
- Not open source
- No real user support service yet
- Initial steep learning curve

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!

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