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Remote sensing data in the SARRA-O model for yield forecast

The SARRA-O model in the early warning system in West Africa

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ACWWA Project Meeting; Tunis, November 12 to 13, 2019

SARRA-H: global view

Academic

~ 70 publications (mainly with African partners)
(~ 50 with impact factor)
+ international meeting communications

Projects

International (AgMip)
European (AMMA, SIGMA, METAGRI, LAUREL)
French (Tosca, Picrevat, Caviars…)

Applications

Agro-climatological services
Food security
Climate Change

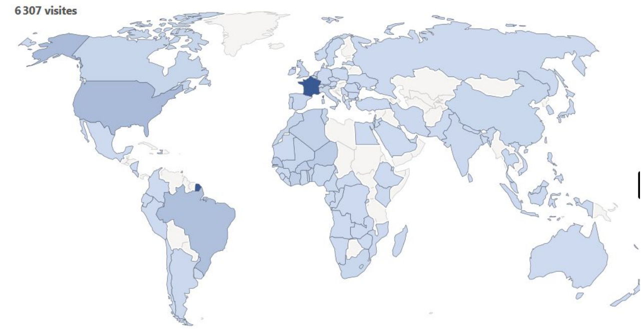
Partners

AGRHYMET, WMO,
Brasil (Embrapa)
National Meteorological Center & National Agricultural Research Services
in West African countries

IRD, CNRS…

SARRA_H & web site (French, English, Portugese)

Site: http://sarra-h.teledetection.fr/



From 2014 to 2019: Constant evolution

Year	Downloading	Visit
2014	255	870
2015	172	830
2016	254	1100
2017	245	1100
2018	418	1080
2019_Oct	693	2121
Total	1610	6302

2018 & 2019 strong increase ...

Continent	Visits %	Of which
Europe	48,3%	France 82%
Africa	26,5%	Niger 14%, Sénégal 14%, Burkina 12%, Côte d'Ivoire 12%
North America	10,5%	Etats Unis 86%, Canada 12%
South America	8,5%	Brésil 90%
Asia	3,4%	Chine 20%, Iran 18%, Inde 14%
Oceania	0,1%	
Unknown	2,4%	

SARRA-O, UN MODELE ET LOGICIEL DU CIRAD, UMR TETIS

Le Modèle SARRA-O

- SARRA-O is the satellite version of SARRA-H (Regional Analysis System for Agro-Climatic Risks)

- It simulates the Potential and actual yields of cereals (millet, sorghum, maize, rice, wheat), also cotton and soybeans, now

SARRA-O : a tool for operational monitoring of agricultural campaigns in West Africa

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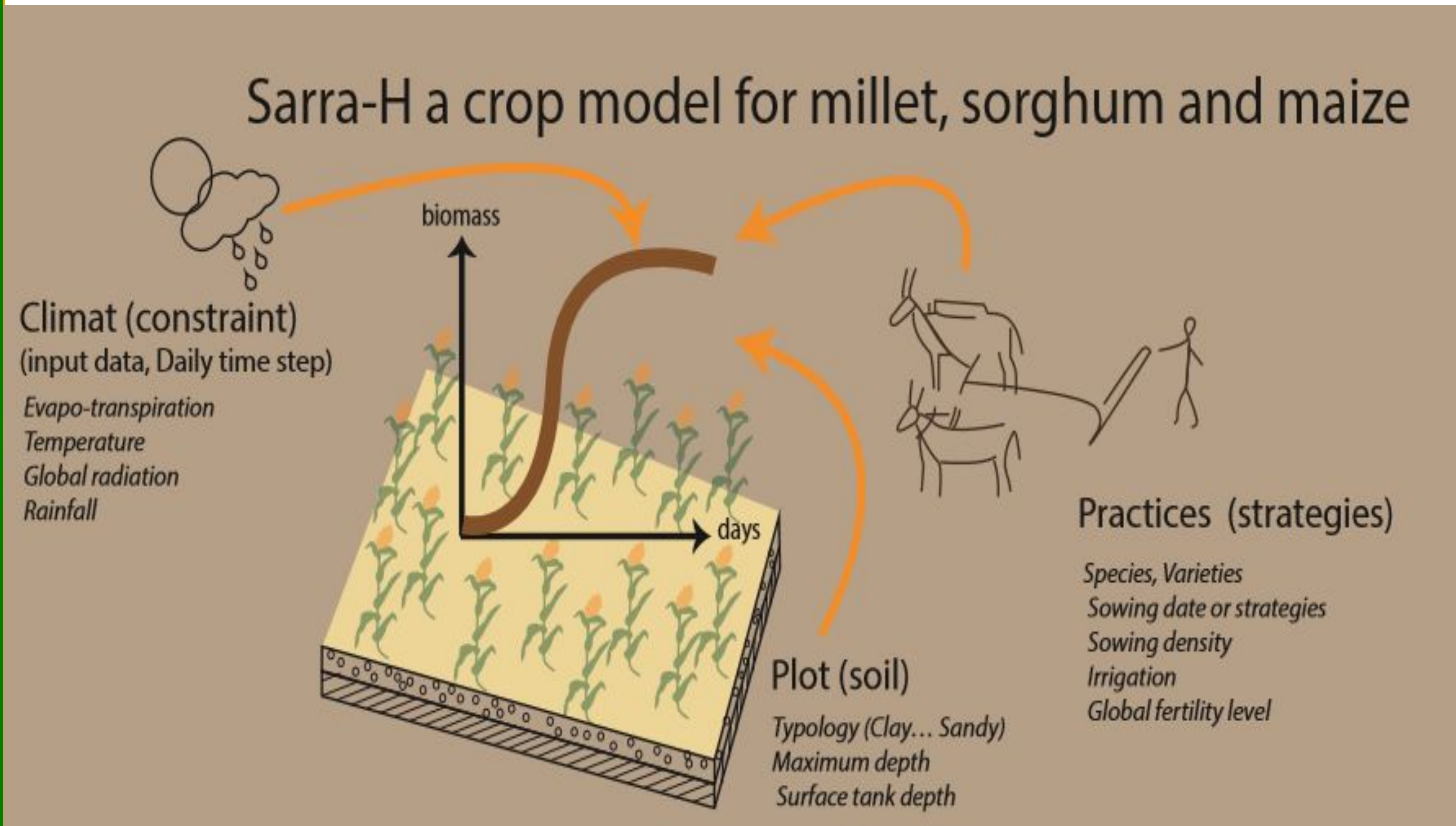
Goals:

- ✔ **Operational monitoring of crop growth, yield forecasting based on soil water availability;**
- ✔ **Detect in time the effects of pedoclimatic conditions** (types and characteristics of soils, onset and end of the rainy season, spatial and temporal distribution of rainfall ….) **and cultural practices** (choice of species / varieties, sowing dates, fertilizer input ….) **on the growth of rainfed crops;**
- ✔ **Alert on the impacts of detected risks** (droughts, soil degradation, production deficit …..) **on food security,**
- ✔ **Analyze the impacts of climate trends (CC) and cultural practices on crop productivity and anticipate adaptation strategies,**
- ✔ **Inform to help decision making**

Operation of the SARRA-H / O Model

- ✔ **Water Balance:** Tanks approach
- ✔ **Carbon balance:** Photosynthesis in a large sheet approach,
- ✔ **Phenology:** Plant growth process management



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SARRA-H Model Input Data

Climate related data

- Rainfall (mm day-1),
- Min, max and / or average temperatures (° C) day-1,
- Relative Humidity Min, Max and / or Avg (%)
- Wind speed at 2 m from the ground (m s-1),
- Duration of insolation (hours) —— **Optional if there is Global Radiation**
- Global Radiation (MJ day-1), —— **Optional if there is Insolation**
- Daily climate demand or ETP (mm day-1) —— **Optional,**

Crop management related Data

- Crop and Variety,
- Sowing date,
- Sowing density (plants ha-1),
- Irrigation
- Overall level of soil fertility

Soil related data

- Typology and Depth,
- Threshold and percentage of runoff,
- Water Retention Capacity, Moisture at Field Capacity, Useful Reserve, Saturation Humidity, Permanent Withering Point (PF4),

Geographical coordinates of the stations

Latitude (photopériodism), longitude and altitude of stations

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Adaptation of the SARRA-H model to the needs for operational Crop monitoring in West Africa

Adaptation to the needs of the monitoring of the agricultural campaign

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LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

The adopted solutions

- Use of satellite data
  - ✔ Daily rain TAMSAT and CHIRPS or others
- Using ECMWF data
  - ✔ Tmax, Tmin, Rad, ten-day ET
- FAO Soil Map
- Maps of average dates of onset and end of season to optimize the setting of simulations

Adaptation to the needs of the monitoring of the agricultural campaign

The adopted solutions

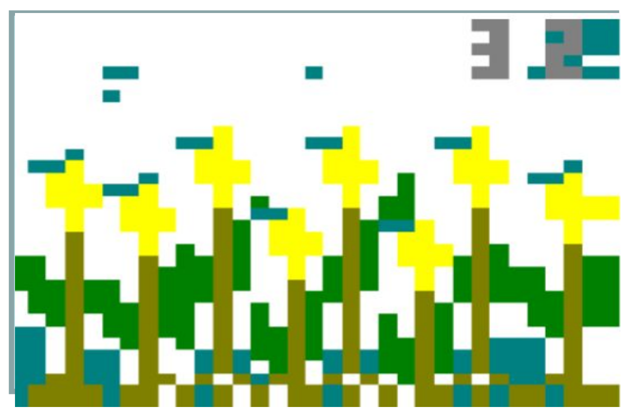
- ✔ **Elaboration of possible scenarios of simulations :** fertility levels and soil depth, species / varieties, sowing dates, crop cycles, ...
- ✔ **Use of the OCELET computing environment :** to perform simulations with images of different spatial resolutions
- ✔ **Use of free QGIS software (or other mapping tools) for maps formatting**

Coupling the SARRA-H model with the OCELET modeling platform

- Modeling of spatial dynamics
- Graphical interaction
- Specific language

Ocelet Modelling Platform

+

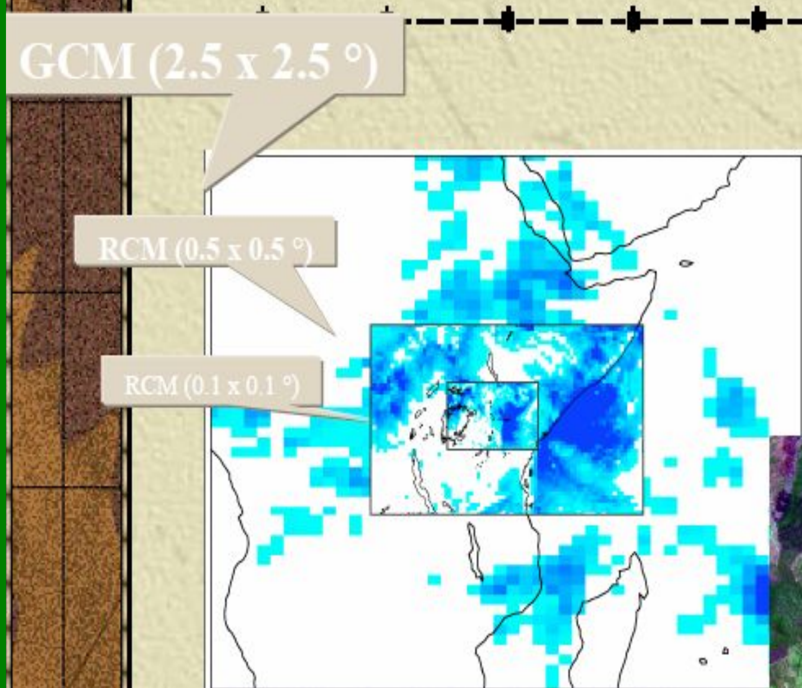


- Modular and deterministic model
- Crop model at the plot scale

Spatialized model of crop growth

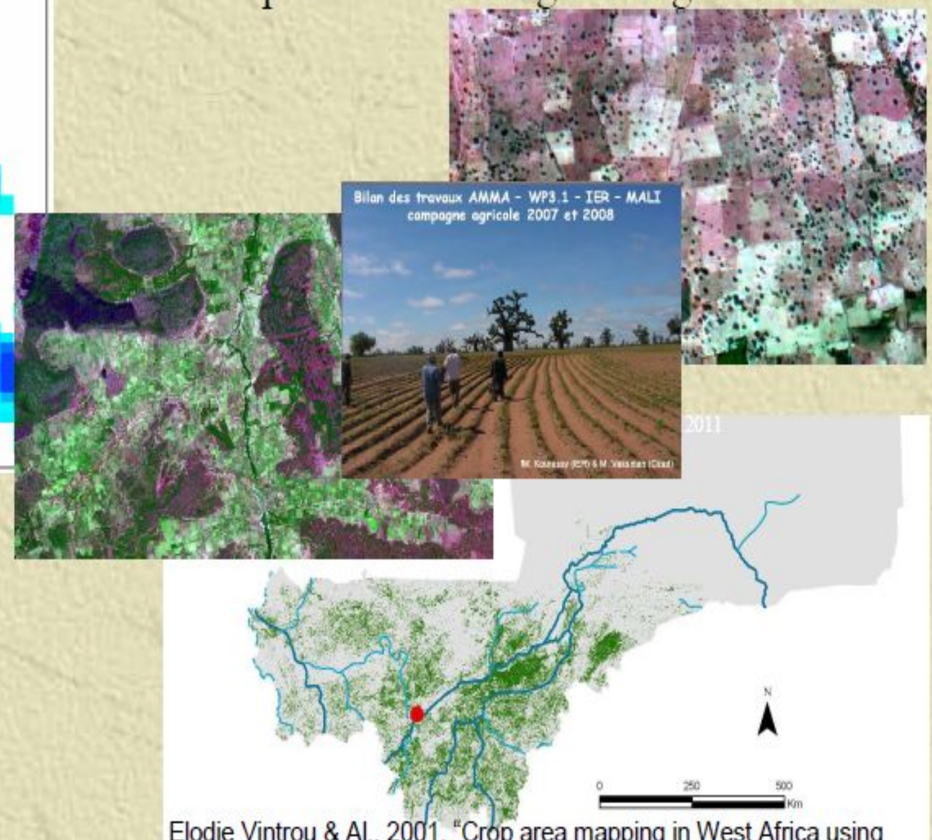
Early warning system

We must adapt the scales



Pour les cultures/productions il faut agréger à des échelles plus grandes :

parcelle -> village -> région



Elodie Vintrou & Al., 2001, "Crop area mapping in West Africa using landscape stratification of MODIS time series and comparison with existing global land products"

Pour le climat il faut désagréger à des échelles plus fines :

de 62 500 km² à 100 km² à 1 km²…

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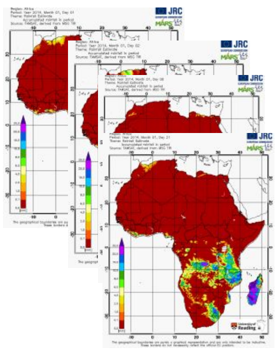
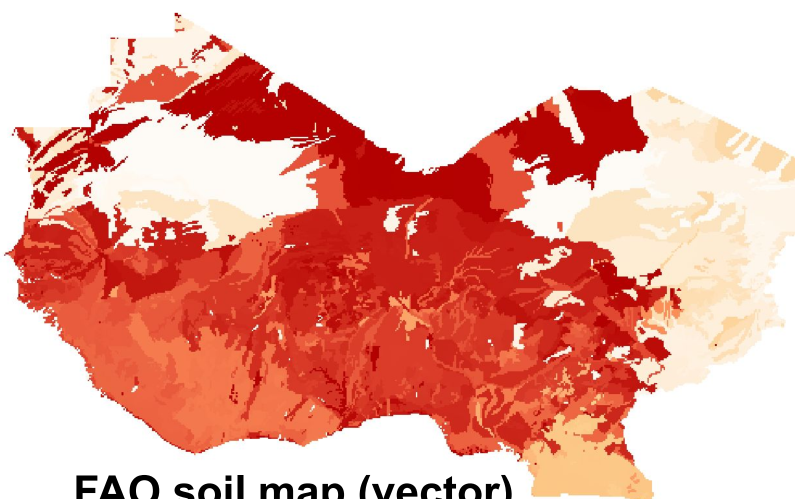
Remote sensing images as input data

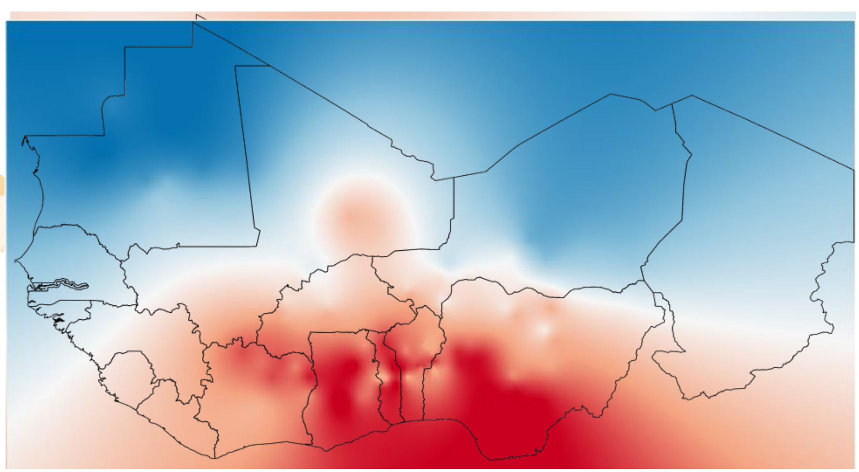
".TIF" format



Rainfall, Global Radiation, Min Temperature, Max Temperature, ET



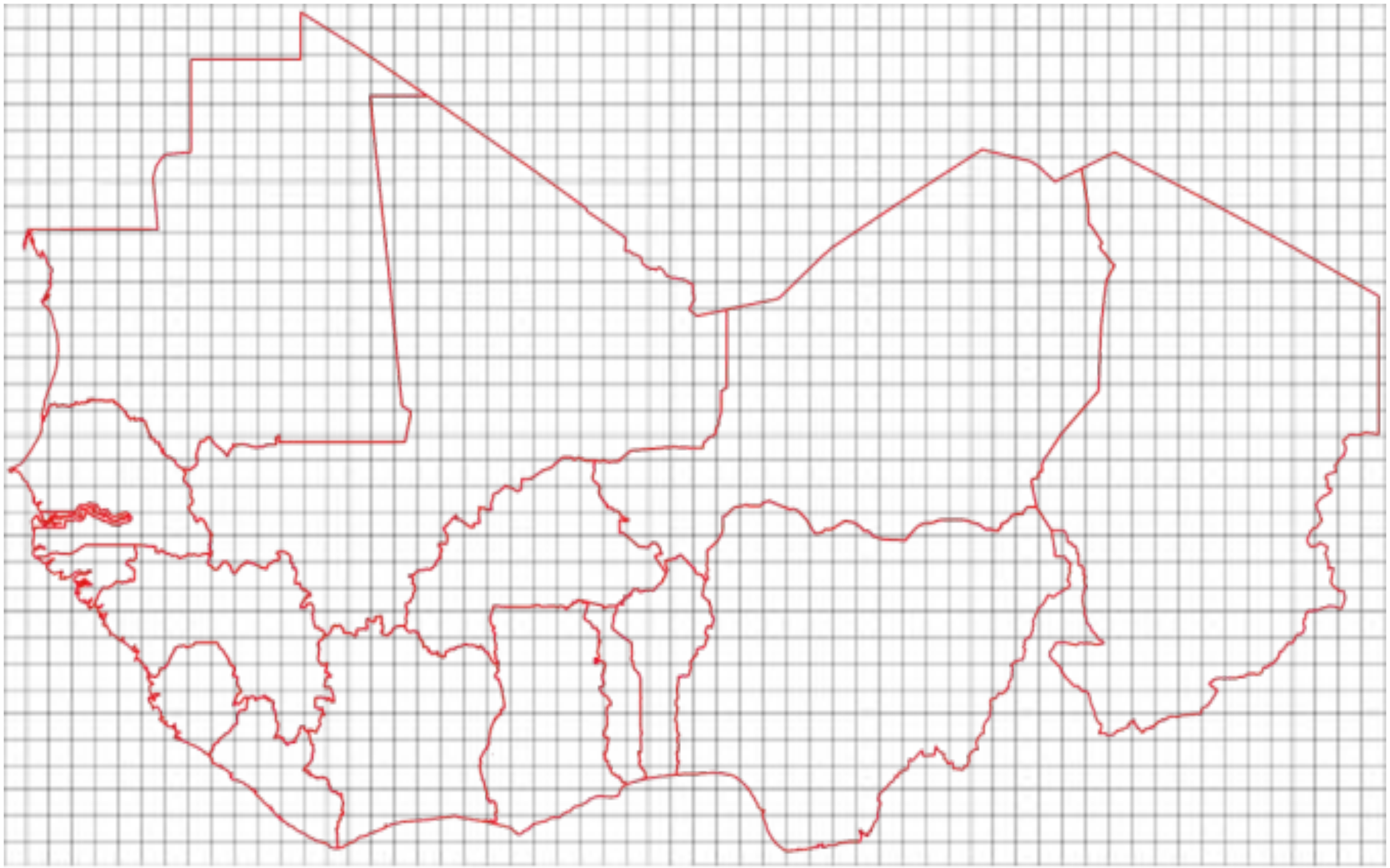
FAO soil map (vector)



Beginning and end of season

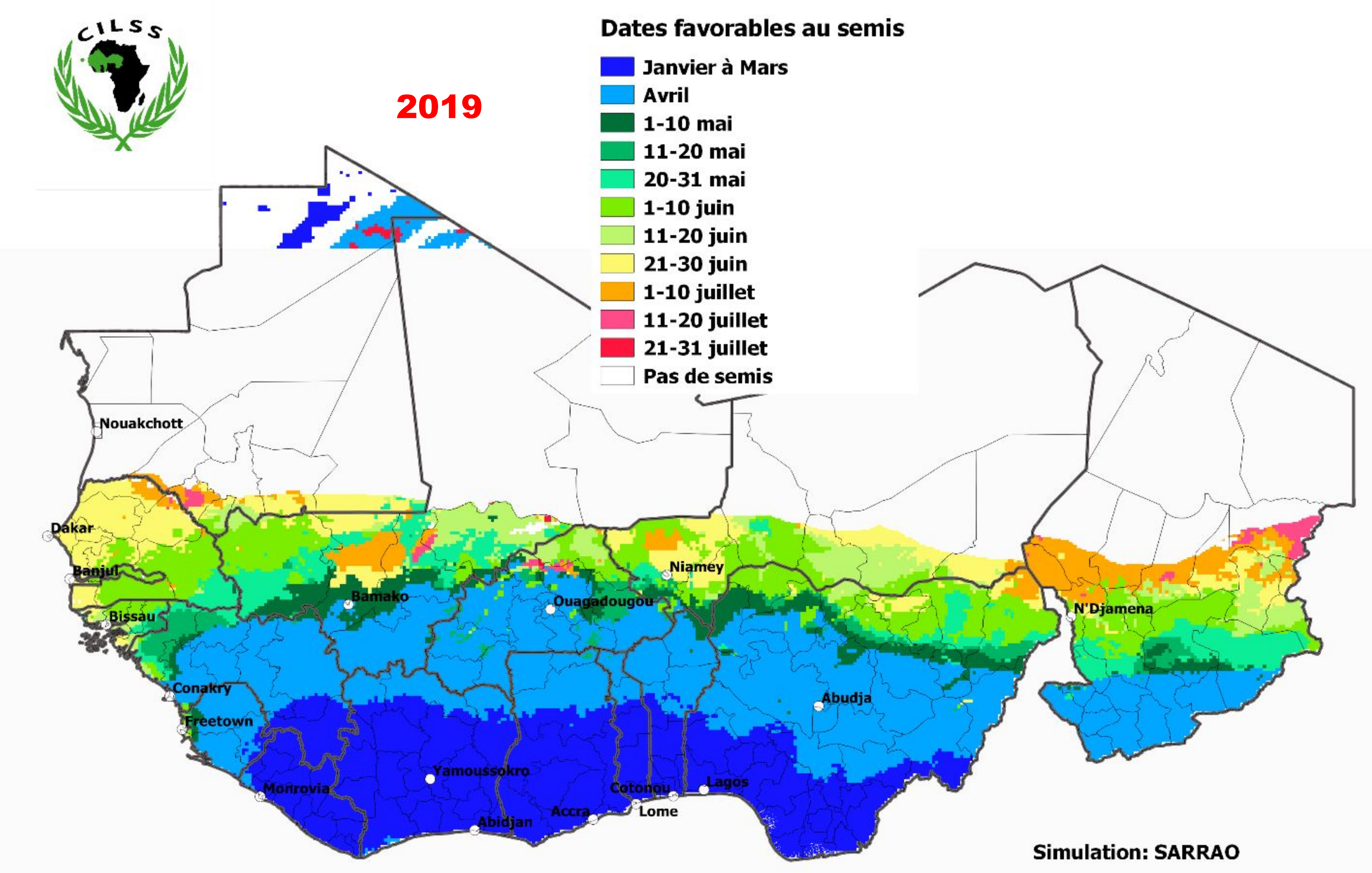
Spatialization of SARRA-H outputs

Each pixel is considered as an entity in Ocelet



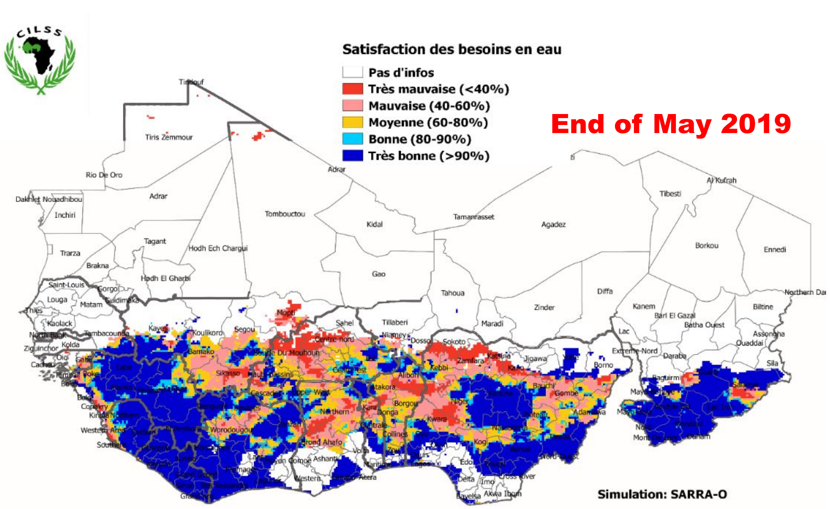
Dates favorable for sowing in WA

Dates favorables au semis d'une cérale pluviale comme le Sorgho photopériodique, au 30 juillet 2019

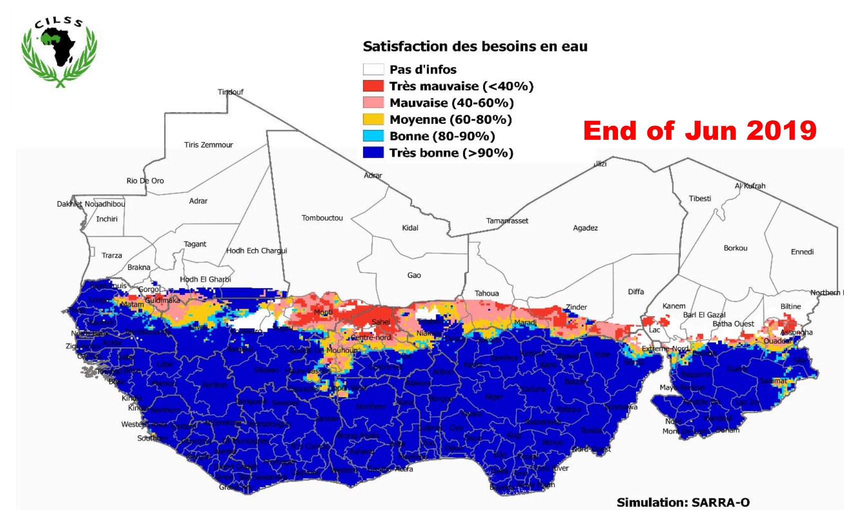


Crop Water Requirements Satisfaction index

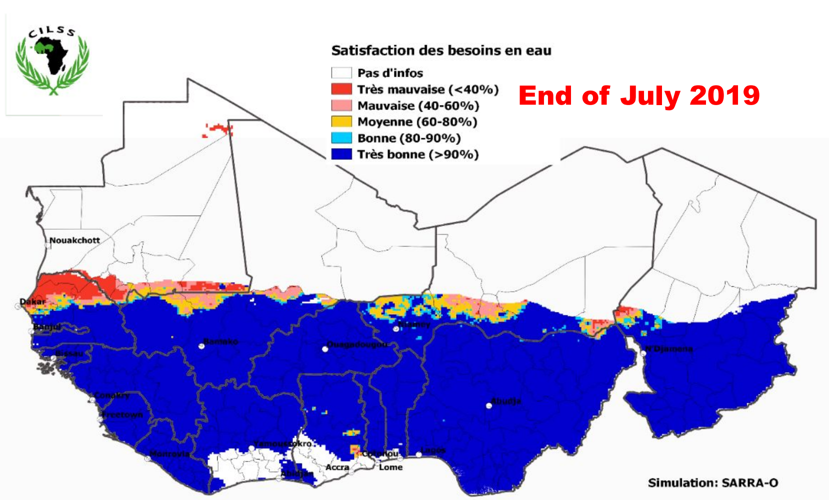
Niveaux de satisfaction des besoins en eau d'une céréale pluviale comme le maïs de 90 jour, au 30 mai 2019



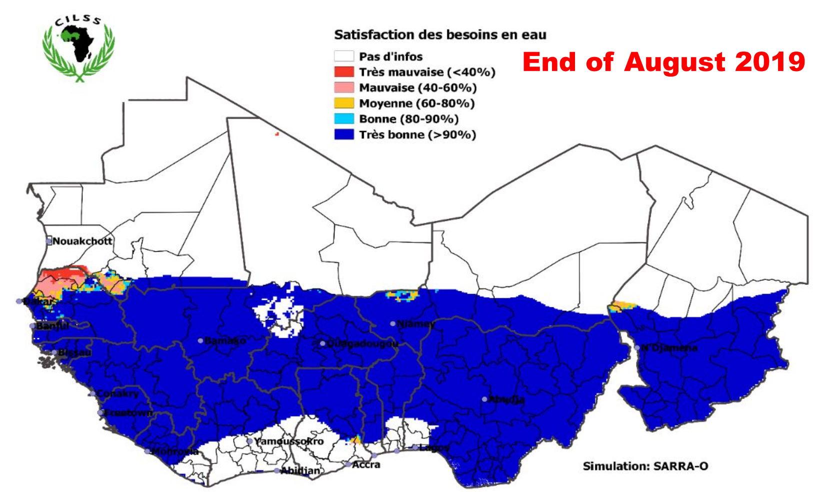
Niveaux de satisfaction des besoins en eau d'une céréale pluviale comme le mil photopériodique, au 01 juillet 2019



Niveaux de satisfaction des besoins en eau d'une céréale pluviale comme le mil photopériodique, au 30 juillet 2019



Niveaux de satisfaction des besoins en eau d'une céréale pluviale comme le mil photopériodique, au 30 août 2019



Stock of water in the soil

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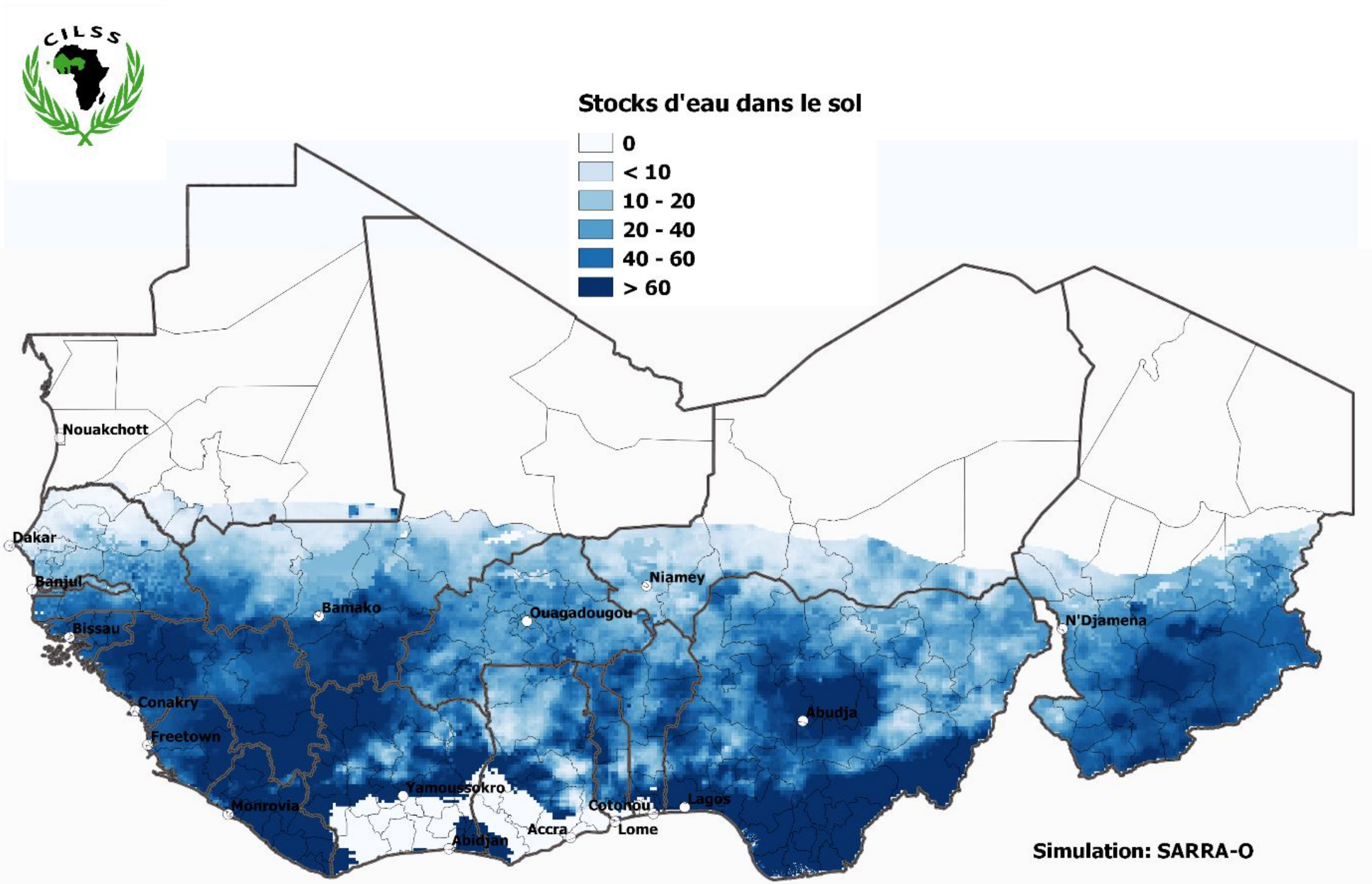
Stocks d'eau dans le sol pour une cérale pluviale comme le Sorgho photopériodique, au 30 juillet 2019



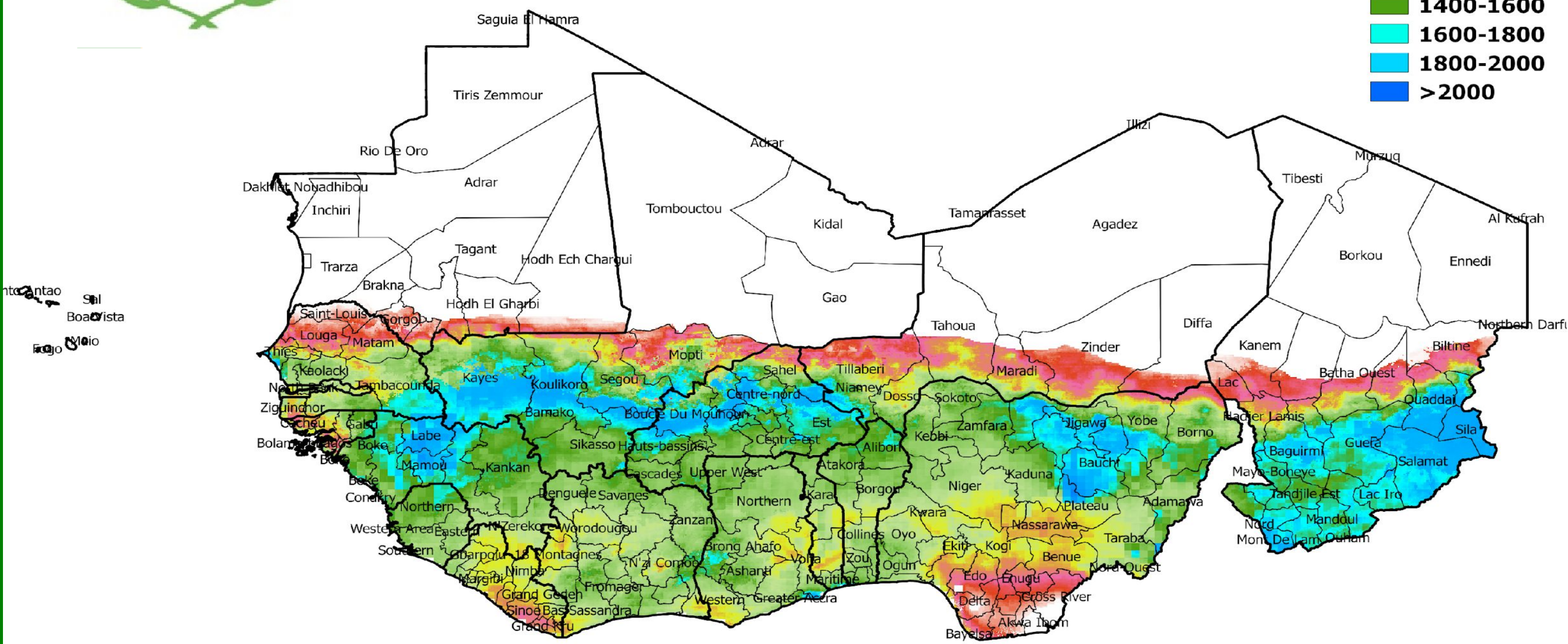
40 ans 1973 >>> 2013

Simulated grain yields

Estimation des rendements du sorgho photopériodique (kg/ha)

Légende

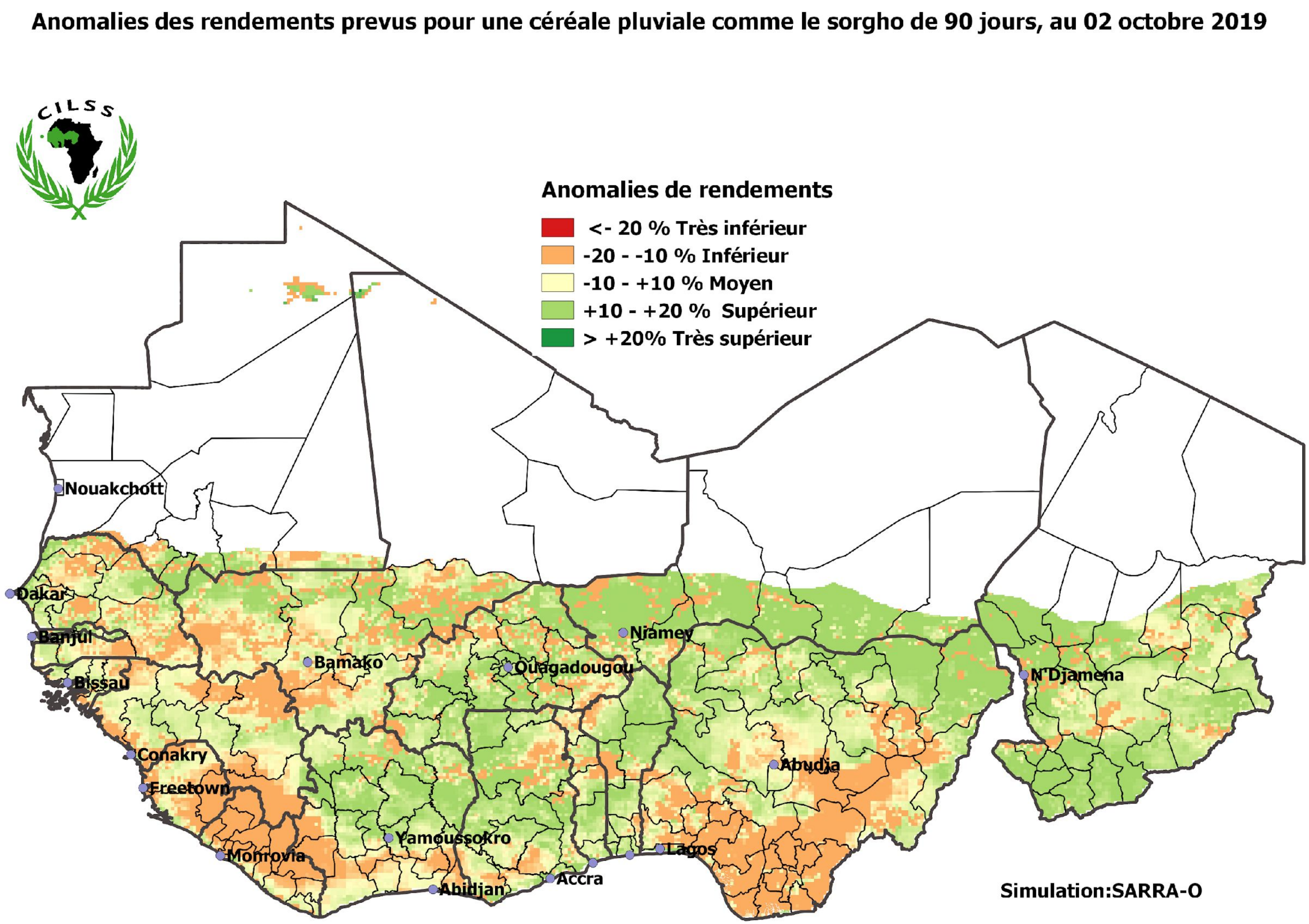
- 0-200
- 200-400
- 400-600
- 600-800
- 800-1000
- 1000-1200
- 1200-1400
- 1400-1600
- 1600-1800
- 1800-2000
- >2000



Simulation: SARRA-H

Anomalies of expected yields for Sorghum

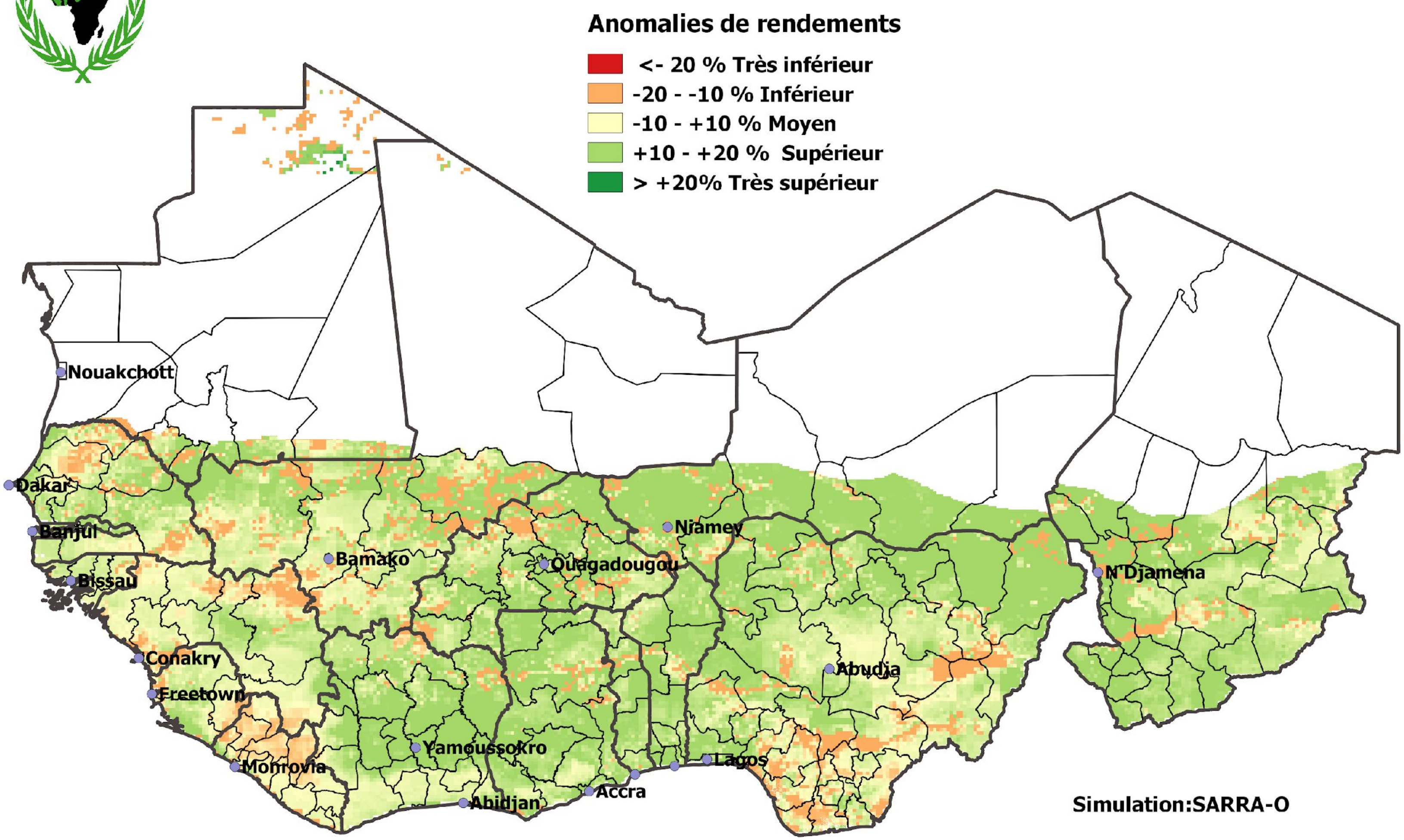
90 days variety



Anomalies of expected yields for Millet

90 days variety

Anomalies des rendements prevus pour une céréale pluviale comme le mil de 90 jours, au 02 octobre 2019



Anomalies of expected yields for Maize

90 days variety

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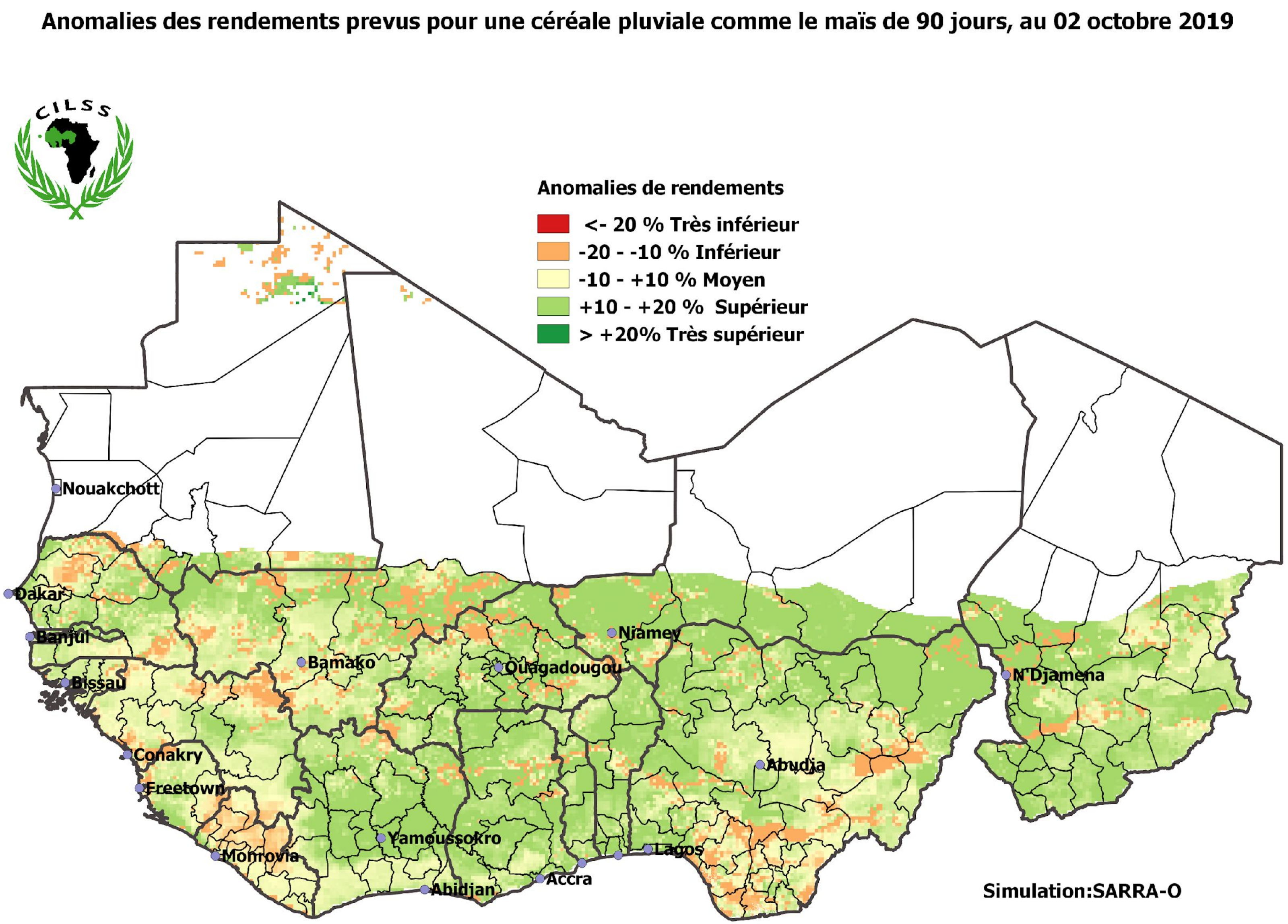

Adaptation to campaign monitoring needs

Still some challenges !!!

- **Regular access to the Internet for updating data**
- **Formalization of the use of downloaded data (TAMSAT, ECMWF / JRC, FEWSNET)**
- **Continuing research activities to improve product quality**
- **Use seasonal climate forecasts to predict crop yields at small scales?**
- **Coupling the model with tools for automatic dissemination of information to farmers (mobile telephony)**

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thank you for your kind attention

What practical value for SARRA-H / O in West Africa?

The models make it possible to advise both governments, farmers, associations, etc. and allow to advance in the field of agronomic sciences. They are thus applied to determine good practices such as optimal sowing dates, optimum sowing densities, adapted varieties, etc. In any case, they must make it possible to inform farmers and decision-makers as soon as possible about practices that favor better yields and the decisions to be taken and the arrangements to be made.

This is the current use of the spatialized version of SARRA-H (SARRA-O), by the AGRHYMET Regional Center in West Africa, which integrates it into its early warning system via bulletins. information during the agricultural season.

Indeed, Agronomic models have a very important role to play in facing the challenges that the 21st century poses to us: climate change, pollutant transfers, management of territories and landscapes, etc. There is a pressing demand from decision makers for advice based on modeling with a certain degree of reliability. The models therefore need to meet this demand increasingly high, facing problematic situations. The teams from CIRAD and AGRHYMET Regional Center continue to work on improving SARRA-H and SARRA-O models, via the simulation accuracy compared to reality and through the opening to wider areas using satellite data.