

Using remote sensing and GIS for agricultural and rangeland monitoring in Senegal

G. Bèye¹, J-A Ndione¹, D.S. Ndiaye¹, T. Ba¹, A. Ka¹

1-Centre de Suivi Ecologique, BP 15 532 Dakar Fann, Senegal, Tel: (+221) 33825 80 66 Fax: (+221) 33825 81 68, Email : gora.beve@cse.sn



Introduction

In the framework of crop and rangeland monitoring in Senegal, the *Centre de Suivi Ecologique* (CSE) in Dakar developed a drought monitoring system that integrates : i) an agrometeorological model Zones A Risque (ZAR) to analyse crop seeding conditions, ii) the SPI calculated on rainfall data of Senegal meteorological network, iii) two versions of VCI index calculated on S10 NDVI images of Spot 4/5 Vegetation. In this way, areas affected by drought are found by combining this 4 components:

1. Analysis of the starting step of the rainy season in relationship with the crops seeding conditions (ZAR model);
2. Specify the rainfall distribution anomaly by using the Standardized Precipitation Index (SPI, McKee & al. 1993);
3. Vegetation monitoring by using VCI and ICN which were calculated by the Normalised Difference Vegetation Index (NDVI) of Spot Vegetation ;
4. Pastureland analysis: biomass production around drilling in the pastoral area of Senegal.

Methodology

1. Analysis of the starting step of the rainy season in relationship with the crops growth conditions

Data : METEOSAT rainfall estimating images (Source : FEWSNET)

Data processing : sensitive area model which allow to characterize the vegetation installation conditions

2. Specify the rainfall distribution anomaly by using the Standardized Precipitation Index (SPI; McKee et al., 1993)

Climate index made by McKee et al (1993) in Colorado Climate Center. The formula of SPI is:

Pi : rainfall of the year i

Pm : mean rainfall

σ : Écart-type

The rainfall data are provided by the National Meteorological Service of Sénégal

$$SPI = \frac{P_i - P_m}{\sigma}$$

SPI values	Classes
More than 2.0	Extremely wet
2 to 1.49	Very wet
1.5 to 0.99	Moderately wet
1.0 to 0.49	Wet
0.50 to -0.49	Normal
-0.50 to -0.99	Dry
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Very dry
Less than -2.0	Extremely dry

3. Normalized Difference Vegetation Index (NDVI) that was designed to measure density and vigour of green vegetation and to discriminate vegetated from non-vegetated surfaces. For heterogeneous land cover, the NDVI is normally higher in areas with more favourable climate and soil, and more productive ecosystems (forest) than in areas with less favourable environmental conditions (dry steppe). To reflect the ecosystem's features and to separate the weather signal from the ecological signal, using multiyear observations, the NDVI was converted into the Vegetation Condition Index (VCI; Kogan, 1997), which was applied successfully for drought monitoring and assessment of the vegetation condition in the United States and some other countries. On the opposite, for crops and rangeland monitoring in Senegal, the authors of this paper applied VCI and ICN (Indice de Croissance Normalisé), that is a VCI derived index, using Spot 4/5 Vegetation data. This paper shows the results of crops and rangeland monitoring in Senegal during 2007 rainy season.

$$VCI = \left(\frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \right) * 100$$

$$ICN = \left(\frac{NDVI - NDVI_{minabs}}{NDVI_{max} - NDVI_{minabs}} \right) * 100$$

The VCI is used for drought detection and the ICN (Indice de Croissance Normalisé) allow the vegetation growth monitoring and curves of the vegetation growth trends can be made with.

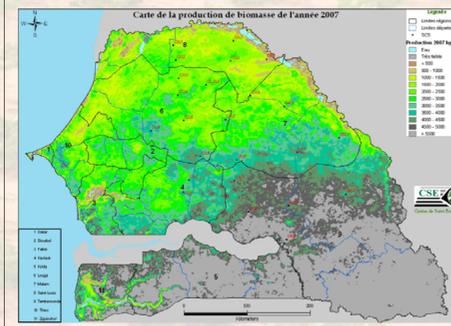
4. Analysis of the rangeland biomass production around drilling for a pastoral purpose

- Calculate the biomass production on pastureland ;
- Make the balance between available fodder and herds in pastureland ;
- Focus on farmable pastureland in 20 km around drilling.

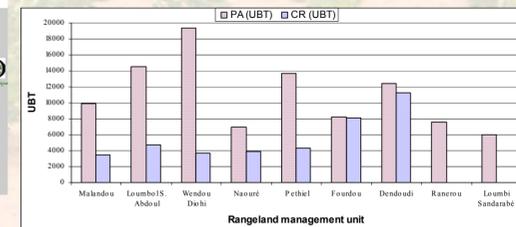


NOAA and DDS antennas

4. Pastureland analysis: biomass production around drilling in the pastoral area of Senegal



Niaka pond (© Ndione, 2006)

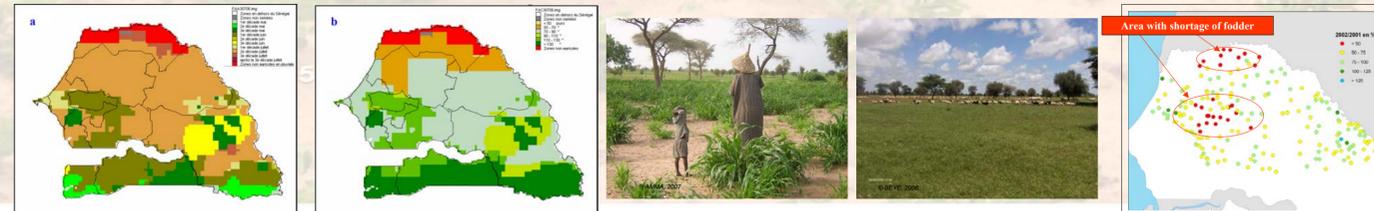


Fodder resources balance of the rangeland management units in the region of Matam (Senegal)

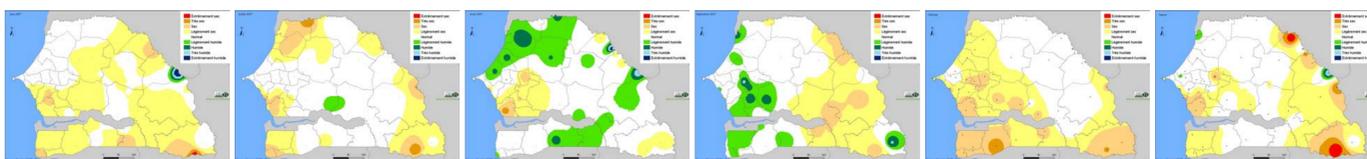
Results

1. Analysis of the starting step of the rainy season in relationship with the crops growth conditions

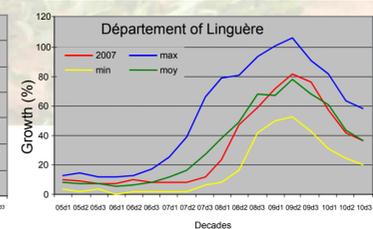
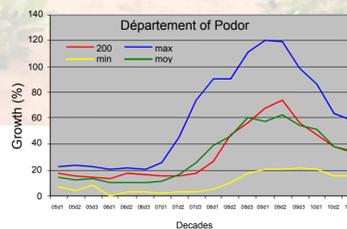
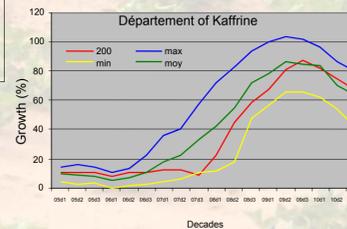
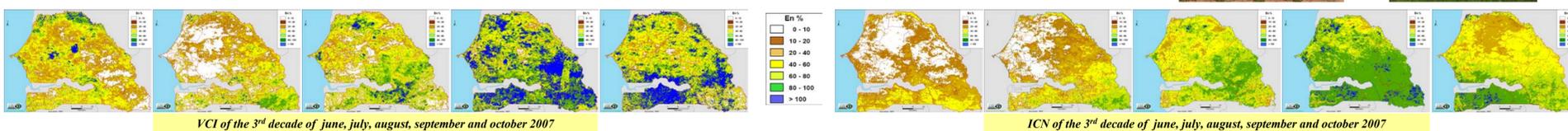
first rain date for seeding crops and expected time for raining period allowing crops growth



2. Specify the rainfall distribution anomaly by using the Standardized Precipitation Index (SPI) of the rainy season of 2007



3. Vegetation monitoring by using VCI and ICN which are calculated by the Normalised Difference Vegetation Index (NDVI) of Spot Vegetation:



Products dissemination

CSE is member of the main committees on agricultural and pastoral monitoring for food security in Senegal:
 Groupe de Travail Pluridisciplinaire: GTP (pluridisciplinary working group)
 Comité Interministériel de Suivi (agricultural department)

Information on agricultural monitoring by remote sensing and GIS are disseminated by:
 - Specific reports/presentations for the ministers council
 - Decadal (10 days) newsletter of the GTP
 - Periodic newsletter of CSE
 - Web page : www.cse.sn, www.sap-senegal.net

