Mapping Changes in Irrigated Rice Area in Senegal Using the PhenoRice Algorithm and MODIS Imagery

Introduction and objectives
- Irrigated agriculture in the Senegal River Basin is highly dynamic in space and time: the area is increasing and rice farmers adapt their management strategies
- Competition for water resources is increasing
- No monitoring system is in place to support sustainable planning of land and water resources
- The goal is to assess the capacities of remote sensing to capture the dynamics in rice area and growing seasons

Study Area
- Achieving rice self-sufficiency is a major policy of the government of Senegal
- Mauritania and Senegal are expanding irrigated rice area at fast pace on the banks of the Senegal River and its delta
- Conversion to dry season rice cultivation and double cropping have been widely reported in the last 10 years
- The major rice areas are characterised by low rainfall in a short rainy season and high temperatures

Methodology
- A time-series combining MODIS Aqua and Terra 250 m resolution composites was used as input
- The PhenoRice algorithm (Boschetti et al., 2014) was deployed to map the main rice areas, and estimate sowing and harvesting dates, based on analysis of the EVI vegetation index and the NDFI flooding index
- Two rice growing seasons (wet season and dry-hot season) were analysed for 14 consecutive years from 2003 to 2016

Major findings
- Farmers shift massively rice cultivation from the wet-season to the dry-hot season when favourable climate condition lead to higher yields
- Rice double cropping, uncommon before 2009, increased significantly, mostly in the delta area
- Bound by climatic conditions and risks in the wet season, farmers changed from medium to short duration varieties to cater for double cropping

PhenoRice is a suitable tool to detect changes in area, length and timing of the growing season, and rice intensification in the Senegal River Valley

Validation
- Official statistics of reported rice area in Senegal in the wet and dry-hot seasons were compared with PhenoRice detected rice areas. The algorithm detects more than 50% of the reported area in both seasons, and correctly depicts its inter-annual variations.
- A field survey of among 100 farmers located in two zones and interviewed annually between 2001 and 2010 was deployed to validate detected sowing and harvesting dates for the wet season. PhenoRice accurately detects the sowing and harvesting dates in the Delta area with RMSE of 6.1 and 5.6 respectively and \( R^2 \) equals 0.97 and 0.78. In the Middle Valley the RMSE is 9.1 and 16.2 and \( R^2 \) equals 0.82 and 0.76 for sowing and harvesting dates respectively.

This work was supported by the ERMES FP7 project (www.ermes-fp7.eu) funded by the European Union Seventh Framework Program (FP7/2007-2013) under Grant 606883.

For more information:
Sander J. Zwart ¹, Lorenzo Busetto ², Mandiaye Diagne ³, Mirco Boschetti ², Andrew Nelson ¹

¹ Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, Netherlands
² Institute for Electromagnetic Sensing of the Environment, Italian National Research Council, Milan, Italy
³ Sahel Station, Africa Rice Center (AfricaRice), Saint Louis, Senegal

AfricaRice
UNIVERSITY OF TWENTE.

For more information:
Sander J. Zwart ¹, Lorenzo Busetto ², Mandiaye Diagne ³, Mirco Boschetti ², Andrew Nelson ¹

¹ Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, Netherlands
² Institute for Electromagnetic Sensing of the Environment, Italian National Research Council, Milan, Italy
³ Sahel Station, Africa Rice Center (AfricaRice), Saint Louis, Senegal

AfricaRice
UNIVERSITY OF TWENTE.

For more information:
Sander J. Zwart ¹, Lorenzo Busetto ², Mandiaye Diagne ³, Mirco Boschetti ², Andrew Nelson ¹

¹ Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, Netherlands
² Institute for Electromagnetic Sensing of the Environment, Italian National Research Council, Milan, Italy
³ Sahel Station, Africa Rice Center (AfricaRice), Saint Louis, Senegal

AfricaRice
UNIVERSITY OF TWENTE.