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QWeCI

Quantifying Weather and Climate Impacts on Health in Developing Countries

Deliverable 5.1.d – Monitoring for Standing Water

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RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Water bodies monitoring over Barkédji site during 2010 rainy season using satellite high resolution

Introduction

Water ponds play an important role in the socio-economic activities in the Sahel area, with regards to pastoralism, agriculture, etc. But with respect to health issues, ponds are in often cases breeding sites for many vector and water borne diseases. In Barkedji Health and Environment Observatory (figure 1), thanks to Fontenille et al (1998), ponds has been identified as one of the key components of Rift valley fever emergence in the Ferlo area (Ndione et al, 2009). The issue of monitoring this standing water during the rainy season can be helpful to build an efficient health early warning system (HEWS).

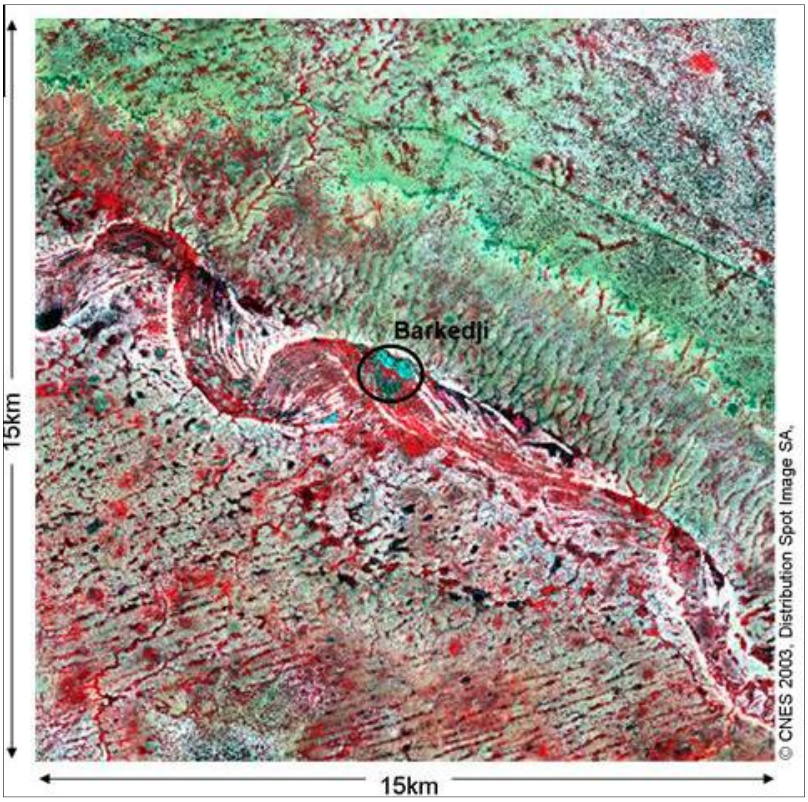

Figure 1: The Barkedji Health and Environment Observatory, study area of the QWeCI project in Senegal.

1. Data and methodology

In the framework of the AMMA project, Lacaux et al (2007) suggested a methodology based on high resolution satellite image data for detecting water bodies in Barkedji area. CSE has taken part too this work and the same methodology has been used in the QWeCI project.

1.1 Data

The main objective is to identify with a very accuracy the ponds' contours in order to delineate them with great details, as well as to distinguish both small and large ponds. Pre-processed 'Level 2A' images SPOT-5 multi-spectral high-spatial resolution images (10-m) has been used for this task. More details about images characteristics are available at http://www.spotimage.com.cn/spot5/ensavoirplus/eng/plus_niveau.html). This data has been obtained thanks to the French Space Agency throughout the project AdaptFVR ((*Impacts of Climate change on Rift valley fever vectors emergence in Senegal: adaptation and strategies for a better pastoralism management in Sahel*, founded by GICC programme)

A SPOT-5 (10m) image covers an area of ~3600 km^2 (60 km×60 km); these ones are centered over the Barkedji village, the heart of the Health and Environment Observatory. Specifically for this task, we focus our investigations on the second window (15 km×15 km, 225 km^2). Table 1 give in details the dates for the processed images, which covered all the 2010 rainy season.

06 July 2010
27 August 2010
28 September 2010
03 October 2010
08 November 2010

Table 1: SPOT-5 (10m) image dates

Different authors highlighted the issue of detecting water bodies by remote sensed data, using both optic and radar data (Puech, 1994; Gao, 1996; McFeeters et al, 1996; Frazier and Page, 2000; Gond et al, 2004; Bagahdadi et al, 2001; Harvey et al, 2001; Lacaux et al, 2007; Ndione et al, 2009; Combal et al, 2009).

Compared to our concern with regards to existing index already used in this area, we prefer NPPI (Normalized Difference Pond Index) to other methods (Lacaux et al, 2007; Ndione et al, 2009).

The NDPI uses the MIR and green bands of the electromagnetic spectrum, in this combination, as follows (DC = digital counts):

$$\mathrm{NDPI} = (\mathrm{DCs_{mir}} - \mathrm{DCs_{green}})/(\mathrm{DCs_{mir}} + \mathrm{DCs_{green}})$$

According to Lacaux et al (2007), detection of ponds is using a simple decision-tree classifier. Threshold 1, based upon a new index, or NDPI, allows for detection of ponds including water, vegetation and suspended materials plus some types of soils. Threshold 2, based upon the middle infrared (or MIR) digital counts (DCs), allows for identification of ponds only (figure 2). In second step, ponds' mapping is produced through manual photo interpretation from in-situ photography for the seven ponds under investigation.

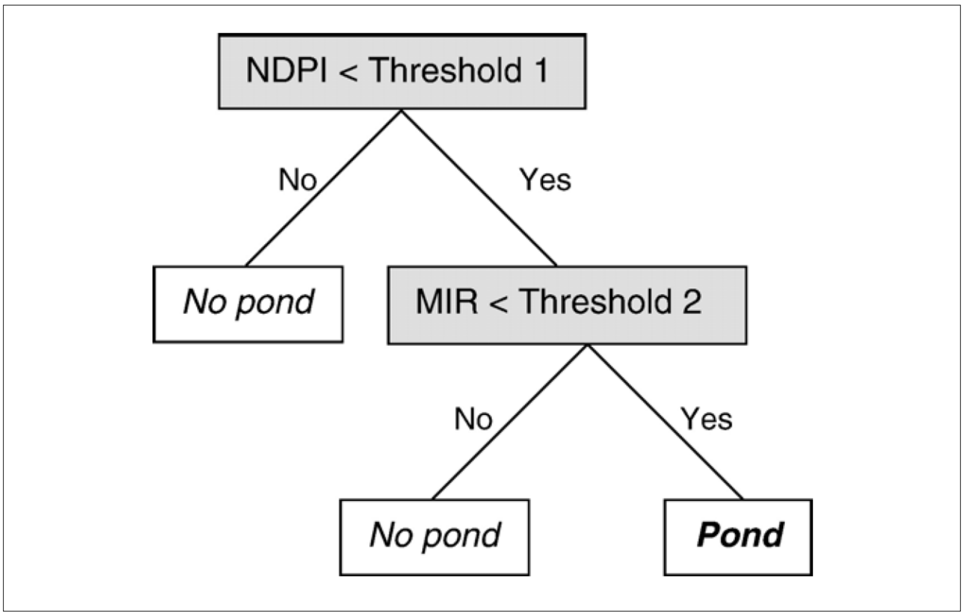

Figure 2: Detection of ponds using a simple decision-tree classifier (Lacaux et al, 2007).

2. Results and discussion

Table 2, figures 3 and 4 below give in details the number of ponds detected along the rainy season. Obviously, this dynamics should be put in relation with rainfall evolution and distribution also.

Number of ponds in percent (%)					
Dates	**06-07-2010**	**27-08-2010**	**28-09-2010**	**03-10-2010**	**08-11-2010**
Ponds with area <0,1ha	27(43.6)	22(37.3)	699(71.3)	469(76.3)	88(65.2)
Ponds with area > 0,1ha and <0,5 ha	25(40.3)	21(35.6)	195(19.9)	103(16.7)	27(20)
Ponds with area > 0,5 ha and <1ha	8(12.9)	2(3.39)	38(3.8)	21(3,4)	13(9.6)
Ponds with area >1ha and <5ha	2(3.3)	10(16.9)	40(4,1)	17(2.8)	6(4.4)
Ponds with area > 5ha and <10ha	0(000.00)	2(3.4)	5(0,5)	4(6.5)	1(0.7)
Ponds with area > 10ha	0(000.00)	2,(3.4)	4(0,4)	1(0,16)	0(00)
Total	62(100%)	59(100%)	981(100%)	615(100%)	135(100%)
Cumulative rainfall between processed satellites data images	**18,0 mm**	**264,4 mm**	**134,5 mm**	**13,0 mm**	**20,1 mm**

Table 2: Statistics of the ponds distribution and evolution from July to November 2010

The higher values of ponds statistics have been recorded in September and October 2010; this is due to the profile of 2010 rainy season. In fact, the onset has been a little bit shifted and July and August wear not wet (July was below normal compared to 1961-1990, and August just normal). In addition, at the beginning of the rainy season, the soil needs to be rehydrated thanks to the first rainfall events, and when it is sufficiently wet, moist and saturated, one can appreciate ponds distribution. But, the ponds whose size is less than 0.1 ha are most numerous whatever the month considered: in September 71.3 % of ponds were less than 0.1 ha; in October, it was 76.3 %. Very big ponds (with area > 5ha and <10ha and more than 10ha) are too weak; they appear from August to October, their maximum value (9) occurred in September, and in November we have just one pond between 5 to 10ha. Also, in November it's good to mention the steep and rapid decline of ponds for every category. For example, the ponds less than 0.1ha move from 469 in October to 88 in November… At this time, we are at the end for the rainy season and there is no more rain events to supply pond in water; with the increasing temperatures, evaporation becomes very important and ponds start to dry up.

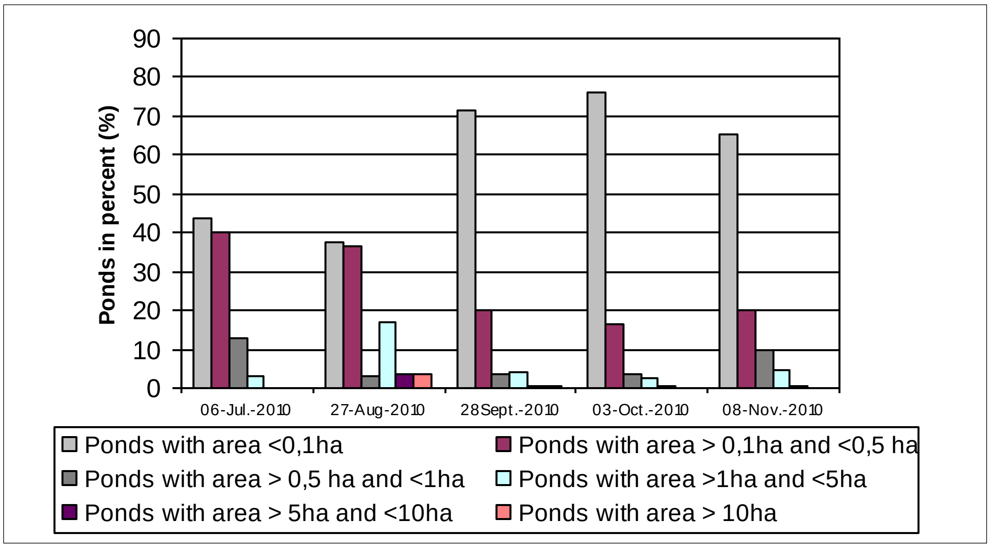

Figure 3: Ponds distribution by six classes in Barkedji area from July to November 2010.

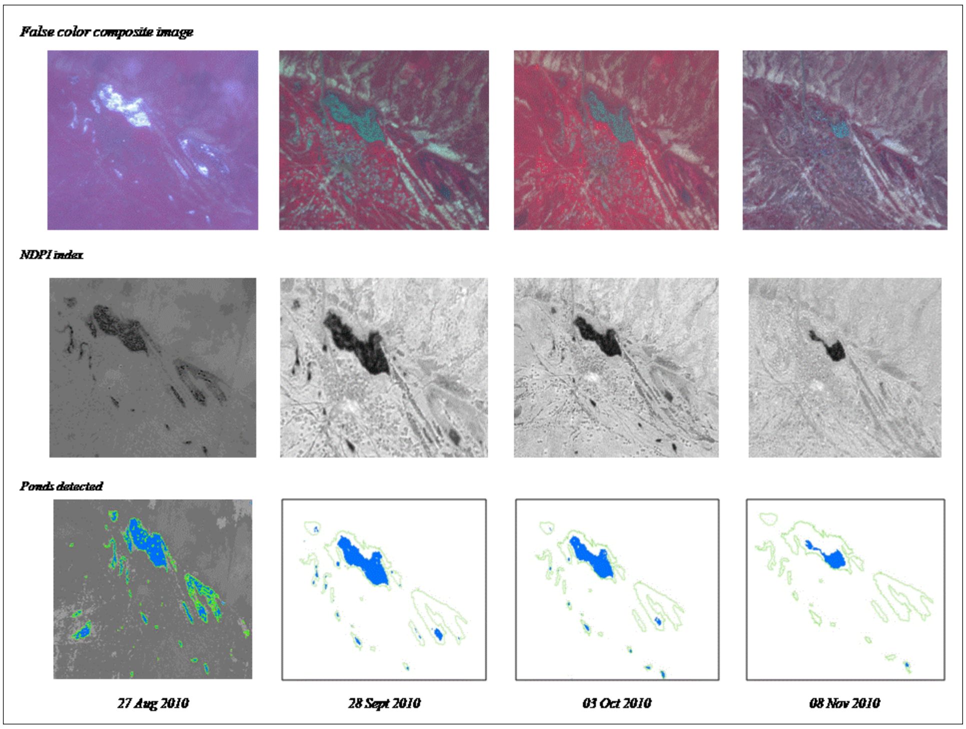

Figure 4: Dynamic evolution of the Barkedji pond during the 2010 rainy season.

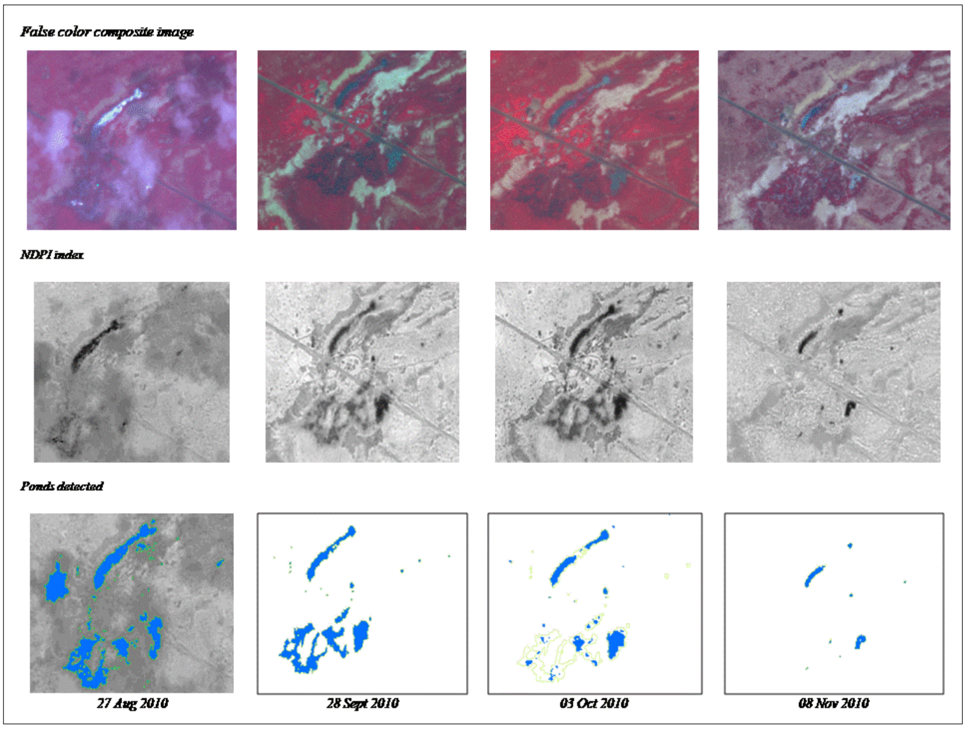

Figure 5: Dynamic evolution of the Loumbel Lana hydrological system during the 2010 rainy season.

Conclusion

Remote sensing is very strong tool to monitor spatio-temporally RVF breeding sites in the Ferlo area. Basically, this information coming remote sensed data are very useful inputs for the HEWS for risk mapping diseases. Obviously, this remote sensed data should be combined with in-situ measurements in different sectors with regards to RVF emergence mechanisms. Also, the outputs can help adaptation strategies coming from both administrative national livestock services and communities at local level.

Acknowledgements

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