Hydrol. Earth Syst. Sci. Discuss., 6, C2790–C2796, 2009
www.hydrol-earth-syst-sci-discuss.net/6/C2790/2009/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Less rain, more water in ponds: a remote sensing study of the dynamics of surface waters from 1950 to present in pastoral Sahel (Gourma region, Mali)" *by* J. Gardelle et al.

J. Gardelle et al.

julie.gardelle@bvra.e.ujf-grenoble.fr

Received and published: 1 December 2009

The authors are grateful to the two anonymous referees for the interest they expressed in the paper and the useful corrections suggested and comments made.

As both referee agreed that the analysis done on the 92 ponds of central Gourma was inadequately presented and the two study cases not sufficiently replaced in the regional context, additional supervised classifications were run on all available LANDSAT scenes taken at the end of the wet season (now free of charges). These scenes allowed to document the area flooded at the peak of the flood, in September (2 addi-

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

tional images in 2001 and 2007 were classified. This did not sensibly change the study area because images' overlap is almost unchanged, leaving 91 ponds common to the whole September series of images), and in the early dry season, in November (6 new scenes: 1972, 1984, 1986, 1999, 2002 and 2006, with an overlap of 51 ponds, but with a really interesting time span, especially regarding to the year 72 and the intermediate dates of the early 1980').

These additional data confirm and precise the trends presented in the initial version of the paper. The results are presented in two additional figures (figure 9 and 10, see uploaded fig1.pdf file). The first of these figures summarizes the dynamics of the flooded area at peak flood, in September, for 91 ponds of central Gourma (a), as well as for the 51 ponds in November (b). In both graphs the area flooded in Agoufou, one of the case studies is plotted for comparison.

The second additional figure (see uploaded fig2.pdf file) displays the change in area flooded in September 2002 compared to 1975 for each of the 91 ponds of central Gourma, with the share of turbid versus less turbid water in 2002. This graph also ranks the two study cases Agoufou and Ebang Mallam in the regional context, responding to one of the concern expressed by the two referees. The few ponds which display a decrease in surface are well identified, and can be compared to the bulk of the increasing ponds. Other specific ponds (Tayalelt, Sabangou) are also pointed on this graph, which facilitates reader's interpretation (e.g. the discussion on Agoufou catchments merging).

Altogether, these two additional figures are very useful to document the regional evolution of the ponds, which was more briefly discussed in the initial manuscript. Answers to different questions of the reviewers can be found in these figures and in the corresponding text. We believe that the revised paper is more conclusive about the increase flood phenomenon at the regional scale.

A second point raised by reviewers was the lack of evidence presenting the changes in

HESSD

6, C2790–C2796, 2009

vegetation growing on shallow soils in the Gourma. Fortunately, a long term survey by the second author allows us to present such evidence, both in the form of references to two recently published papers (Hiernaux et al. 2009a and 2009b, with indications of the figures/tables of interest) and in the form of a new figure (see uploaded fig3.pdf file) prepared for the revised manuscript. This figure summarizes the evolution of tree cover over the 1984-present period for shallows soils compared to the evolution of the tree cover over sandy and lowland clay soils.

Concerning these changes, complementary information from a collection of in situ photographs are also available (some were shown at the Ouagadougou AMMA international conference – 20/24 July 2009 -, by Kergoat et coauthors and Trichon et coauthors). They illustrate rather clearly the changes in vegetation over time for a suite of shallow soil survey sites. However, we feel that including such photographs in the present paper would introduce a bias towards 'eco-hydrology', whereas our main point is to diagnose the change in pond surface. We think that our paper is probably the starting point of a broader study, which will progressively address the different issues raised by this Gourma paradox. Detailed eco-hydrology will be one of these issues.

Both referee criticise the references made to 'hydric regimes' and to 'ponds regime' in absence of any discharge measure and assessment of the volume of water stored in the ponds. This was systematically corrected sticking to the observations by remote sensing: the flooded area of the ponds. Then, to respond to another concern of the referees about the alleged causes of the observed changes in flooded areas, the discussion has been broadened with the separation of the possible causes of the uneven increase in pond flooded areas from the possible causes of increase in surface runoff.

Last, we provide extensive point-by-point answers to reviewer's comment in a supplementary information file (see uploaded supplement file)

We thank again both reviewer's for their in-depth review, and we hope that we were able to take the opportunity to develop the regional view of the increase in pond surface as

HESSD

6, C2790–C2796, 2009

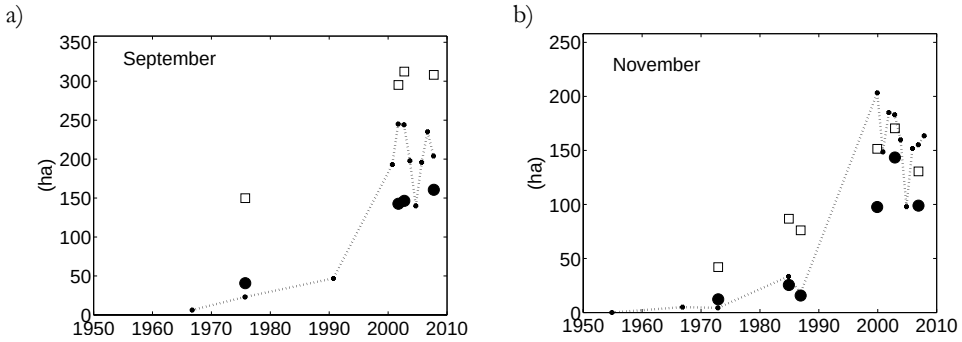
well as to provide evidence for changes in the vegetation.

P Hiernaux, J Gardelle, L. Kergoat, and M. Grippa.

New References . Hiernaux P., Lassine D., Trichon V., Mougin E., Baup F., 2009, Woody plant population dynamics in response to climate changes from 1984 to 2006 in Sahel (Gourma, Mali). Journal of Hydrology, special issue AMMA-CATCH, 375 (1-2), 103-113. doi: 10.1016/j.hydrl.2009.01.043. . Hiernaux P., Mougin E., Diarra L., Soumaguel N., Lavenu† F., Tracol Y., Diawara M., 2009, Rangeland response to rainfall and grazing pressure over two decades: herbaceous growth pattern, production and species composition in the Gourma, Mali. Journal of Hydrology, special issue AMMA-CATCH, 375 (1-2), 114-127. doi:10.1016/j.jhydrol.2008.11.005.

Please also note the Supplement to this comment.

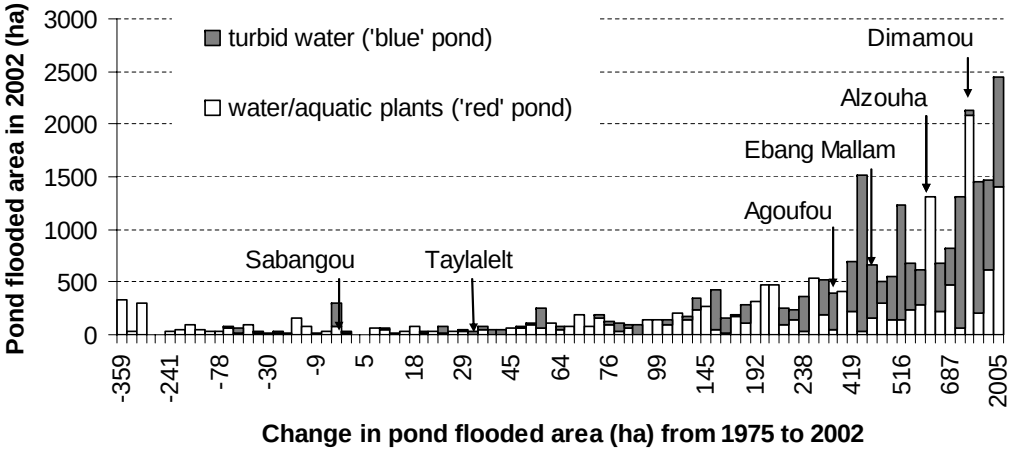
Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 5047, 2009.



a) Average surface of water per pond (open square), average surface of turbid water (full circle) for the 91 ponds present in all September Landsat images. Also figured is the surface of the Agoufou pond in September (line), derived from all data sources.
b) same as (a) but for November and for the 51 ponds present in all November Landsat images.

Fig. 1.

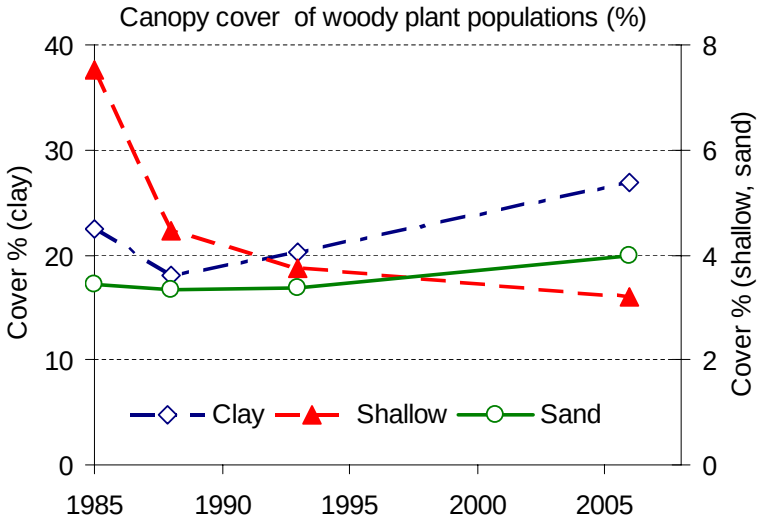
Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper



The 91 ponds of central Gourma ranked by the absolute value of the change in flood area between 1975 and 2002 (X axis, negative values indicate decrease in flood area, positive value increase), in relation with the area covered by the pond in 2002, separated into turbid water without vegetation ('blue' pond) and less turbid with aquatic vegetation ('red'pond).

Fig. 2.

HESSD
6, C2790–C2796, 2009



Changes of the mean the canopy cover of woody populations over low-land clay soils (5 sites, left scale), dunes and low-land sandy soils (13 sites, right scale) and eroded slopes shallow soils (4 sites, right scale) in the Gourma following the 1983-84 drought (adapted from Hiernaux et al. 2009a).

Fig. 3.

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper