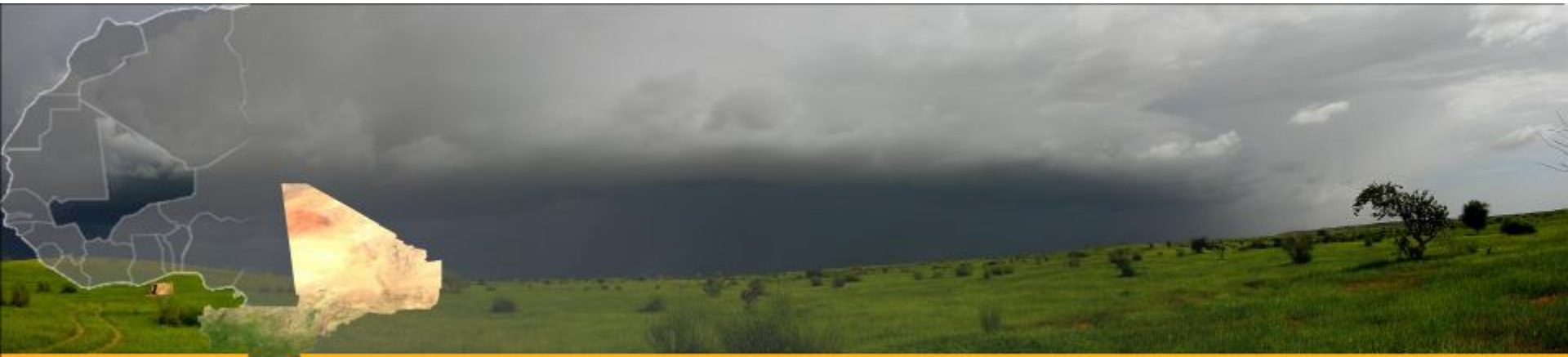


# **Rising ponds in uncultivated Sahel:**

**A delayed effect of drought,  
involving plant dynamics and soil erosion.**

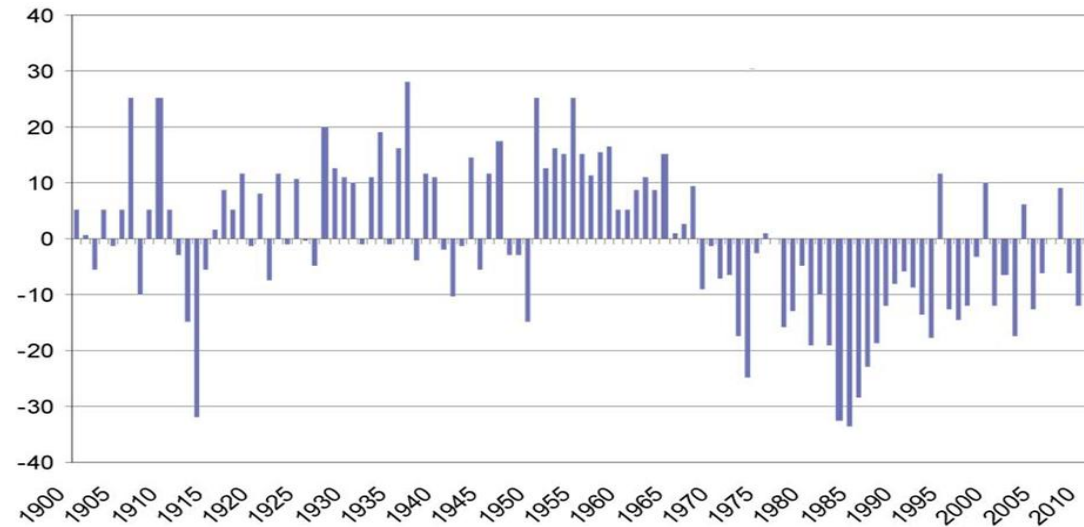
**Laurent Kergoat,**

**Manuela Grippa, Pierre Hiernaux, Johanna Ramarohetra  
Geoscience Environnement Toulouse, France**



## Context

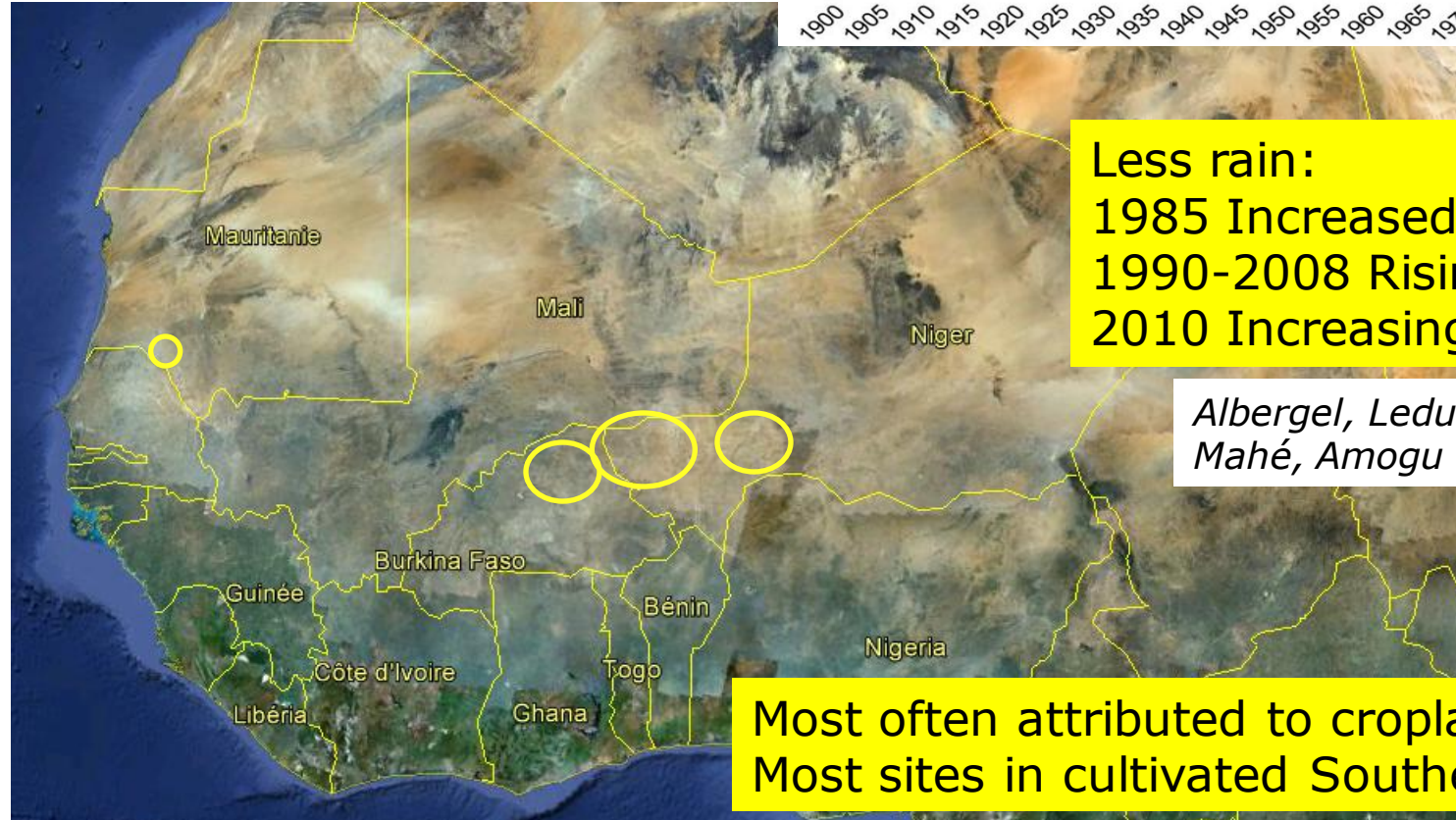
- 1) The Sahel drought  
Response of surface water ?
- 2) The Sahelian Paradox



Less rain:  
1985 Increased runoff  
1990-2008 Rising water table  
2010 Increasing river flow

*Albergel, Leduc, Favreau, Descroix  
Mahé, Amogu et coll.*

Most often attributed to cropland expansion  
Most sites in cultivated Southern Sahel



Question: What happened in **UNCULTIVATED** Sahel ?

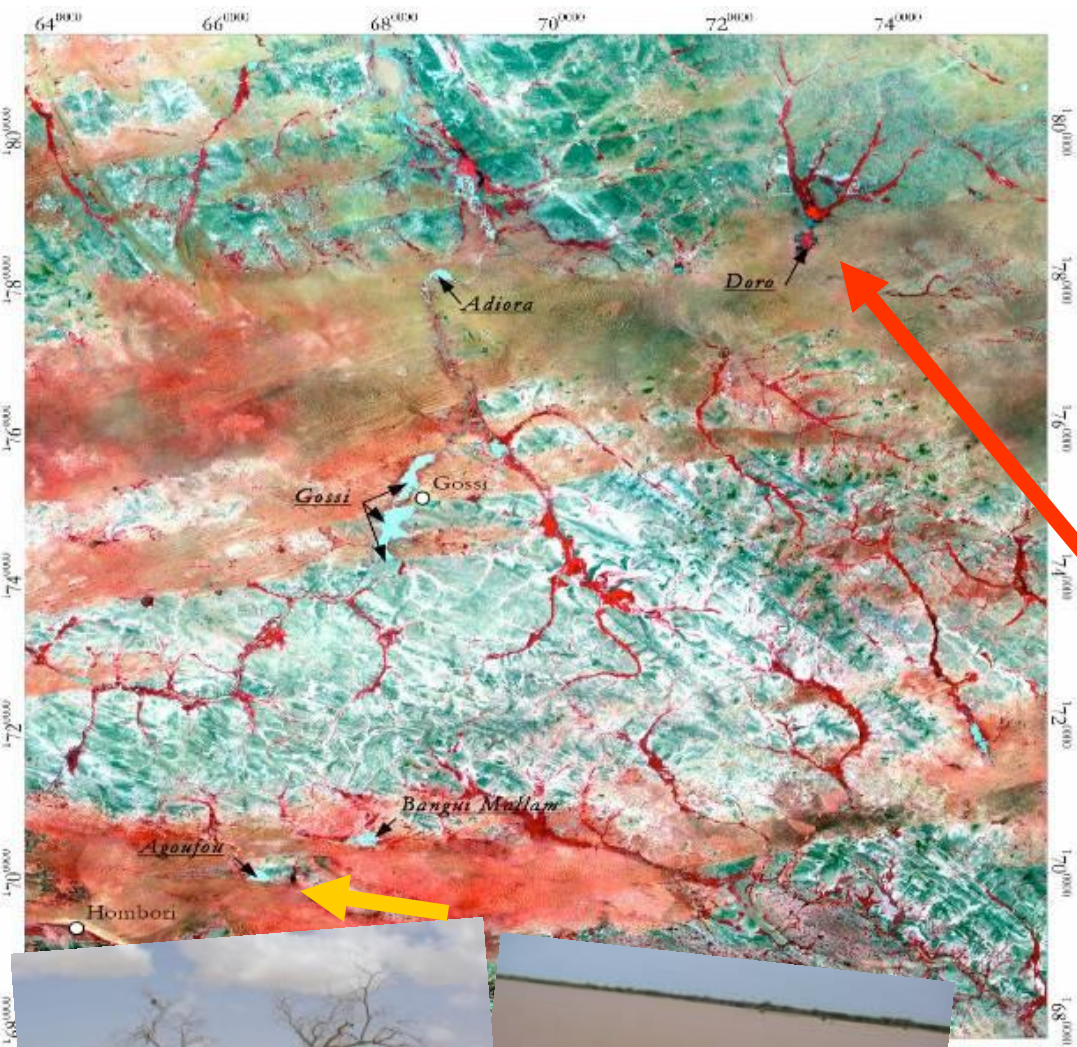
Whay can we learn in terms of processes ?

Hodh area

Gourma area



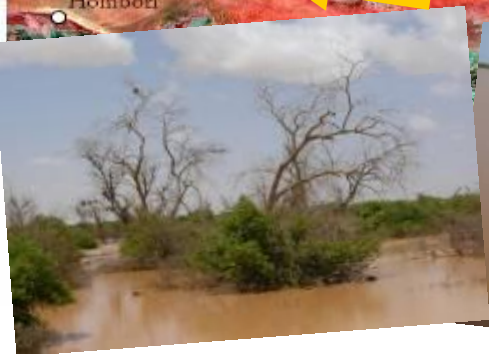




**Rain = 350 mm / year**

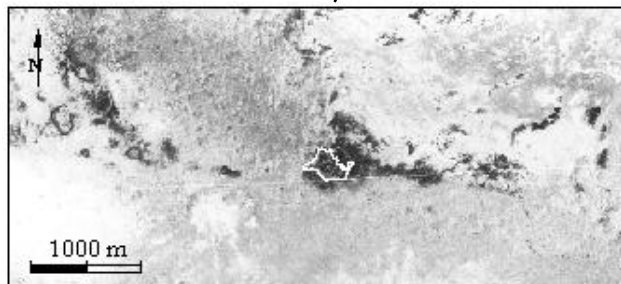
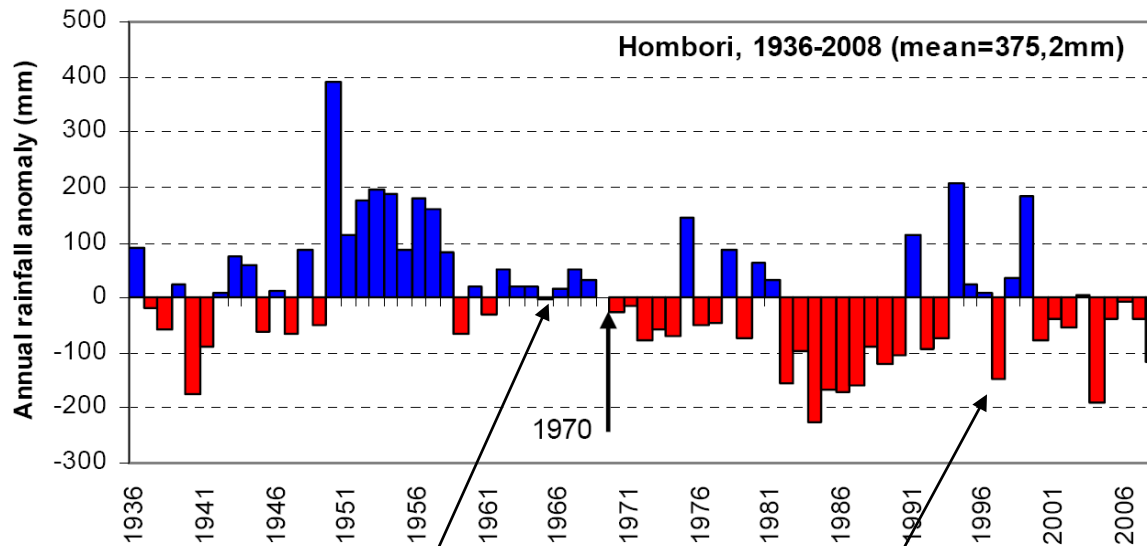
**Runoff on shallow soils (35%)  
feeds ponds**

**No runoff on deep sandy soils**

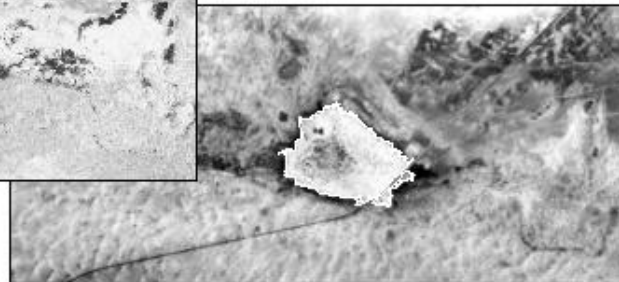


Method: Compilation of remote sensing data, aerial pictures

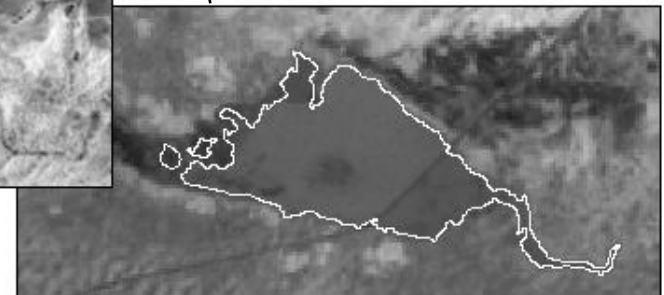
Results: The striking case of the Agoufou pond (AMMA supersite)



1966

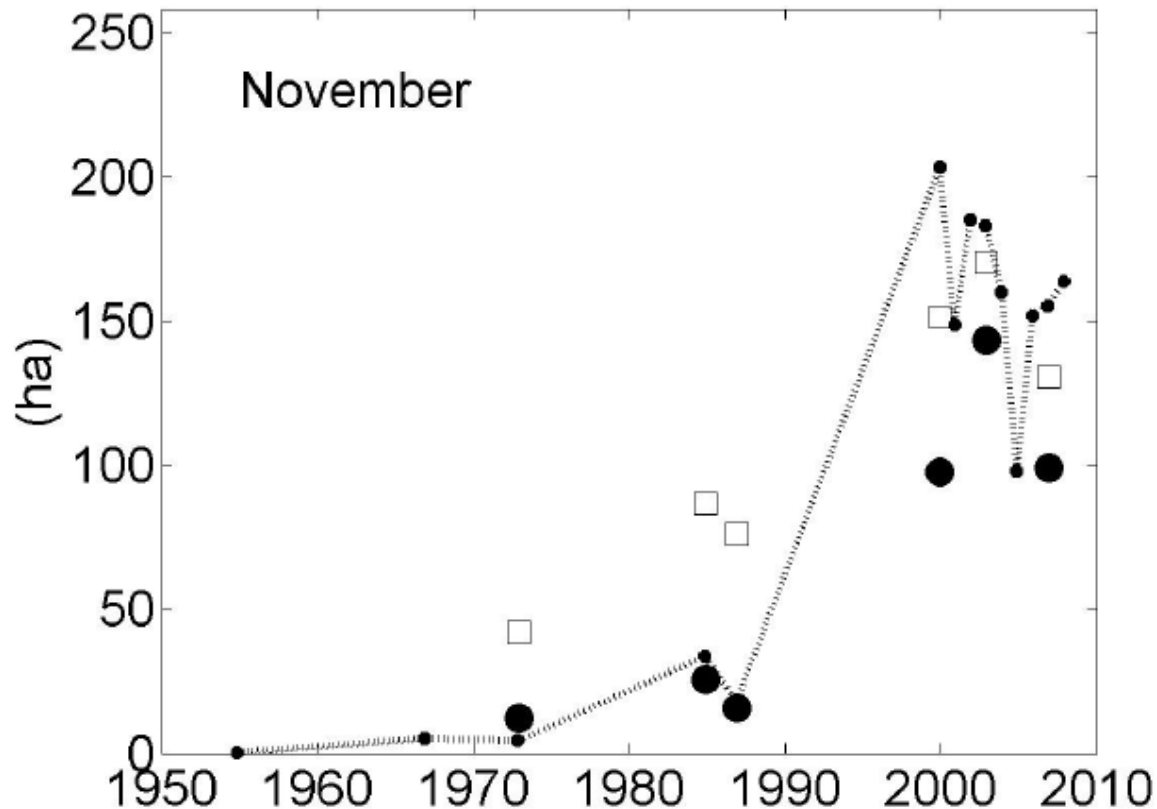


1996



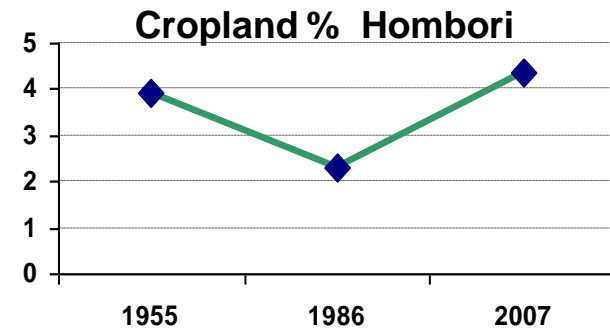
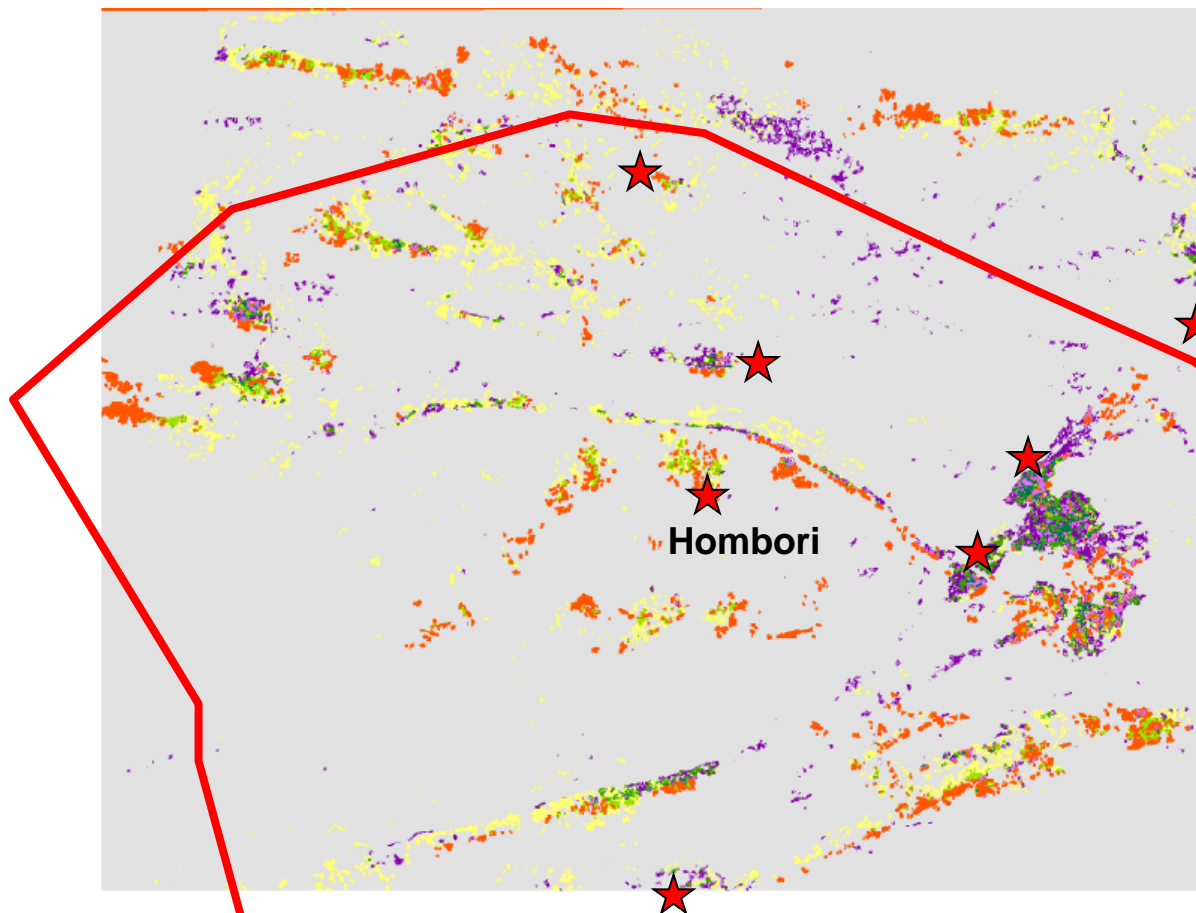
2007

Results: the Regional view for the Gourma :

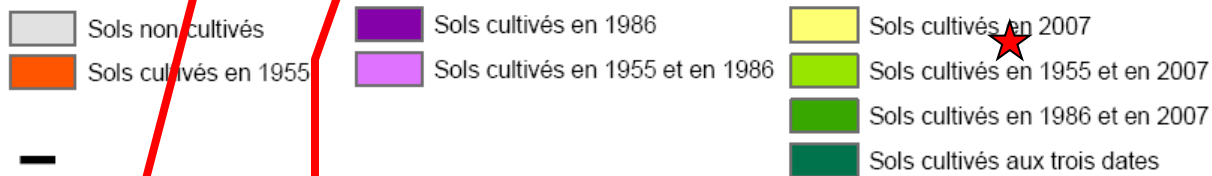


**Strong increase of ponds' surface in the dry last 30 years, compared to the wet 50-60'. Acceleration in the early 90'.**

**Sahelian paradox holds for uncultivated Gourma !**



### Légende



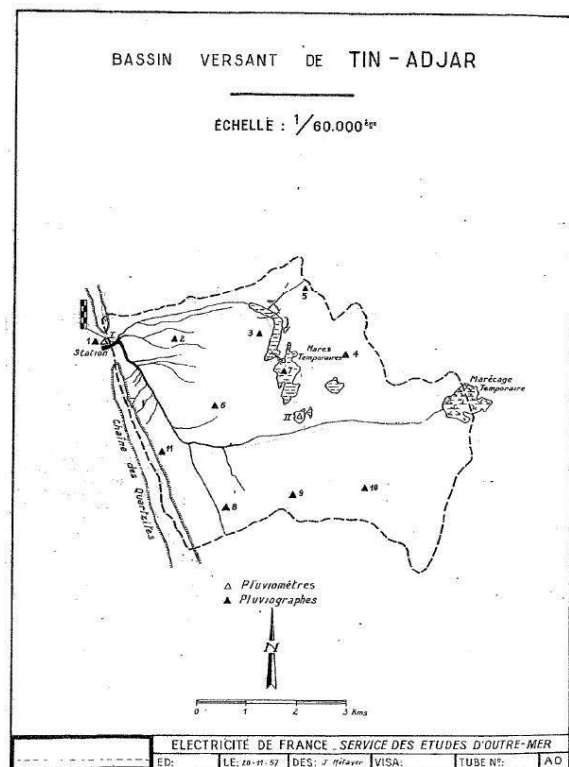
0 2 154 300 8 600 12 900 17 200 Meters

### Croplands Hombori



# What's going on in the Gourma ?

Revisiting Tin Adjar 50 years after Dubreuil et col.



Field work 1954-1956

Dubreuil 1976

Valentin 1988

Revisit in 2007, 2008

Small watershed

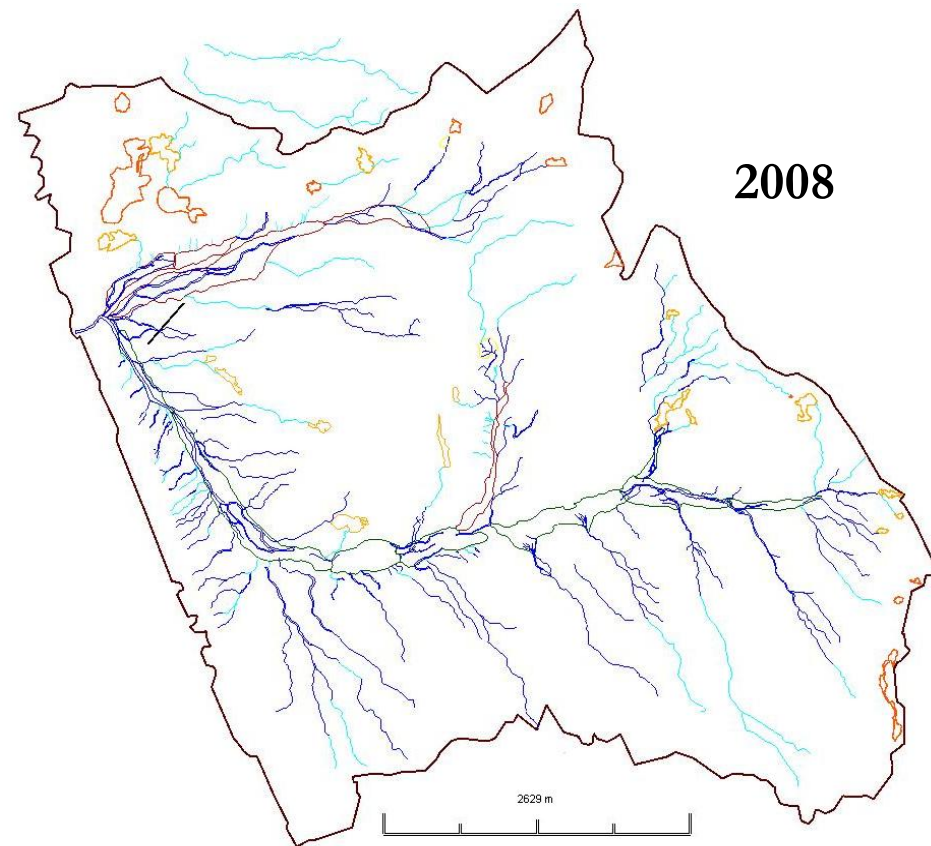
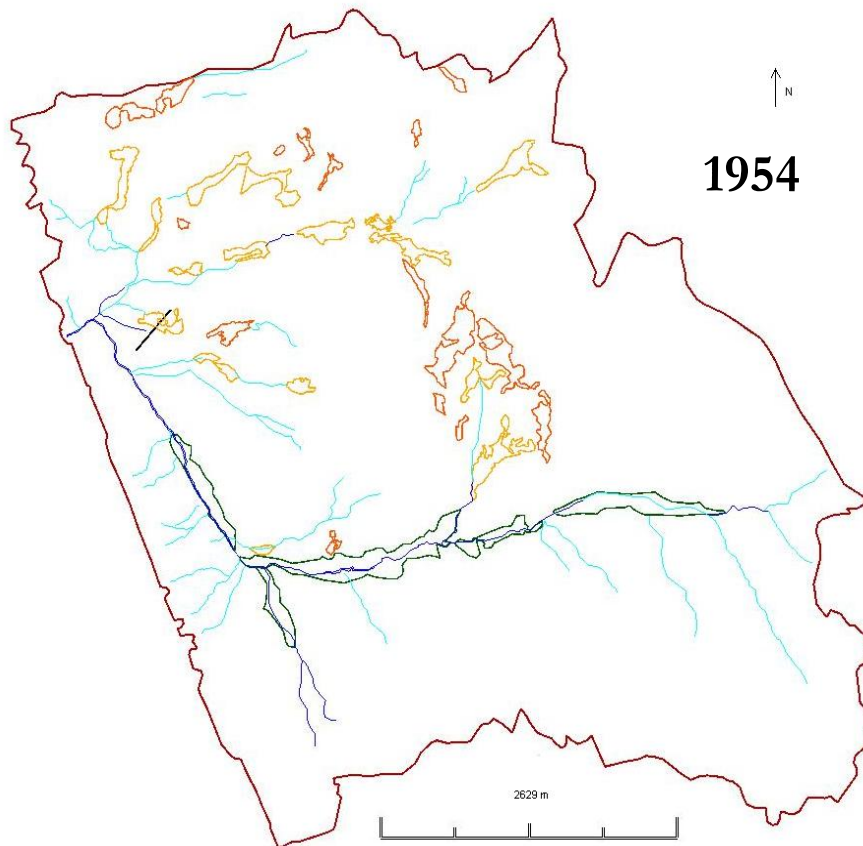
20 km<sup>2</sup>, 100-200 mm / year

- Some grass cover (annuals) on sand and in depression
- Scattered trees/bushes (mostly in depressions)
- Bare soil (rock, loam)





## Comparing 1954 (aerial picture) and 2008 (Quickbird)

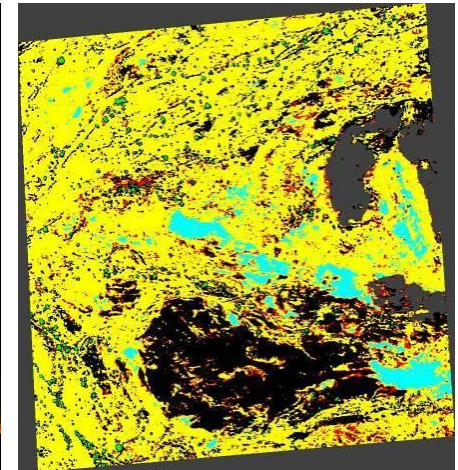
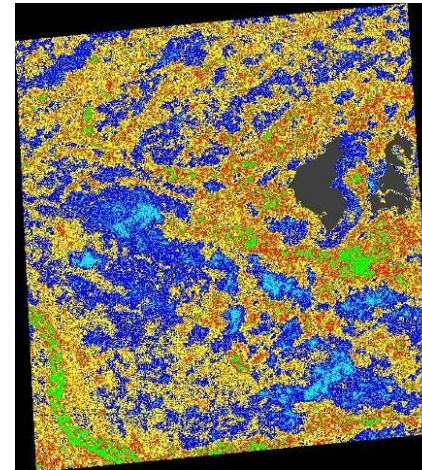
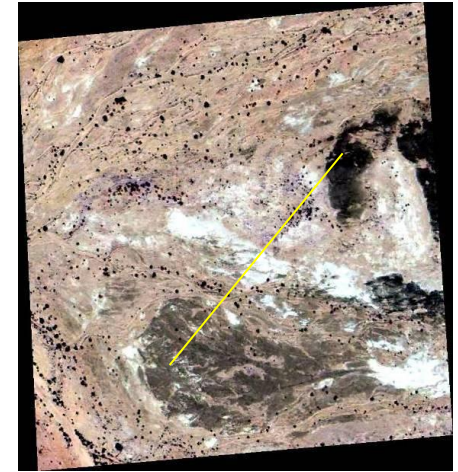
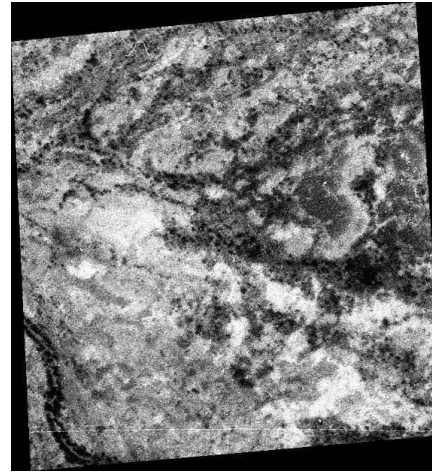
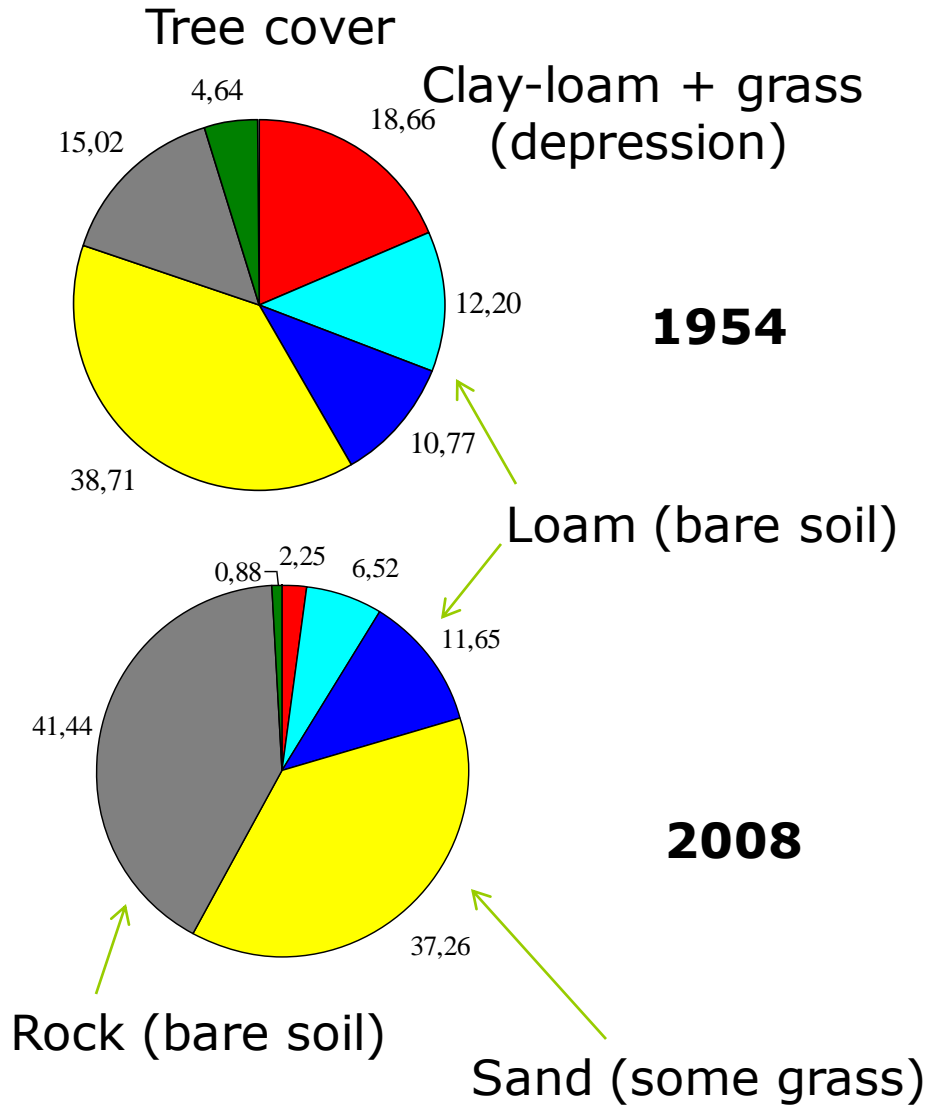


### Legend :

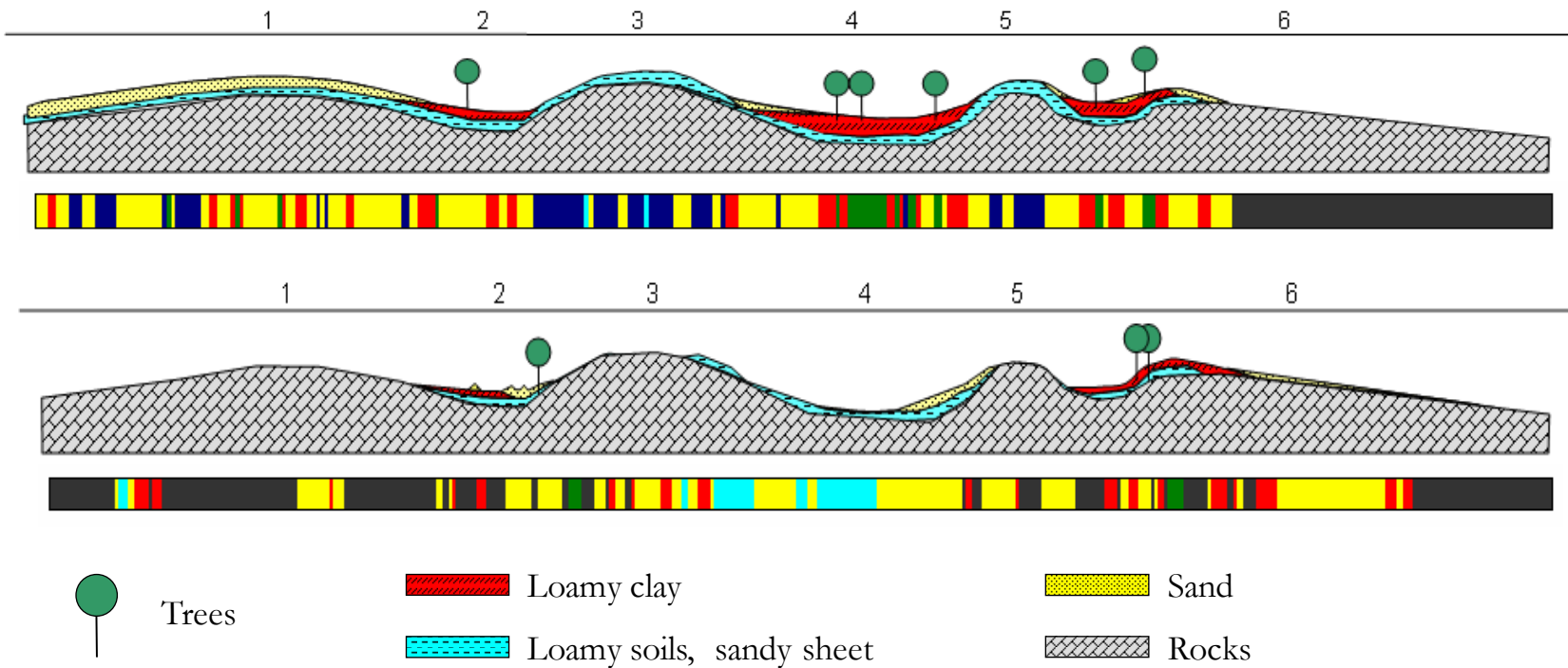
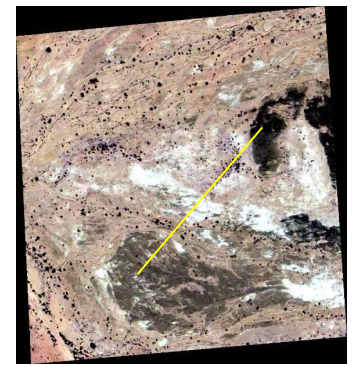
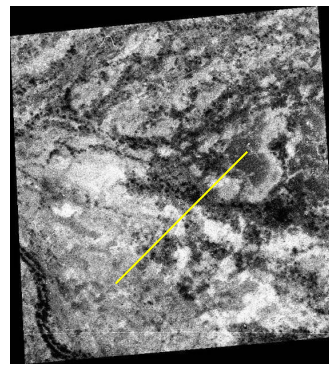
- |         |                    |                 |
|---------|--------------------|-----------------|
| Gullies | Flood plain        | Ephemeral water |
| Gullies | Drained 'cuvettes' |                 |

Increased gully network  
-> Increased runoff

## But also : drastic changes in land surface type



Erosion : rock ++,  
 Sand moved  
 Loamy clay+trees : washed out



Mechanism:  
 less grass cover (max drought),  
 increased runoff + concentration of runoff  
 further depriving vegetation and strong erosion





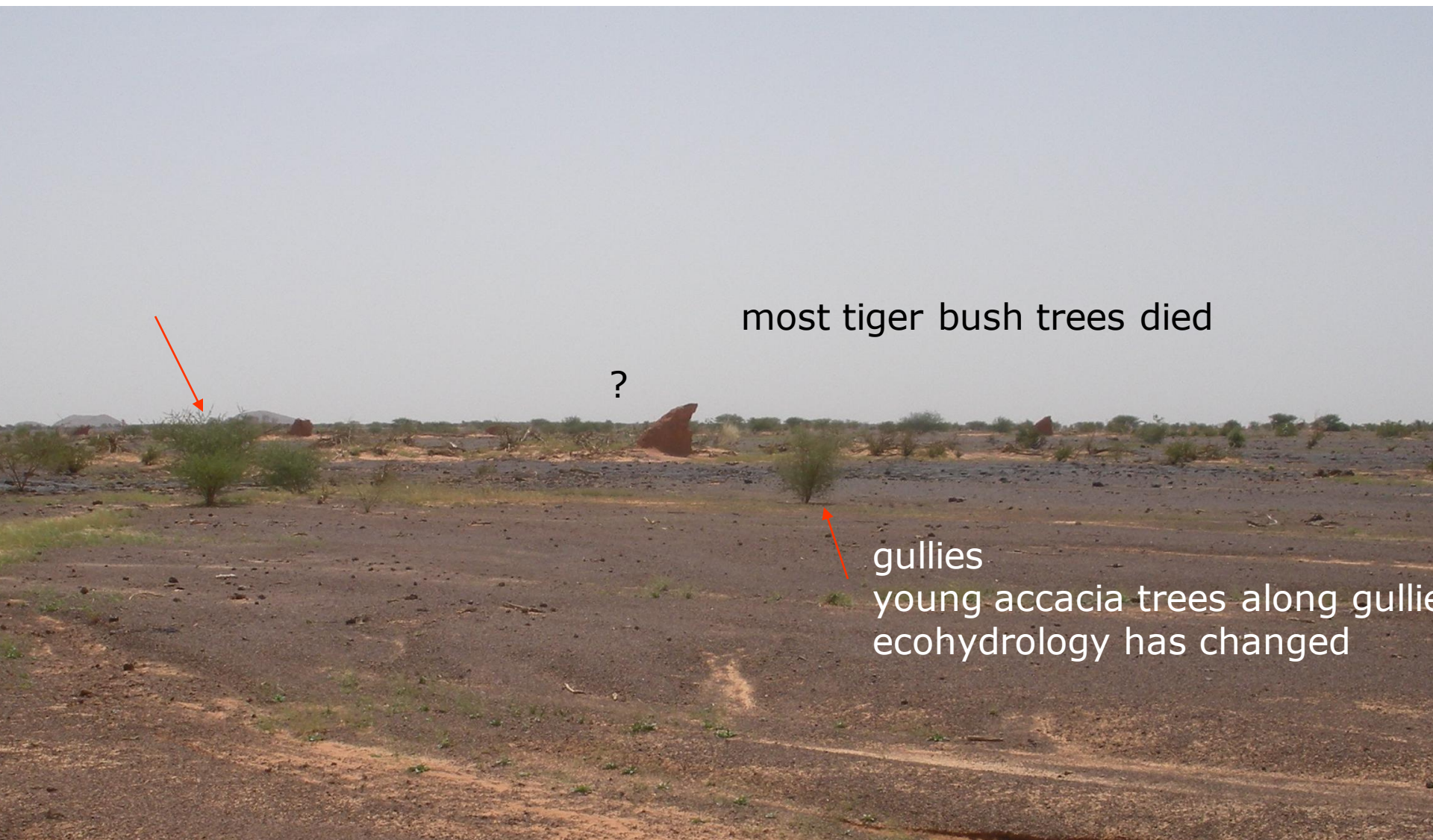
1986





1994





most tiger bush trees died

?

gullies  
young accacia trees along gullies  
ecohydrology has changed

2008

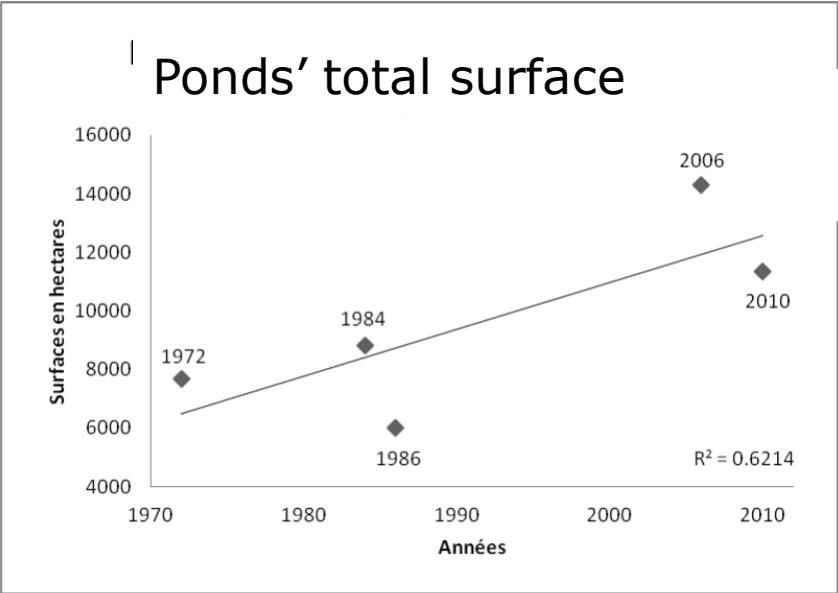
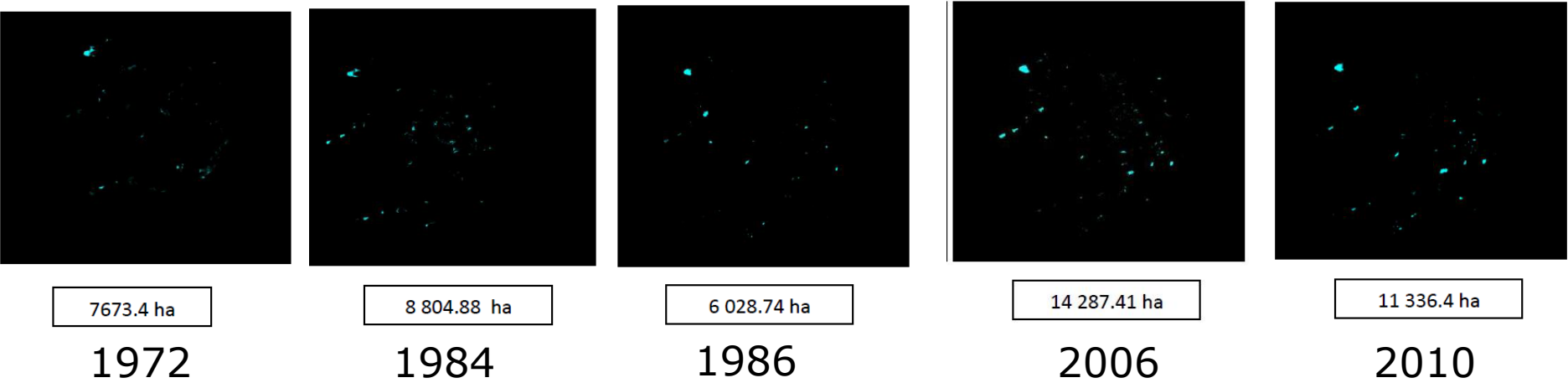


Is this observed in other places ?

Prerequisite: relatively similar shallow soils + ponds system



# Water bodies classification from Landsat archive



|                        | 1972  | 1984  | 1986  | 2006 |
|------------------------|-------|-------|-------|------|
| Précipitations<br>(mm) | 267.9 | 143.3 | 106.9 | 233  |

Preliminary results near Zinder  
and Damagaram suggest similar increase

# CONCLUSIONS

**Large increase in water bodies over several regions in (mostly) un-cultivated Sahel during the 30 yr drought**

**Mechanisms = ecohydrology**

- immediate reponse to drought :  
regression of grass layer  
runoff concentration in gullies,**
- delayed response:  
vegetation further deprived, continued decay  
soil erosion, increase runoff  
preventing grass recovery**

**Land use : not responsible (in these cases ...)**

**Open question:**

**multi-decadal evolution of gullies, erosion, Sahel greening ?**

**Prediction: ponds reasonably full in the next 20 years**