

Rising ponds in uncultivated Sahel : mechanisms and spatial extension from Mauretania to Niger

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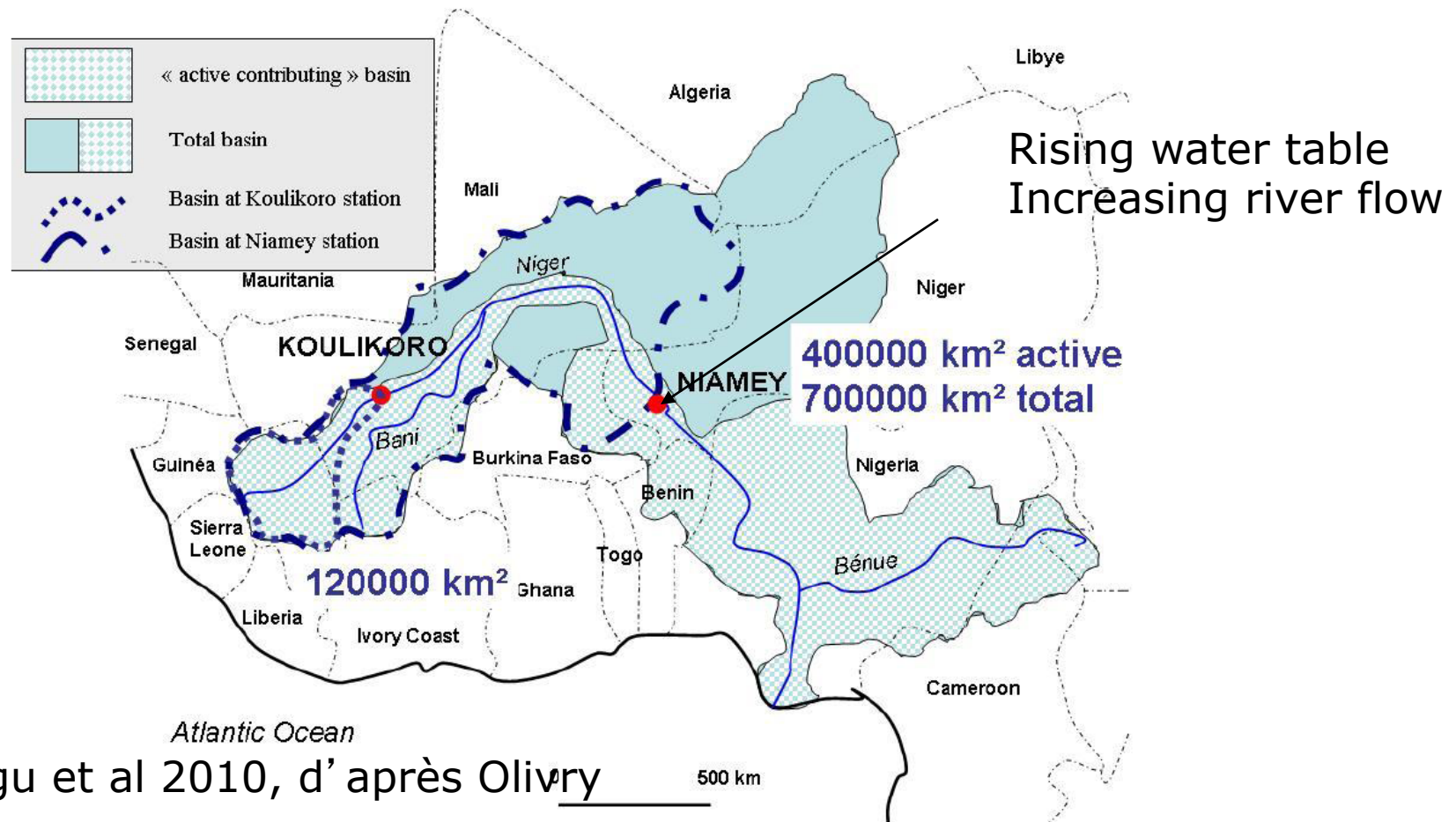


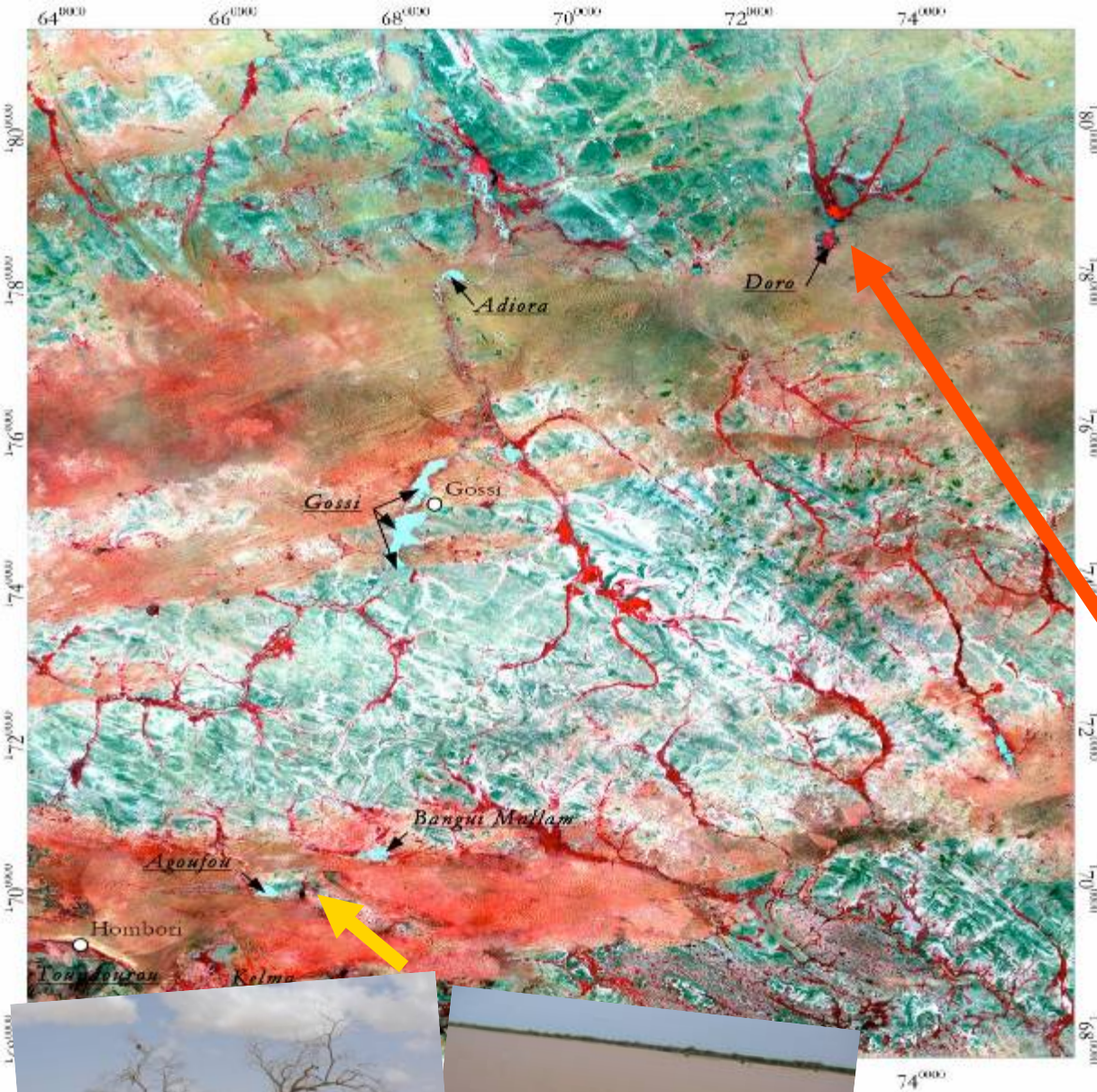
Scientific context:

During and after the 70' 80' drought:

Runoff increases, runoff coefficient have increased
(Albergel, Leduc, Favreau, Descroix....) **Sahelian paradox**

Often attributed to cropland expansion (and sometime to drought)



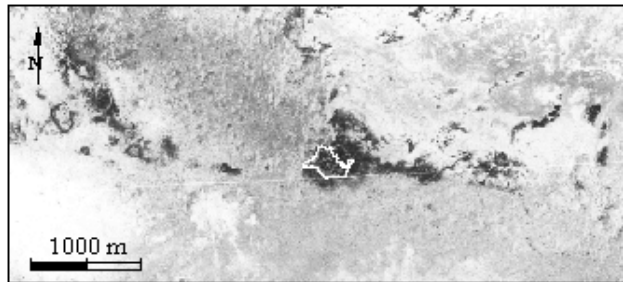
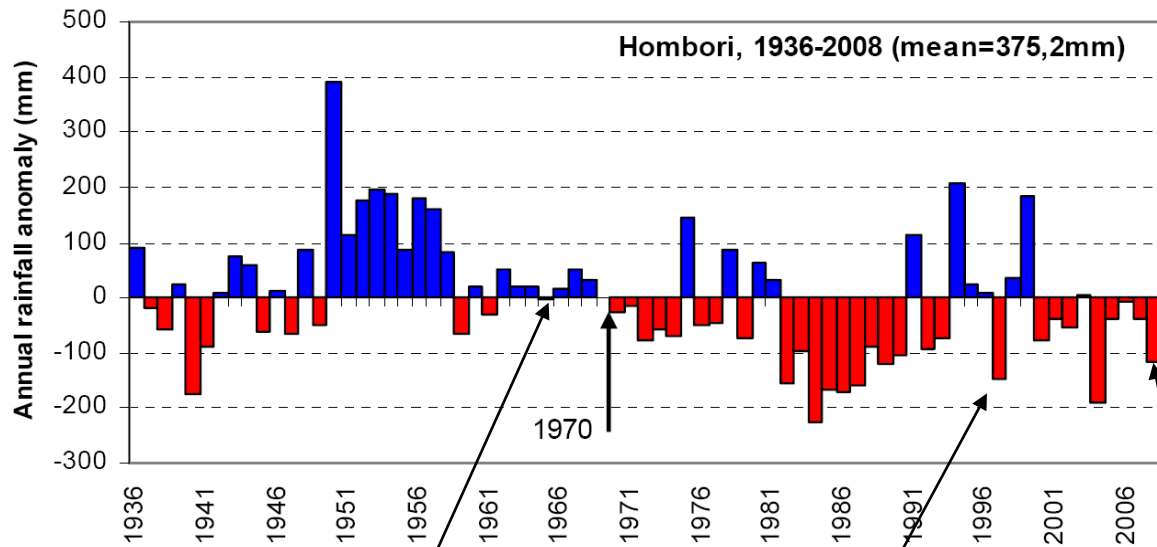


However, we showed in 2010 that ponds surface dramatically increased over 50 years in Gourma 97% uncultivated !

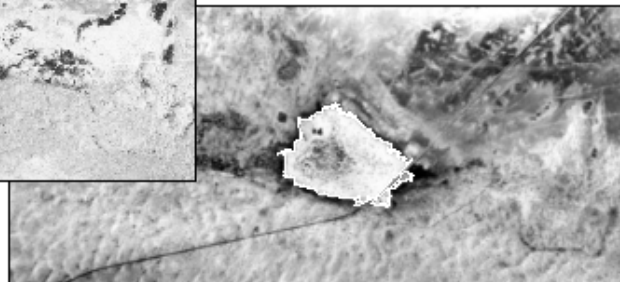
Gardelle et al. HESS 2010



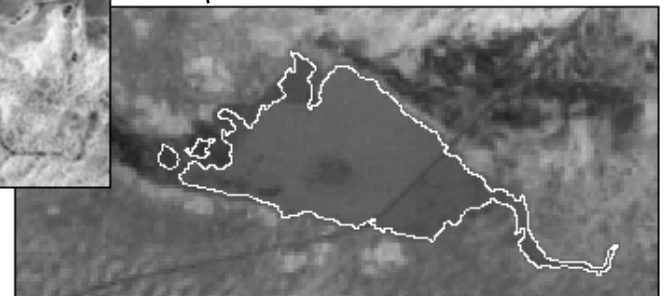
Exemple of Agoufou (AMMA-Catch site)



1966

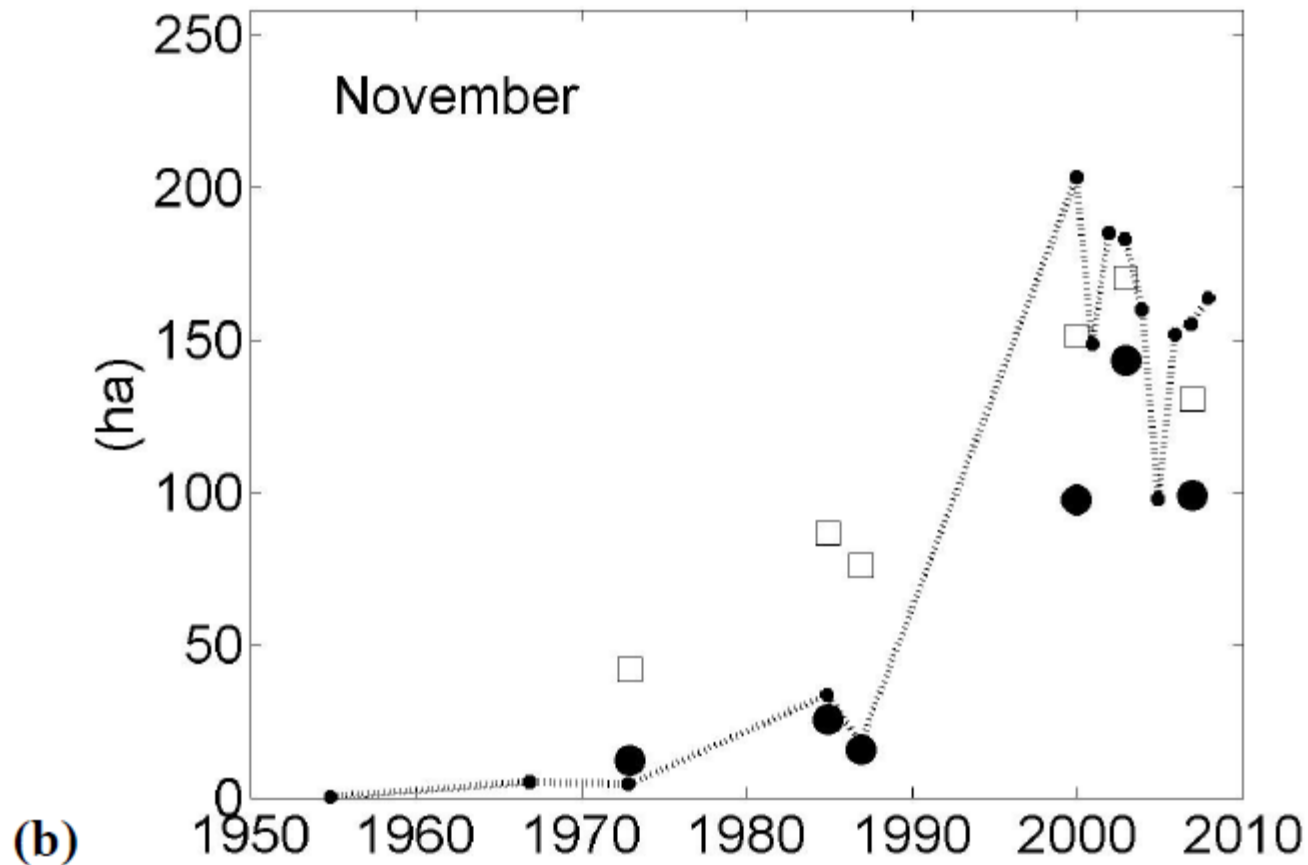


1996

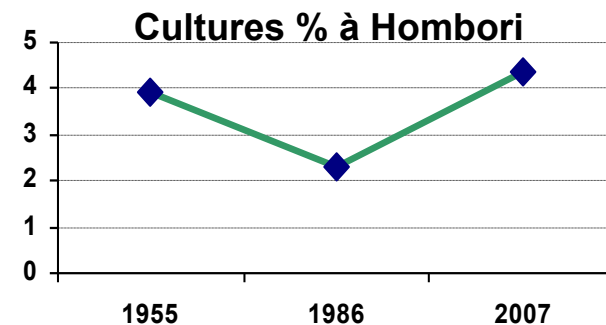
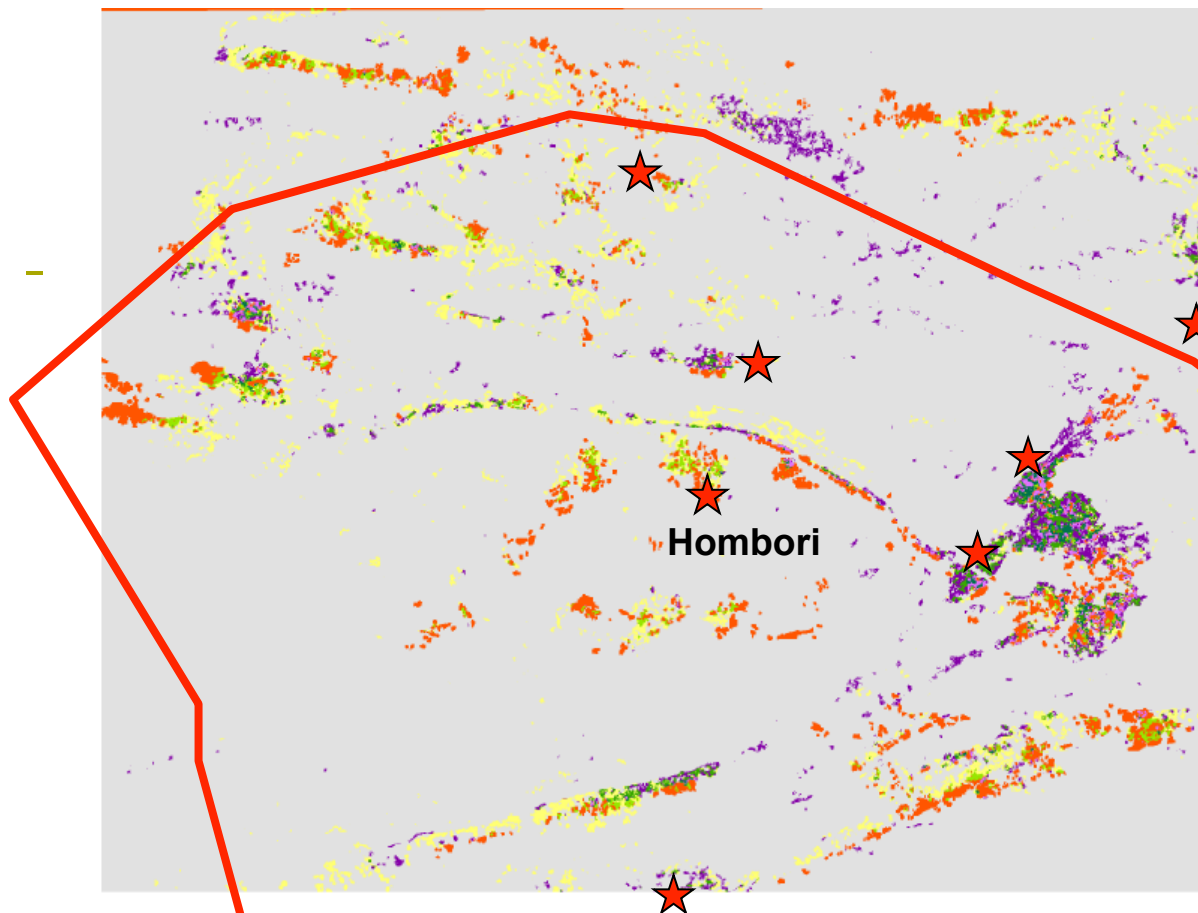


2007

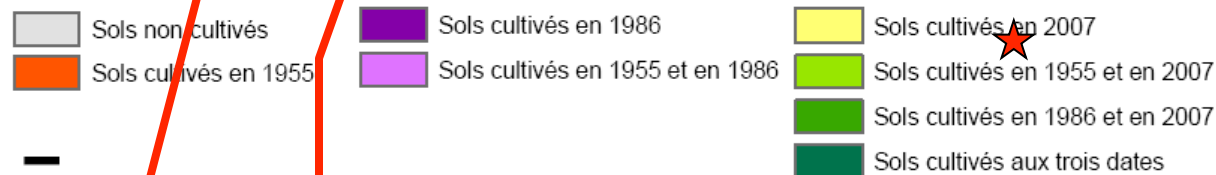
Gourma average (91 ponds)



Gardelle et al. 2010



Légende



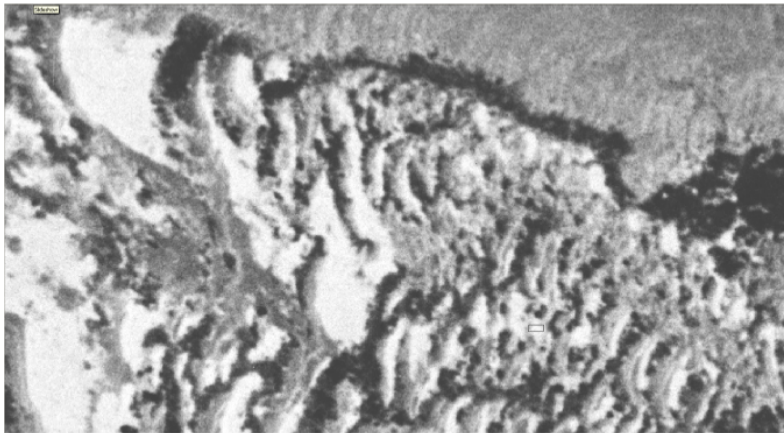
0 2 154 300 8 600 12 900 17 200 Meters

Croplands Homb ri

Source: Cheula, 2009

What's going on in un cultivated Sahel ?

Hypothesis: coordinated changes of
Vegetation (grasses) and water regime
on shallow soils



CORONA. 15/10/1965

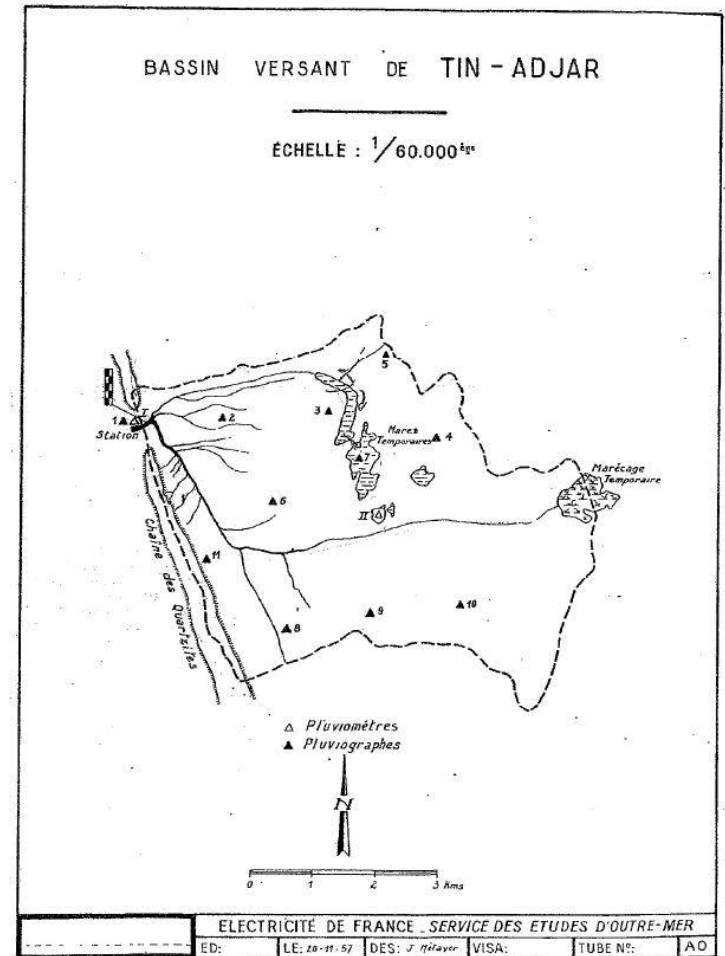


SPOT du 28/12/03

Revisiting Tin Adjar 50 years after Dubreuil

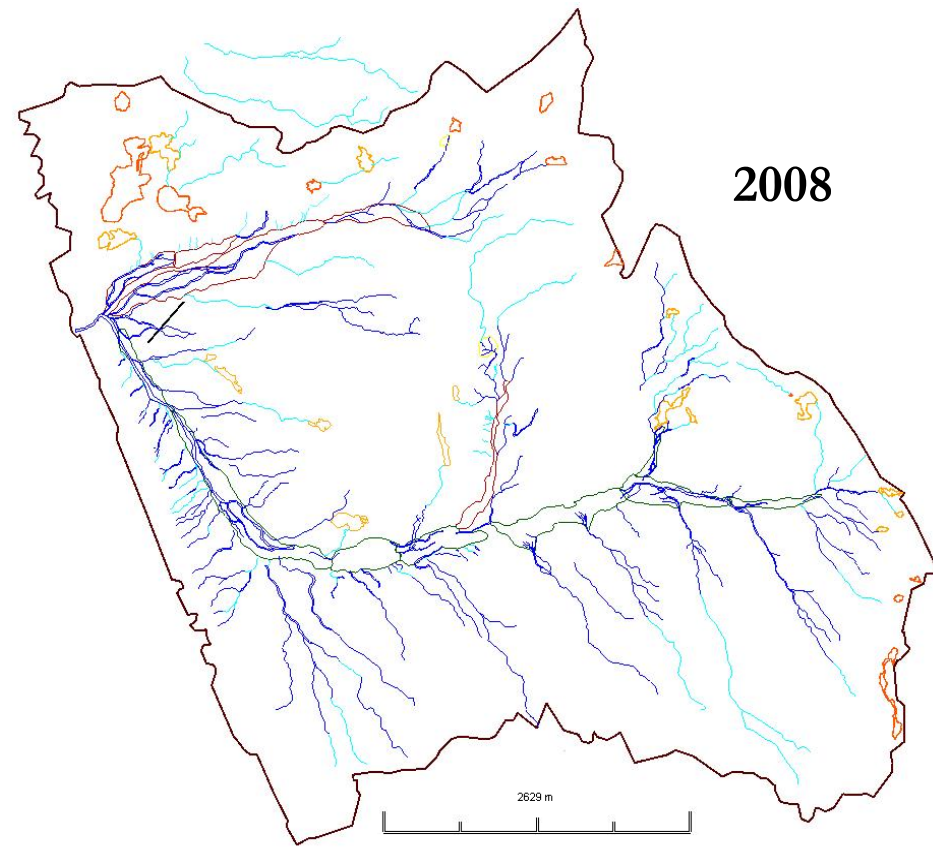
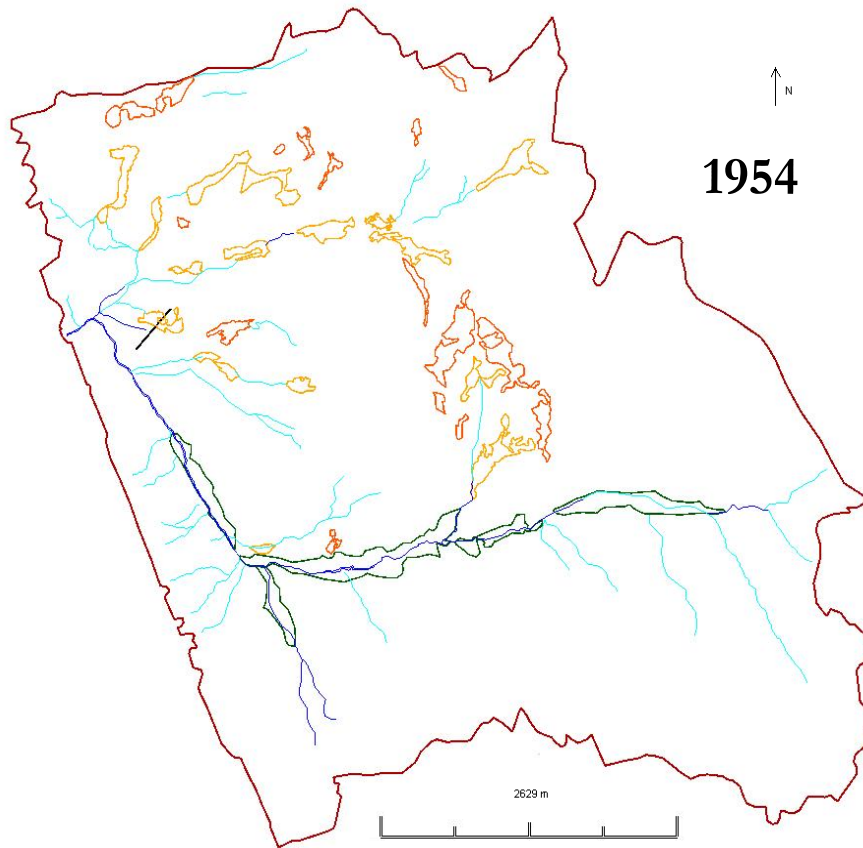
▣ Former studies 56-58:

Dubreuil (1972) et Valentin (1988)



Bassin versant de Tin Adjar. Dubreuil 1957.

Revisiting Tin Adjar Gullies, wadis/koris :



Légende :

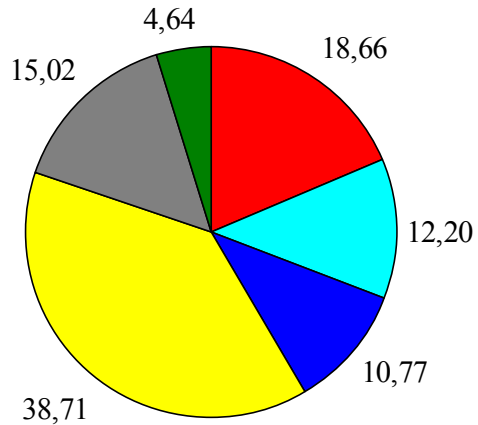
— Chenal principal
— Chenaux secondaires
alimentés sporadiquement

Plaines d'inondation
Réseau anastomosé

Cuvette
Cuvette drainée

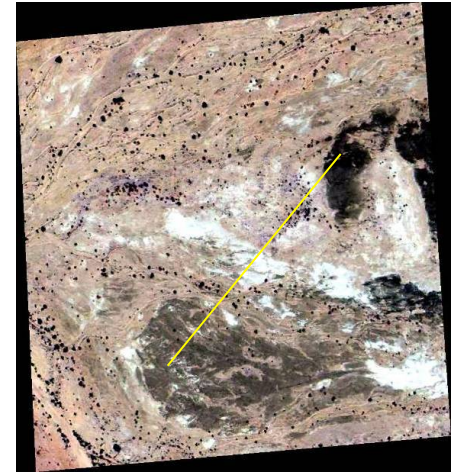
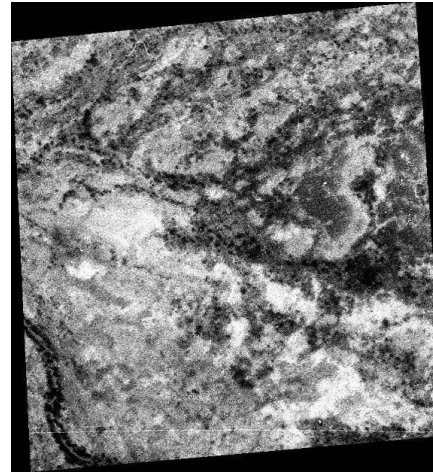
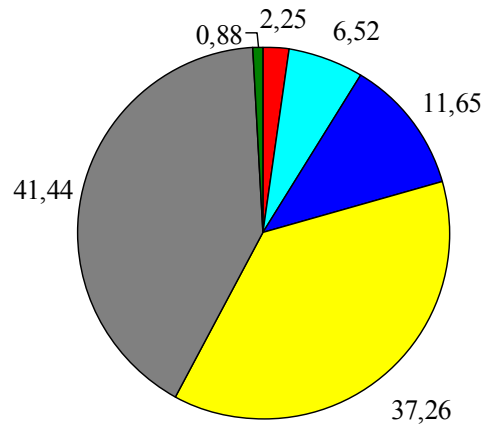
But also : important changes in land surface.

1954



- Argilo-limoneuse
- Limoneuse (décapée)
- Sableuse (voile) sur placage limoneux
- Sableuse (plaine et dunes)
- Rocheuse
- Arbres

2008



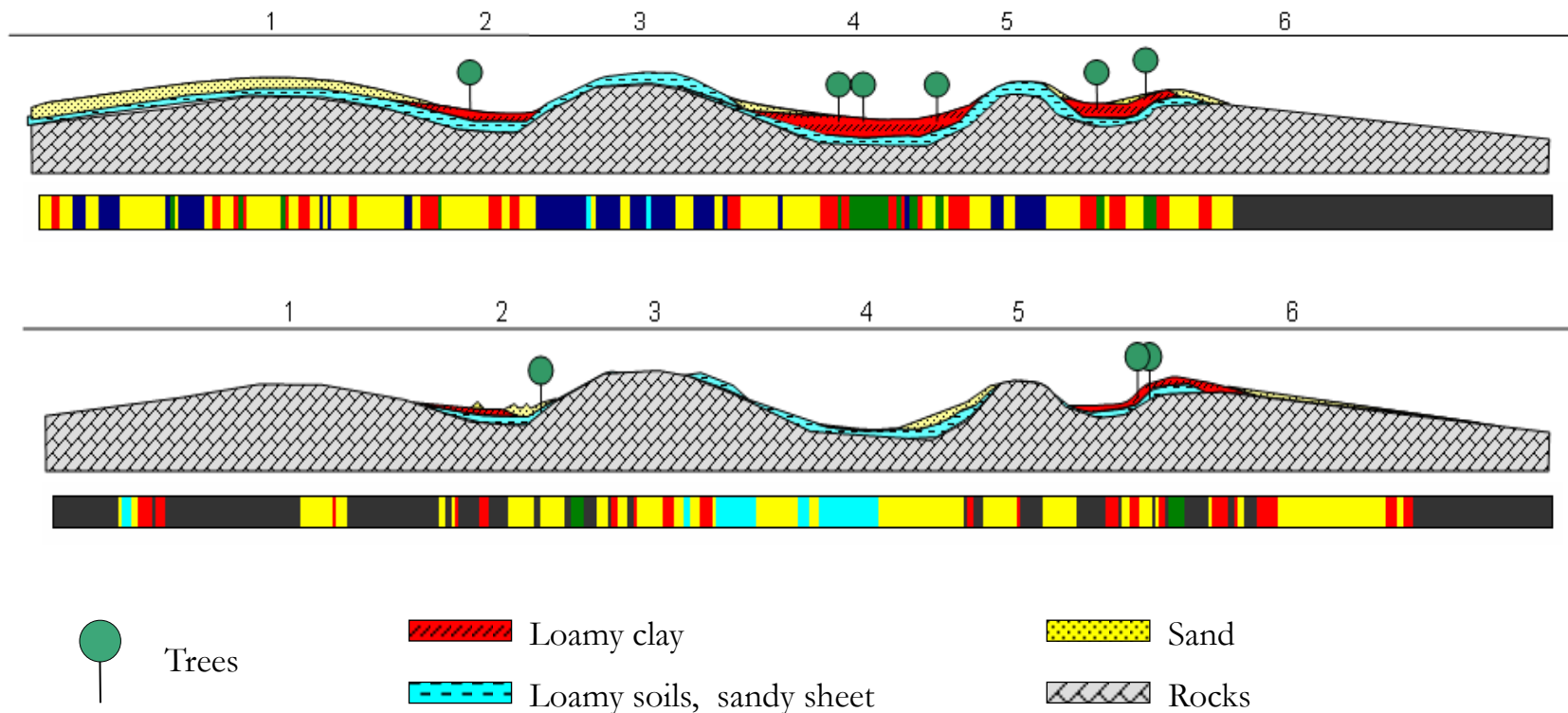
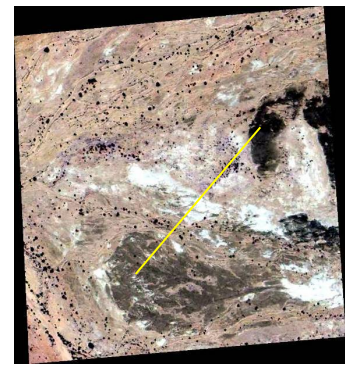
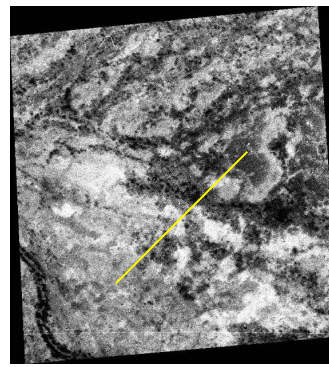
Mechanism :

less grass cover (max drought),

increased runoff,

concentration of runoff

further depriving vegetation and strong erosion





31/07/86



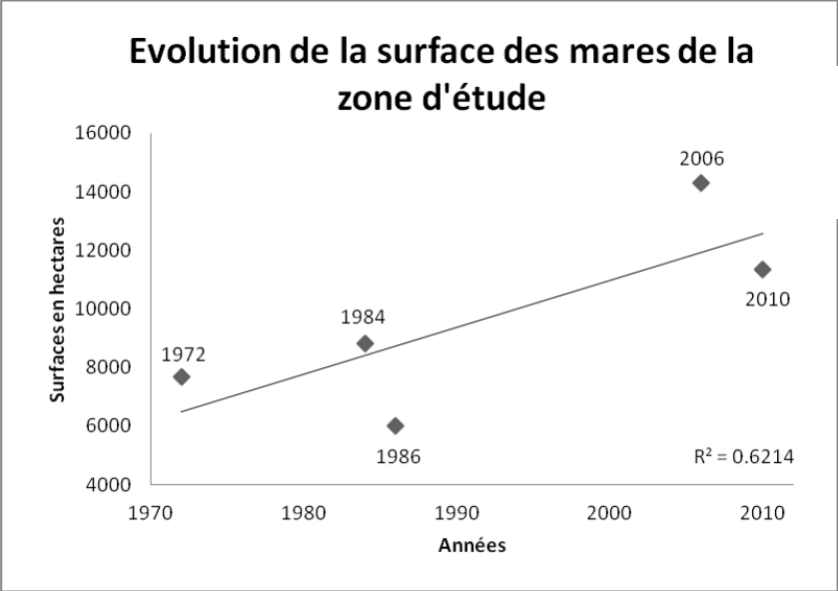
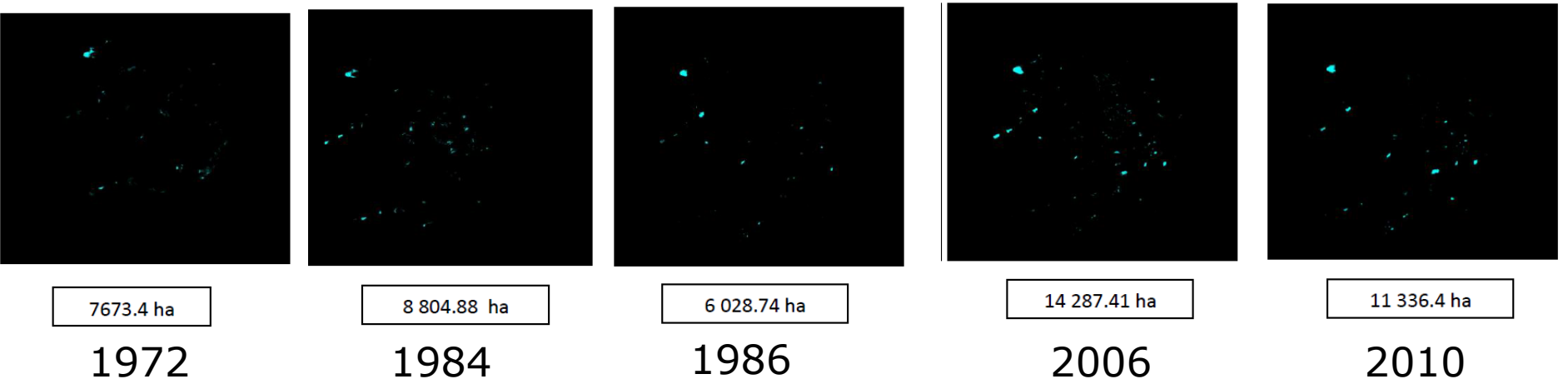
23/09/08

Prerequisite: relatively similar shallow soils + ponds system



Calas (M1) Gippa, Hiernaux

Water bodies classification from Landsat archive



	1972	1984	1986	2006
Précipitations (mm)	267.9	143.3	106.9	233

Preliminary results near Zinder and Damagaram suggest similar increase

CONCLUSIONS

Increase in water bodies established over several Regions in (mostly) un-cultivated Sahel (Mauretania, Mali, Niger)

Confirm the relevance of the Gourma study

Mechanisms involve vegetation response to drought

- immediate layer of grass layer,
- runoff concentration in gullies,
- erosion preventing grass recovery

Open question: multi-decadal evolution of gullies, erosion ?

**Prediction,
ponds should be reasonably full in the next 20 years**

Good news is that we don't rely on CMIP3, or CMIP5 or 7, 9 ...

CONCLUSIONS ET PERSPECTIVES

**Pour rétablir un couvert végétal herbacé,
il faudrait un ensablement généralisé,
peu probable dans les années à venir**

**Quelque soit le climat des prochaines décennies,
(mousson plus active ou mousson moins active)**

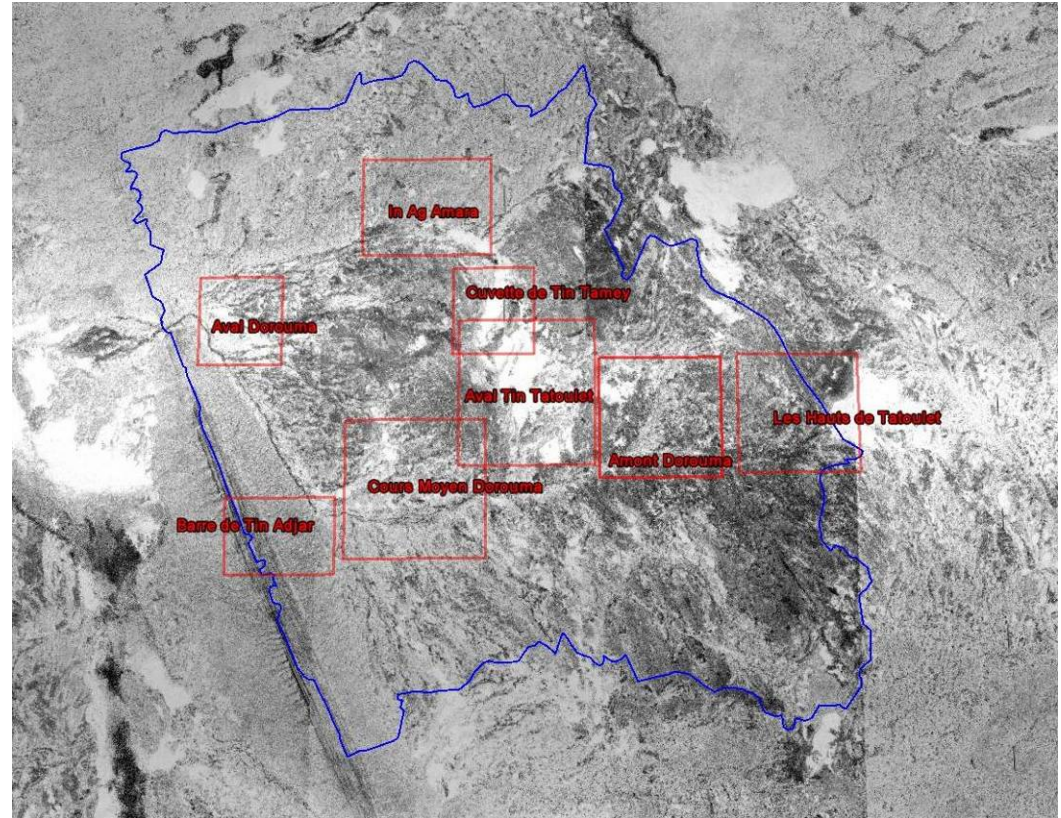
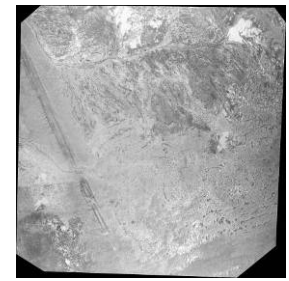
les mares du Gourma resteront remplies !

quelque soit le climat des prochaines décennies,

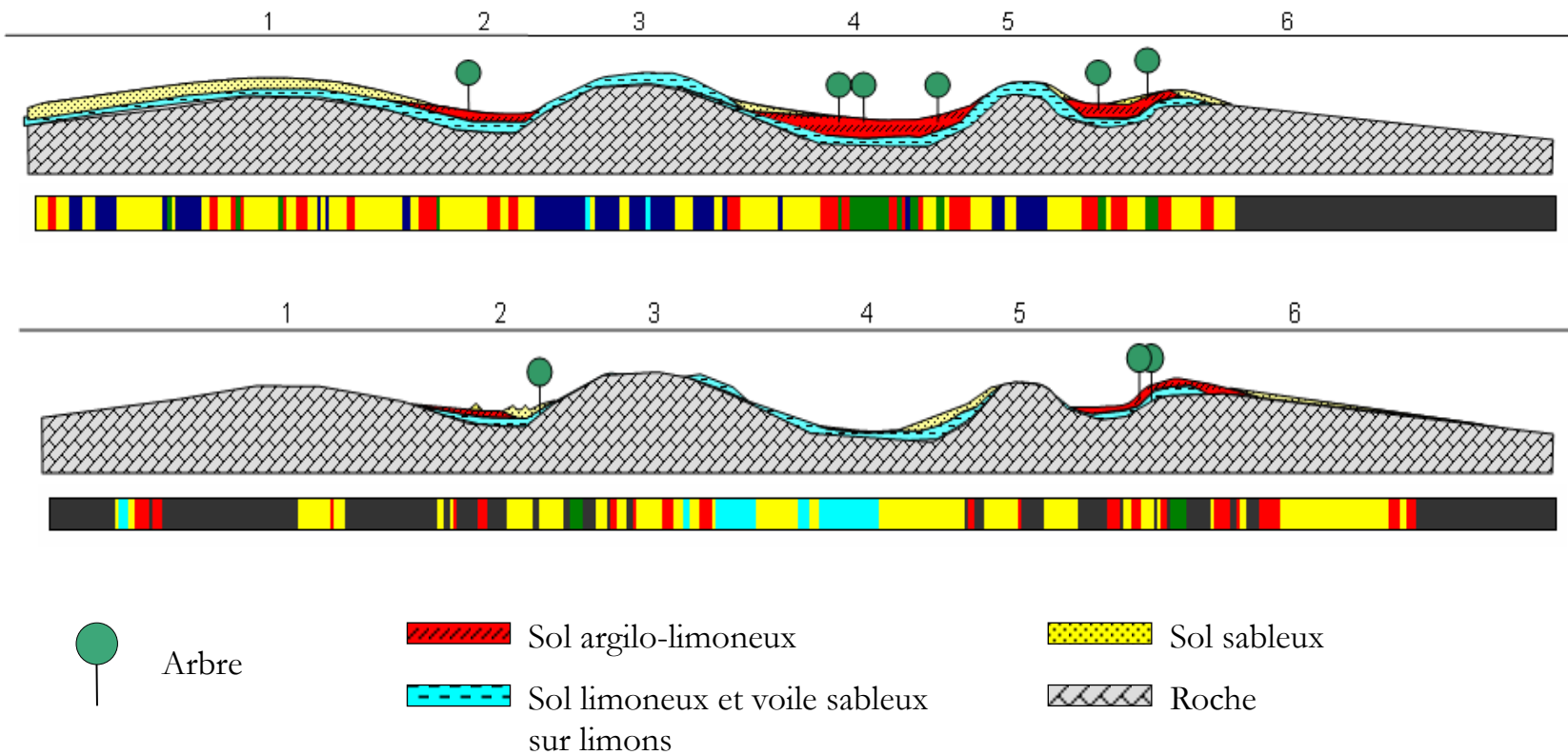
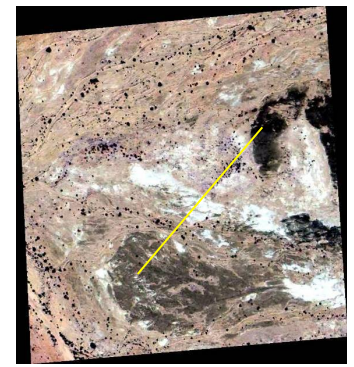
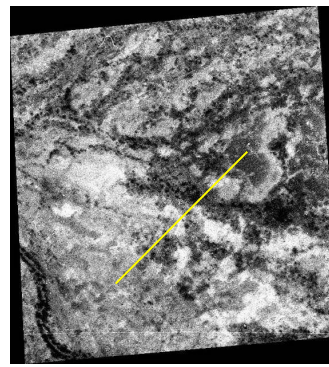
**Conséquences importantes dans une région où les eaux
de surface conditionnent tout simplement
l'occupation du territoire**

Méthodologie

- ❑ Les données
 - Photographies aériennes de l'IGN (MD AO 1954-1955), monochromatique, stéréoscopiques
 - Image QuickBird (septembre 2008)
- ❑ Le traitement d'image
 - Géoréférencement
 - Correction du vignettage et mosaïque
- ❑ La classification supervisée
 - Définition des classes
 - Le masque
 - L'évaluation
- ❑ Le relevé du réseau hydrographique (critères objectifs)

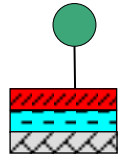


Les Mécanismes. Coupe.

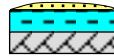


Les Mécanismes. Généralisation.

Replats et dépressions

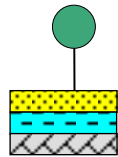


Ensemble du bassin versant



Bas du bassin versant

Pentes



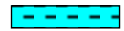
Ensemble du bassin versant



Arbre



Sol argilo-limoneux



Sol limoneux et voile sableux
sur limons



Sol sableux



Roche



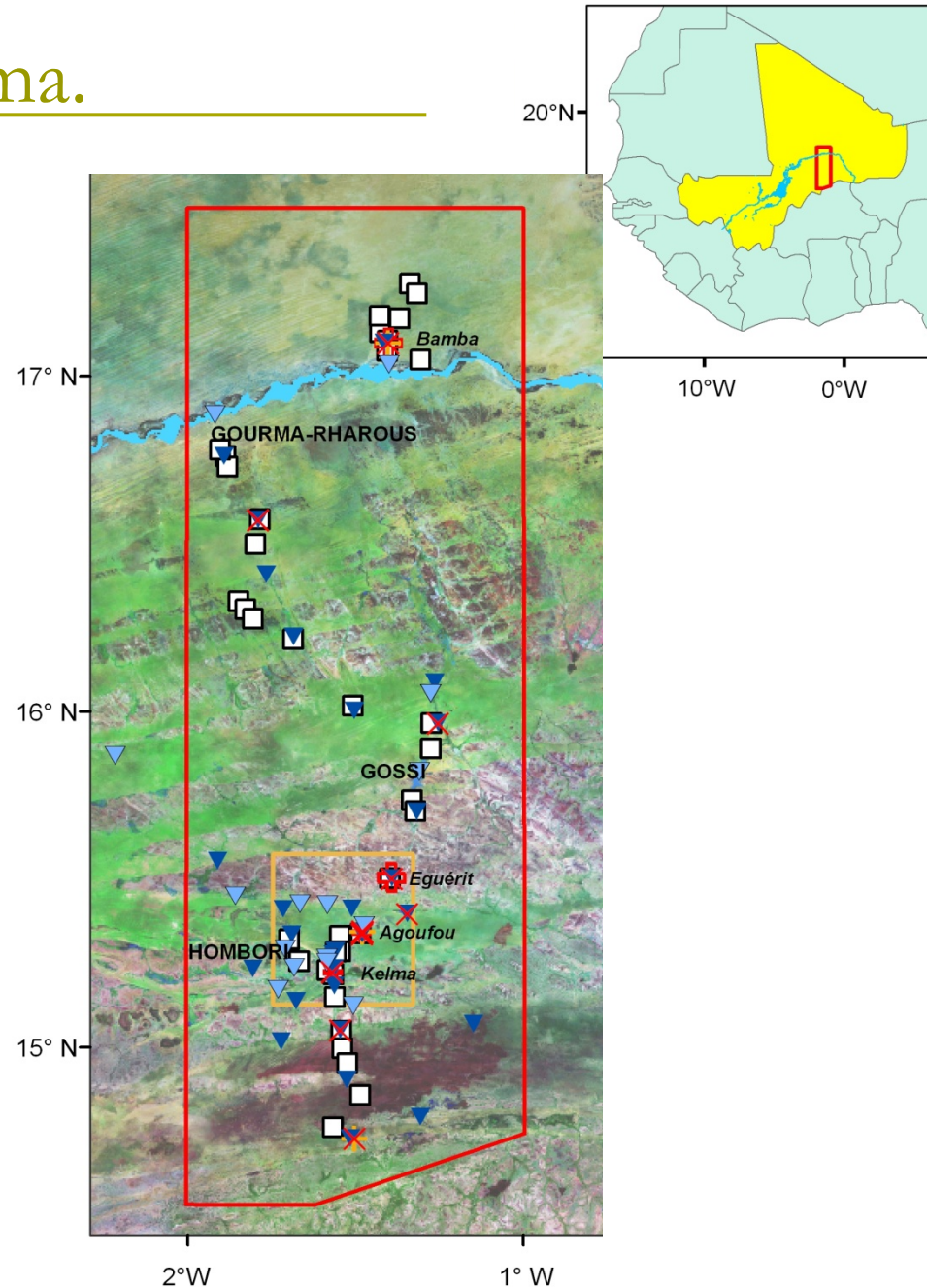
Erosion



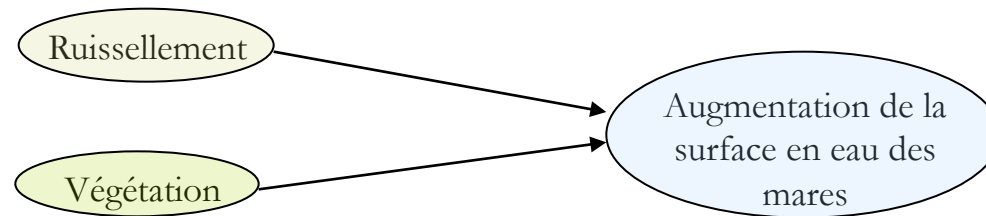
Alluvionnement ou
ensablement de surface.

Le Contexte. Le Gourma.

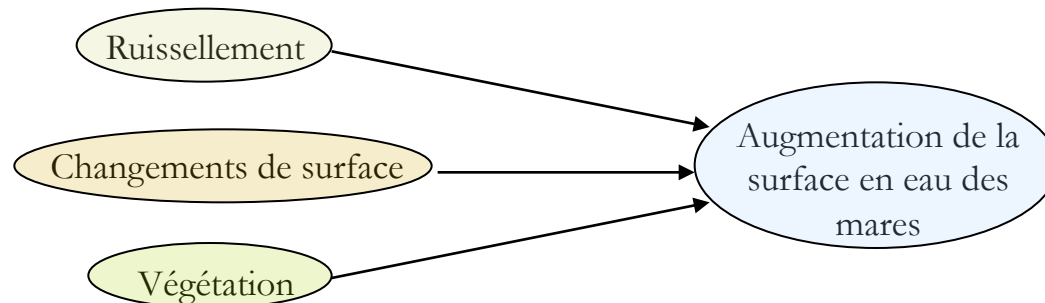
- ❑ Système de mousson
- ❑ Entre 100 et 450 mm/an.
- ❑ Région globalement **endoréique**.
- ❑ 2 types de surfaces:
 - **Dunes de sable:** 60%
ruissellement en nappe limité
 - **Sols peu profonds:** 40%
(cuirasse ferreuse, sols fins des dépressions, roche mère: grès et schistes érodés),
ruissellement concentré jusque dans des mares



Facteurs pressentis

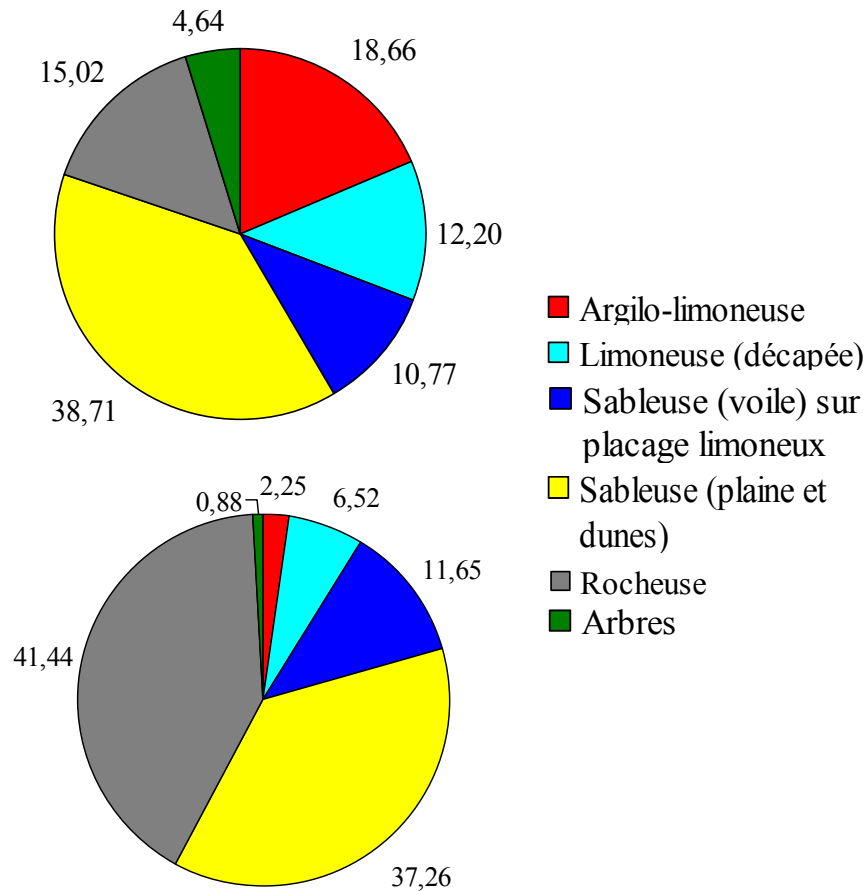


Facteurs mis en évidence

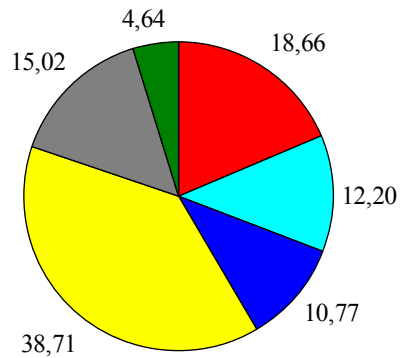


- ❑ Confirmation de l'hypothèse de départ
- ❑ et mise en évidence par J. Ramarohetra et al. d'un autre facteur
- ❑ EROSION RAPIDE DES SURFACES sur sol peu profonds
- ❑ (alors que le couvert végétal augmente sur les sol sableux = 65 % surface !)

Résultats. Les changements de surface.



Résultats. Les changements de surface.



- Argilo-limoneuse
- Limoneuse (décapée)
- Sableuse (voile) sur placage limoneux
- Sableuse (plaine et dunes)
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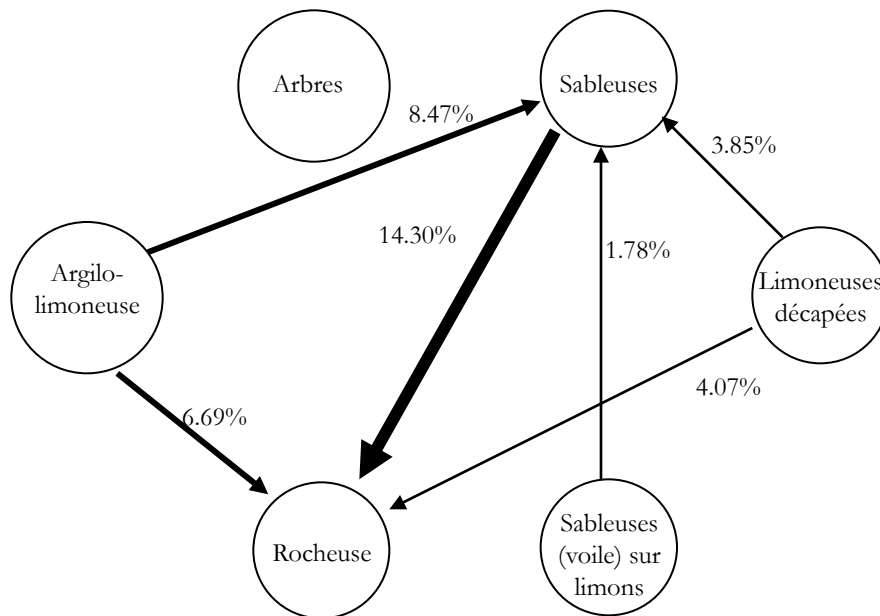


Questions ouvertes

- Des changements continus ?
- Un processus réversible ?
- La modélisation. Un défi.



Résultats. Les transitions.



- « Déplacement » des surfaces sableuses.
- Surfaces argilo-limoneuses érodées,
 - puis recouvertes d'une mince couche de sable ou
 - laissant apparaître la roche.
- Surfaces de limons décapés aujourd'hui
 - recouvertes d'un voile sableux ou
 - érodées jusqu'à la roche.

Merci

