

TT4

Surface processes on Niger site

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CONTEXT

- Rainfall decreased by 15-30% after 1968
 - Population increases by 3.5% per year
- Fallows are shorter and shorter, natural areas have almost disappeared
- On the other hand, water table is rising for 5 decades



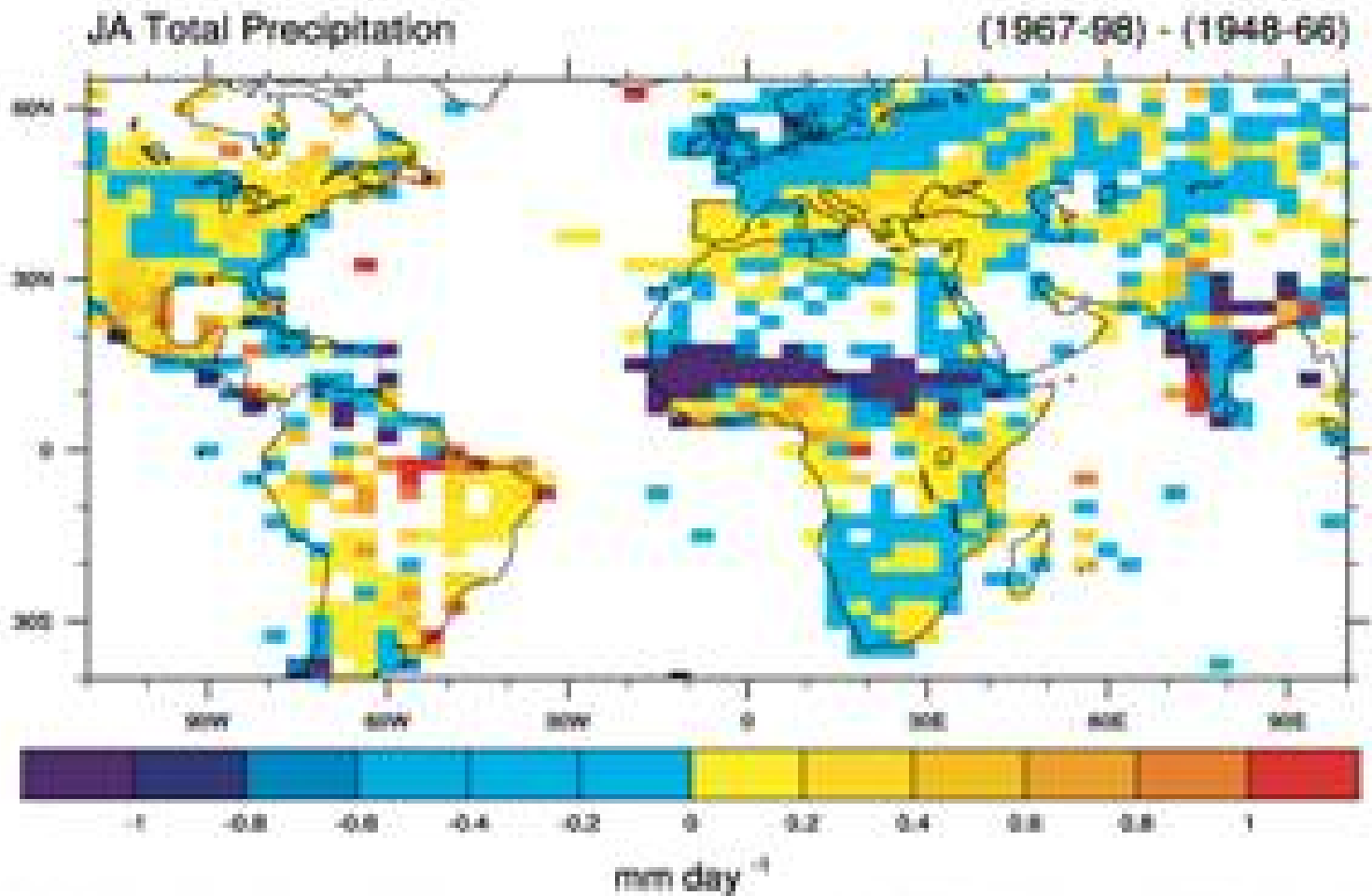


Fig. 3 The change in high summer (July-August) total precipitation (mm day⁻¹), 1967-1998 minus 1948-1966, estimated from land surface records ('g/land008.dat' constructed and supplied by Dr. Mike Hulme at the Climatic Research Unit, Univ of East Anglia, Norwich, UK).



1. Scientific justification and objectives

1-1 Hydrology:

- Investigating small scale variability of certain variables:
 - rainfall ;
 - soil moisture
 - runoff
 - evapotranspiration
 - aquifer recharge
 - and their impact on the water budgets at larger scale.
- Joint modeling of surface hydrology and the aquifer at the mesoscale (Kori de Dantiandou)
- Investigating the role of vegetation in runoff, infiltration, soil moisture and aquifer recharge, and determine the thresholds and boundaries of each process.



1-2 Vegetation:

- Analyse the seasonal cycle of the vegetation - focusing on millet, fallow trees - in interaction with water constraints.
- Provide a re-parameterisation of the Treegrass model (initially developed for humid tropical eco-systems) and upscaling towards a larger scale model (Tgpix)
- Investigate the influence of land use changes in water cycle evolution based on farm surveys over the square degree to validate the SARRA_H crop simulation model for regional yield forecasting and climate change impact studies.



1-3 Validation of aircraft and remote sensing measurement

Satellite data validation:

- **radar** (ASAR ENVISAT): measurements campaigns are made to validate this new sensor in **soil moisture**;
- **SPOT 5: land use** map actualized in the entire SPOT 5 scene (60 X 60 km) owing to land observations and description
 - seasonal **dynamics of vegetation**
 - **mapping of surface water pools**, a major feature in this endoreic area.



1-4 Process modeling

Particular emphasis is given to the development and coupling of hydrological models and vegetation dynamics models at the local scale and then on the supersite.

Health.

An AMMA application program which investigates the climatic part of malaria transmission hazard according to environmental typology.

Agronomic applications.

The aim is to investigate the impacts of monsoon and climate evolution on crops and the adaptation of rural population to these changes.



2 Observing strategy

2-1 Overall strategy for hydrologic studies

Mesoscale processes have been heavily documented since Hapex. This has shown a very significant modification of the water balance linked to both the drought and the degradation of the vegetation

The enhancement of observations during the EOP aims at further analyzing the processes that couple the various compartments of the hydrologic cycle, and more specifically the interactions between water and vegetation as well as the spatial distribution of groundwater recharge.



The respective parts in groundwater recharge of the following landscape features need to be investigated:

- **Ponds**, to extend the knowledge acquired during 14 years at the Wankama site.

There is a great need of improving the calibration methods allowing the determination of ponds areas (by remote sensing) and their progression during the rainy season and after this, to increase the knowledge in evaporation, infiltration and thus, in duration of the ponds during the dry season

- **Gullies**

- **Spreading areas**

- **Vegetation strips of the tiger bush**



2-2 Experimental sites covering the hierarchy of scales

At the mesoscale α

- One site is the support of continued and refined studies on the interannual and intraseasonal variability of rainfall, the focus being on the documentation of convective structures.

This site is a 16000 km² rectangle (**Niamey meso-site**)

- The second site partially overlaps the Niamey meso-site. It is named **Kori de Dantiandou Basin** (5645 km²).

In order to control the lateral exchange terms, the boundaries were defined from the geometry of the aquifer



NIGER land sites

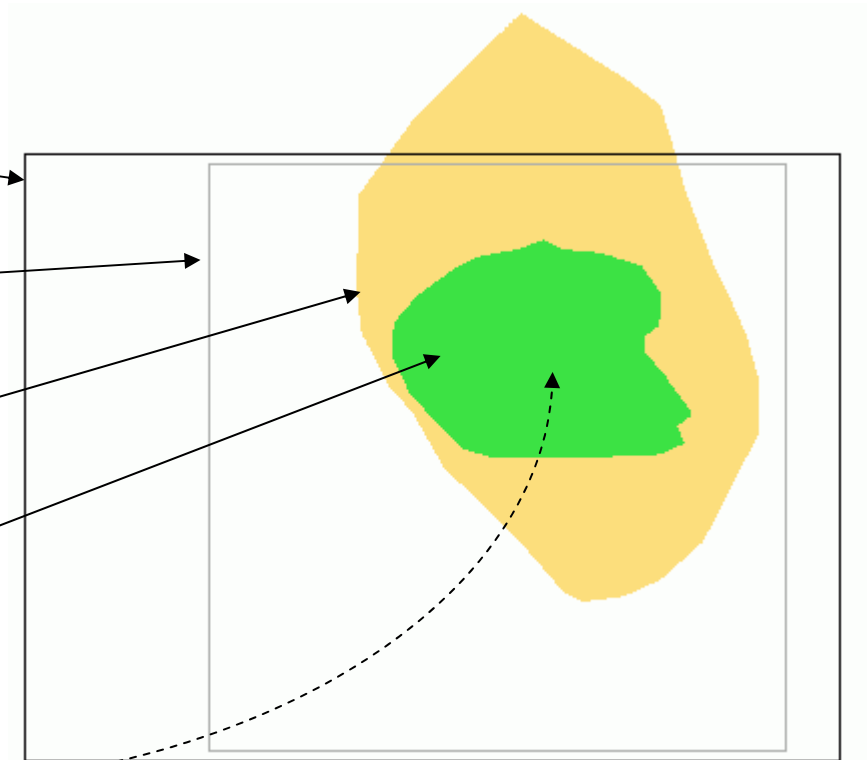
Niger meso-site (N)

Niamey square degree

Kori de Dantiandou Basin (Nkd)

Niger Central Super Site (Nc)

local intensive sites are located within Nc supersite (green)



At the mesoscale β

A composite of endoreic areas covering 1760 km² (**Niger Central Super Site**; that means the Dantiandou Basin Central Area) was chosen to compute a more comprehensive and accurate water budget.

This smaller area enables the providing of regular land use maps allowing the modeling of vegetation/hydrology interactions and the evolution of water balance due to land use current changes.

On this site denser measurements of the various terms of the water balance will be performed



2 mesoscale entities

- Niger meso-site

- KD basin

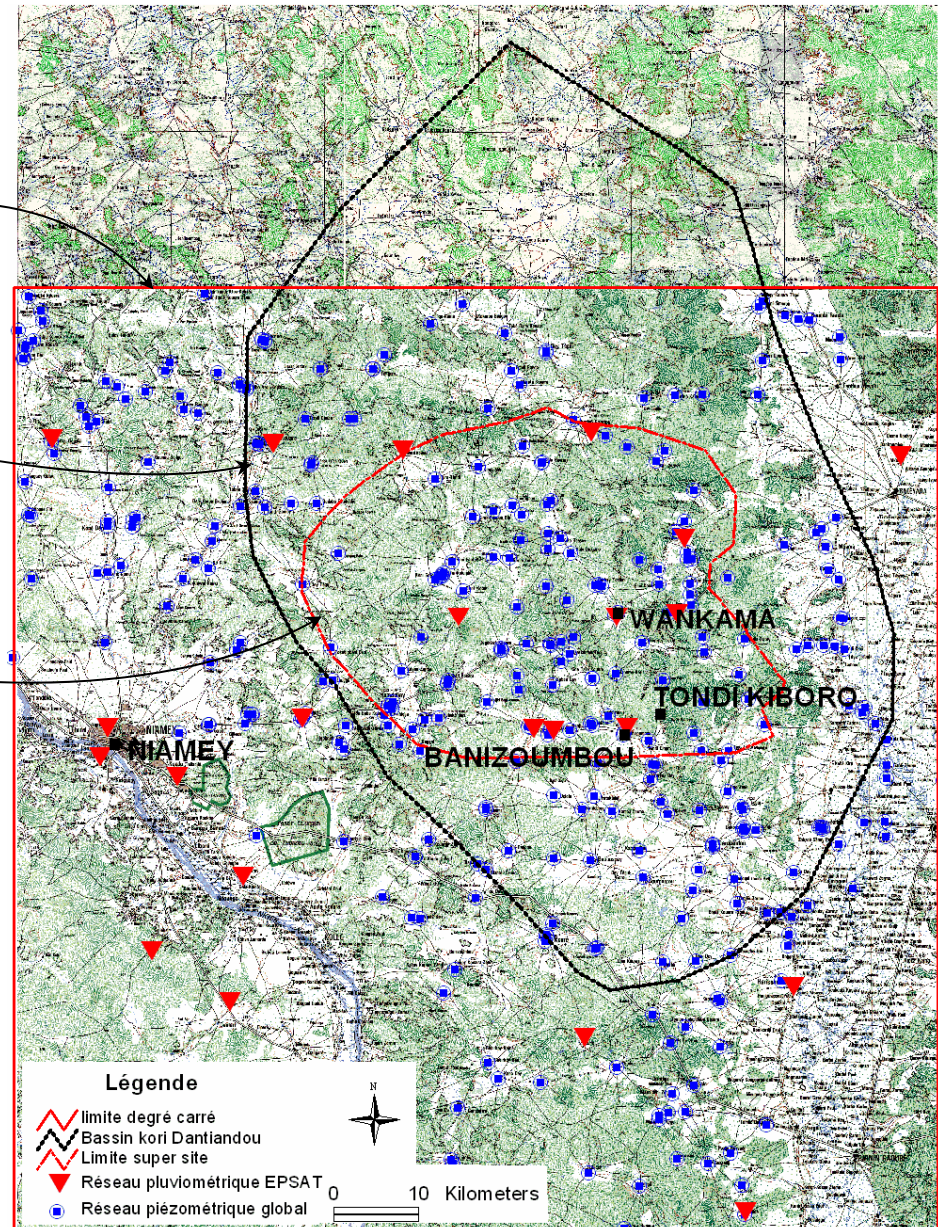
(*Kori de Dantiandou*)

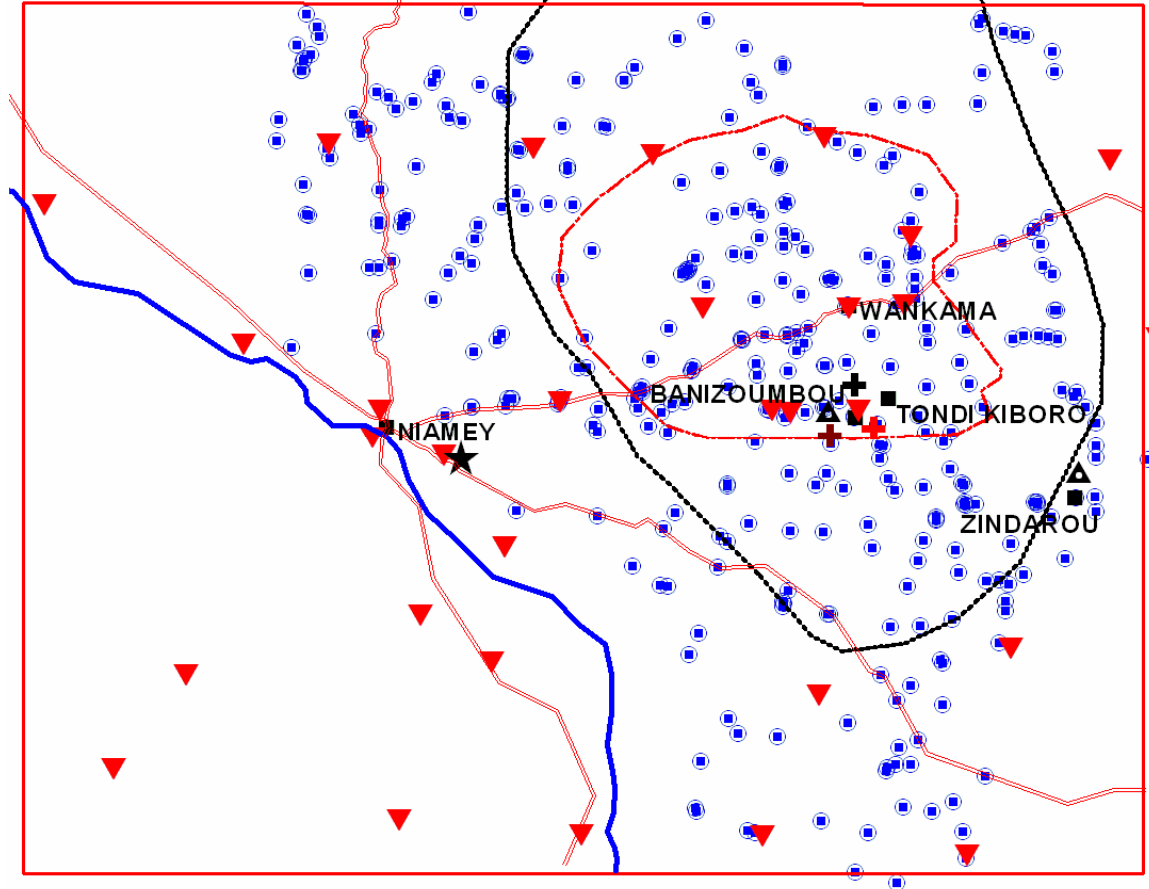
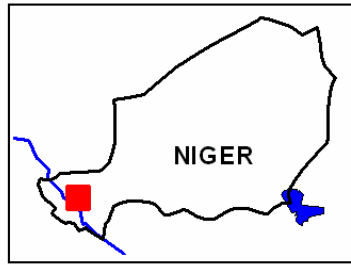
1 super site

2 intensive local sites

- Wankama

- Tondi Kiboro





Légende

- Réseau routier
- Fleuve Niger
- Limite EPSAT
- Site Malaria/hydrologie
- Réseau pluviométrique EPSAT
- Bassin kori Dantiandou
- Limite super site
- Réseau piézométrique global

- Station**
- Aérosols IDAF
 - Aérosols AER ONET
 - Mesure Aérosols & Erosion éolienne
 - GPS



Echelle
0 10 Kilometers



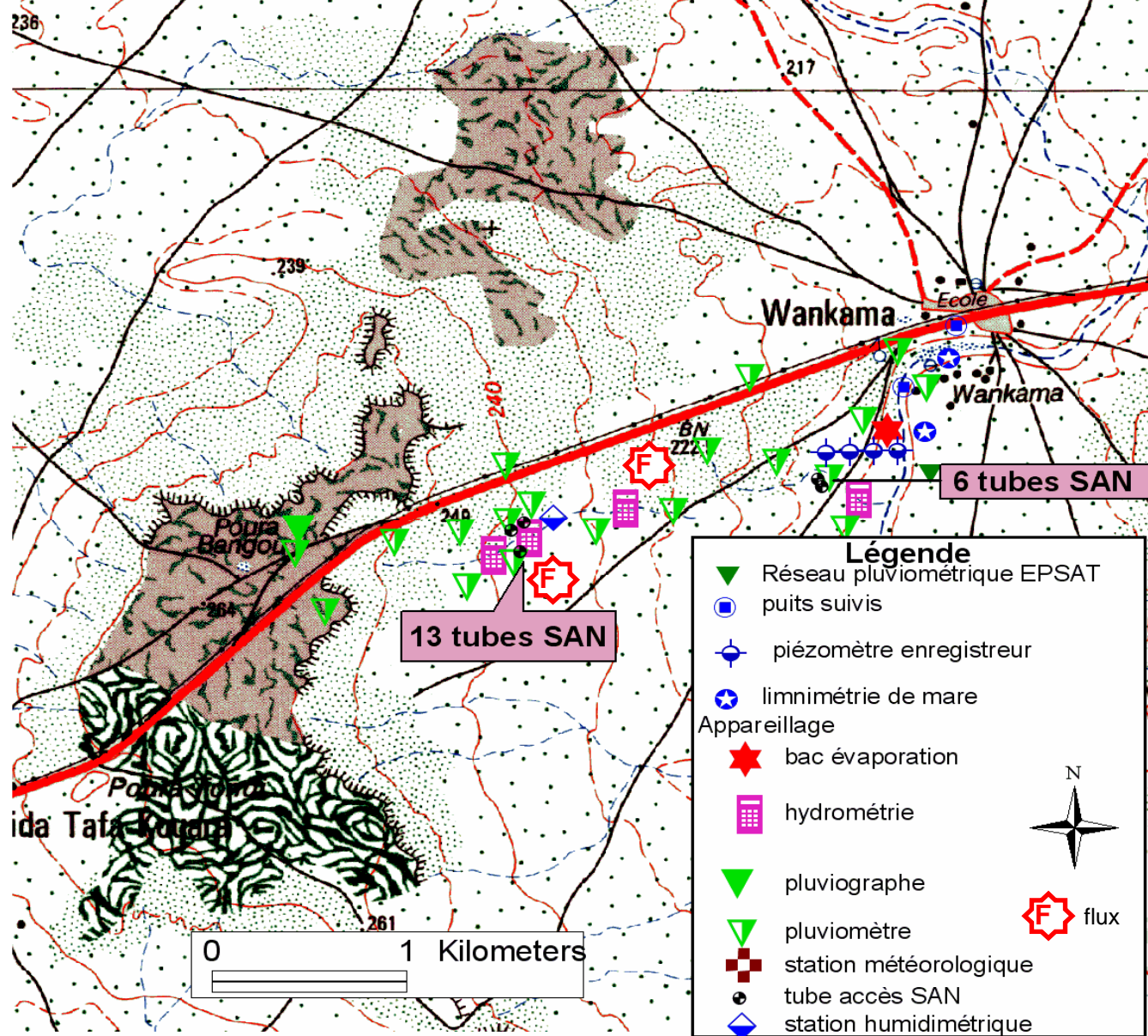
At the local scale,

2 intensive sites - elementary endoreic units - were selected to study basic processes such as infiltration and evapotranspiration, based on dense instrumentation.

These 2 sites are representing the various typical situations in the super-site landscape.

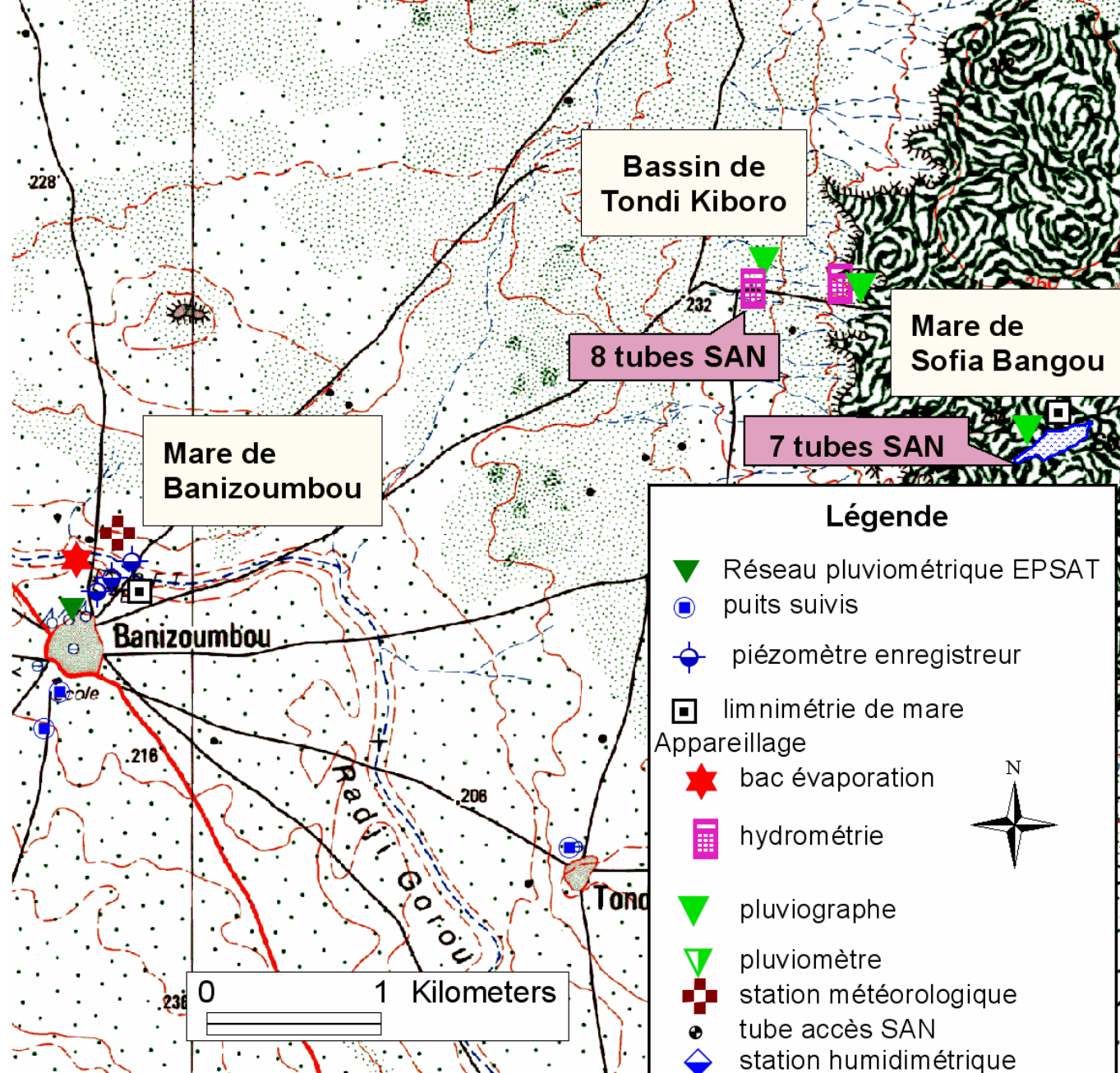
The main aims are to validate at this elementary scale a coupled vegetation/hydrology model and to describe the processes of changes in water and sediment budget due to land use evolution, at the plot and at the small basin scales.





Wankama experimental catchment





Tondi Kiboro catchment



,2-3 Overall strategy for vegetation monitoring

Vegetation monitoring on Niamey square degree is four fold:

1- Vegetation will be assessed in the experimental sites (Wankama, Tondi Kiboro):
current situation mapping, historical inventory : aerial pictures, IGNN and Corona, satellite files, "Pixy" inventories (Pixy is a small flying device conceived by IRD)

2- At Wankama basin site, a specific study of vegetation is carried out. The parameters for the Treegrass model are measured in fallow and millet plots.



3- a study on millet phenology and productivity on 11 villages is performed: 100 plots per village, sociological and agronomical surveys

4- the link between the inverse phenology of *Faidherbia albida* and the behaviour of watertable is investigated over the last past decades

Besides, the TT4 can use the experience of:

- ICRISAT and its large GIS of the Fakara
- ROSELT network and its monitoring of fenced plots



As a conclusion, two points can be underlined:

- The importance of partnership
- The persistence of a severe scientific and technical understaffing in TT4



Partnership

The main partners of TT4 are:

- *LTHE*
- *HSM*
- *UAM*
- *ICRISAT*
- *AGRHYMET*
- *CIRAD*
- *ENS Biologie*
- *CETP*
- *INRAN*



List of existing programs:

- Adamou Ousmane Manga (Physician UAM) : atmospherical optic / dusts characterization / remote sensing with MSG (infra red radiometer, visibility...)
- Moustapha Amadou (Agrometeorologist at INRAN): influence of vegetation development on aerodynamical roughness ; determination of aquifer recharge areas by neutron probe measurements ;
- Zibo Garba (Geologist UAM) : source of land-originated aerosols and deposit monitoring in Mainé Soroa area– comparison with Niamey area.
- Ibrah Sanda (physician – UAM) : Influence of dust on precipitations (statistical correlations, modelling with Reg CM3 / CHIMERE).
- Ibrahim Bouzou Moussa (dept of Geography, UAM) and Moustapha Adamou (dept of Agronomy, UAM): characterization and process study (erosion, runoff and infiltration) on the “bas fonds” areas (valleys bottoms);



- Abdou Guéro and Hassan Adamou (DRE: water resources dept of Niger): geophysical study of the Sama Dey pond area
- Bruno Gérard (ICRISAT): determination of the contribution of runoff from the plateaux on the degradation of landscape; spatial variability of rainfall;
- Jean Bernard Duchemin (CERMES): (AMMA application project): malaria and hydrology: a case study in 15 villages of the Fakara area.
- Seydou Traore (AGRHYMET). 11 villages identified over the 1°x1° square for the monitoring of the determining factors of millet yield (agricultural practices, phenology, pests, yield components).



	2004	2005												2006												2007												2008	
	exist	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	contd.	
level recorders on ponds																																							
1 H2O flux station																																							
15 recording raingauge network																																							
Network of 6 recording streamgauges																																							
Level recorders, 12 drilled boreholes																																							
4 sites Watermark and TDR																																							
Soil water neutron probe																																							
Li COR LAI-2000 and Li COR 6400																																							
Banizombou TEOM site																																							
Campbell Met. Station																																							
30 recording raingauge network																																							
Level recorders in wells (aquifer)																																							
5 stations IDAF (4 avec aethalomètre)																																							
GPS Niamey																																							

