

***Some very preliminary comments about Volta's watershed
(Burkina Faso point of view)
and what could be the Ecological assessment at this scale
in the framework of our CP project...***

This is:

- an informal production***
- a schematic even caricatural presentation***
- only to give global information***
- and eventually suggest and promote communication...***

The Volta's watershed:

- upper parts in sahelian countries



- mainly in **Burkina Faso**

- lower part in soudanian areas



- namely in Ghana



A dilemn relative to the equitability in the exploitation of Volta's water resources:



- thousands of reservoirs in Burkina Faso

versus



- the giant Akosombo dam in Ghana

MOUHOUN & tributaries

size (km ²)	91 036
annual runoff (Mm ³)	2 646

**NAKAMBE,
NAZINON,
SISSILI,
OUALE,
PENDJARI & tributaries**

size (km ²)	81 932
annual runoff (Mm ³)	2 444

BURKINA FASO

Mainly GHANA

THE VOLTA WATERSHED

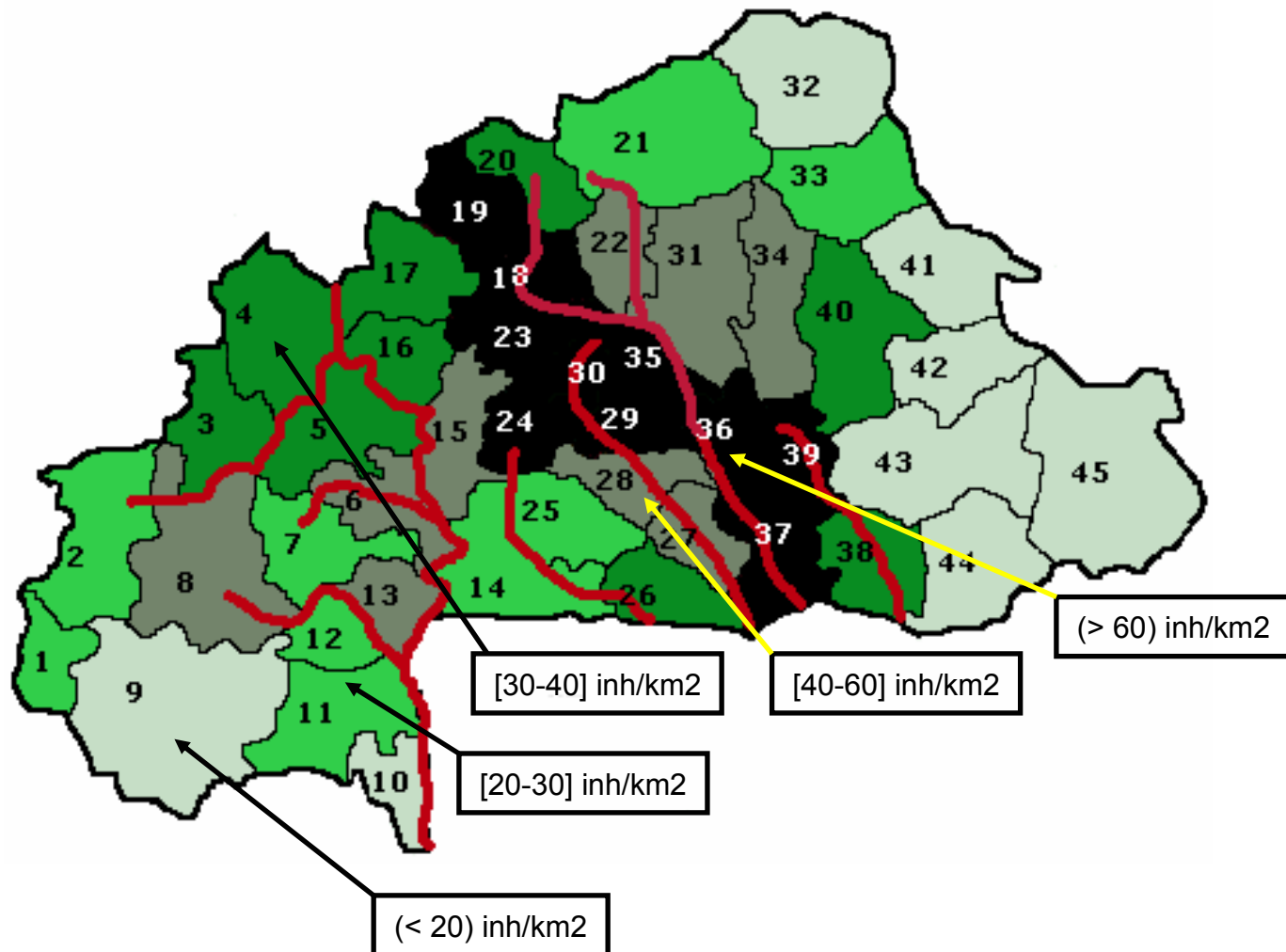
size (km ²)	172 968 in Burkina Faso
annual runoff (Mm ³)	5 090 flowing in Ghana

Watershed & Populations

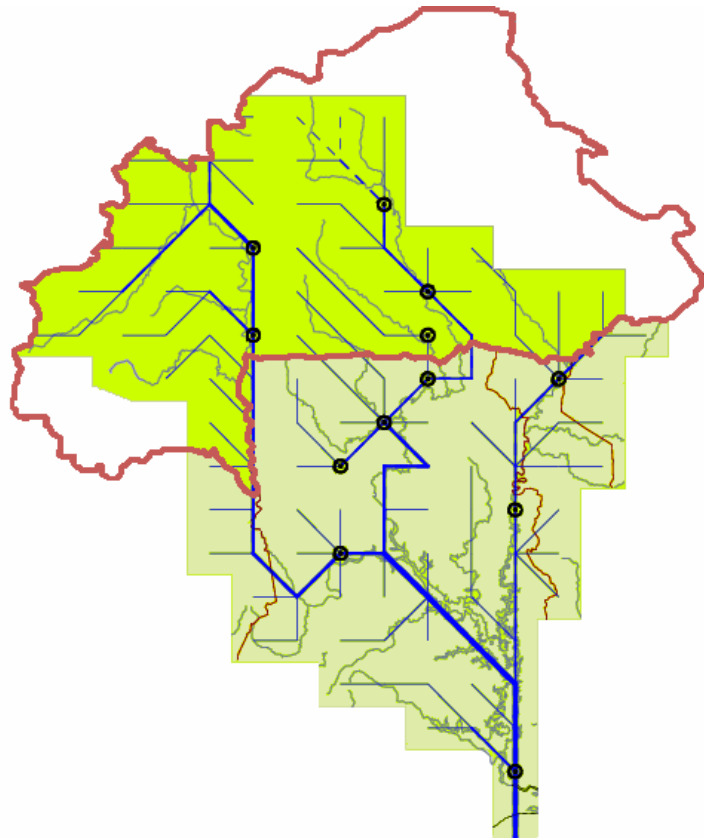
- The main tributaries of Volta in Burkina Faso concern very contrasted areas:
 - in terms of morphological, geological and climatic (etc.) properties,
 - but in terms also of landscape occupation and, particularly, of populations densities.

Schematic map of Burkina Faso:

- approximative position of Volta's and tributaries (red)
- administrative background (45 provinces/districts)
- with 5 classes of settlement densities (see legend)

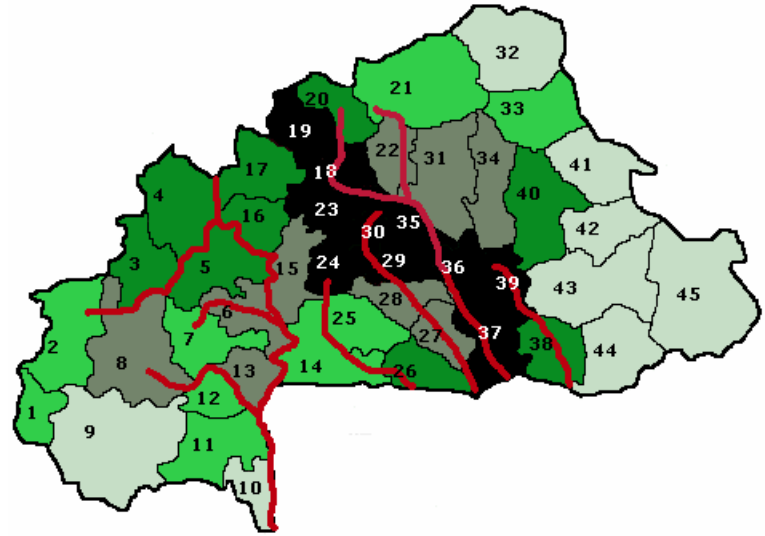


watershed



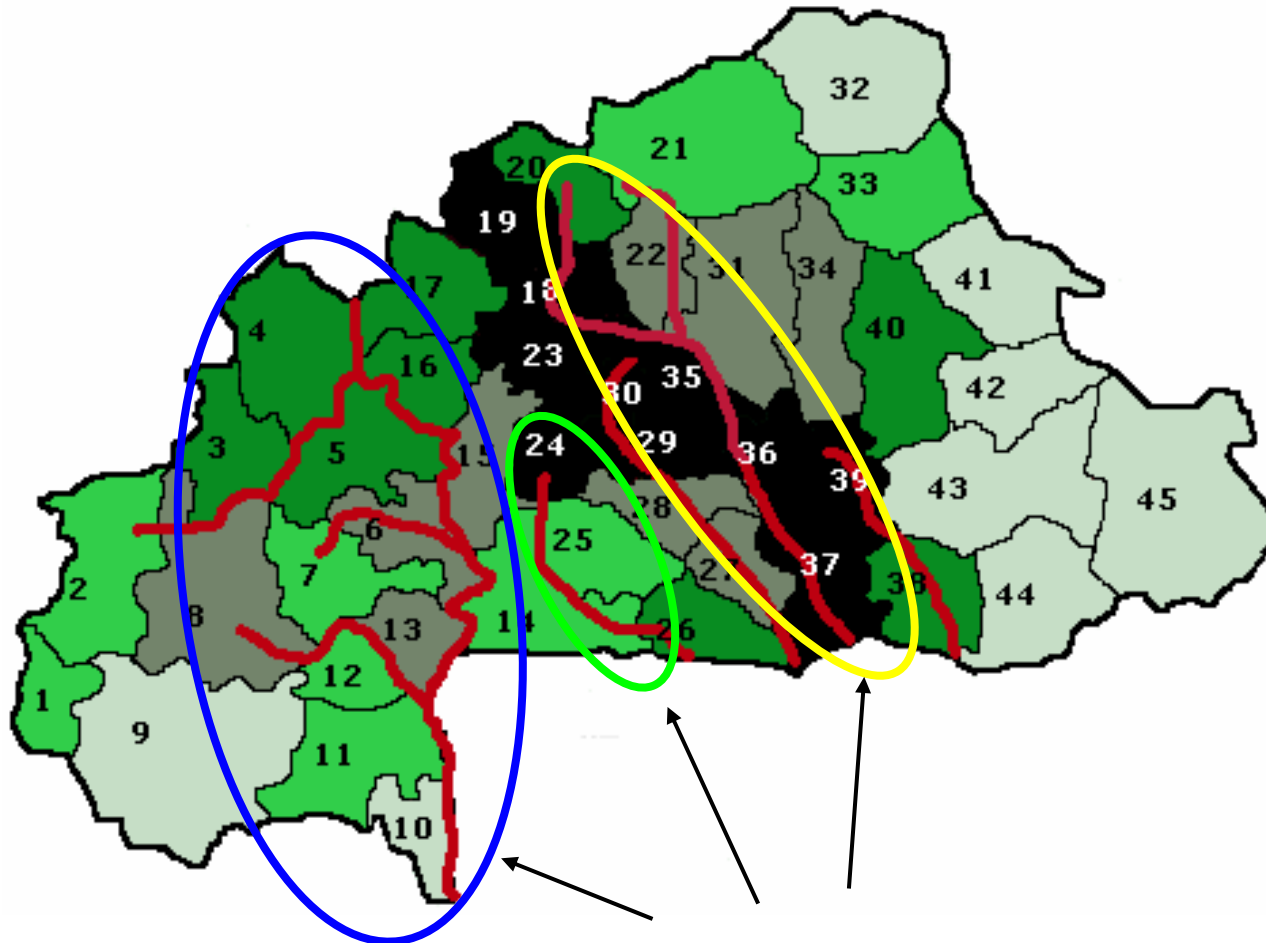
+

populations



Watershed & settlement: important disparities

- Nakambé (*yellow ellipse*): [40 – 335] inh/km²
- Mouhoun (*blue ellipse*): [<20 – 60] inh/km²
- Sissili (*green ellipse*): [40 – 60] inh/km²



(very) schematic disposition of main watersheds

Different kind of gradients at different scales...

1/ inter watersheds

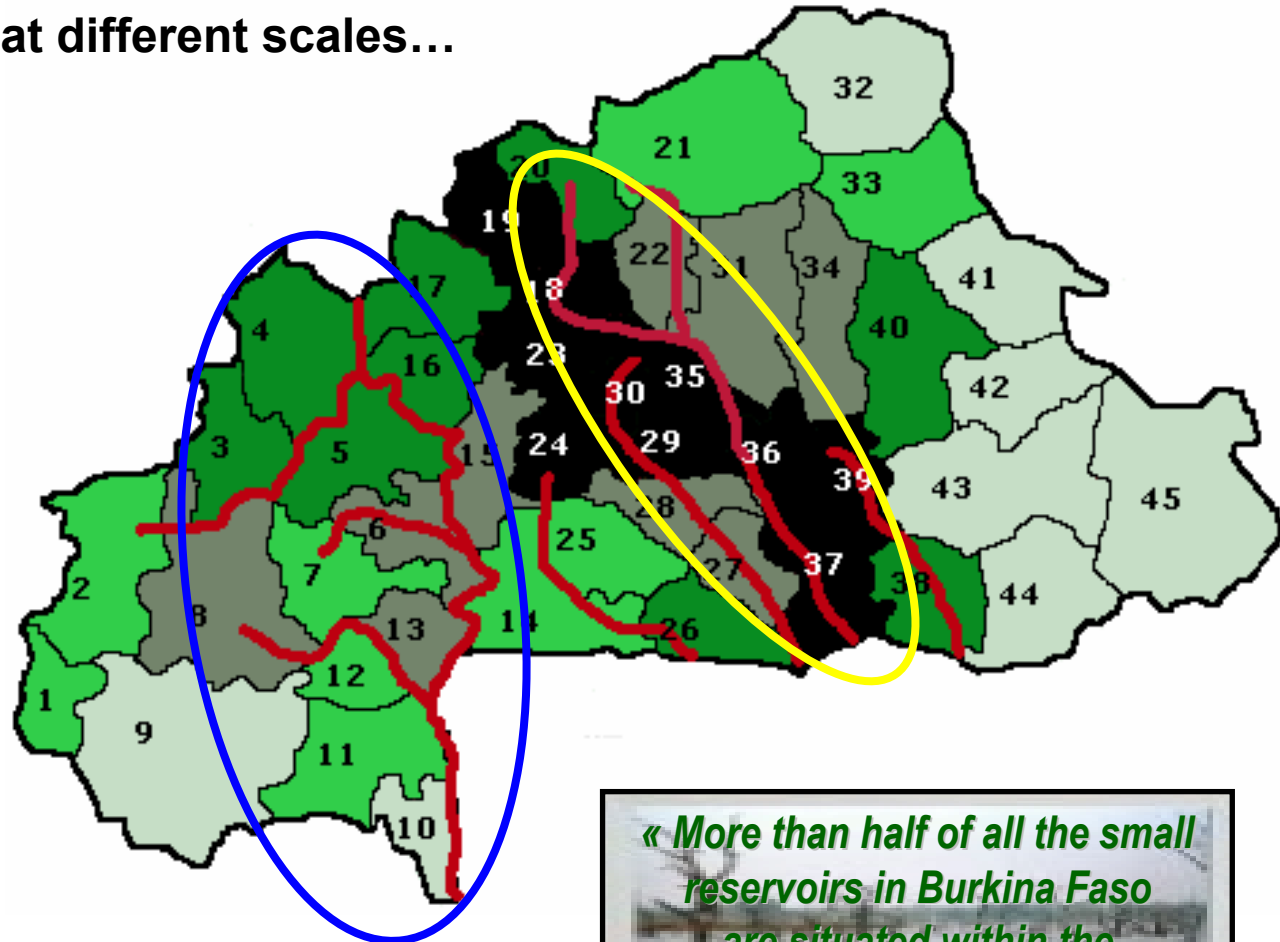
(eg. Nakambé versus Mouhoun)

- geology & soils
- population settlement
- landscape occupation
- anthropization *sensu largo*
- other

2/ intra watershed

(eg. Nakambé continuum alone)

- population settlement
(from urban to rural areas)
- geology & soils
- landscape occupation
(from urbanisation to intensive agricultural practices)
- climate
(from sahelian to soudanian conditions)
- position of reservoirs along the hydrographic continuum
(cascading : upstream vs downstream)
- size of reservoirs (small in North, large in south)
(cascading again, but from a size point of view)
- anthropization *sensu largo*
- other



« More than half of all the small reservoirs in Burkina Faso are situated within the Nakambé watershed »

Hypothesis:


1/ The density of reservoirs within a watershed is linked to the anthropic pressure exerted on this watershed (demographic as agricultural):

 *more anthropization; more reservoirs.*

2/ The demand for the creation of new reservoirs is dependant on the number (density) of the existing amagements within the watershed considered:

 *more and/or more.*

3/ The intensification (densification) of amangement has consequences (direct or not) on the ecosystems properties and capacities (quality, metabolism of reservoirs):

 *more is not free of consequences.*

Question:

Is there an optimal density of reservoirs (at a scale to be determined) that could optimize the utilization/exploitation of water resources, without compromising the quality, properties, capacities and services provided by aquatic ecosystems?

Method:

Phytoplankton dynamics and Harmful Algal Blooms (H.A.B.) occurrences will be used as **health indicators** of the **aquatic ecosystems** to answer the question: H.A.B are always linked to the deregulation of the ecosystem metabolism.

Ecological issue: H.A.B. as indicators of ecosystem's health

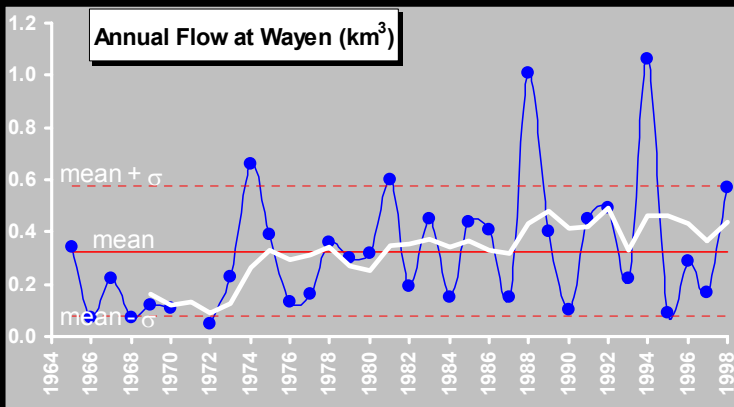
Keeping in mind the previously proposed hypothesis and the existing organization of reservoirs along the **hydrographic continuum**;



Main reservoirs along the Nakambé river
(total capacity : 1.9 km³)
(Source: DGIH, 2003)

&

Many Small reservoirs (not shown)



Remembering that the actual **hydrological tendency indicates an augmentation of liquid, solid & probably also dissolved transports with floods**

(either because of local and/or global climate changes, or because of landscape degradations whatever their origin: urbanization, intensification of crop or other cultures productions, erosion...);

Source:

Mahé et al., 2003 – Climatic & Anthropogenic Impacts on the flow regime of the Nakambé River in Burkina.

Ecological issue: H.A.B. as indicators of ecosystem's health

1/ The position (*upstream vs downstream; in reference of cascading of reservoirs*), the size (*mean and max depth, area*), the geographic localisation (*length and intensity of rain and flooding events, eg. climatic gradient on one hand ; soils and geology on another hand*), etc., may constitute fundamental and relevant data in the determinism of key properties of Aquatic Ecosystems;

Magnuson JJ & Kratz TK, 2000. *Lakes in the landscape : approaches to regional limnology*. Verh. Internat. Verein. Limnol., 27: 74-87

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2/ However, their role in controlling the metabolism of ecosystems may be modulated by direct and indirect anthropogenic pressures, described/resumed either in terms of population densities, or in terms of recent land cover evolutions;

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3/ Light, nutrients, trophic food web and aquatic living communities structuration interact to control (eg. enhance, limit, prohibit) the (Harmful) Algal Blooms (H.A.B) events;

See <http://www.mpl.ird.fr/flag>

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5/ **Field and experimental studies** focused on the **phytoplankton dynamics** will be conducted on contrasted sites and at different scales (in situ long term surveys & spatial approaches, in vivo experimentations) to **characterize the metabolism of ecosystems and identify the causes and consequences of their eventual deregulation**.

THUS,

It could be possible, after an initial step of identification, localisation and synoptic characterization of all water masses (at an ultimate scale to be precised), to define clusters of reservoirs:

- within one or several sub-basin(s) (All Volta, Nakambé only) ?
- along different gradients (eg. geology, climate, etc.),
- situated in contrasted conditions along the hydrographic continuum (eg. cascading),
- distinguished by contrasted global characteristics (eg. size),
- and submitted to contrasted anthropogenic pressure (eg. populations densities),

IN THE AIM OF

- **RESEARCHING THE LINKS BETWEEN ANTHROPIZATION AND H.A.B.**
- **TESTING THE PREVIOUSLY PROPOSED HYPOTHESIS**

« Methodological perspective »

(proposition to be discussed locally with partners and during the workshop with YOU)

- **Inception phase: localization & characterization**
- **Selection of clusters:**
what is the method: identifying contrasted clusters (with elevated variance inter-clusters but in minimizing the intra-cluster variance)? Other method?
Nature & number of key factors used for clustering?
- **Data collection:** different spatial & temporal scales
(see next)
- **Exploitation: validation, valorization, etc.**
- **Integration of results within the global CP perspectives and tools.**

« Methodological perspective »

(proposition to be discussed locally with partners and during the workshop with YOU)

Ecosystem level

(eg. Water masses):



LONG TERM (1 year) surveys,
- **biweekly sampling** (algal biomass & composition, nutrients, light, etc.),
- **Instrumentation**: water column; hydro- & meteorology).
- 10 sites (5 year 1, 5 year 2);

Watershed level

(eg. Landscape:
actual & recent evolutions;
10 sites)



SEASONAL field sampling & experimentations:

- **Spatial heterogeneity**: variance inter & intra clusters → many sites within each cluster;
- algae & other primary producers (eg. macrophytes);
- structuration of trophic pelagic food web (zooplankton, fishes);
- **Ecology of algal bloom populations**:
 - experimental assessment of their fitness;
 - physiological adaptation;
 - toxicity expression for cyanobacteria.

- Population (agricultural practices, urbanization, pollutions in their diversity...);
- Inputs (flux) of liquid, solid and dissolved materials;
- Exploitation and usages of watermasses themselves.