

# *Quantifying Weather and Climate Impacts on Health in Developing Countries (QWeCI)*

## *Science Talk*

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13 partners from 9 countries

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### **Modeling the Hydrological dynamic of the ponds in Barkédji's zone**

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# Plan

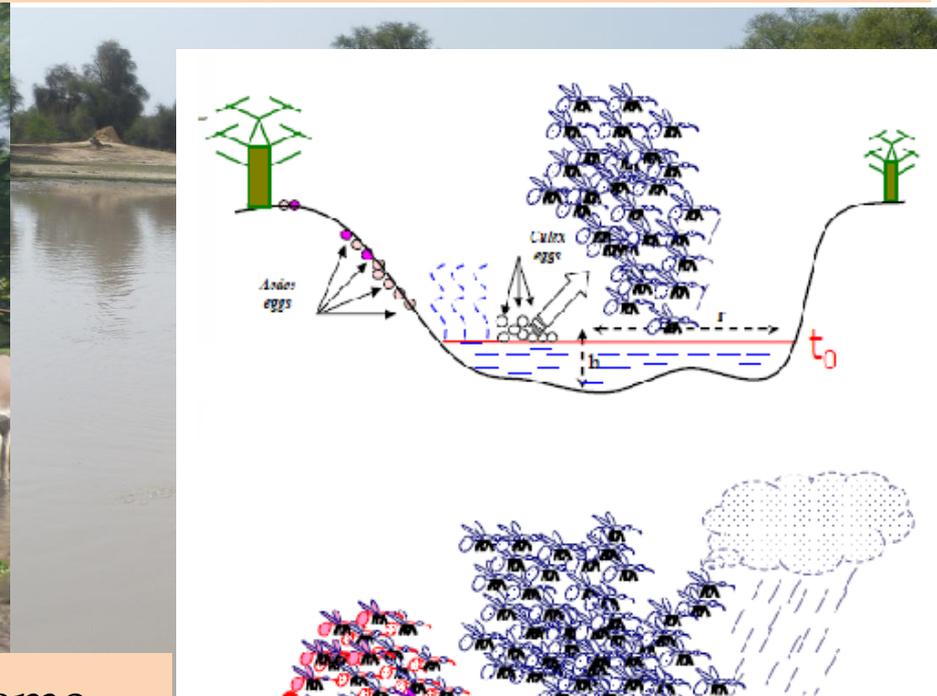
- **Introduction**
- **Problematic**
- **Study area**
- **Materials and methods**
- **Preliminary results**
- **Conclusion and prospects**

Hydrologic modeling is commonly used to simulate runoff and subsequent stream flow from watersheds. Stream flow estimations may be used for a variety of purposes:

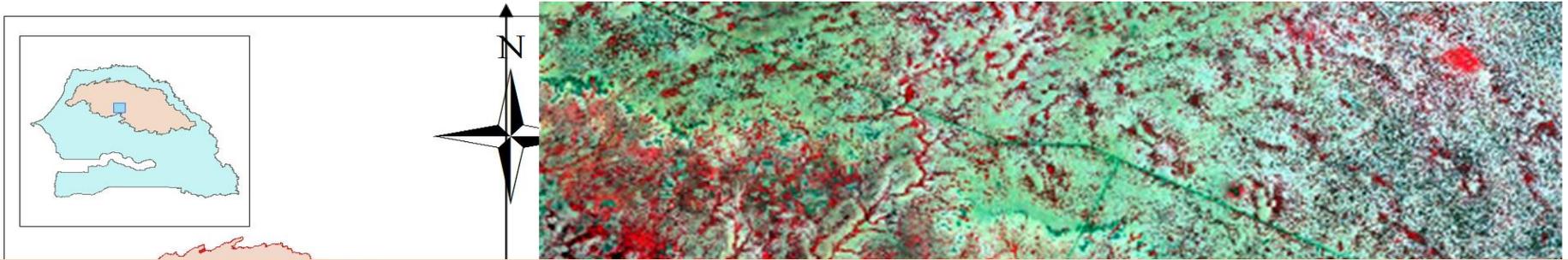
- ✓ such as design of hydraulic structures;
- ✓ prediction of flood stages;
- ✓ ecological restoration design;
- ✓ understanding the impact of water on the socio-economical life of the population

✓ In the Ferlo, the hydrographic is an endoreic system : characterized by an ensemble of ponds that are filled during the rainy season

That ponds are focal points where humans and livestock accede to water (Diop et al., 2004).

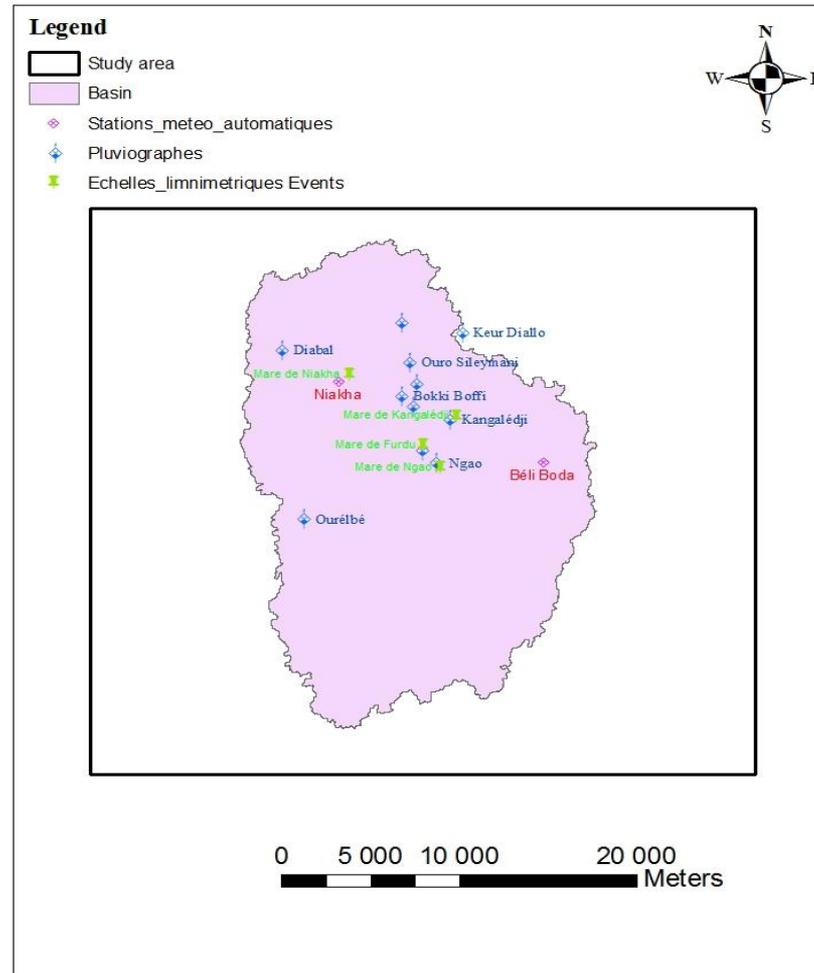


✓ However, the ponds are also at the same time favorable breeding sites for mosquitoes that transmit various arboviruses (Ex: Rift Valley Fever )



- ✓ Sahelian climate (rainfall average = 400-500 mm;  $T^{\circ}\text{C} = \sim 40^{\circ}\text{C}$  in may);
- ✓ 2 seasons: rainy ( $\sim 3-4$  months) and dry ( $\sim 8-9$  months); hydrographic system = endoreism (fossil Ferlo valley).
- ✓ The relief is characterized by low latitude (25m average)

### Equipments Tools and Hydro-climatical Data

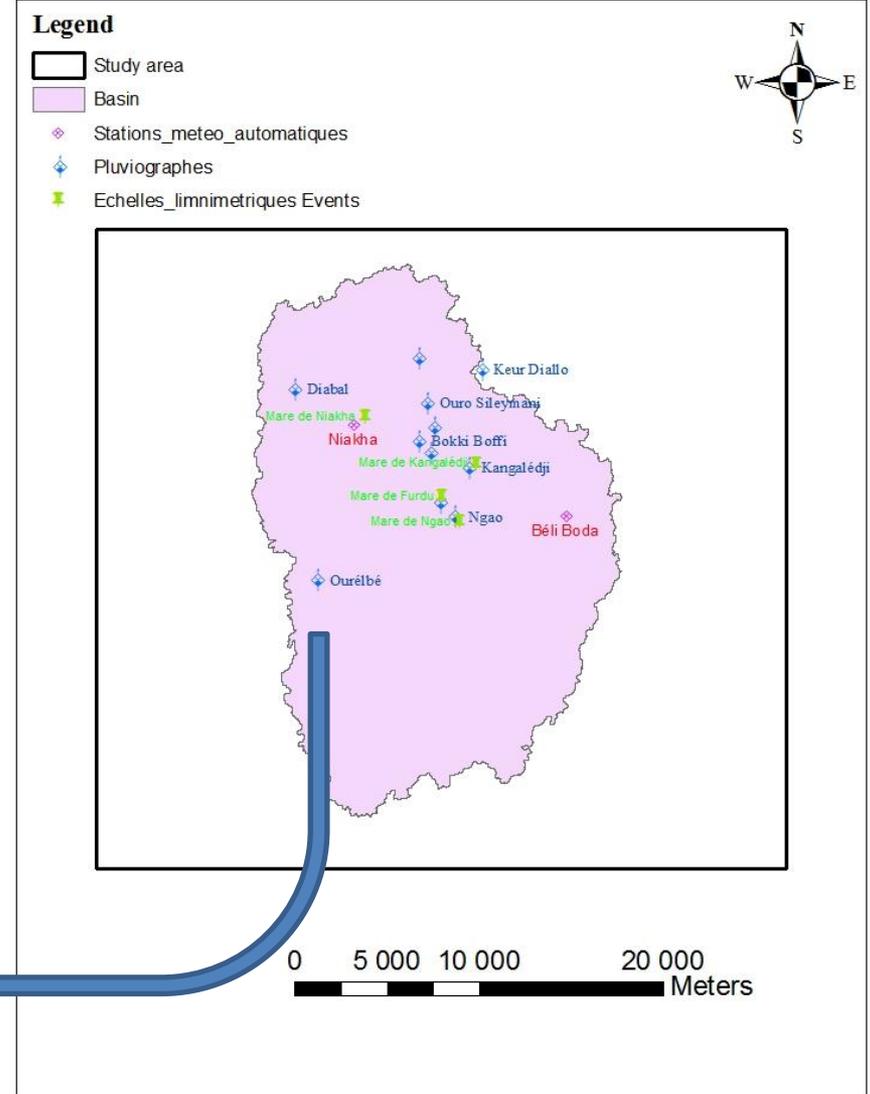


Map of the equipments tools of the observatory

Equipments Tools and **Hydro-climatical Data**



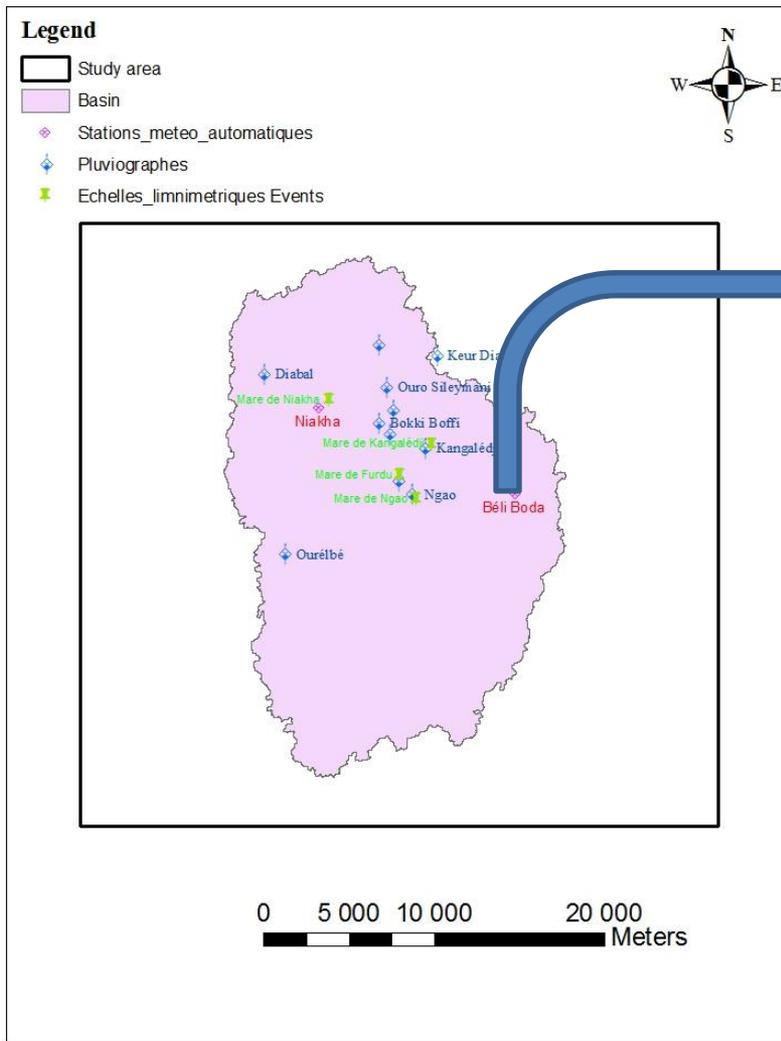
- ✓ **Measured data**
  - ✓ Rainfall
  - ✓ Temperature
- ✓ **Time step**
  - ✓ 5 mn
- ✓ **Memory capacity**
  - ✓ 72 days



Raingauge (10)

Map of the equipments tools of the observatory

Equipments Tools and **Hydro-climatical Data**



Map of the equipments tools of the observatory



Automatic weather station (02)

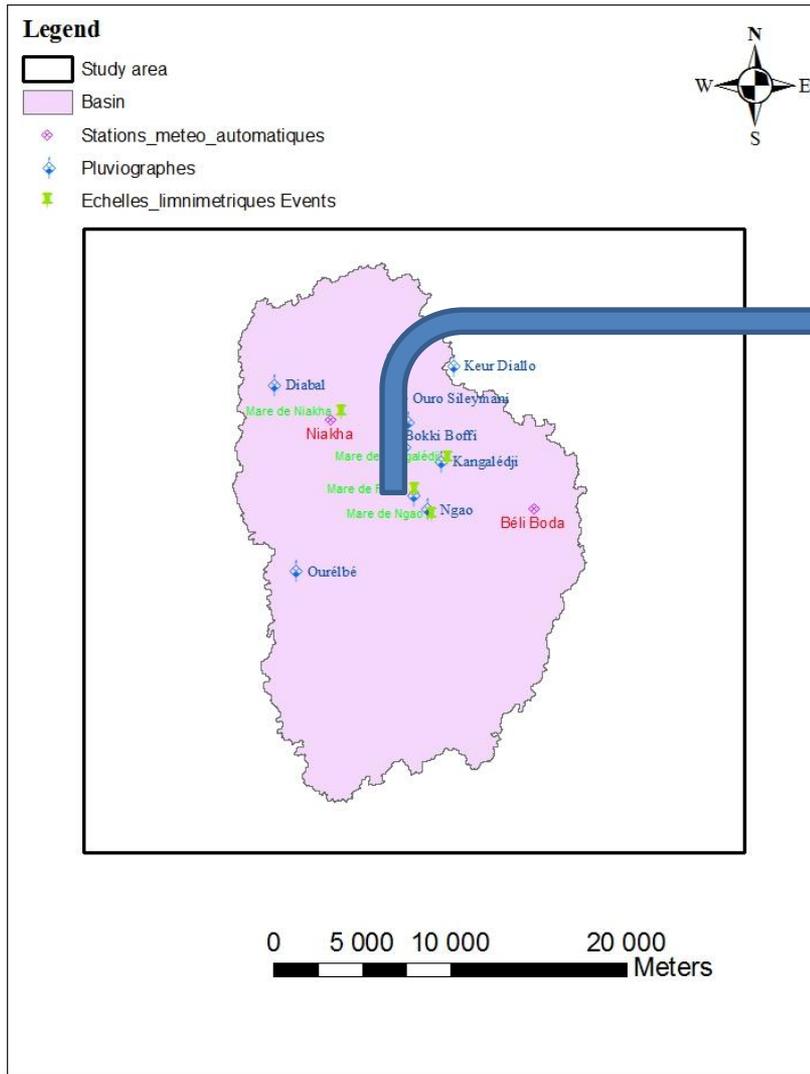
Measured data

- ✓ Rainfall
- ✓ Temperature
- ✓ Evaporation
- ✓ Humidity
- ✓ ETP
- ✓ Wind (direction and speed)
- ✓ Solar radiation

Time step

- ✓ 1 h

Introduction, Problematic, Study area, **Materials and Methods**, Results, Conclusion and Prospects  
 Equipments Tools and **Hydro-climatical Data**



- ✓ Measured data
- ✓ Water level
- ✓ Time step
- ✓ 1 day

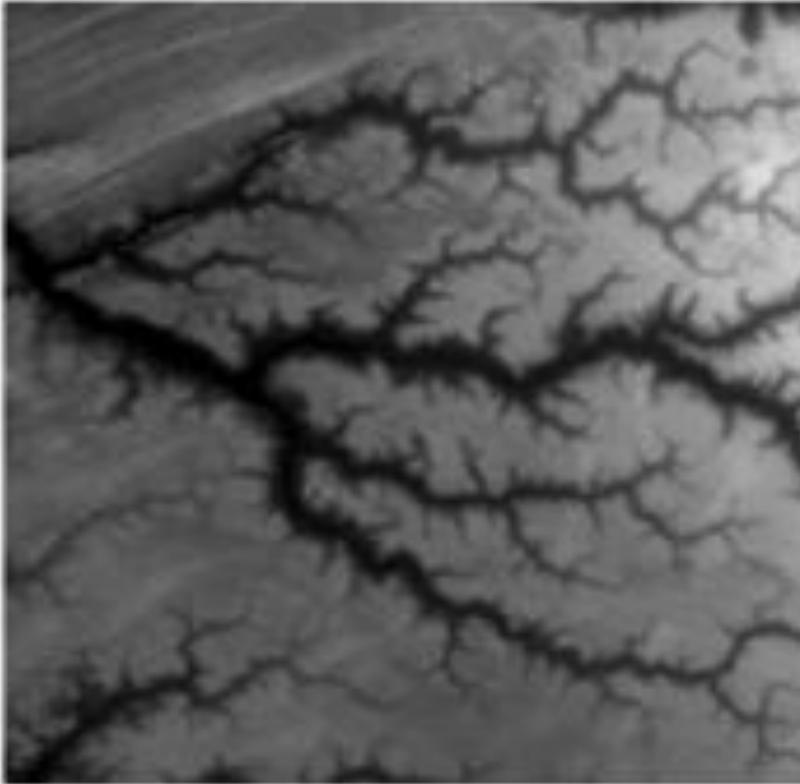


Map of the equipments tools of the observatory

Staff gauge (on every pond)

## Topographical and Remote sensing Data

- ✂ DEM (srtm 30 m of resolution)
- ✂ topographic data taken with a differential GPS in April 2008



□ Arc GIS (SWAT)

✓ Delineation of the sub-basins

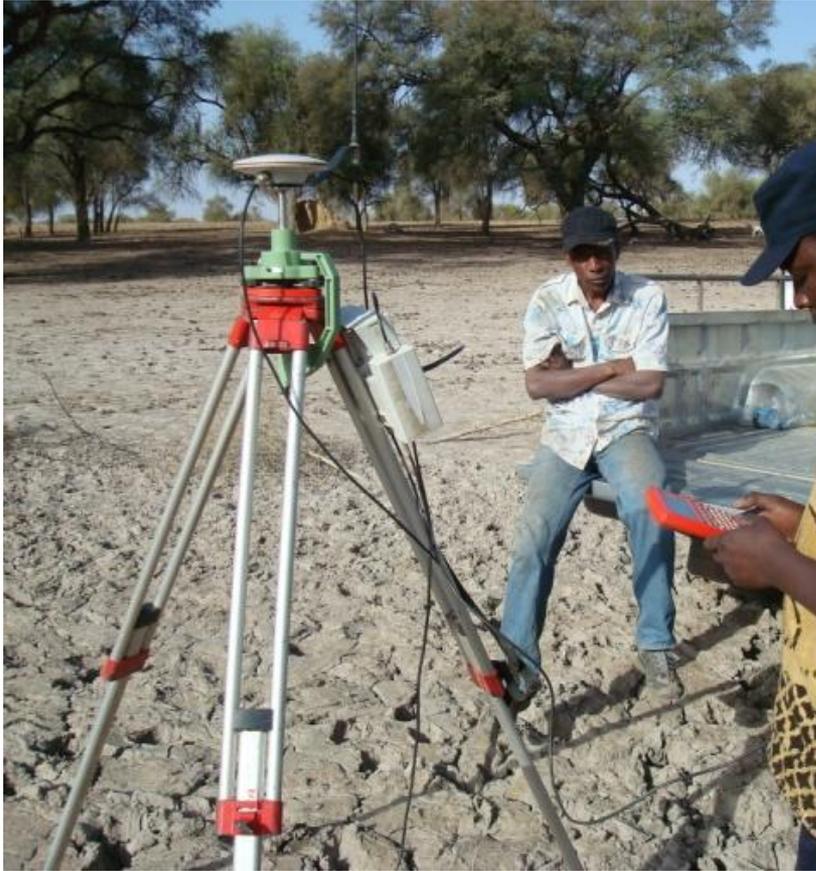
✓ Characterization of the Watersheds

DEM: SRTM ( 30m of resolution)

<https://wist.echo.nasa.gov/wist-bin/api/ims.cgi?mode=MAINSRCH&JS=1>

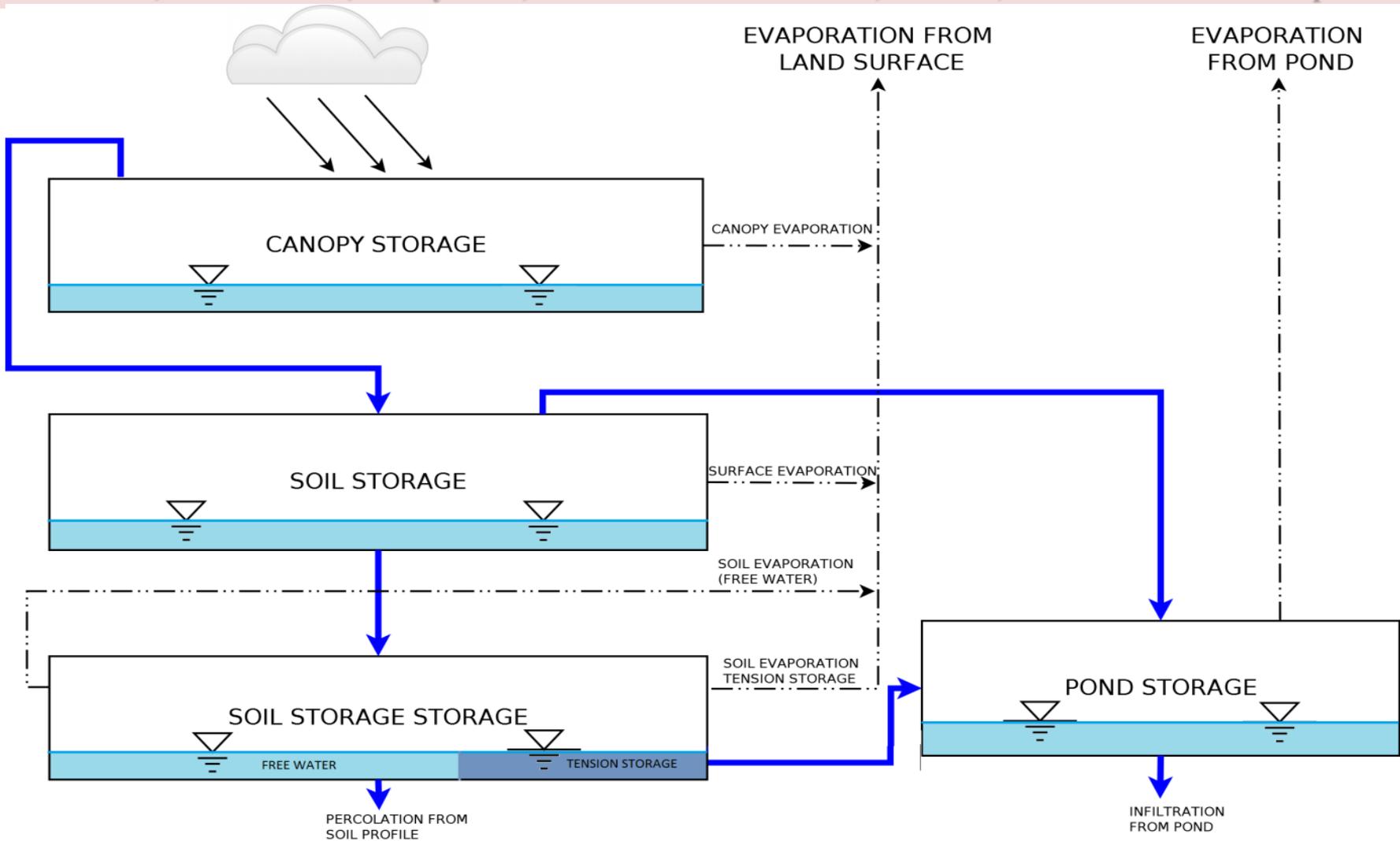
## **Topographical** and Remote sensing Data

- ✗ DEM (srtm 30 m of resolution)
- ✗ topographic data taken with a differential GPS in April 2008



Differential GPS

- Surfer
- ✓ Characterization of the Ponds
- ✓ Calculated the water area and volume for every Water level
- ✓ Plot the rating curve of the ponds



**Schematic Description of simple  
Simple lumped hydrological model**

**Characteristics of the Hydrological Model**

The model describes each pond's watershed as three interconnected reservoirs: canopy, surface storage and soil storage and uses linear relations to describe infiltration, percolation and baseflow (out of the soil reservoir).

Canopy

Characterized : **canopy**  
**stockage capacity**

$$V_{cj} = f(V_{cj-1}, P, ETP)$$

Surface

Characterized: **Surface Storage capacity (mm)**

**Soil storage capacity (mm) , Maximum Infiltration in the Soil (mm/h) , Maximum Percolation from the Soil (mm/h)**  
**Snowmelt threshold , Snowmelt coefficient**  
**Baseflow coefficient Pan coefficient , Soil revap and coeff Tension storage**

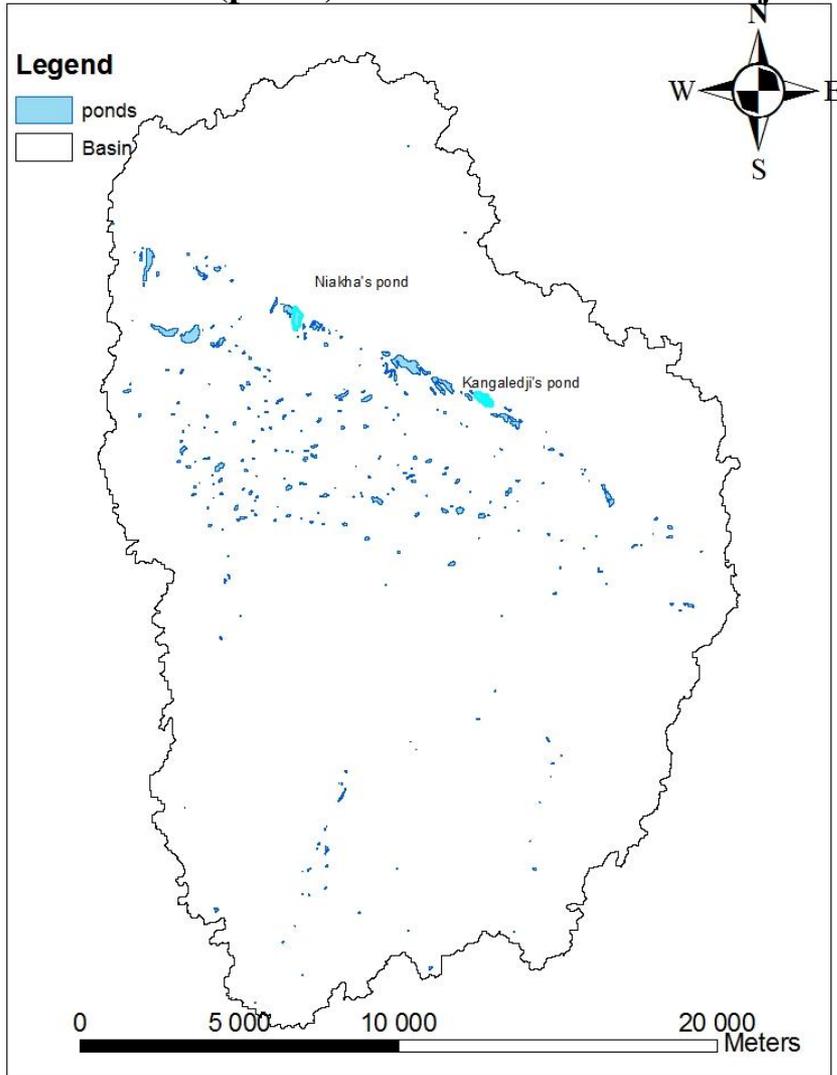
Pond

Characterized: **pond infiltration (mm/day/m), revaporation**

$$V_{pj} = f(V_{pj-1}, P_{eff}, I_p, E_{vp}, Q)$$

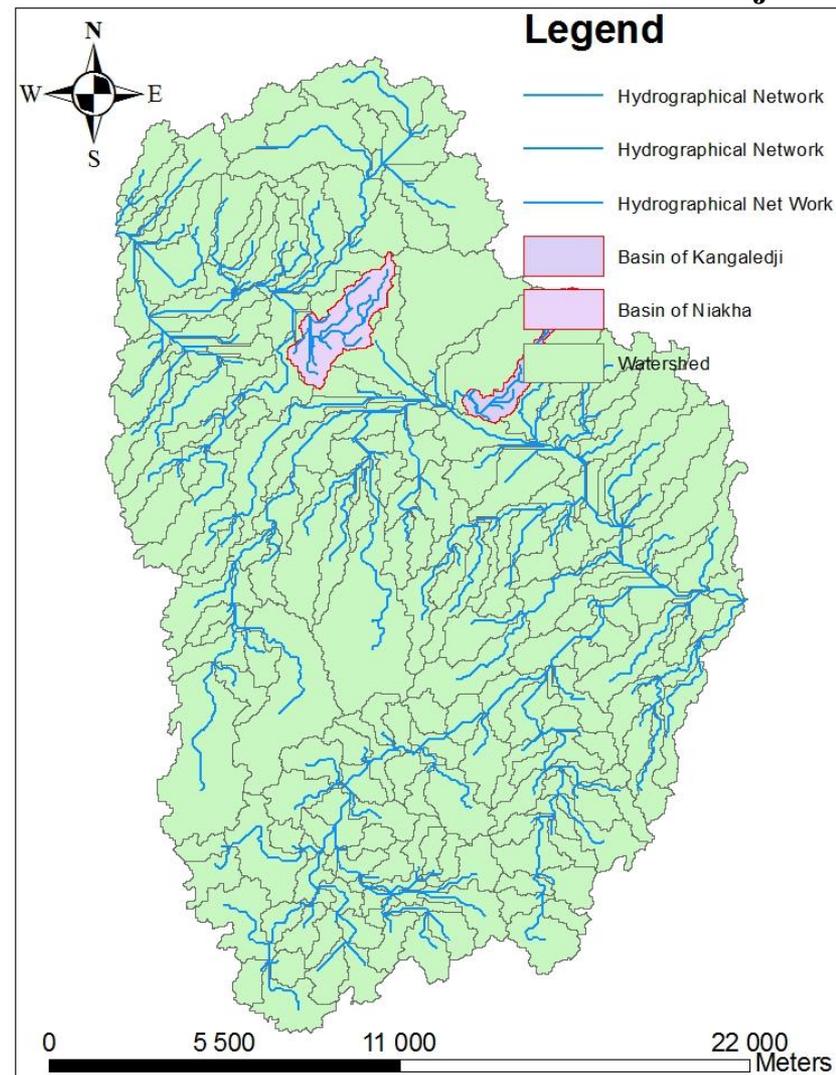
Q(runoff)  **Triangular unit hydrograph**

313 wet zones (ponds) are inventoried in Barkedji's basin

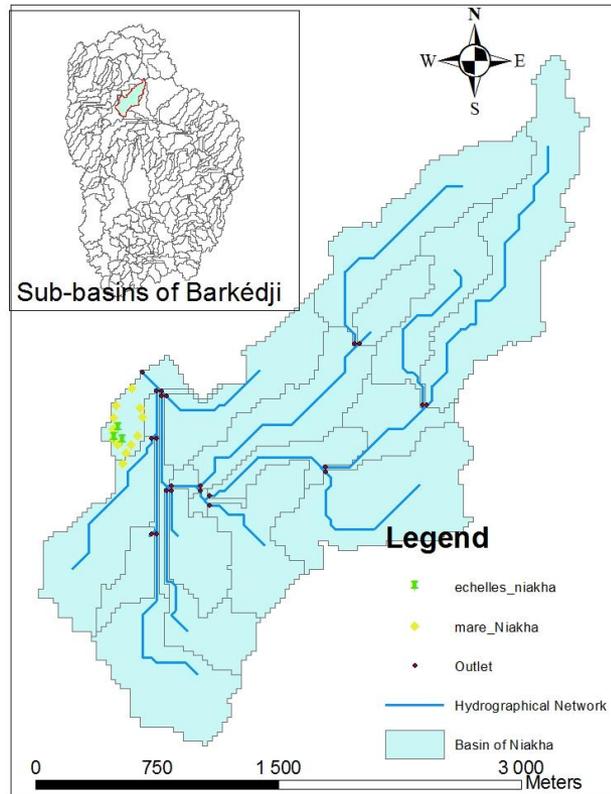


Map of the ponds in Bakédji's basin

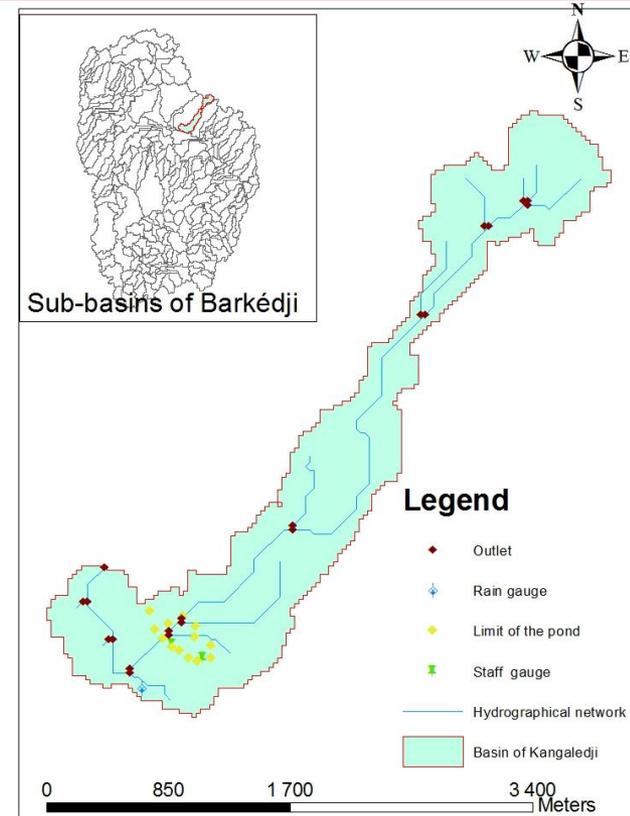
263 watersheds are delineated around Barkédji



Map of the sub-basins



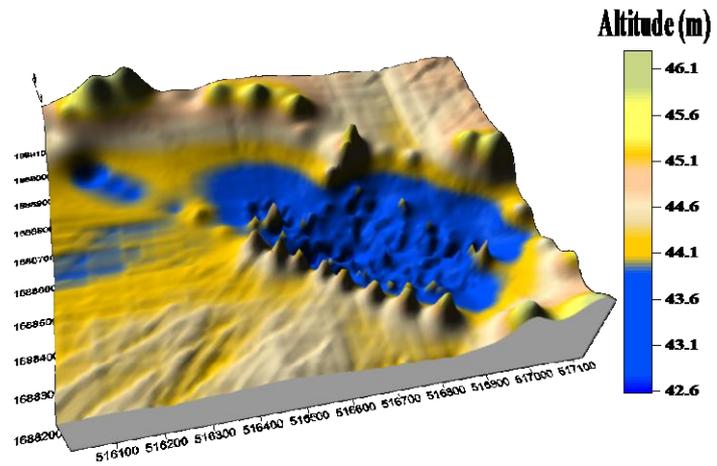
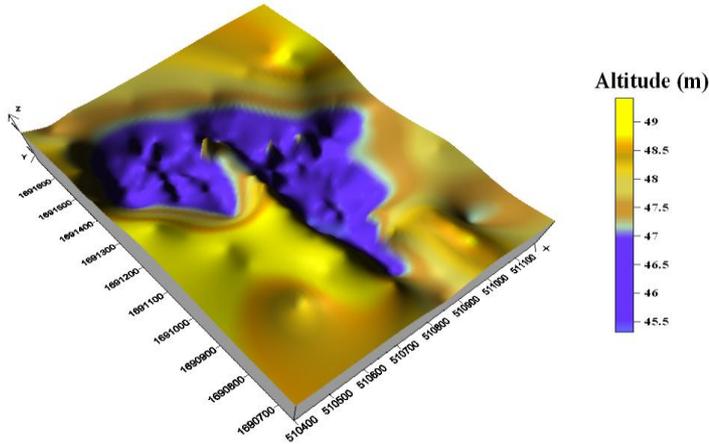
**Niakha's basin**  
Morphometrics parameters of the basins



**Kangelédji's basin**

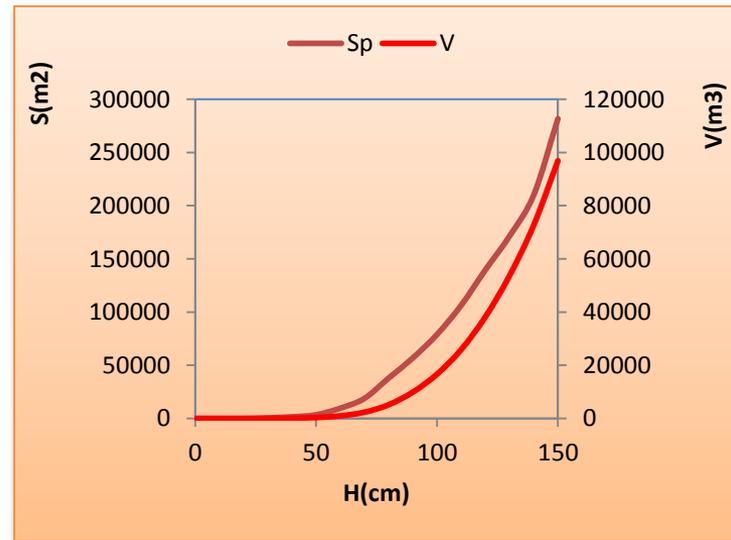
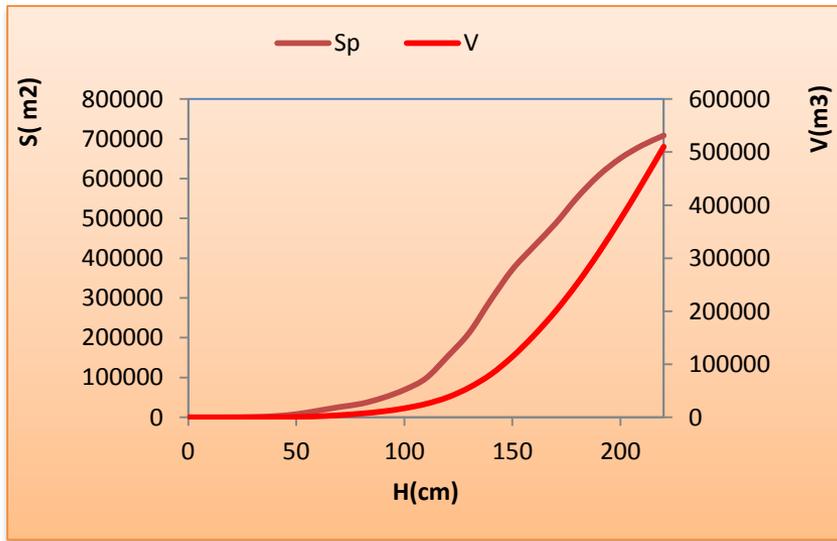
	A(km <sup>2</sup> )	P (km)	Z <sub>min</sub> (m)	Z <sub>moy</sub> (m)	Z <sub>max</sub> (m)	Slope	La (km)	I <sub>G</sub>
<b>Niakha</b>	<b>5.72</b>	<b>16.98</b>	<b>13</b>	<b>21.84</b>	<b>48</b>	<b>1.72</b>	<b>5.36</b>	<b>1.98</b>
<b>Kangelédji</b>	<b>3.56</b>	<b>18.9</b>	<b>13</b>	<b>31.17</b>	<b>54</b>	<b>1.64</b>	<b>6.94</b>	<b>2.8</b>

Characterization of the ponds



3D-dimensions of Niakha's pond

3D-dimensions of Kangelédji's pond



Rating curve of the pond of Nikaha

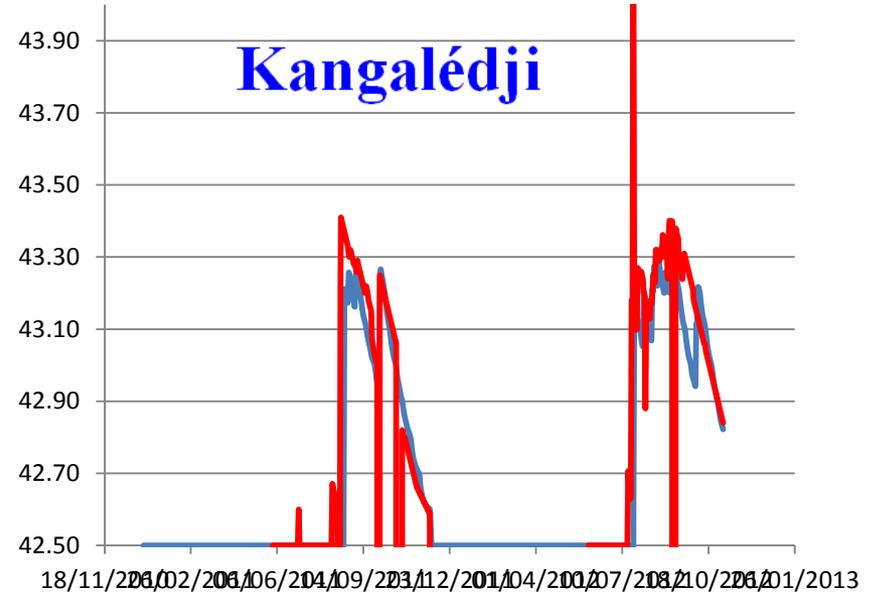
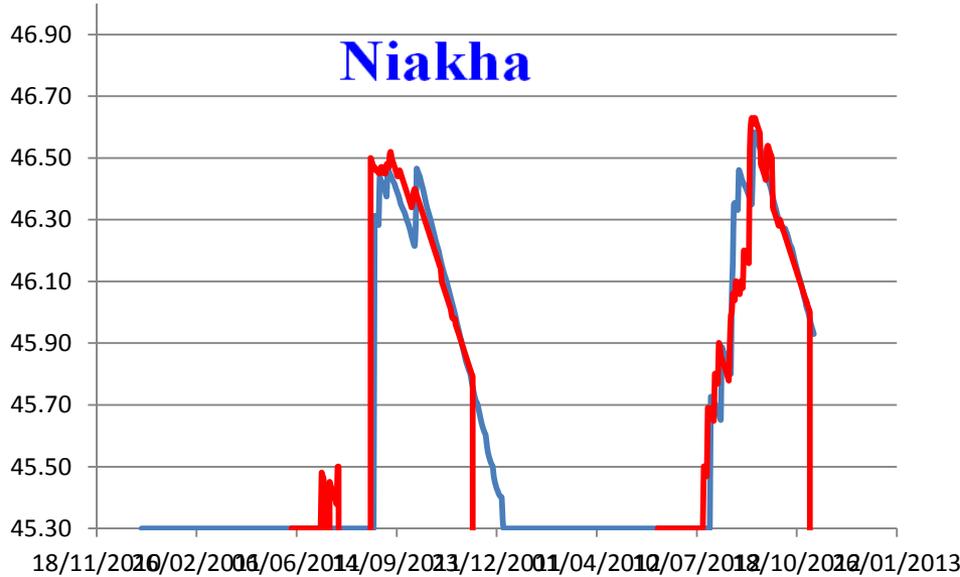
Rating curve of the pond of Kangelédji

— SIMULATED LEVELS (m) — OBSERVED LEVELS (m)

— SIMULATED LEVELS (m) — OBSERVED LEVELS (m)

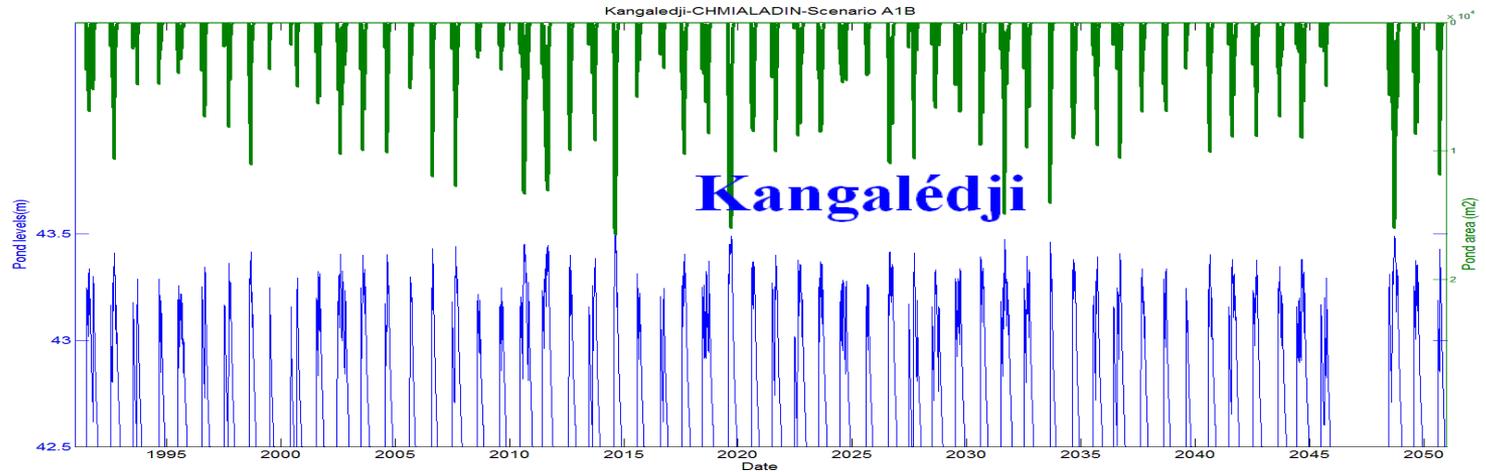
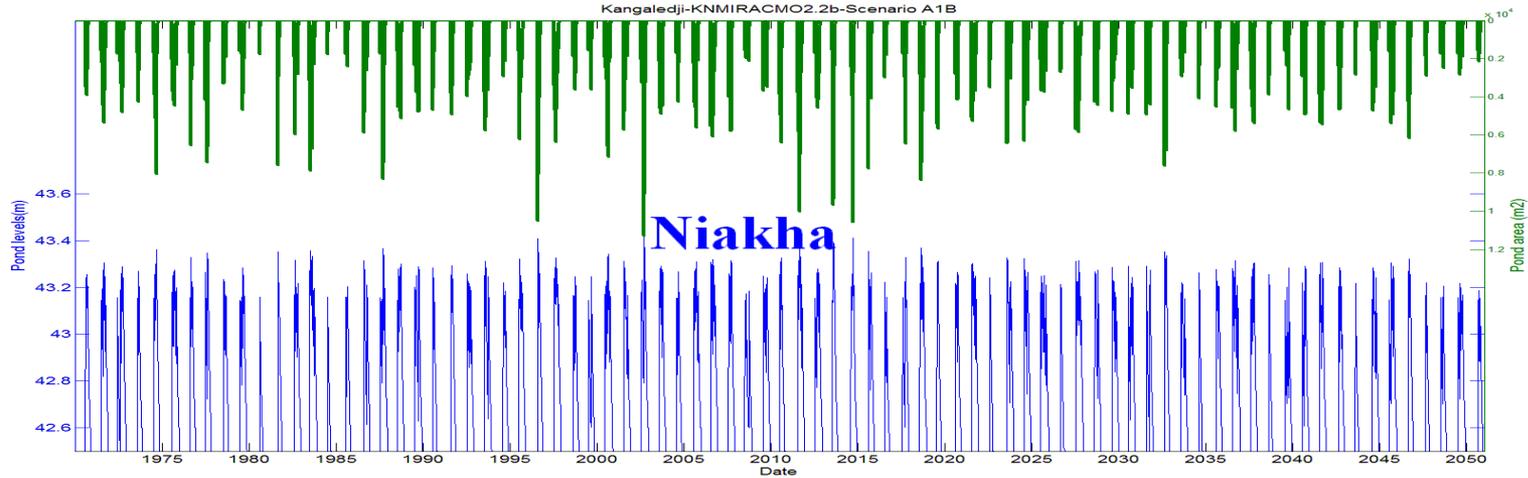
### Niakha

### Kangalédji

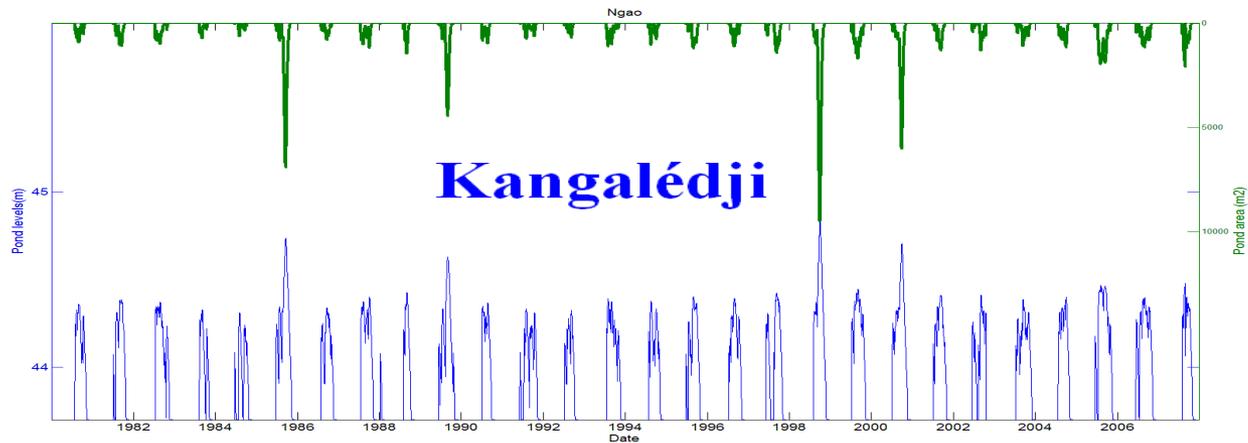
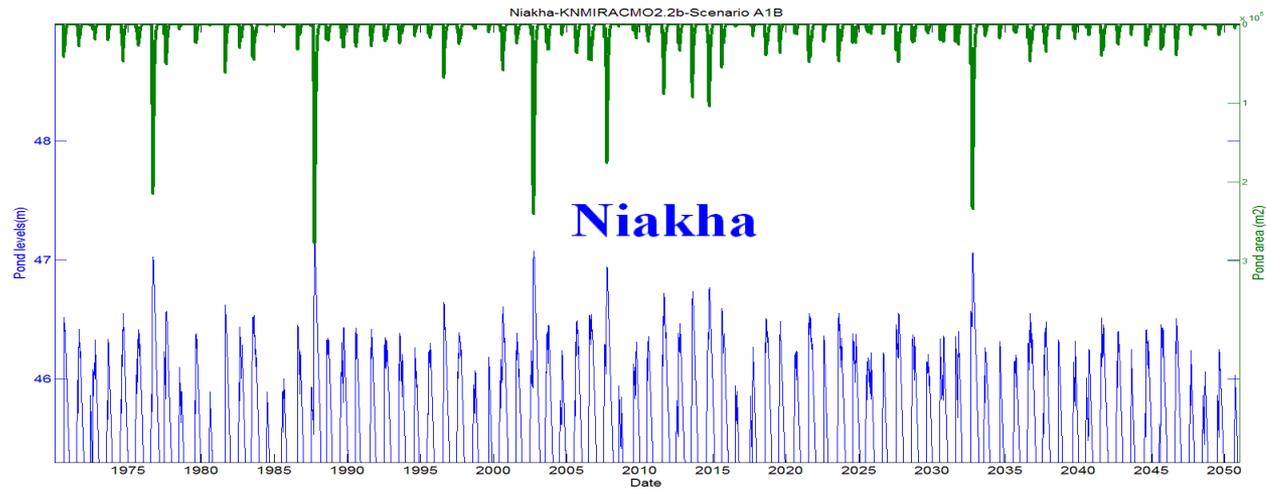


## Simulated and observed level of the ponds

**Calibration was done using two years observations (2011 and 2012)**  
**No validation could be done due to the short duration of observation**



## Reconstituted level and area of the ponds



## Projected Pond level and area

- ✓ The calibration was successful and water level in the two ponds was simulated with a Root Mean Square Error (RMSE) of 4cm
- ✓ The model give some good results with the two ponds for only two years of calibration
- ✓ That model can be used to estimate the water resource in the zone and other to calculate the runoff
- ❖ The developed models will soon be used to generate historical time series of pond areas and correlate these to mosquitoes infestation in the region
- ❖ Future time series of pond areas will be generated as well in order to assess the evolution of the disease in the next 40 years.

# THANK YOU

