Groundwater recharge and trends : comparative analysis of sedimentary and basement aquifers in Benin

Results obtained thanks to GRIBA project

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PLAN

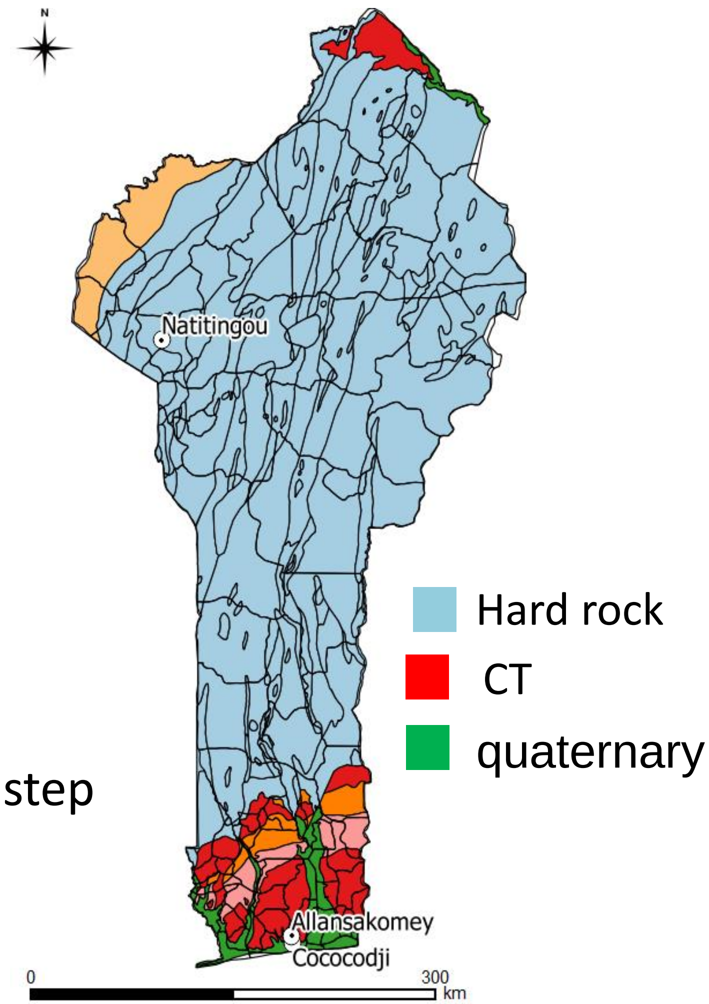
- INTRODUCTION
- METHODOLOGY
- RESULTS
- CONCLUSION AND OUTLOOKS

INTRODUCTION

- Groundwater in Benin
  - Main resource for domestic needs
  - 950 new boreholes/year (1996-2012)
  - Recharge poorly known
    - ✓ Quantification
    - ✓ Trend

INTRODUCTION

- Groundwater in Benin
- This study aims at:
  - Quantifying the recharge
    - ✓ Hard rocks (Precambrian)
    - ✓ Mio-pliocene (Continental Terminal)
    - ✓ Quaternary sediments
  - Analyzing the trend in recharge
    - ✓ Longer chronicles of SWL in Benin
    - ✓ Medium frequency measurement time step



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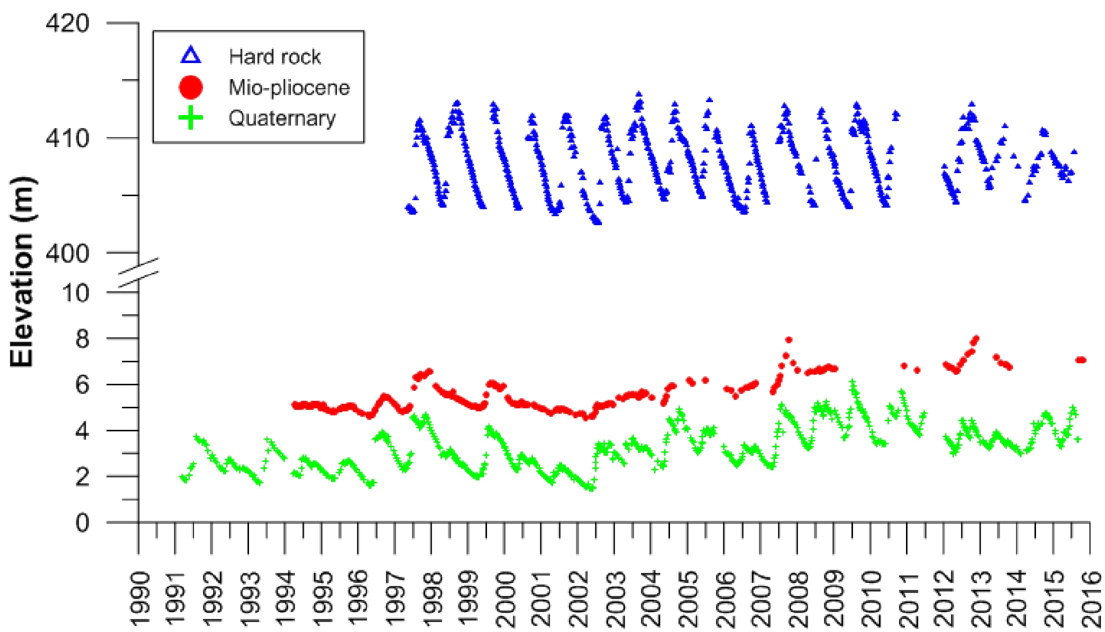
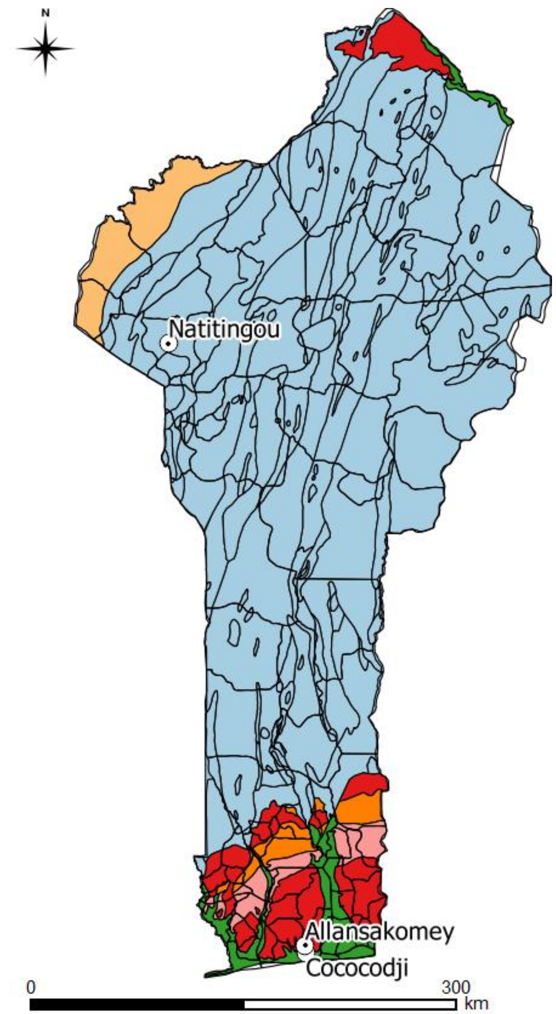
MATERIAL AND METHOD

- Material
  - 3 chronicles of 17-25 years
  - 10-days time step
  - Rainfall records (located at 0-14 km)





MATERIAL AND METHOD

- Material
- Method
  - Water Table Fluctuation Method

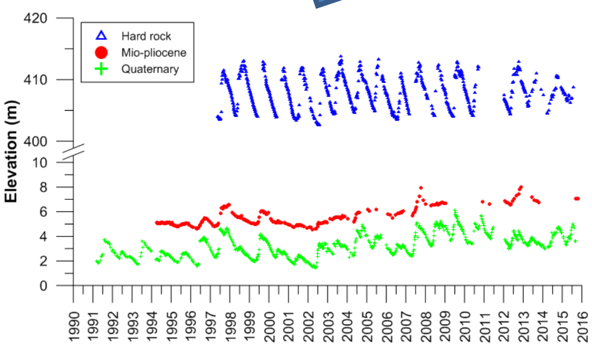
$$R_{\Delta t} = \left(\frac{\Delta_{H+}}{\Delta_t} + \frac{\Delta_{H-}}{\Delta_t}\right).S_y$$

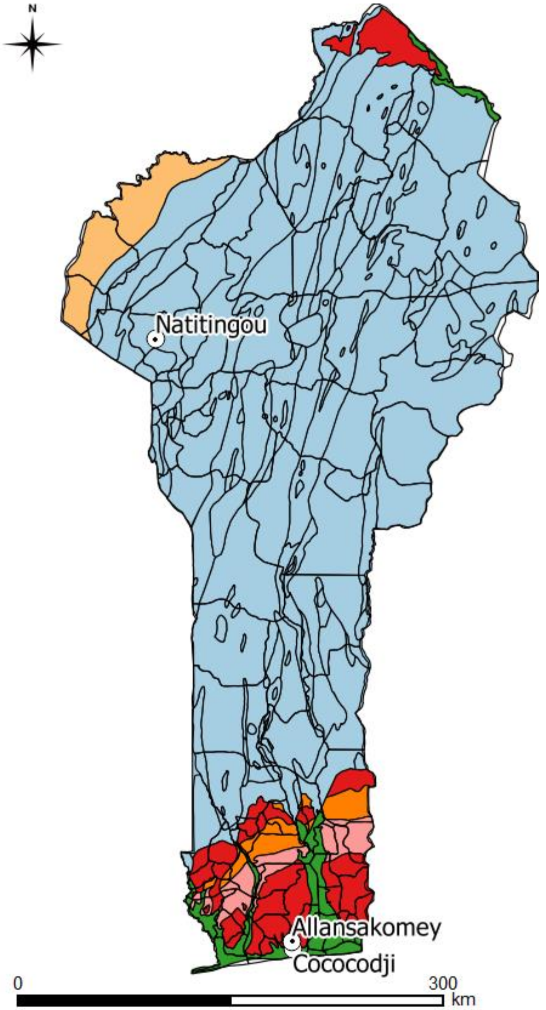
$R_{\Delta t}$ = Recharge during Δt

Δ_{H+} = Positive WL variation

Δ_{H-} = Groundwater outflow

S_y = Specific yield





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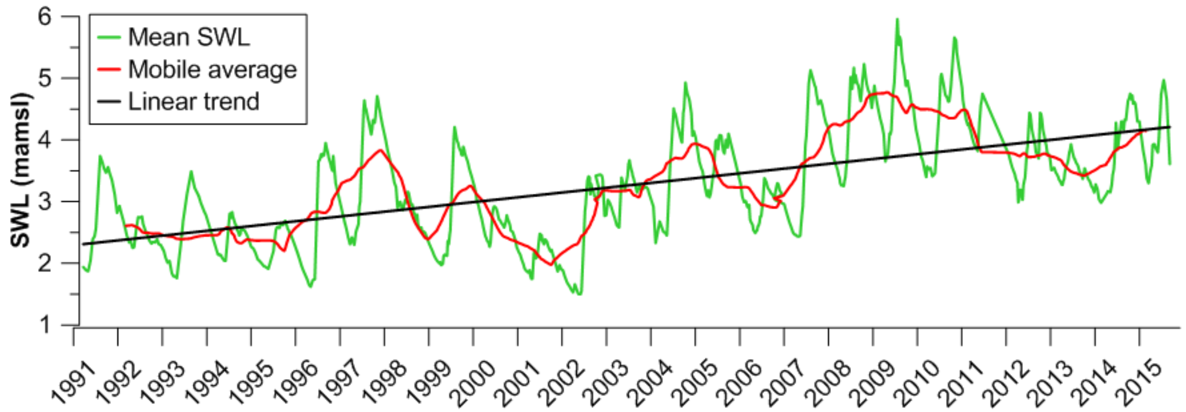
MATERIAL AND METHOD

- Material
- Method
  - Water Table Fluctuation Method
  - Trend analysis
    - Linear trend
    - Mobile average (5 years)
    - Standardized index : $SPI = \frac{X_i - X_m}{S_i}$

Xi = annual rainfall

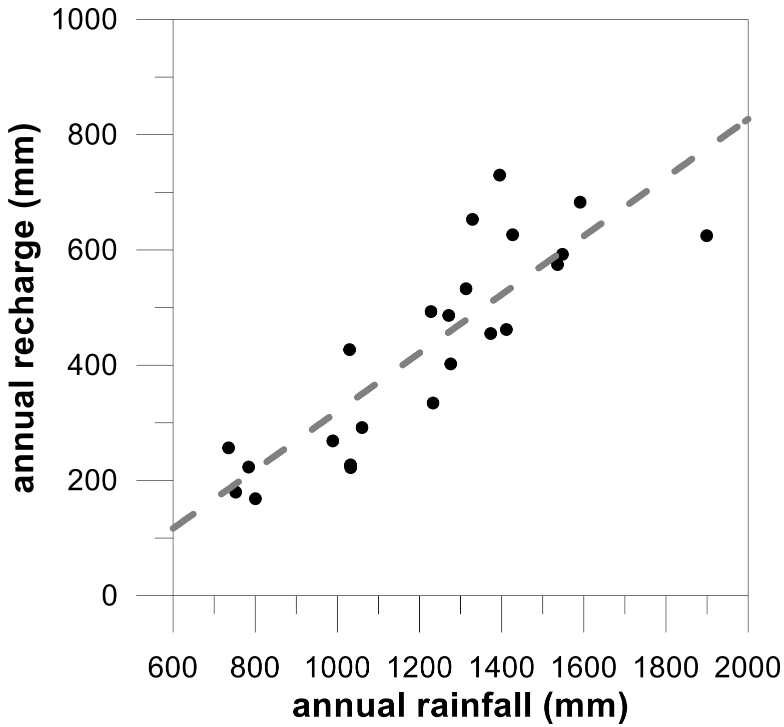
Xm = mean rainfall

Si = Standard deviation



RESULTS

- Quaternary sediments (unconsolidated sandstone)
  - 170mm < Recharge < 700mm
  - Recharge = 34% of Rainfall (annual)



Annual recharge strongly controlled by rainfall

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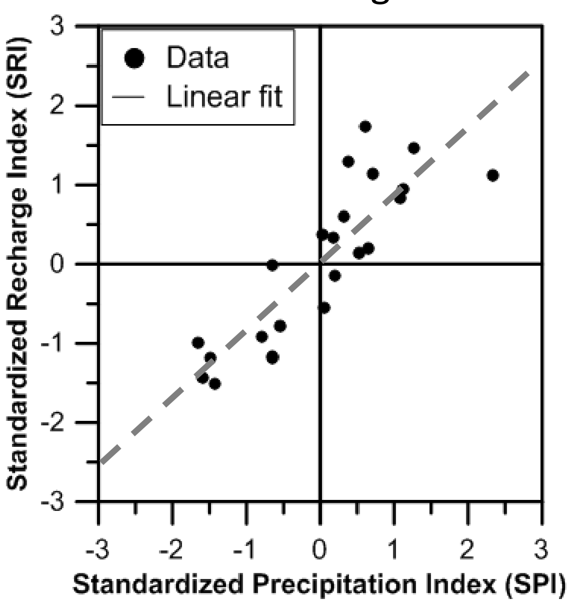
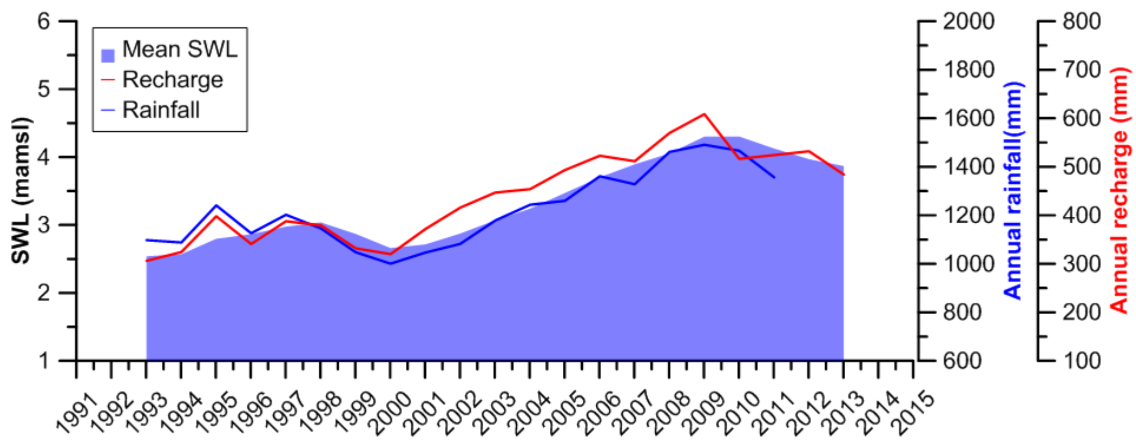
RESULTS

- Quaternary sediments (unconsolidated sand)
  - 170mm < Recharge < 700mm
  - Recharge = 34% of Rainfall (annual)
  - Trend 1991-2014:
    - ➢ Rainfall → +13 mm/year
    - ➢ Recharge → +11 mm/year

Annual recharge strongly controlled by rainfall
Trend in recharge controlled by trend in rainfall





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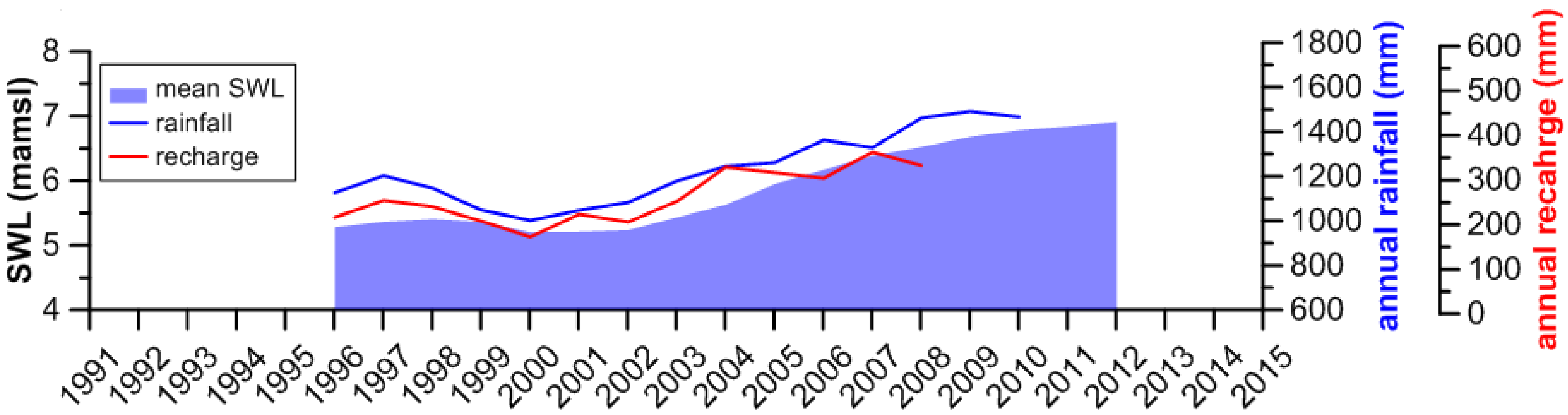
RESULTS

- Continental Terminal (Sandstone)
  - 38mm < Recharge < 580mm
  - Recharge = 21% of Rainfall (annual)
  - Trend 1994-2014:
    - ➢ Rainfall → +16 mm/year
    - ➢ Recharge → +7 mm/year

Annual recharge strongly controlled by rainfall
Trend in recharge controlled by trend in rainfall



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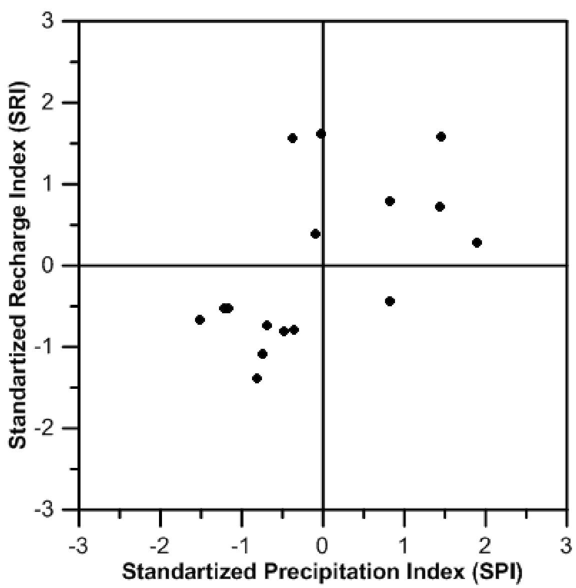
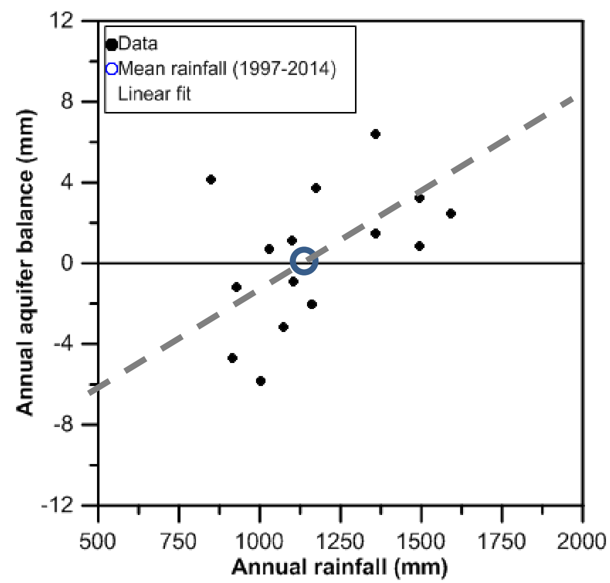
RESULTS

- Hard rock
  - 56mm < Recharge < 85mm
  - Recharge = 6% of Rainfall (annual)
  - Trend 1997-2015:
    - ➢ Rainfall → +1.5 mm/year
    - ➢ Recharge → -0.8 mm/year

Groundwater storage in equilibrium with rainfall
No trend





CONCLUSION AND OUTLOOKS

- Conclusion
  - Recharge → geology
  - Recharge → rainfall
  - Trend in recharge → trend in rainfall

	Mean rainfall (mm)	Mean recharge (mm)	Recharge/ rainfall	Trend in rainfall (mm/year)	Trend in recharge (mm/year)
Quaternary sediment	1251	460	34%	+13mm	+11mm
Continental Terminal	1215	256	21%	+16mm	+7mm
Hard rock	1176	65	6%	No trend	No trend

CONCLUSION AND OUTLOOKS

- Conclusion
  - Recharge → geology
  - Recharge → rainfall
  - Trend in recharge → trend in rainfall

→ **Aquifer storage vulnerable to rainfall change**

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Quaternary sediment	1251	460	34%	+13mm	+11mm
Continental Terminal	1215	256	21%	+16mm	+7mm
Hard rock	1176	65	6%	No trend	No trend

- Outlooks
  - Link geology/recharge?
  - Linear process (recharge/rainfall)?

THANKS

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