

The importance of groundwater for the African population

- Key facts on water resources in Africa
- Challenges
- Scientific questions
- Solutions

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Coopération franco-allemande
Berlin, 1-2 juin 2015

Water resources in Africa

- Freshwater stored in lakes: 30,000 km³
- Annual renewable freshwater
(rivers and aquifer recharge): 4,000 km³
- Groundwater storage: 660,000 km³

MacDonald et al., 2012

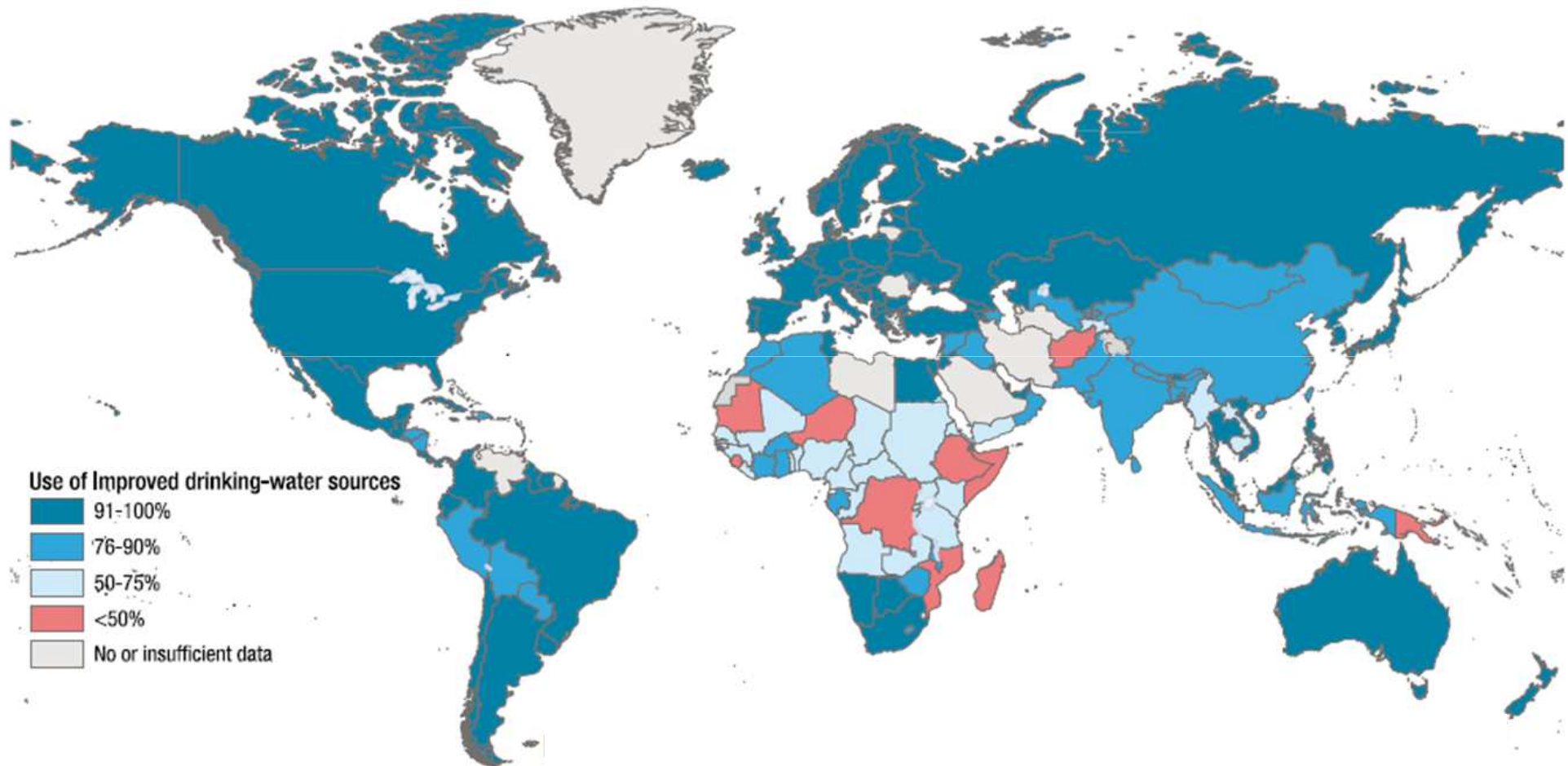
Challenges

- Access to safe drinking water
- Provide water for food security
- Meet growing water demand
- Manage effects of climate change

UNEP, 2010



Access to safe drinking-water



UNICEF/WHO, 2013

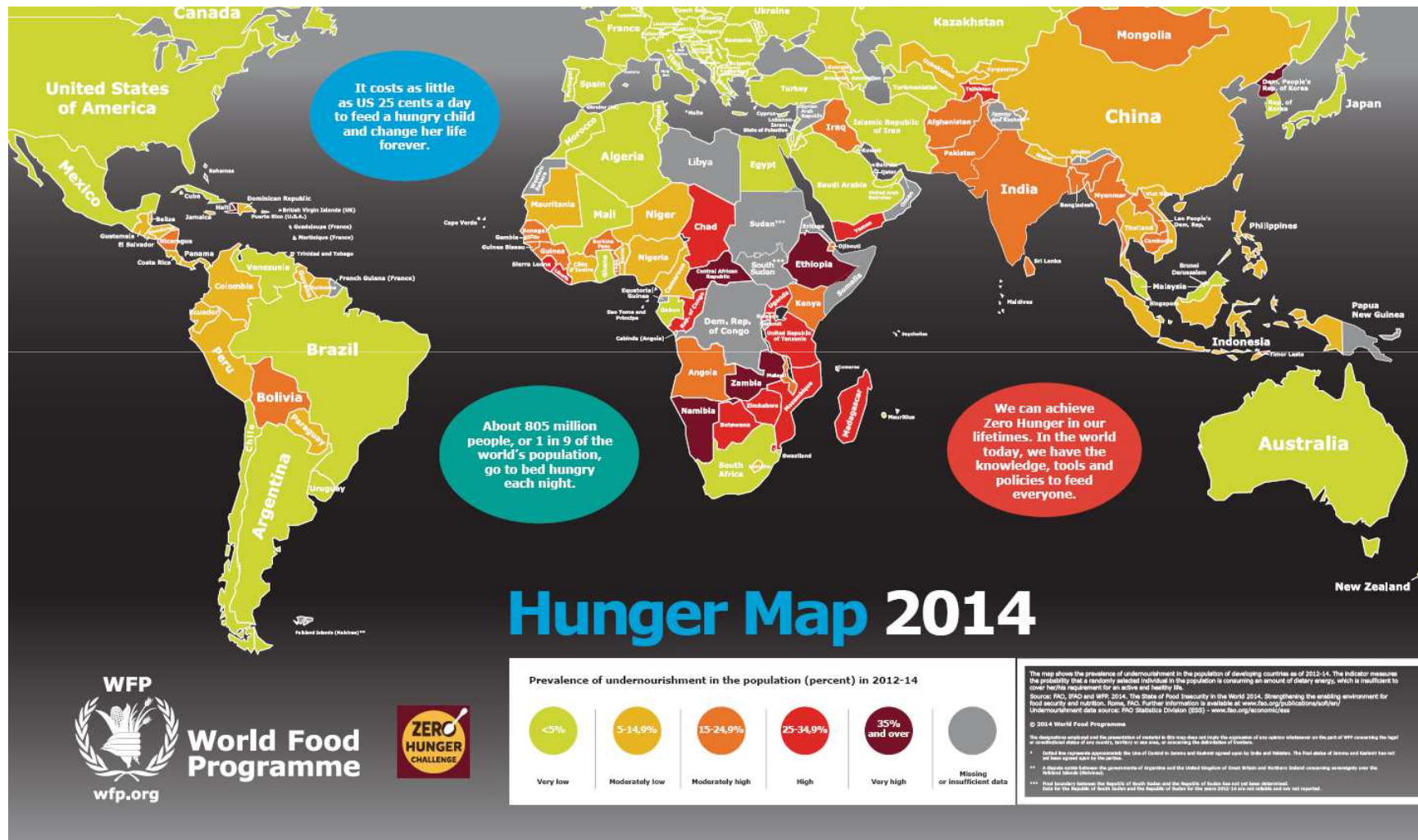
Access to safe drinking-water

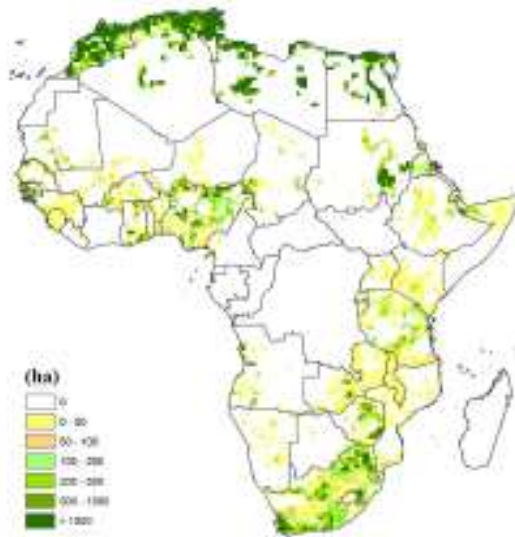
- Only 64% of the African population has access to safe drinking-water
- 75% of the population relies on groundwater for living



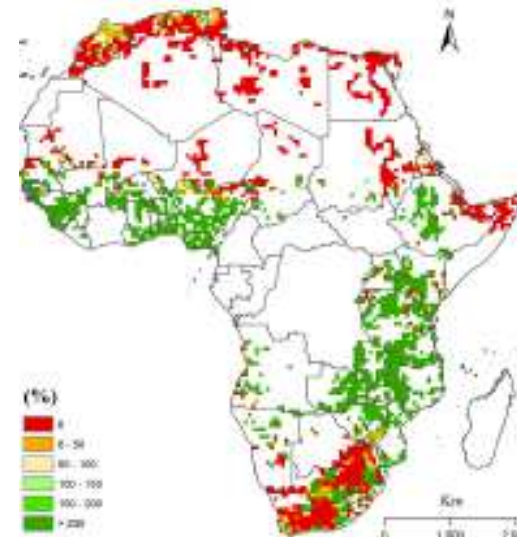
Photos: BGR

Provide water for food security





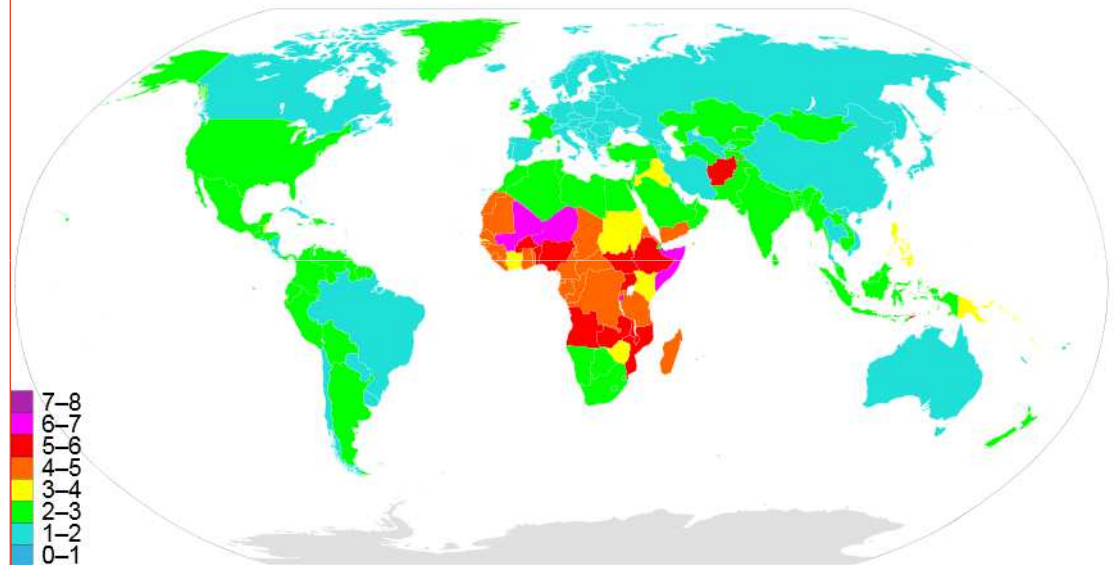
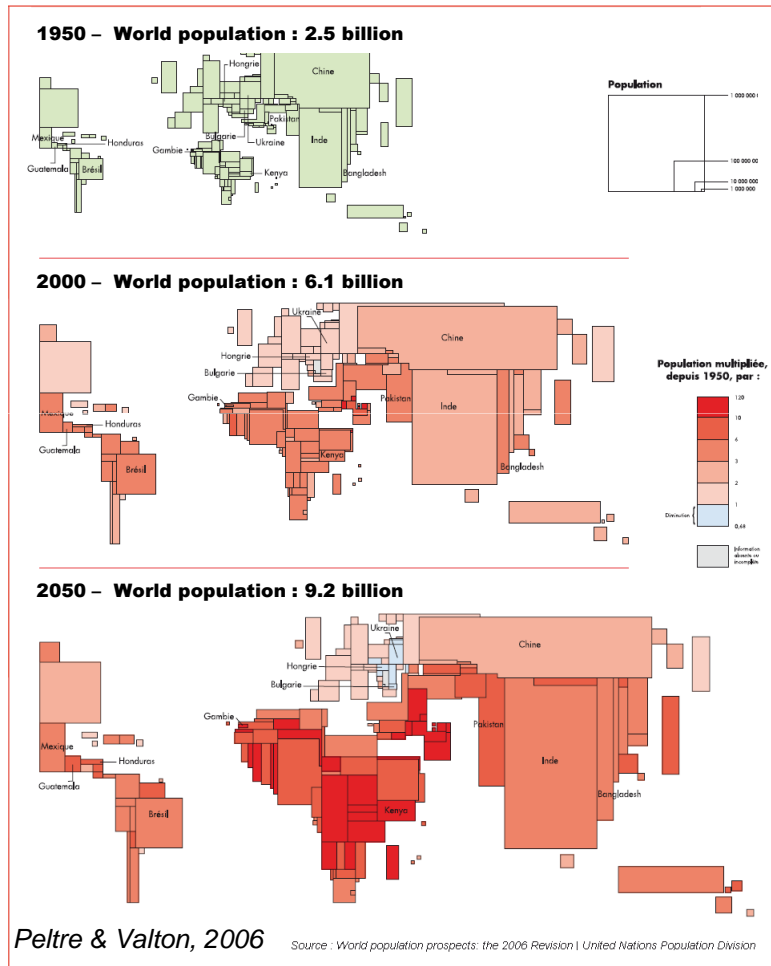
Groundwater irrigated areas in 2005
(Siebert et al., 2010)



Groundwater irrigation potential with 50%
of recharge (Altchenko & Villholth, 2015)

- Irrigation with groundwater has been developed in northern and southern Africa
- Abstracting from non-renewable or already stressed sources
- It could be improved in the Sahel and East Africa

Meet growing water demand

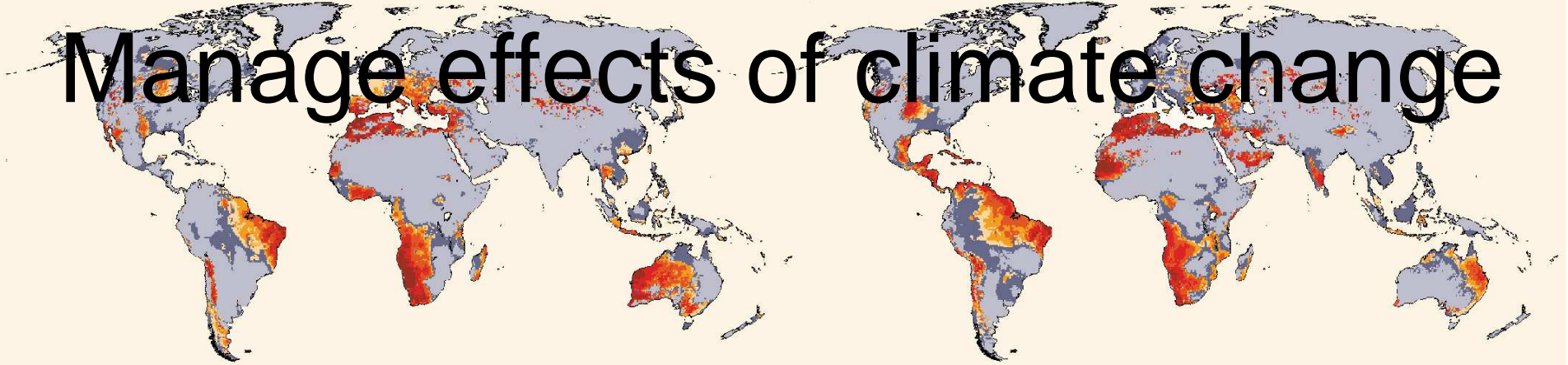


Fertility rate per woman (CIA Factbook)

A2 - ECHAM4

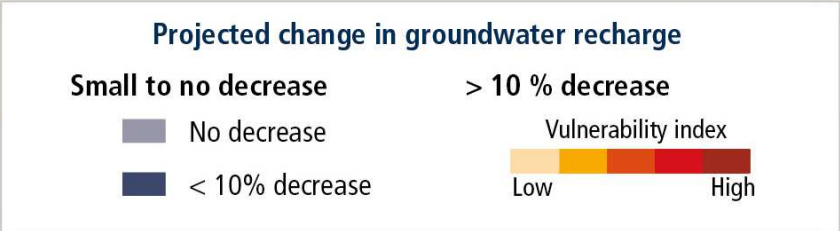
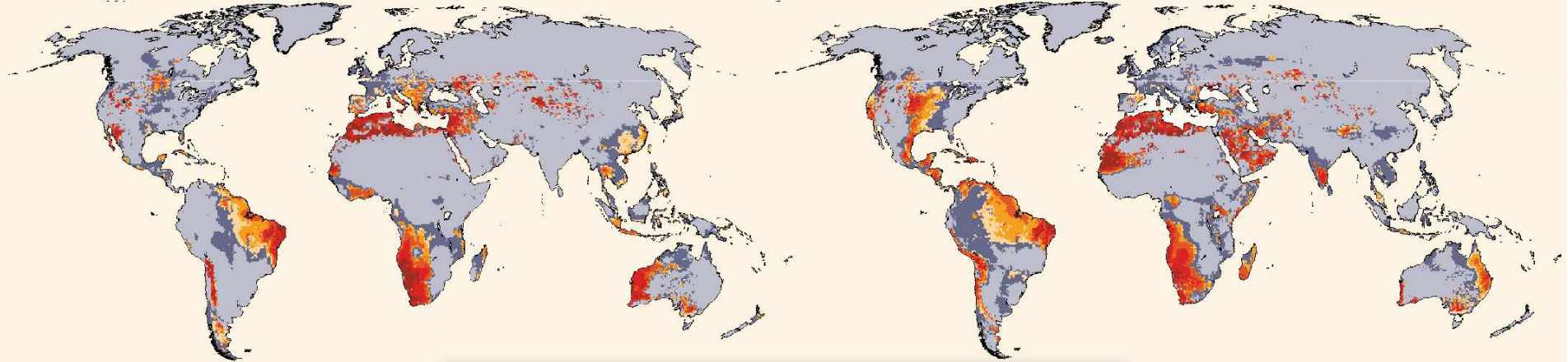
A2 - HadCM3

Manage effects of climate change



B2 - ECHAM4

B2 - HadCM3



IPCC, 2014

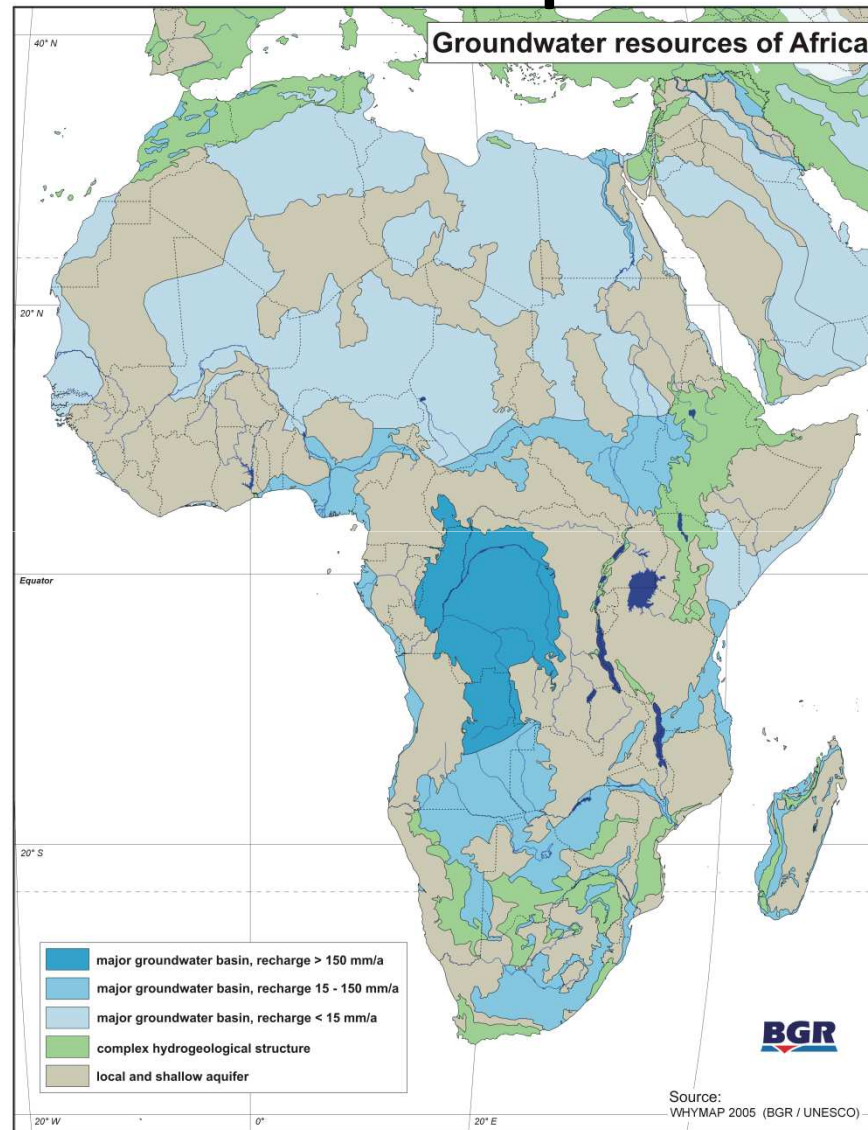
by 2050

Scientific questions

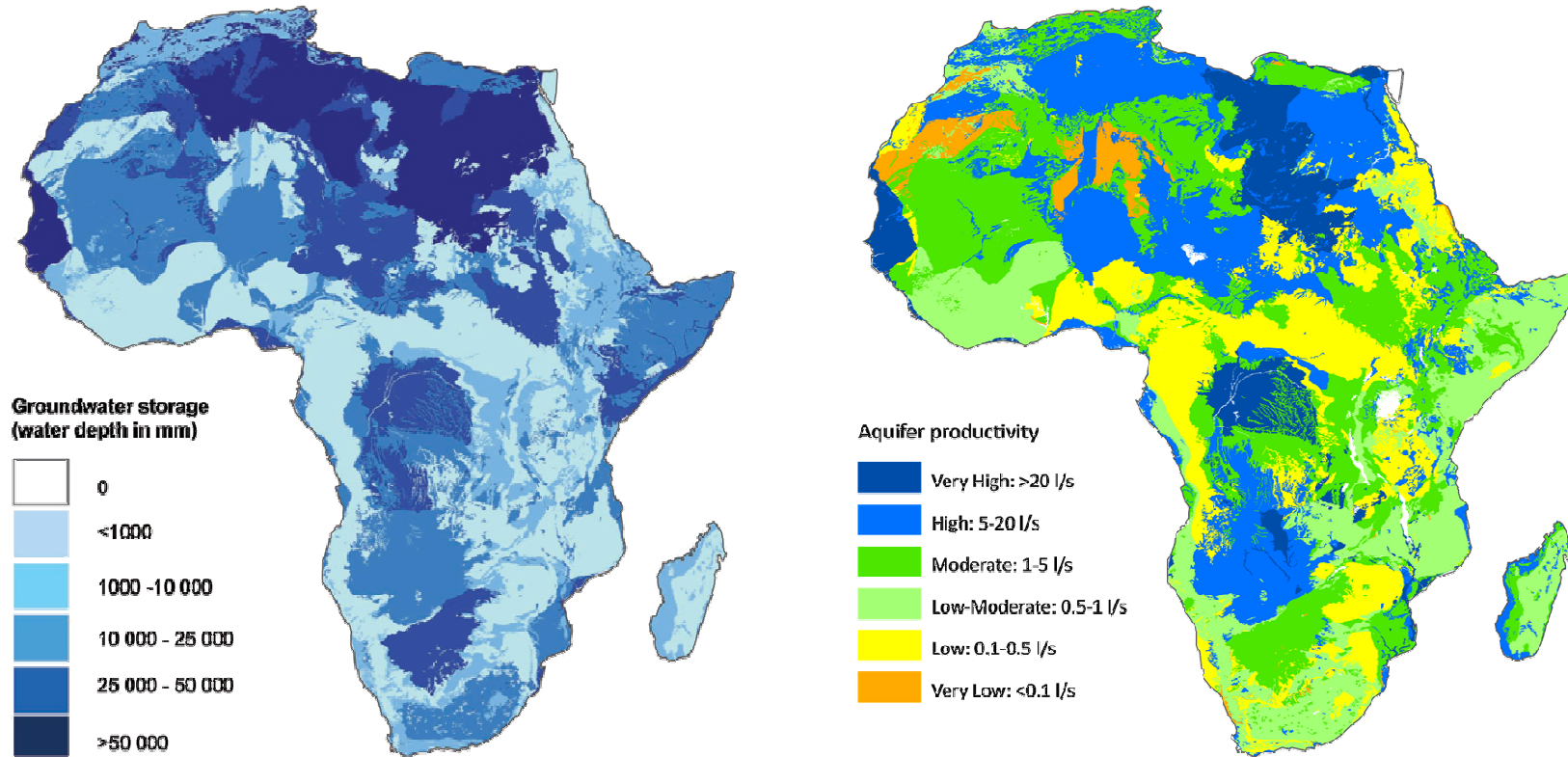
- Groundwater potential
- Groundwater recharge
- Human impact
- Climate change



Groundwater potential?

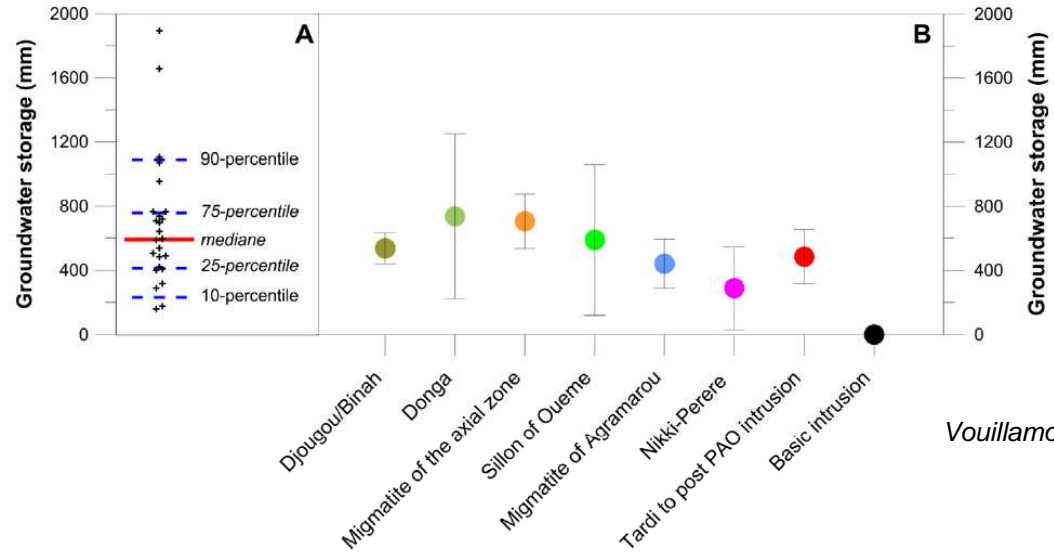
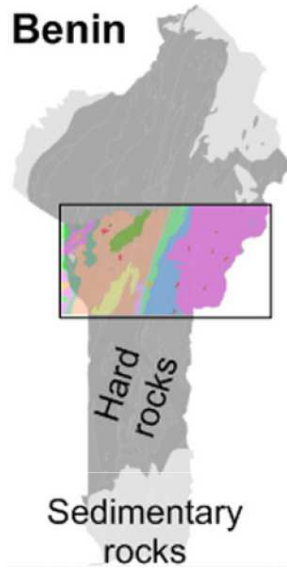


Groundwater potential?

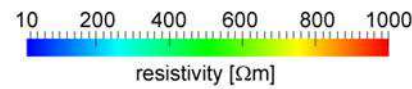
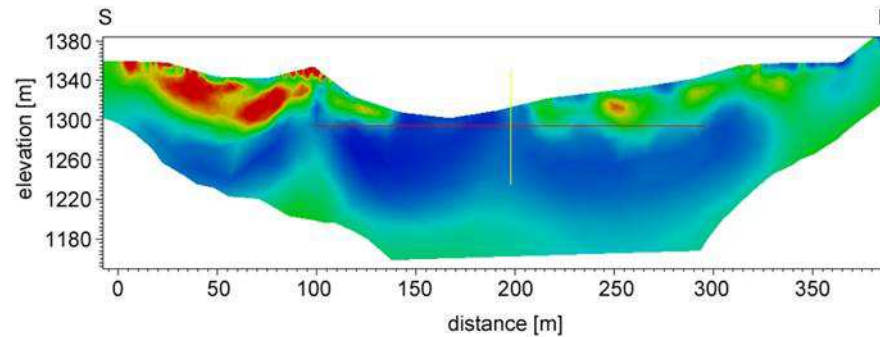
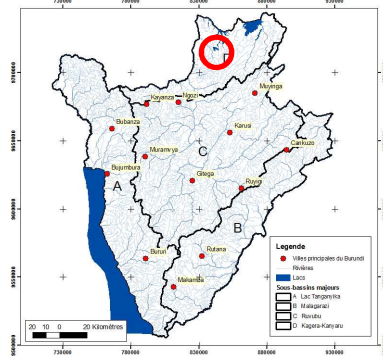


MacDonald et al., 2012

Groundwater potential?

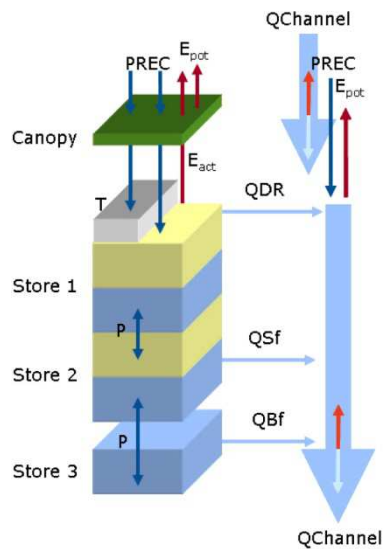


Vouillamoz et al., 2015



Noell et al., unpublished

Groundwater recharge?

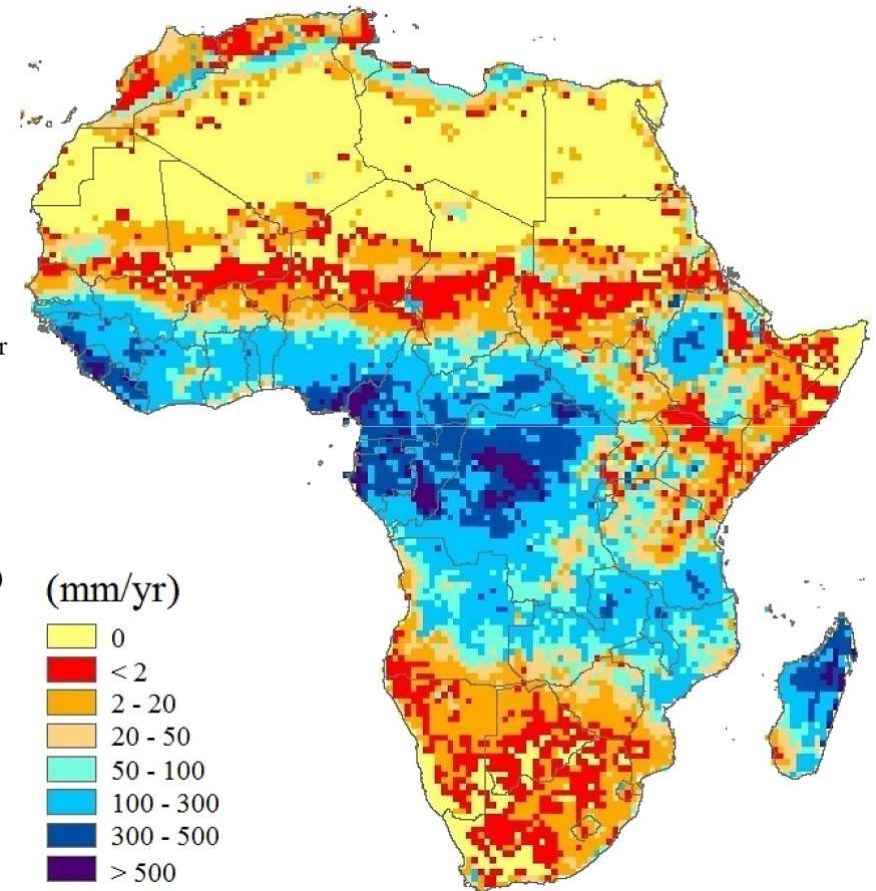


van Beek & Bierkens, 2009

$$R_g = \min(R_{g \max}, f_g R_l) \text{ with } f_g = f_r f_t f_h f_{pg}$$

- $R_{g \max}$ = soil texture-specific maximum groundwater recharge (infiltration capacity) [mm/d]
- R_l = total runoff of land area of cell [mm/d]
- f_g = groundwater recharge factor ($0 \leq f_g < 1$)
- f_r = relief-related factor ($0 < f_r < 1$)
- f_t = soil texture-related factor ($0 \leq f_t \leq 1$)
- f_h = hydrogeology-related factor ($0 < f_h < 1$)
- f_{pg} = permafrost/glacier-related factor ($0 \leq f_{pg} \leq 1$)

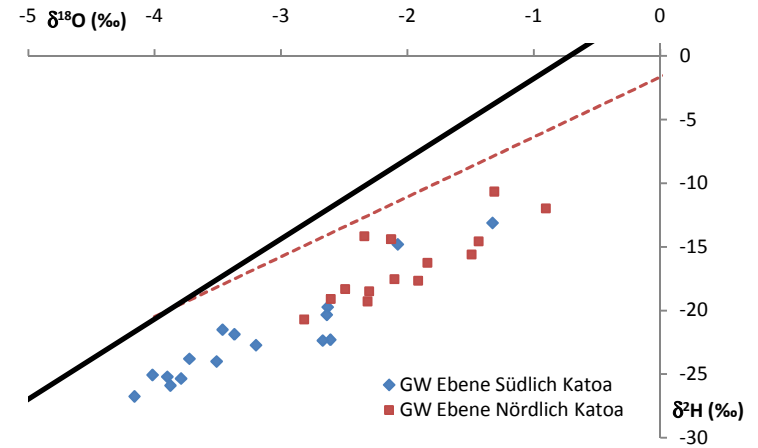
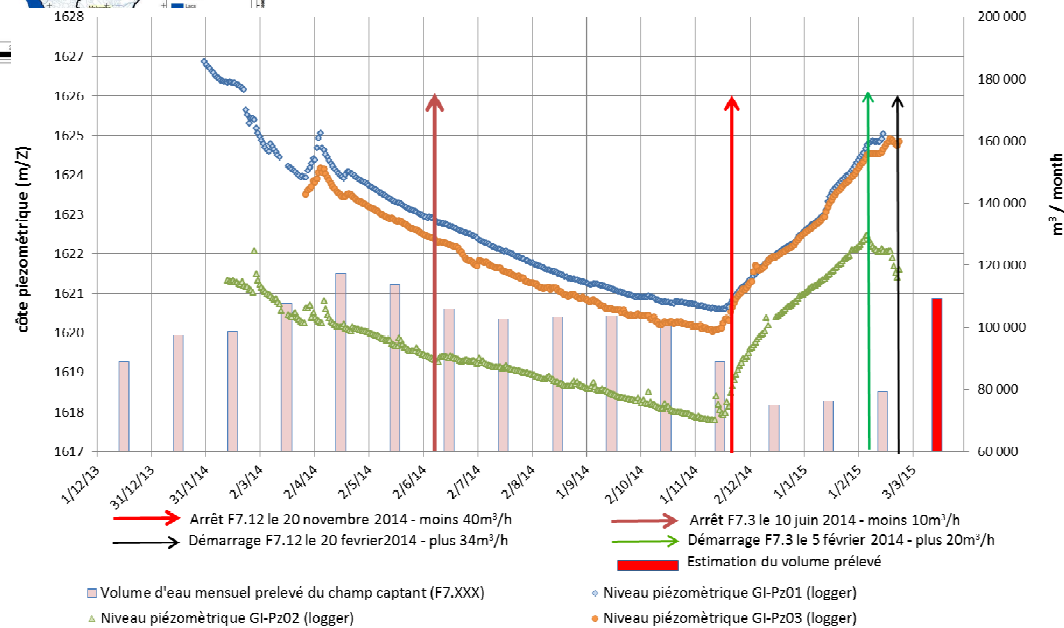
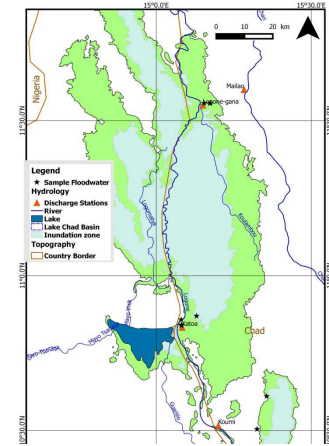
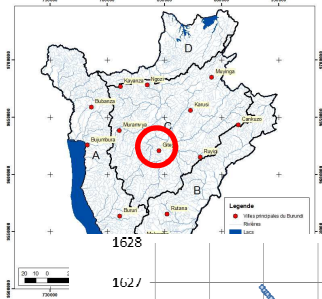
Döll & Fiedler, 2008



Altchenko & Villholth, 2014

Hydrological models

Groundwater recharge?



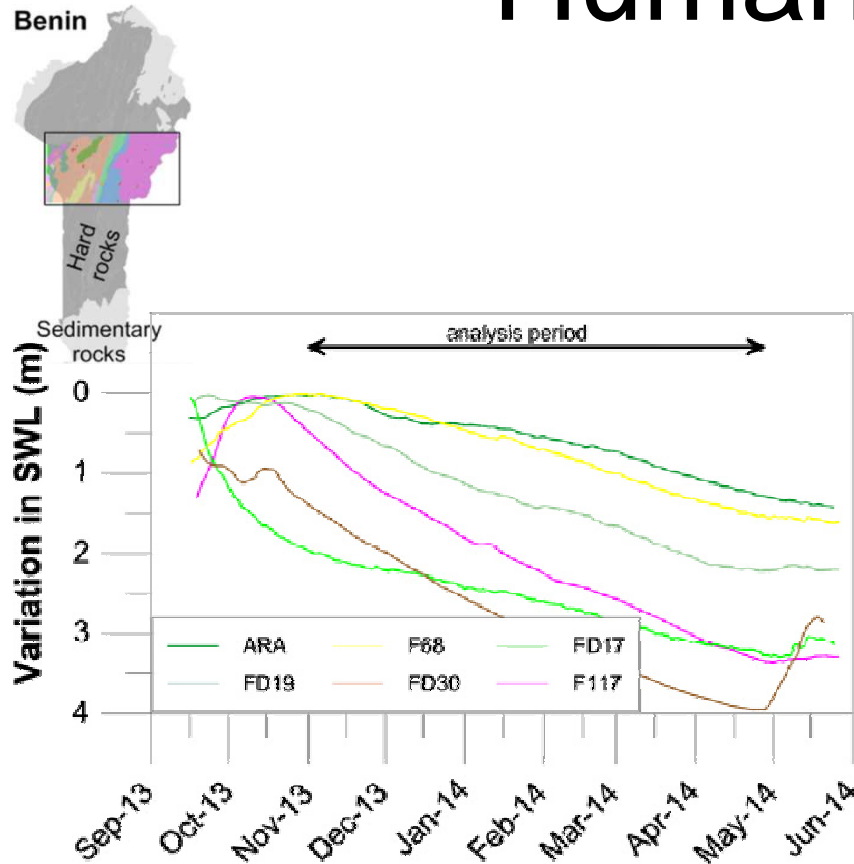
- Recharge area = 5.5 km²
- Groundwater recharge = 264 mm/a
- Recommended extraction = 85,000 m³/month

Tiberghien et al., unpublished

- Annual recharge = 10 mm

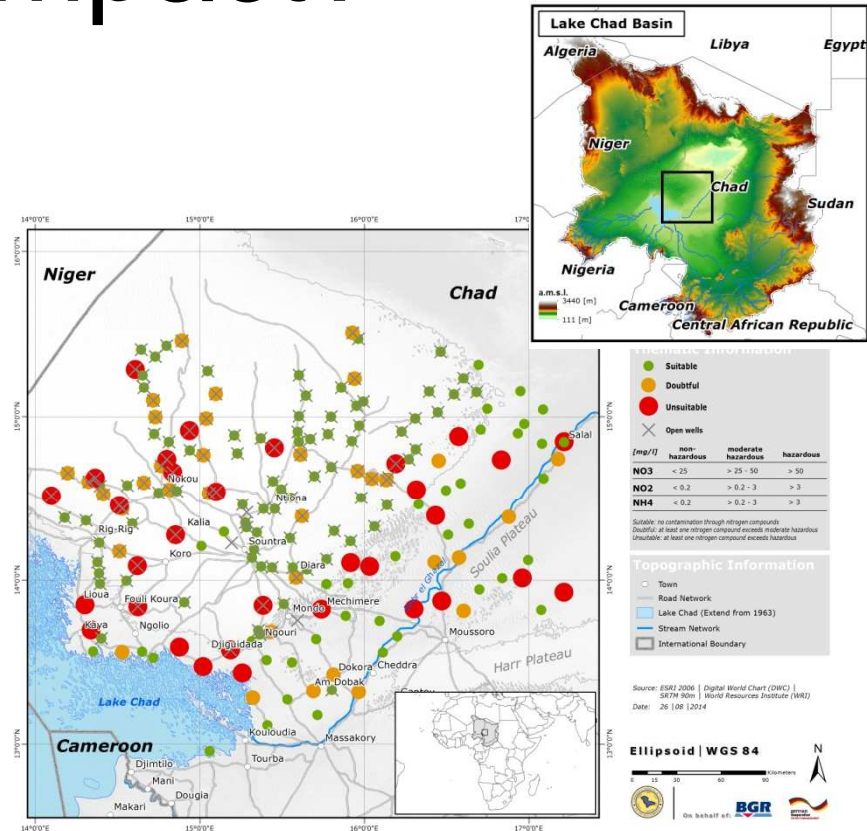
Seeber et al., 2014

Human impact?



- Aquifer storage = 440 mm ± 70 mm
- Natural outflow = 190 mm/a ± 90 mm/a
- Human abstraction = 0.34 mm/a ± 0.07 mm/a

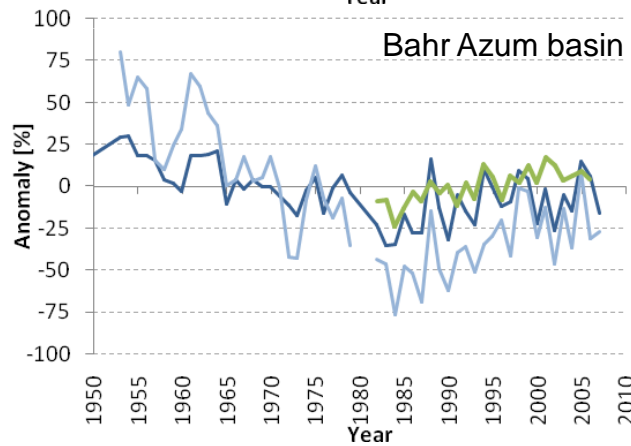
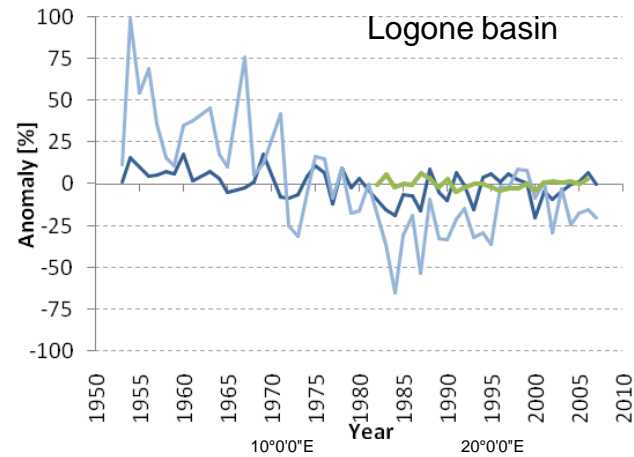
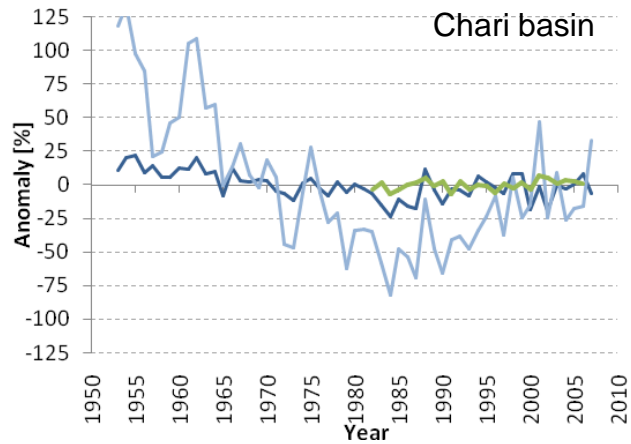
Vouillamoz et al., 2015



- Excess of NO₃, NO₂ and NH₄, due to human contamination

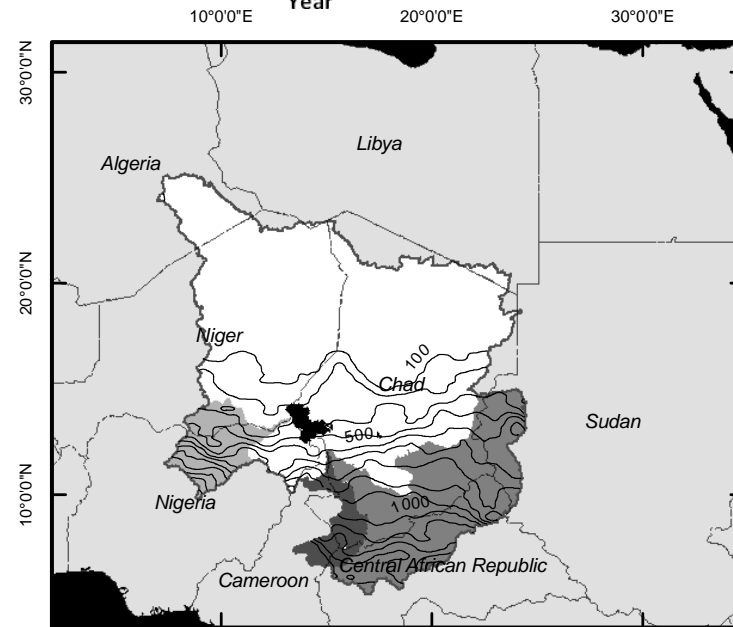
Vassolo et al., 2015

Climate change?



Anomalies: Catchment Means

- Precipitation
- River Discharge
- NDVImax



Source: Geerken et al., 2010

Solutions

- Development of new methods and approaches for aquifer characterisation to improve resource management on both regional and local scales
- **International cooperation** is needed to toggle the challenges. It is the **key for success**

International cooperation

- BGR
 - Mainly with governmental institutions,
 - but also with universities (Cameroon, Chad, Namibia, Niger, Nigeria)
- IRD – LTHE
 - Mainly with universities (Benin, Burkina, Uganda, Tanzania, Niger, Cameroon)

Thanks