Renewable groundwater and water security

Valparaiso Workshop December 2010

Arid and semi-arid development through water adaptation





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OXFORD CENTRE FOR WATER RESEARCH

Water security

- The availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (Grey and Sadoff 2007).
- Water security is closely linked to climate change, energy needs and demographics as well as water availability for domestic, food and industry……
- Importantly it is a political issue!

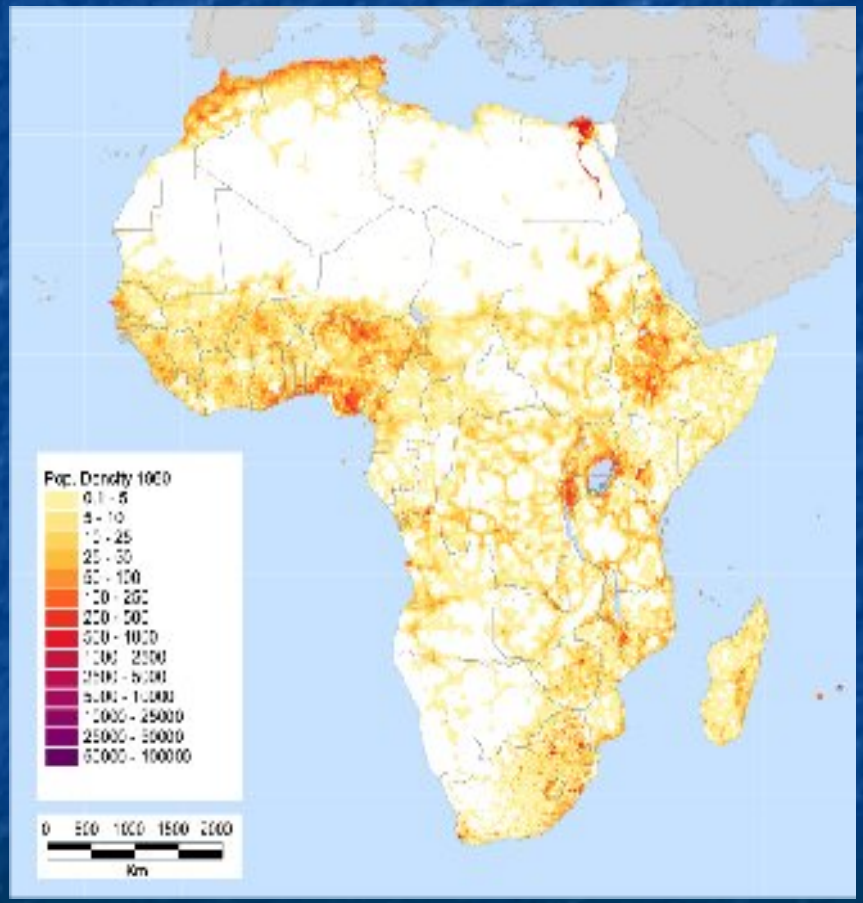
Grey, D. and Sadoff, C. (2007) Sink or Swim? Water Security for Growth and Development. *Water Policy*, Vol. 9, pp. 545-571.

Water Security: Science and Policy

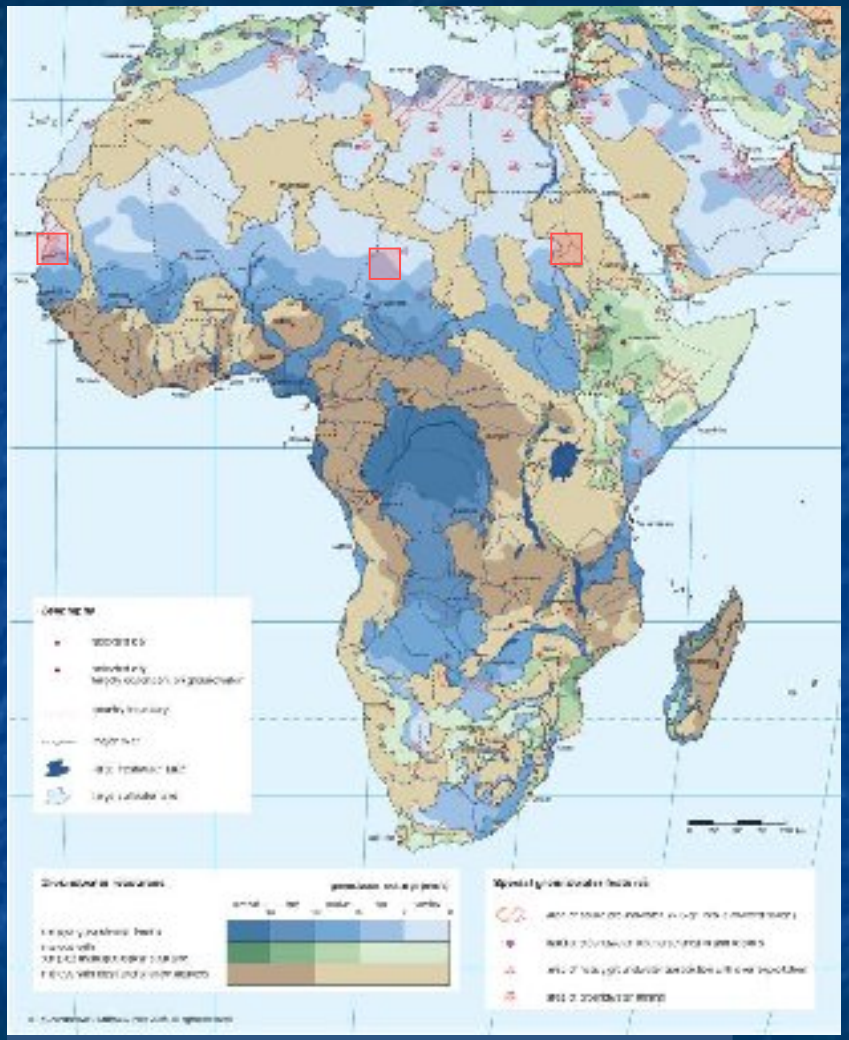
- 50 years of Science have provided understanding of water occurrence, great benefits and opportunities but also carry a warning
- Disequilibrium exists between discovery and application, science and practioner, know-how and end-user
- How can we improve the bridge between these areas – with equitable ownership and application of knowledge
- What are the capacity requirements needed to become well informed, water-efficient, develop sustainably

Keeping pace - knowledge and application

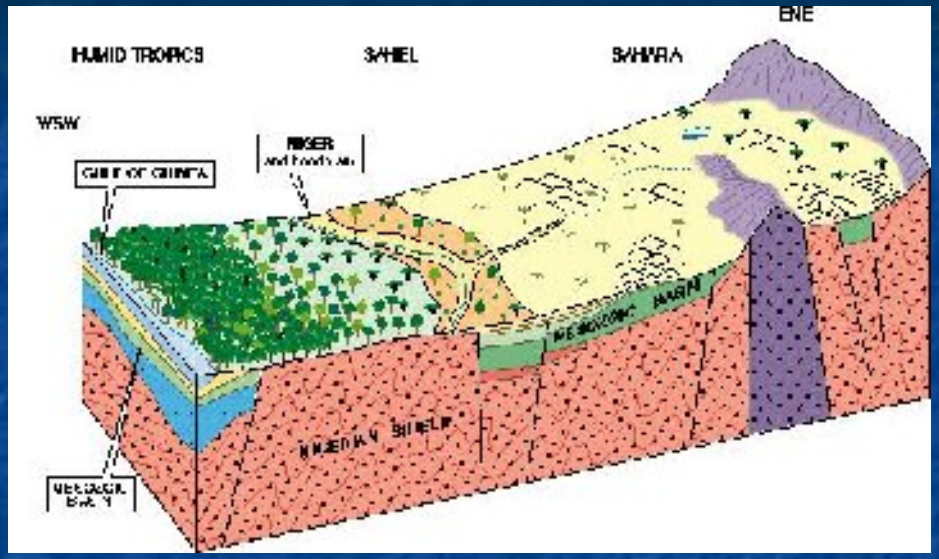
- Rapid rates of development and water use: need to distinguish human and natural timescales
- Falling water table in most areas and declining river flows
- Rising living standards and expectations
- Rising populations and growing demand



Groundwater occurrence in Africa

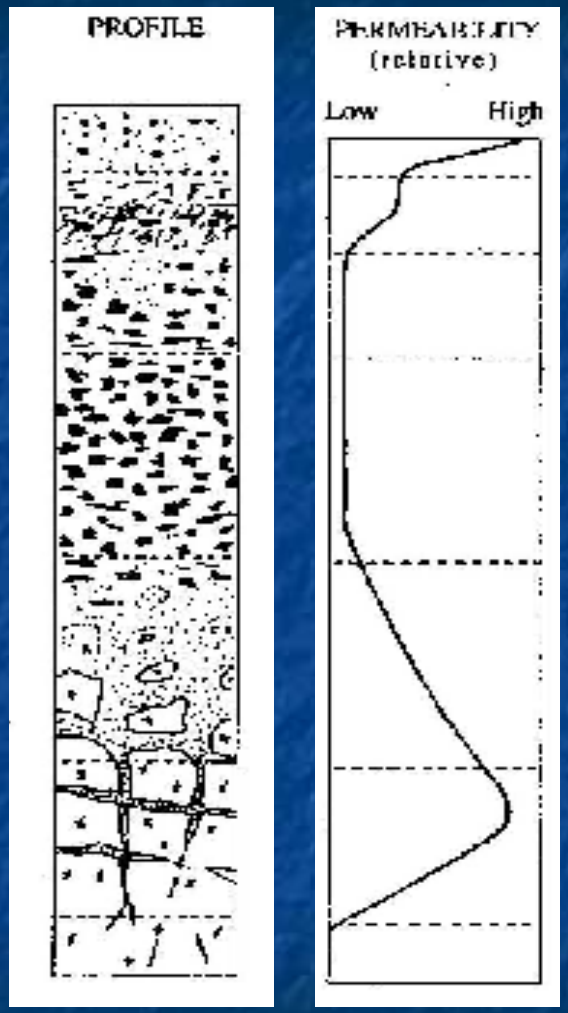


GROUNDWATER IN AFRICA
WHYMAP (UNESCO – BGR)



- Hard rock or soft rock terrain: sedimentary basins, basement rocks, Quaternary deposits?
- Large reserves in the wrong place – eg Congo Basin
- **Is groundwater renewable - if so how much and over what timescales?**

Basement aquifers – the challenge

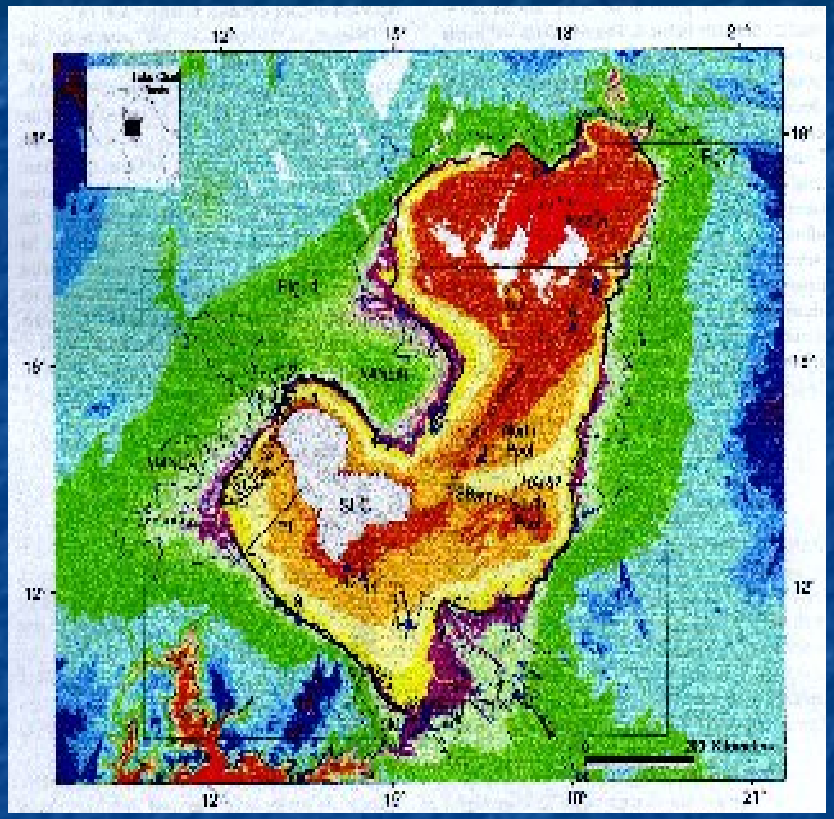


- Heterogeneity of the geology makes water exploration and exploitation difficult
- Storage usually low
- Improvements needed in data analysis and management

Renewable or non-renewable groundwater?

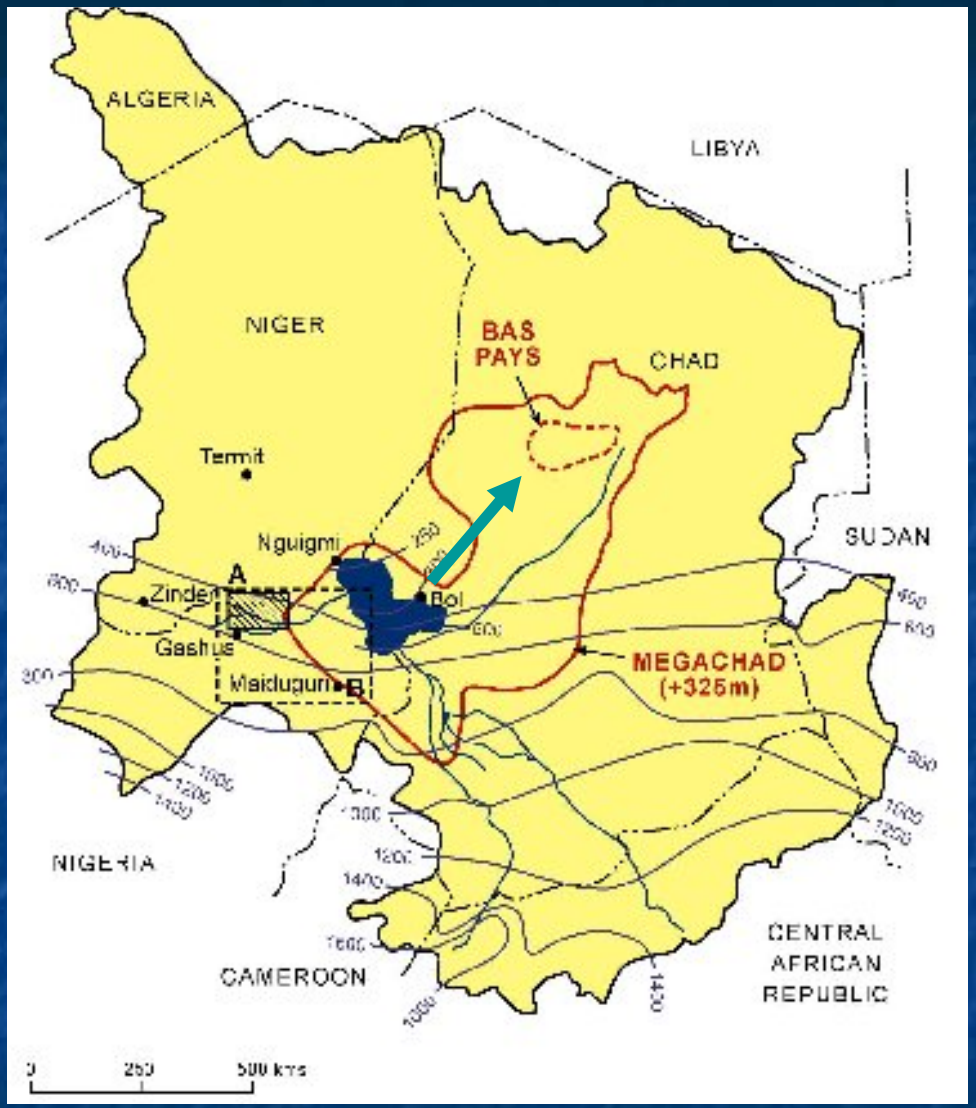
- What are the timescales of renewal?
- How can we assess these?
- How fast are we depleting from storage
- Water quality considerations

Lake Chad Basin



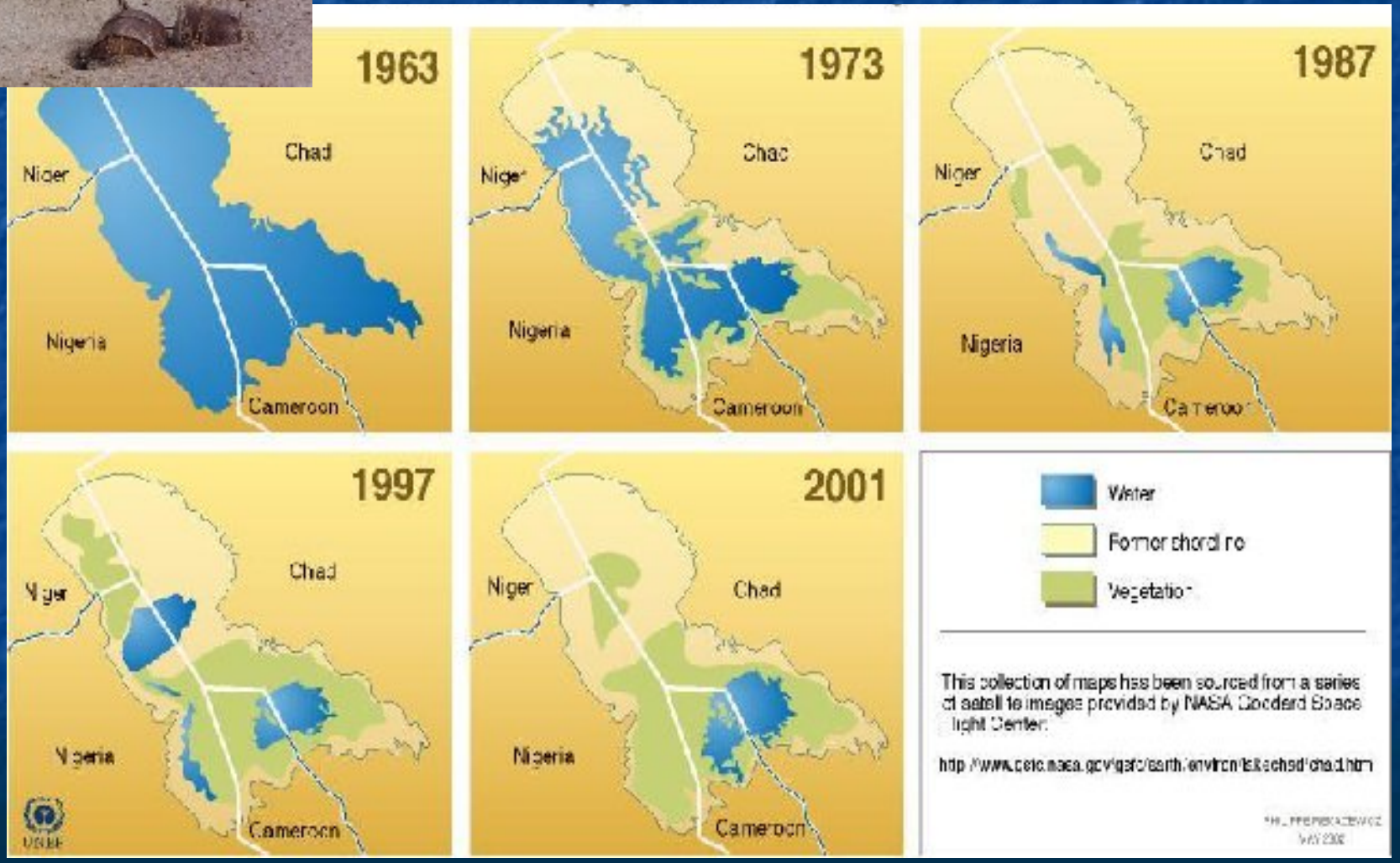
Holocene Lake MegaChad:
palaeoshorelines from space
7000 years BP

M Schuster et al.
Quat Sci Rev. 24 2005, 1821 -1827

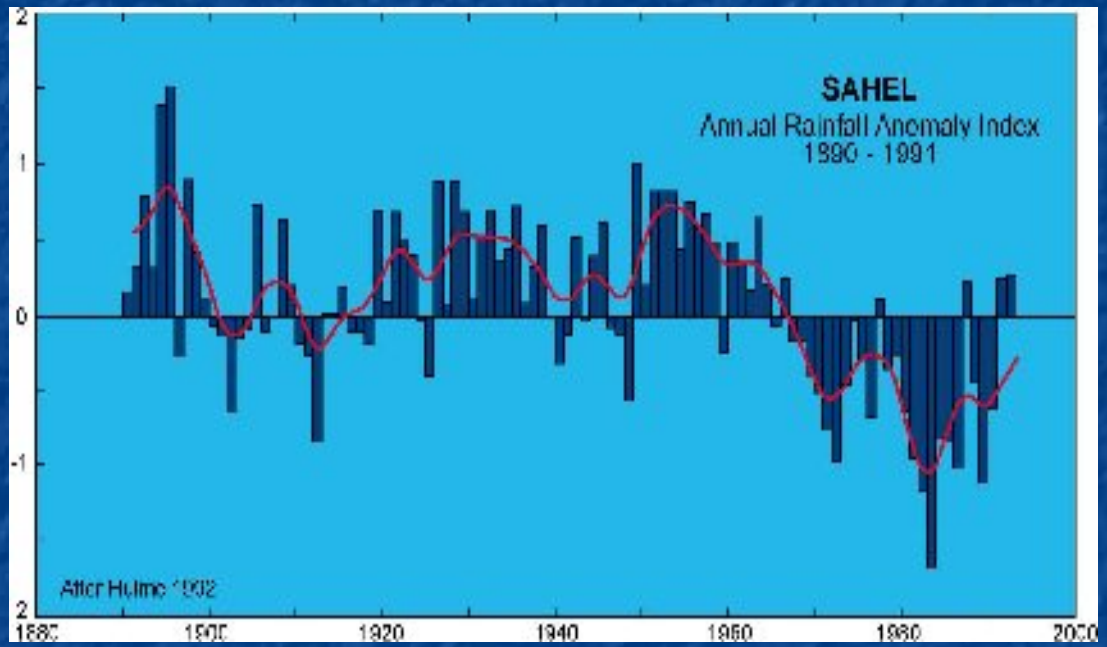


A chronology of change

Natural and anthropogenic factors affecting Lake Chad



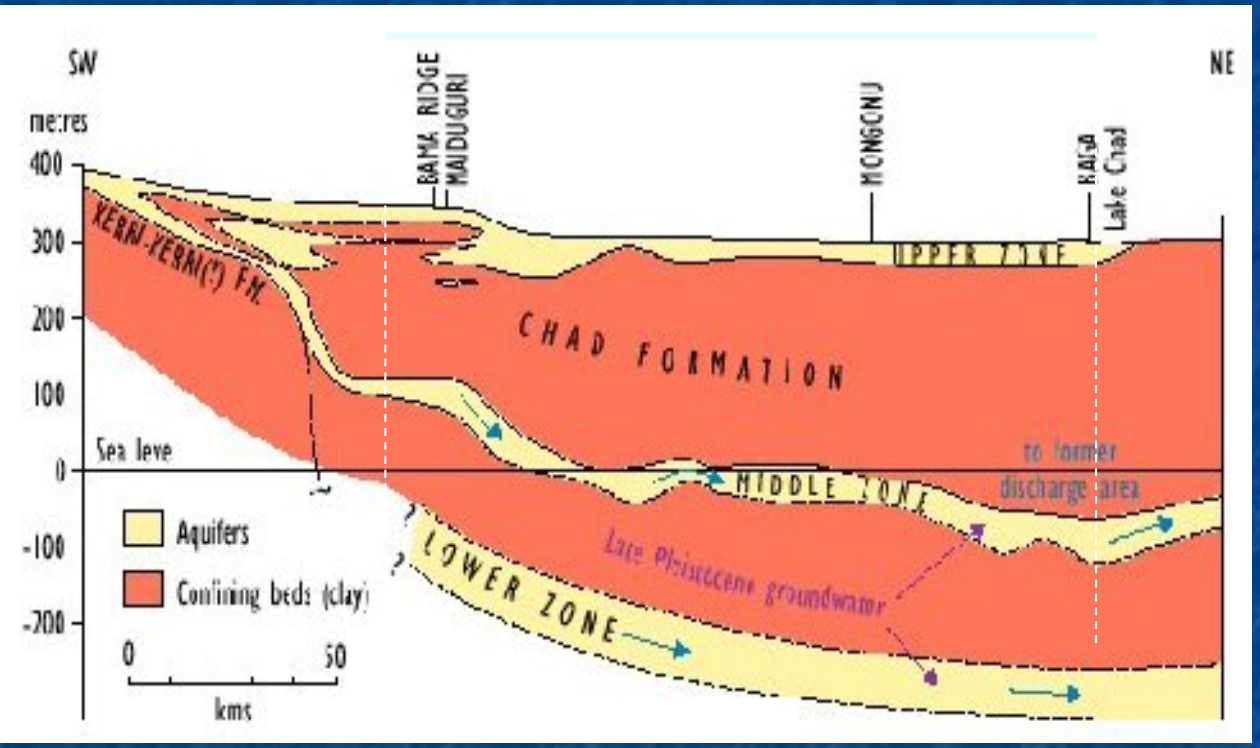
Climate change or human impacts?

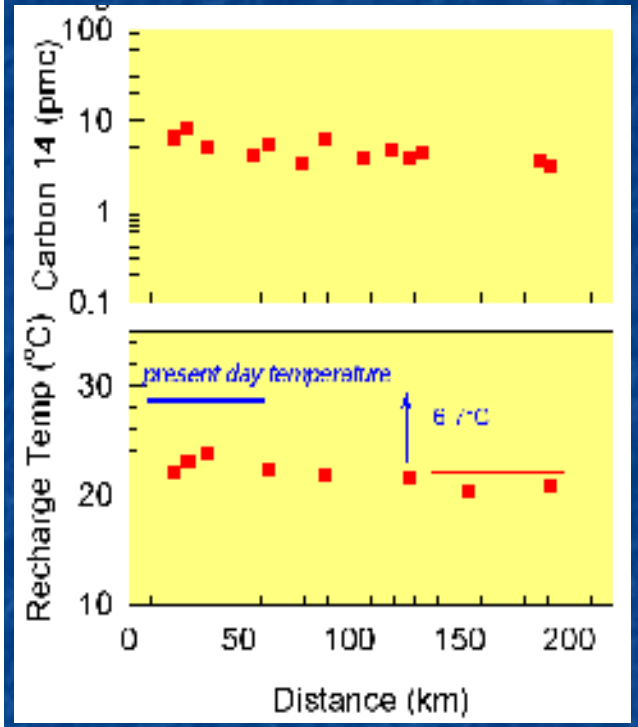


- 1966-75 irrigation accounts for 5% decrease (UNEP)
- 1983-1994 irrigation accounts for 50% of decrease
- Future trends?

What happens *beneath* Lake Chad?

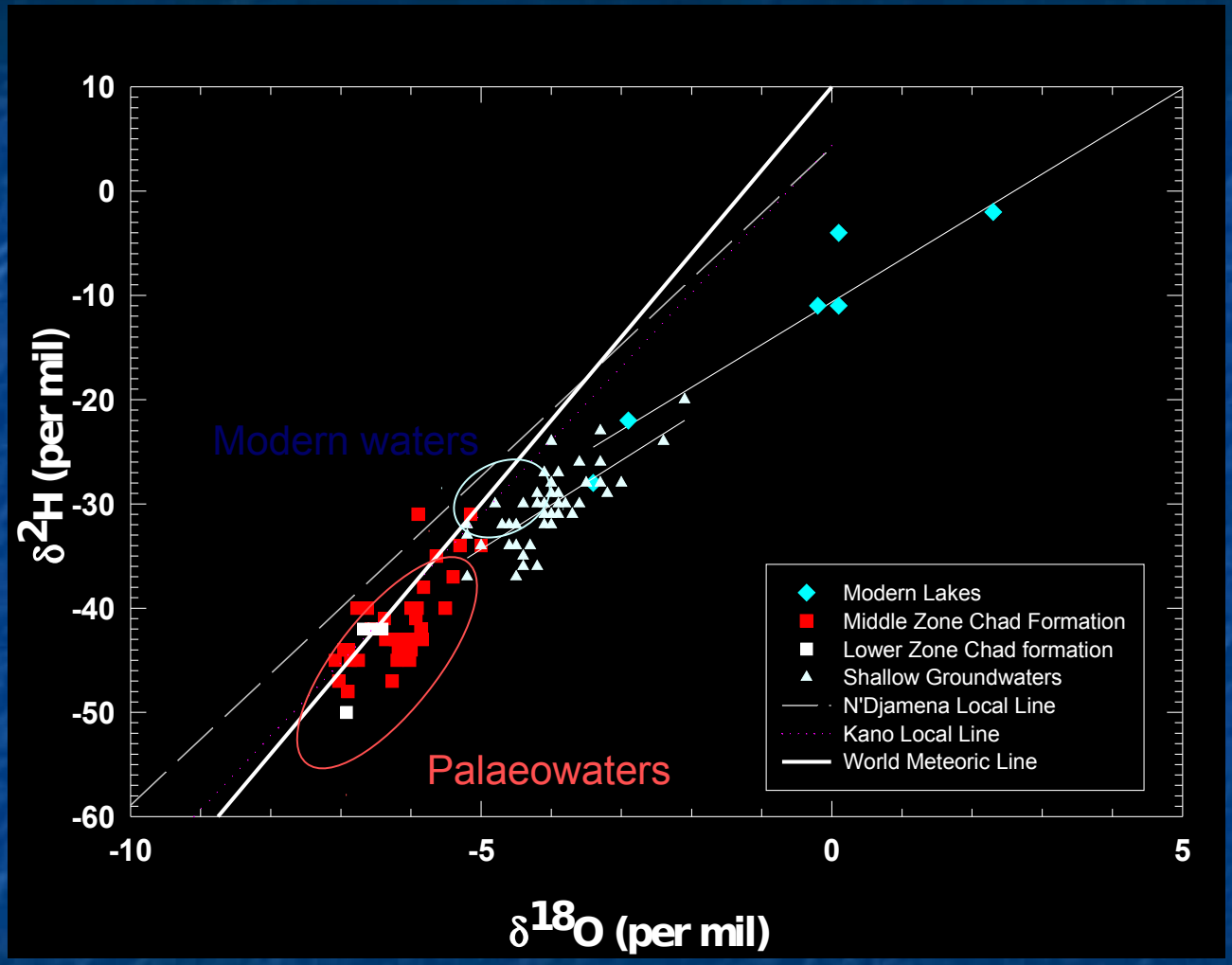
Down-gradient flow line in Middle Zone Aquifer of Chad Basin





Recharge under wetter climate – more than 20,000yrs ago:
Cooler conditions – 6-7° lower than today (Noble Gas Recharge Temperature measurements)

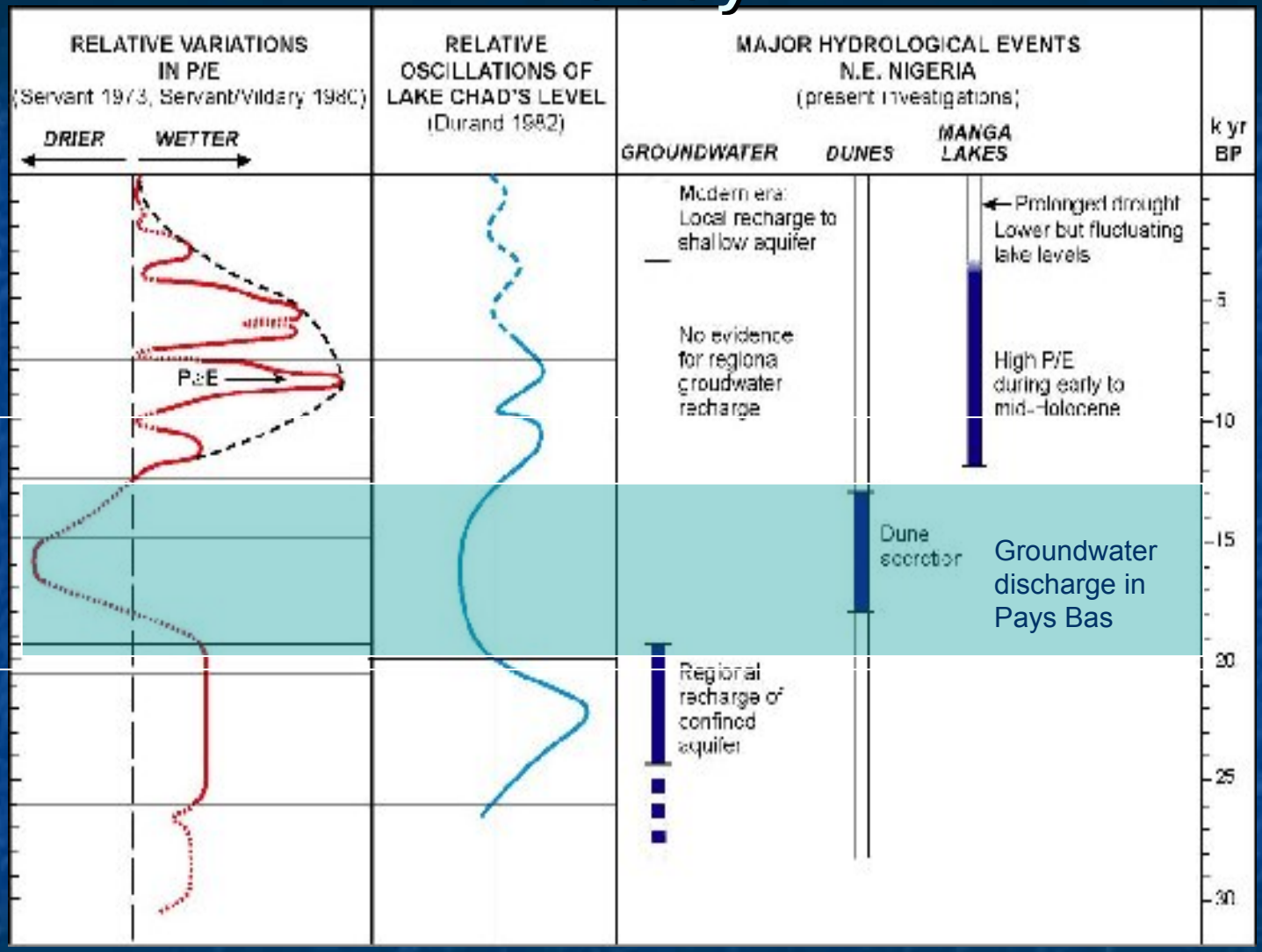
Isotopic indicators of modern and palaeowaters
Chad Basin artesian aquifer N Nigeria



The Chad Basin aquifer today

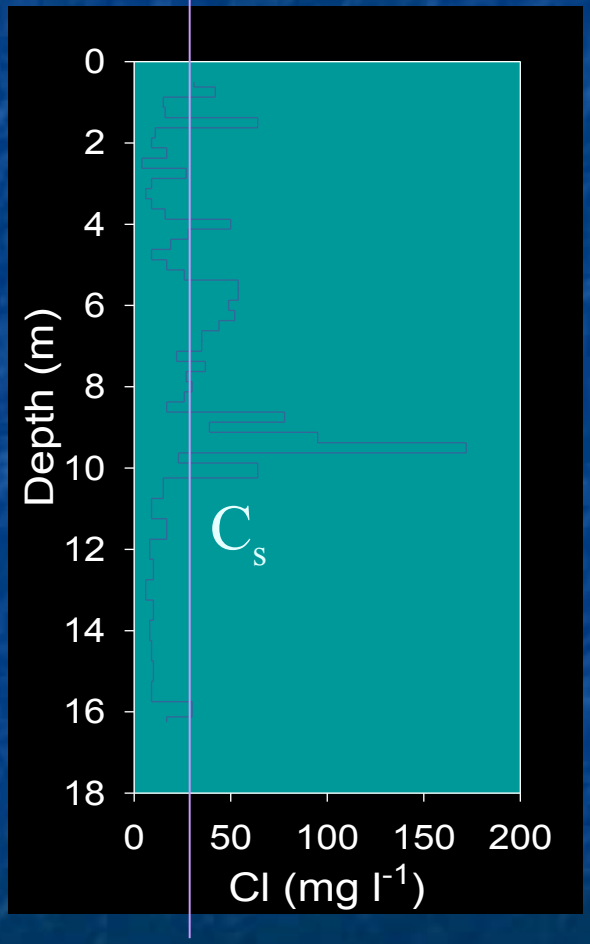
- Artesian Basin drilled in 1960s
- Now nearing exhaustion, wells corroded and leaking uncontrollably

Chronology of events over 30 000yr



EDMUNDS, W.M., FELLMAN, E. & GONI, I.B. (1999). Lakes, groundwater and palaeohydrology in the Sahel of NE Nigeria: evidence from hydrogeochemistry. J.Geol.Soc. London, 156, 345-355

How much water is being recharged today?



Magumeri profile

$R_d = P.C_p/C_s$

P - 400 mm

C_p - 2.0 mg/l

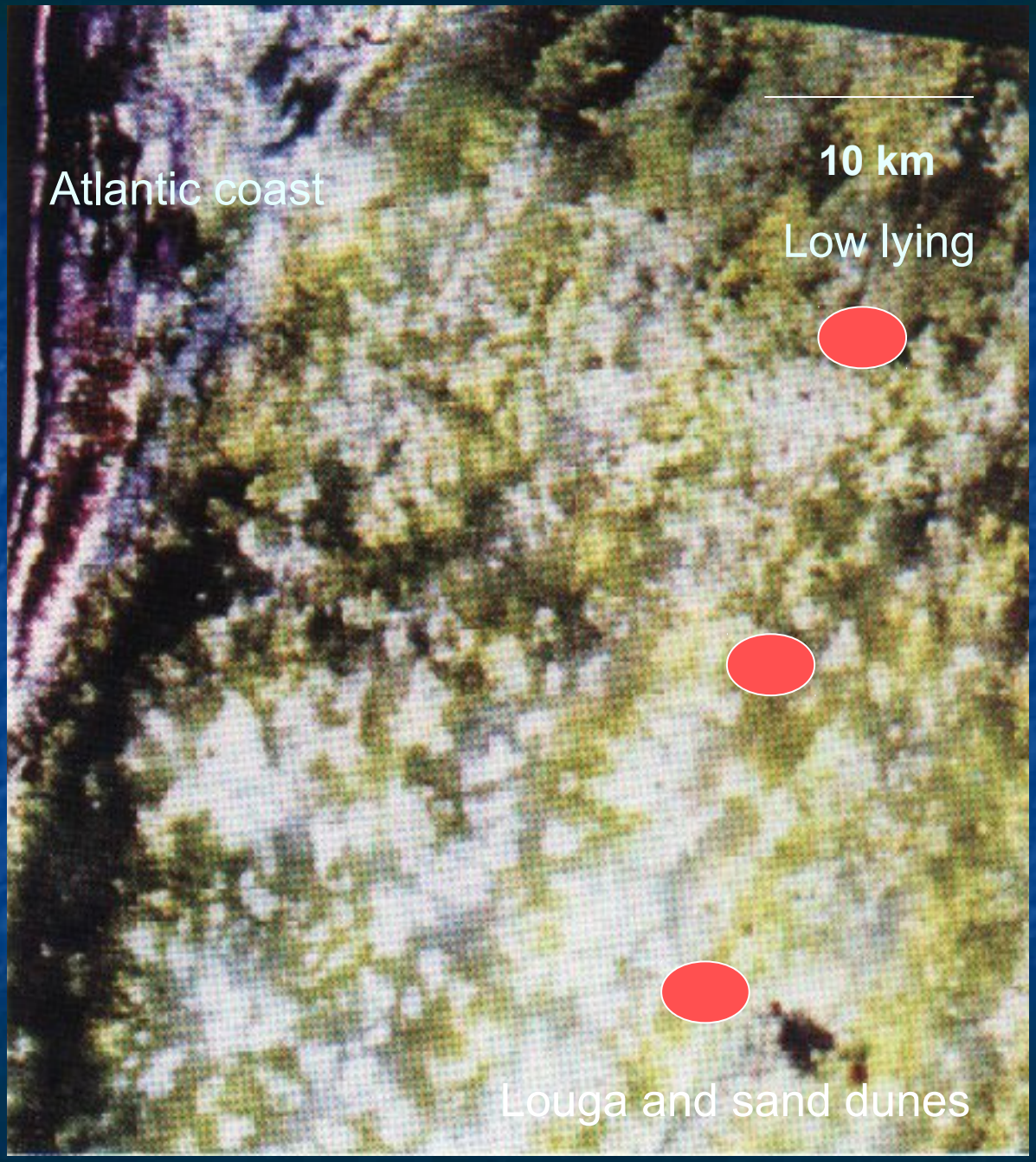
C_s - 29.5 mg/l

R_d - 25 mm yr

T - 27 yr

Renewable or non-renewable water? Chad Basin aquifer

- In the Manga grasslands with 434 mm rainfall present day recharge rates are 10% of rain (mean 44 mm/yr) and except in years of severe drought have even been sufficient to maintain shallow lakes.

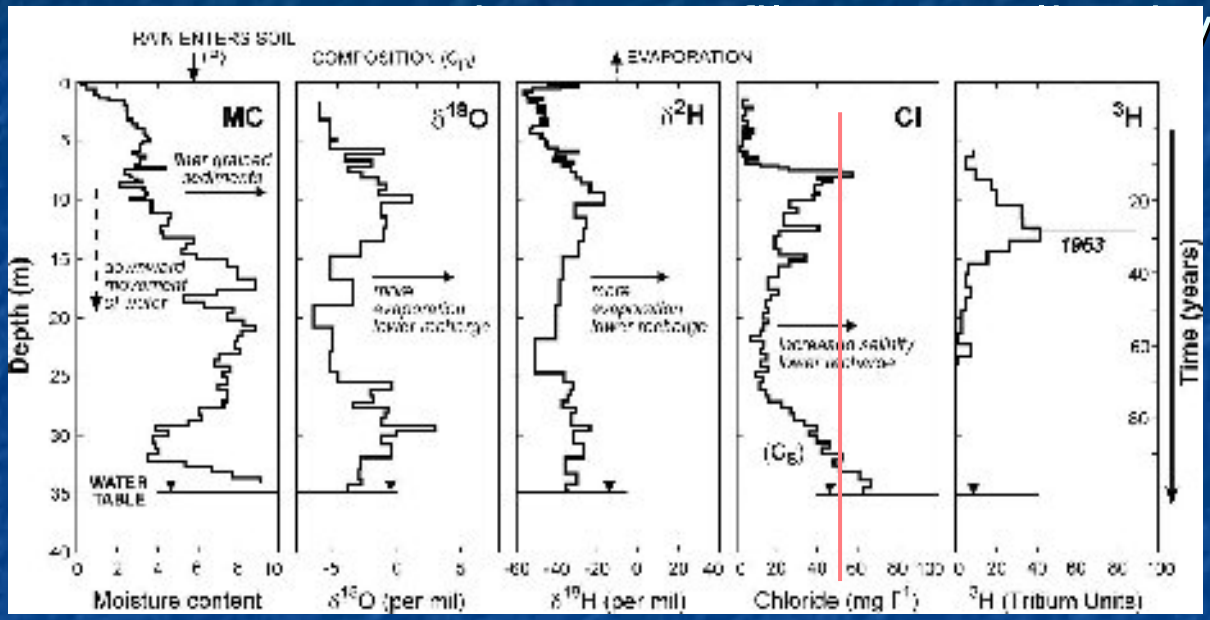


Spatial variability of salinity and recharge

Louga, Senegal

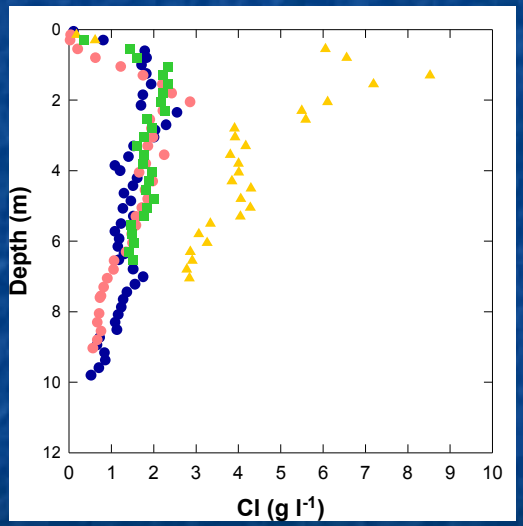
Renewable or non-renewable groundwater?

Measurement of recharge rates using salinity and isotopes in [illegible] hand augur



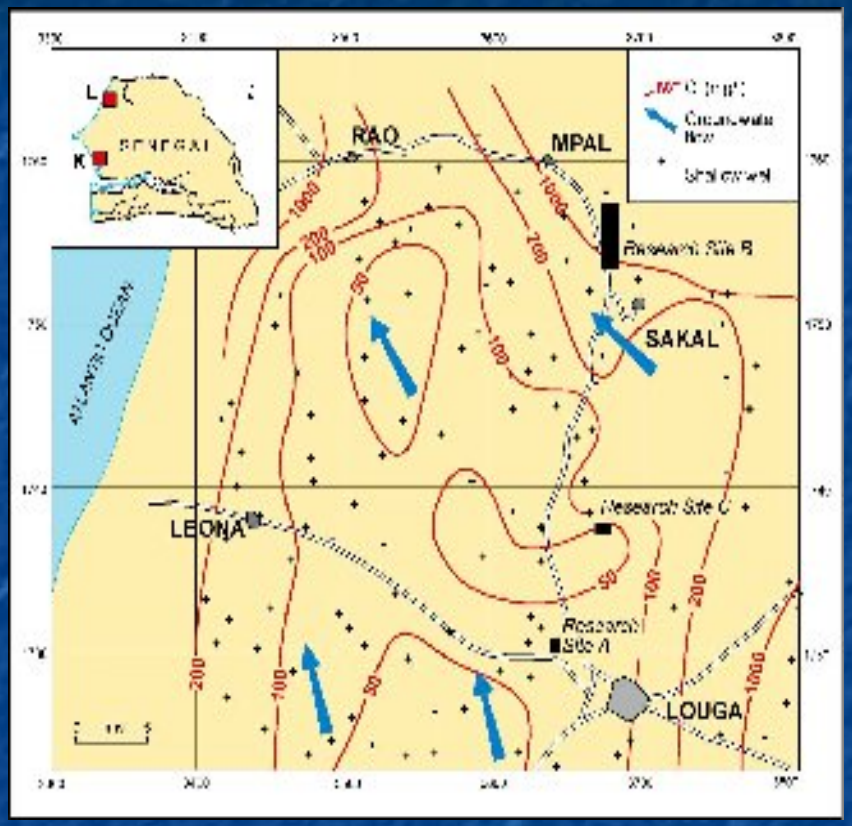
Northern Senegal
34mm/yr recharge

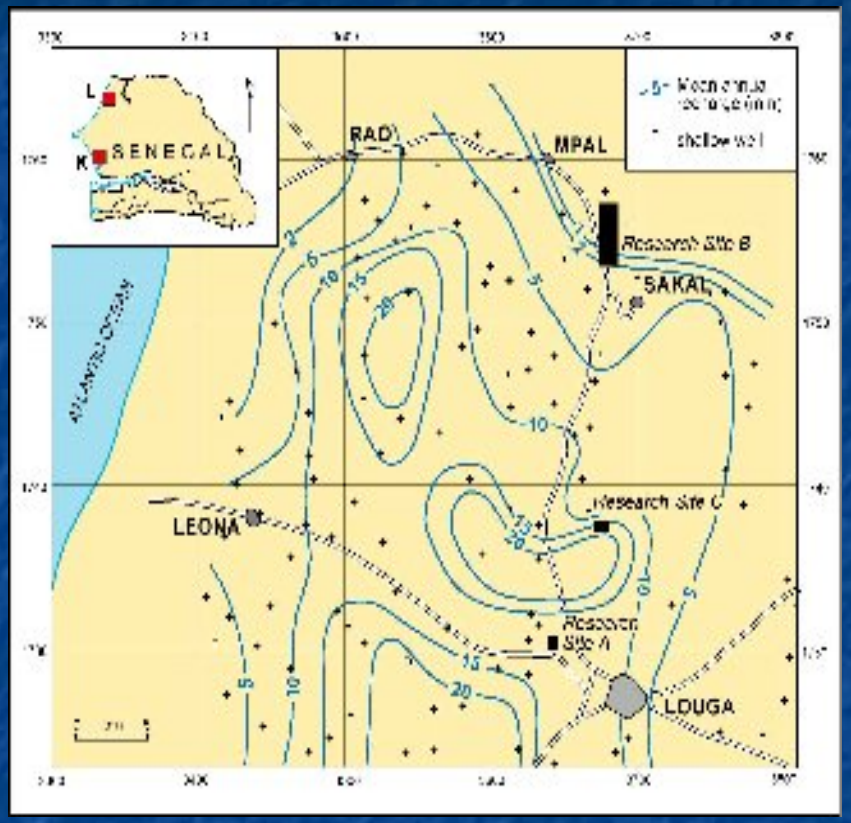
Sudan – zero recharge (salinity accumulation!)



Regional Cl Distribution - limits to potability

Samples from village wells - Louga Senegal





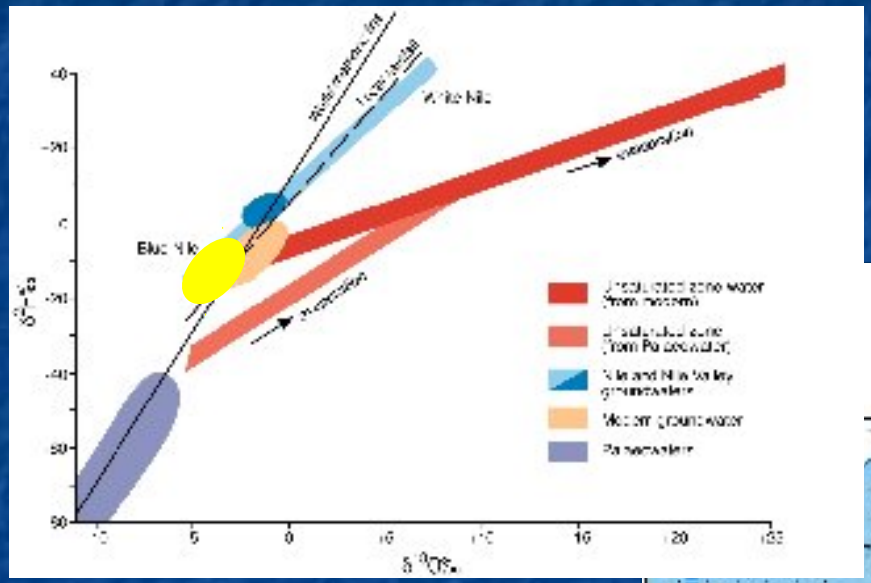
Cl gradients reflect the spatial distribution of recharge with higher values in NE and E reflecting the edge of the dune field and a change in geology.

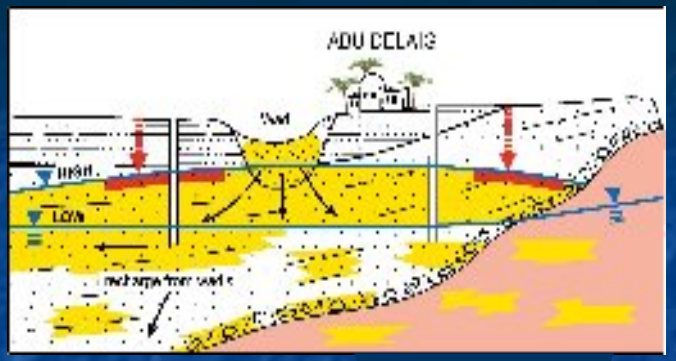
Recharge values may be calculated proportional to recharge in the range 1-20 mm/yr

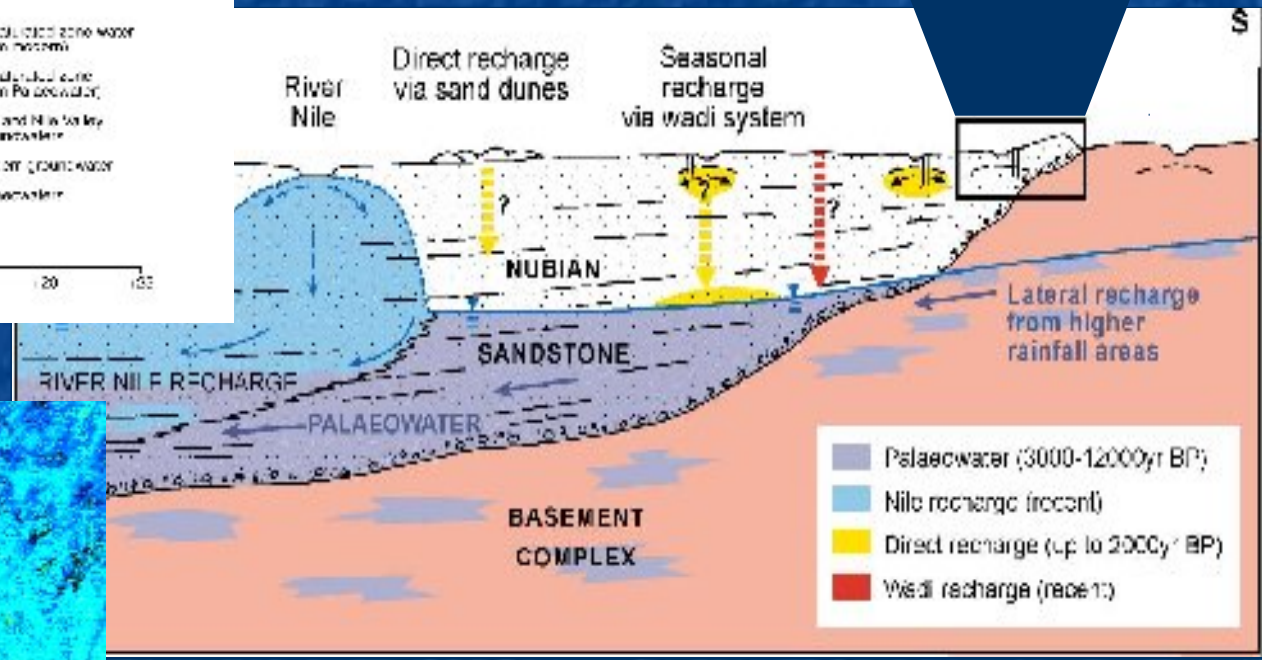
This coincides with the average of profile data at the research sites

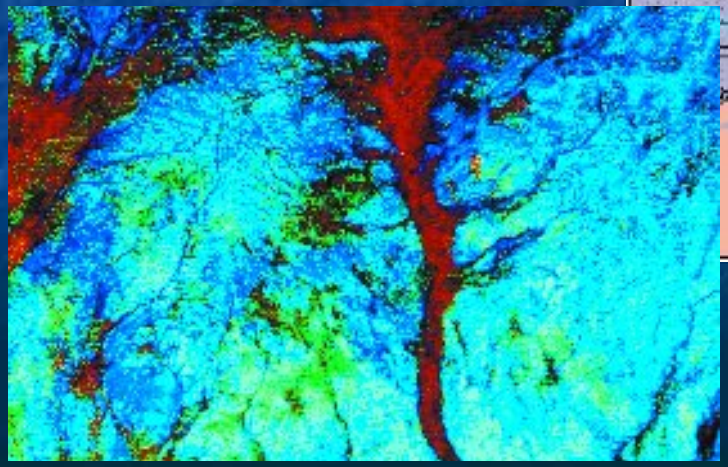
Abu Delaig Sudan

Sources of renewable water resources identified using isotopic fingerprints

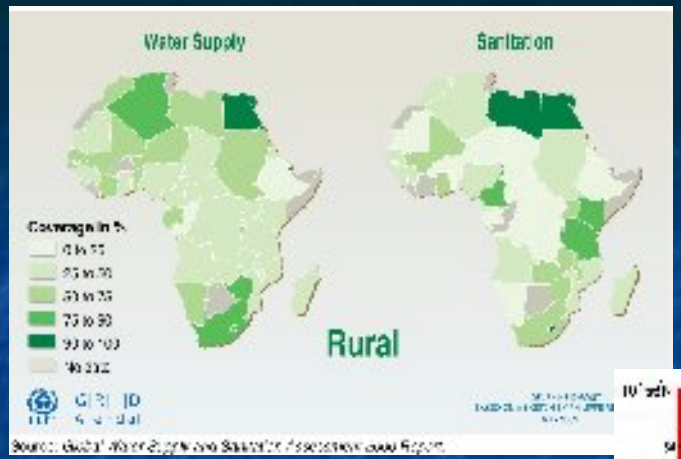




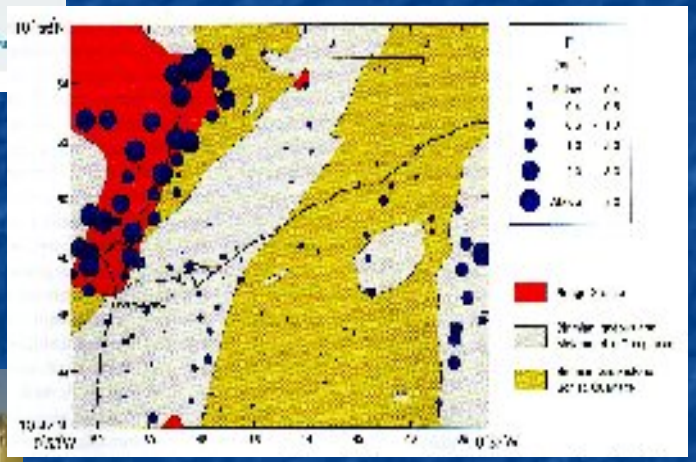




Water security - water quality and health



- Groundwater a source of high purity water with some anomalies eg fluoride

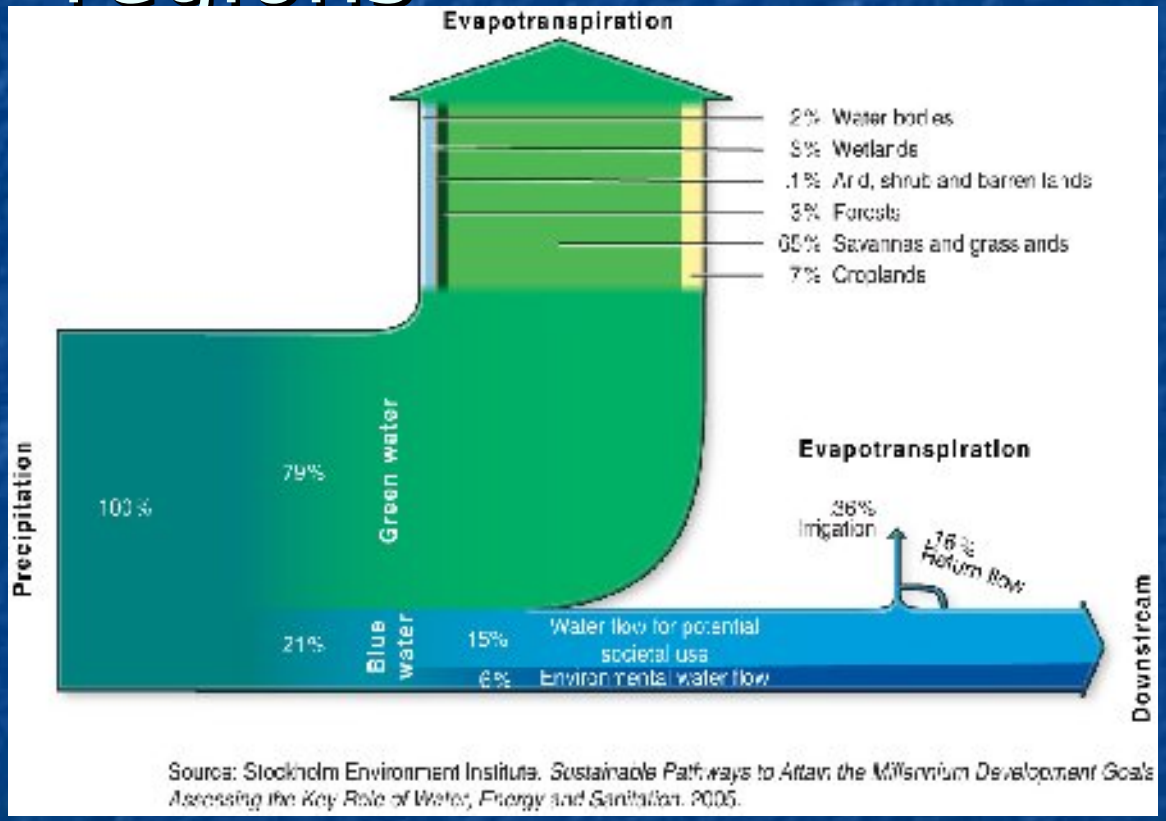


BOLGATANGA

- Most health problems related to contaminated water, poor sanitation and hygiene
- Small scale technology help for drinking supplies

New and improved approaches to water security in rural semi-arid regions

- Traditional knowledge & use
- Water harvesting
- Conservation
- Green water
- Small scale agriculture
- Demand rather than supply led solutions
- Managed Aquifer Recharge



Source: Stockholm Environment Institute. *Sustainable Pathways to Attain the Millennium Development Goals: Assessing the Key Role of Water, Energy and Sanitation*. 2005.

Saving the rain

- Green water – rainfed aqriculture and groundwater recharge
- Water harvesting structures - soil moisture and aquifer recharge
- Underground storage (MAR)

Holistic rural development based on water security

efficient and productive uses of domestic water

- Paradigm shift – construct water systems where resources, system capacity and user demand can deliver water beyond basic needs to allow for small-scale productive uses (livestock, gardens, business) for food, health and dignity
- Integration of technical, social and economic aspects of this approach on a “water first” basis

Avoiding past mistakes ...

dopting soft engineering approaches..

Some conclusions

Africa water solutions and capacity development

- Need to focus on rural water solutions within sustainable resource limits; holistic development based on “water first”
- Need to work within renewable water resource base
- Improved rainwater harvesting initiatives including cisterns, aquifer recharge
- Better management of information systems for benefit of all – valuing data
- Water efficiencies, groundwater controls, agricultural adaptation
- Putting the poor first: Policy failure is increased when the incentives, preferences and choices of the poor are ignored
- Capacity building and raising awareness at all levels;
- Community involvement in programmes

Awareness raising and communication