Groundwater-dependent ecosystems

S. Vassolo

World Water Week
Stockholm
27th August 2018

Definition

- GDEs rely on groundwater (permanently or irregularly) to survive
  → Maintenance of plant and animal communities, ecological processes, and ecosystem services

Classification

1. Cave and aquifer ecosystems (stygofauna)
2. Ecosystems dependent on aquifer discharge (river base-flow, streams, wetlands, springs, oasis)
3. Ecosystem reliant on groundwater at the rooting depth (via capillarity)

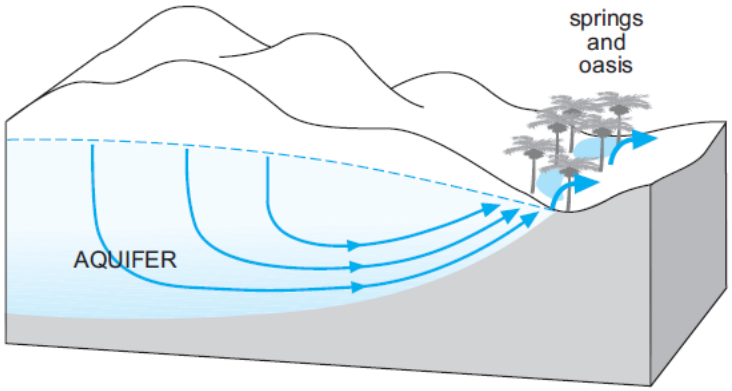
Source: R. Eamus et al. (2015)

Importance

- **Water quality benefits**: Microfauna helps to clean up pollutants
- **Biodiversity**: Many species depend on groundwater discharge. They add to the ecological diversity of a region
- **Archaeological and social value**: Some sites (springs) have cultural significance

GDEs

- Groundwater source (spring, oasis or seepage) that directly irrigates the ecosystem


springs
and
oasis
AQUIFER

GDEs

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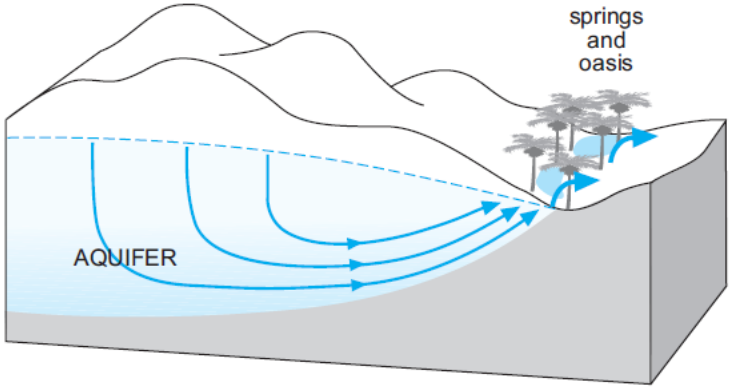
- Groundwater collected in depressions above impermeable strata (clay)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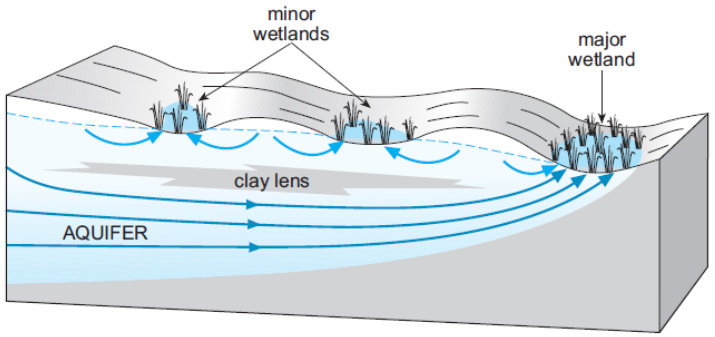
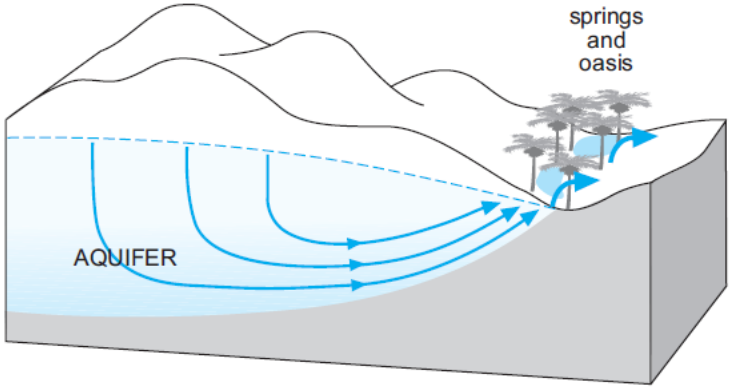

minor
wetlands
major
wetland
clay lens
AQUIFER

GDEs

- Groundwater source (spring, oasis or seepage) that directly irrigates the ecosystem
- Groundwater collected in depressions above impermeable strata (clay)
- High groundwater table that maintains a seasonally waterlogged condition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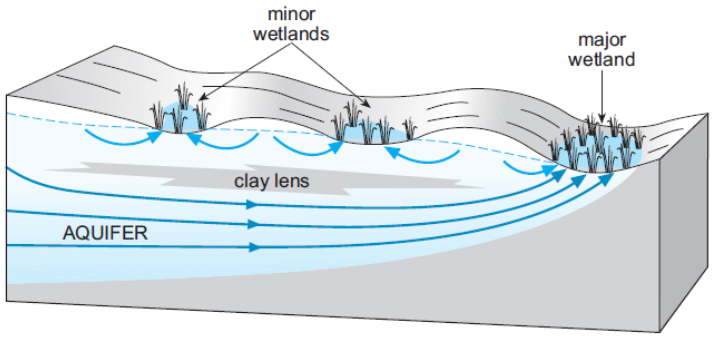
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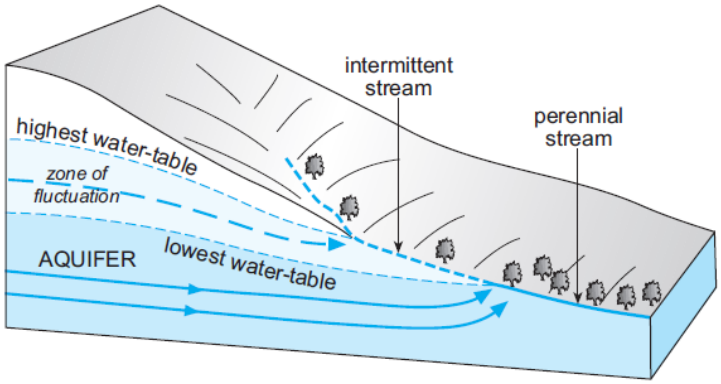
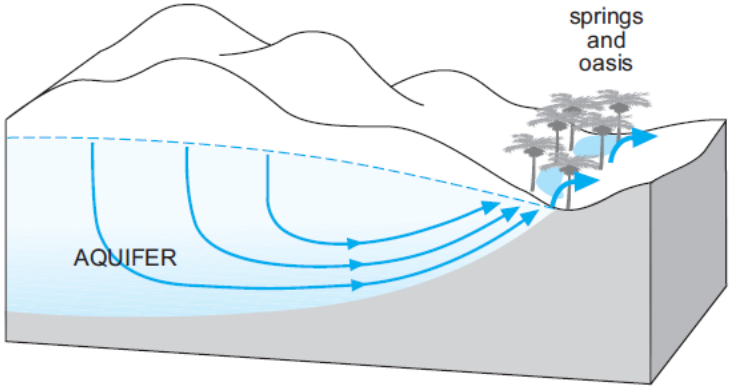

intermittent
stream
perennial
stream
highest water-table
zone of
fluctuation
AQUIFER
lowest water-table

GDEs

- Groundwater source (spring, oasis or seepage) that directly irrigates the ecosystem
- Groundwater collected in depressions above impermeable strata (clay)
- High groundwater table that maintains a seasonally waterlogged condition
- Discharge of groundwater into coastal lagoons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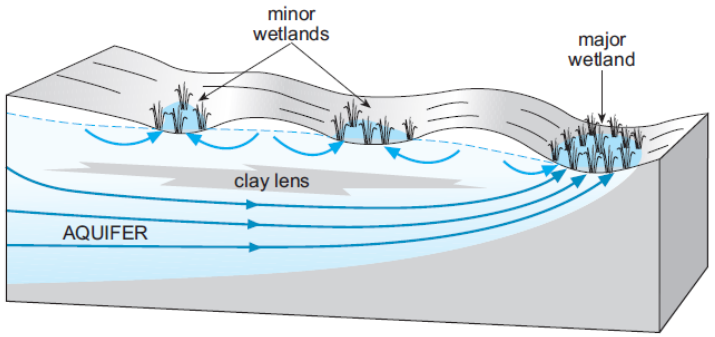
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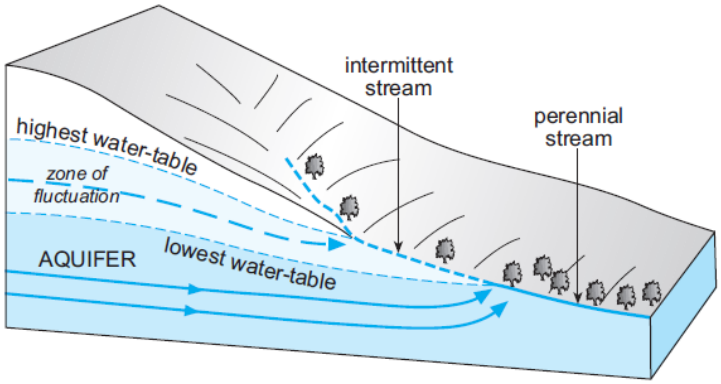
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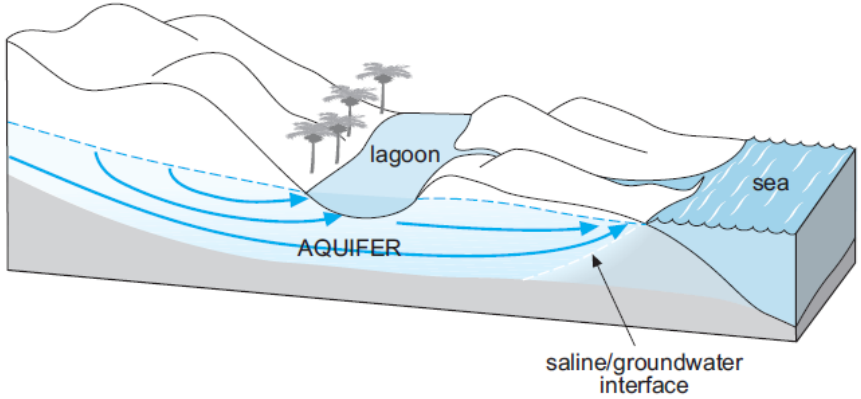
lagoon
sea
AQUIFER
saline/groundwater
interface

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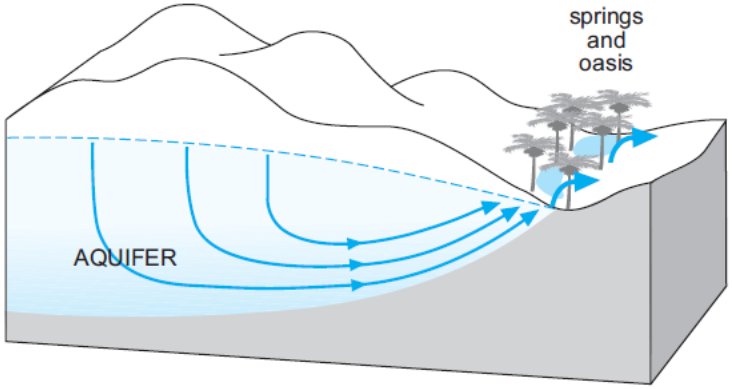
- High groundwater table that maintains a seasonally waterlogged condition
- Discharge of groundwater into coastal lagoons
- Deep-rooted vegetation that extracts water from water-table (dependency increases with aridity of the environment)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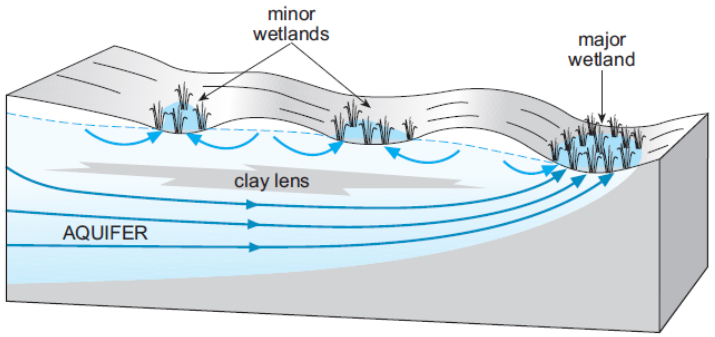
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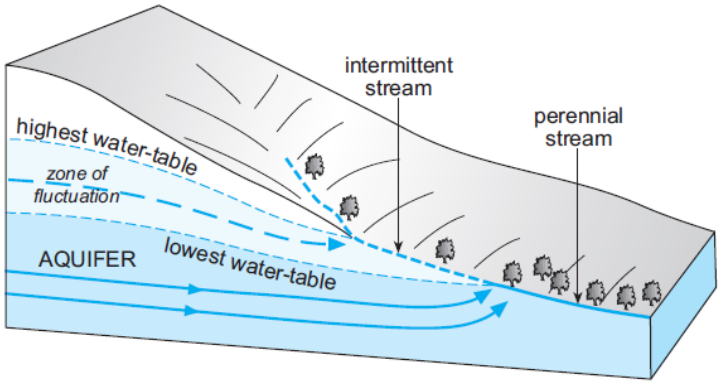
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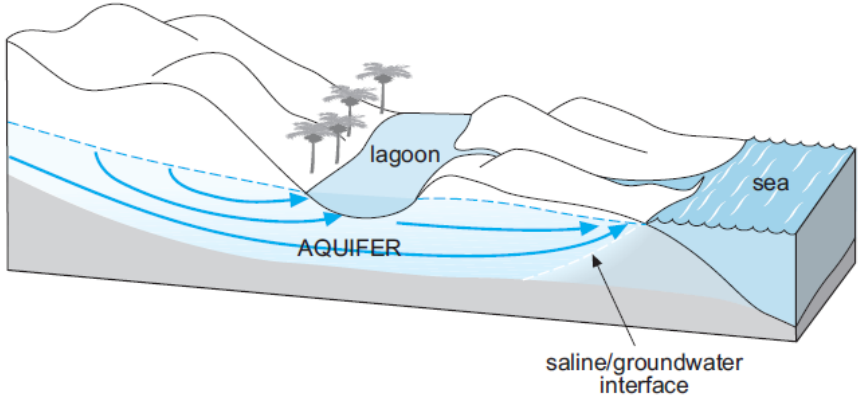
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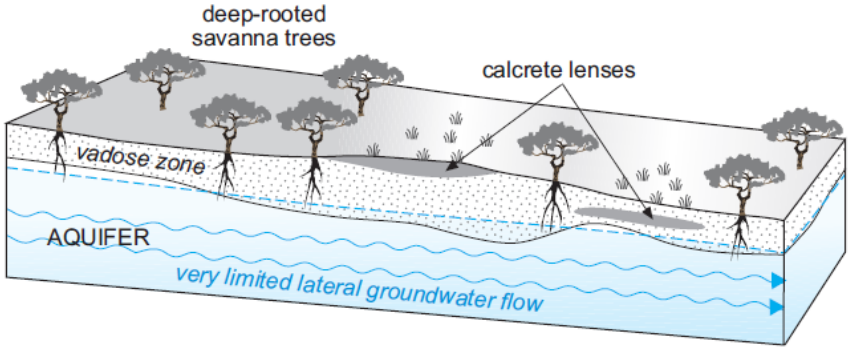
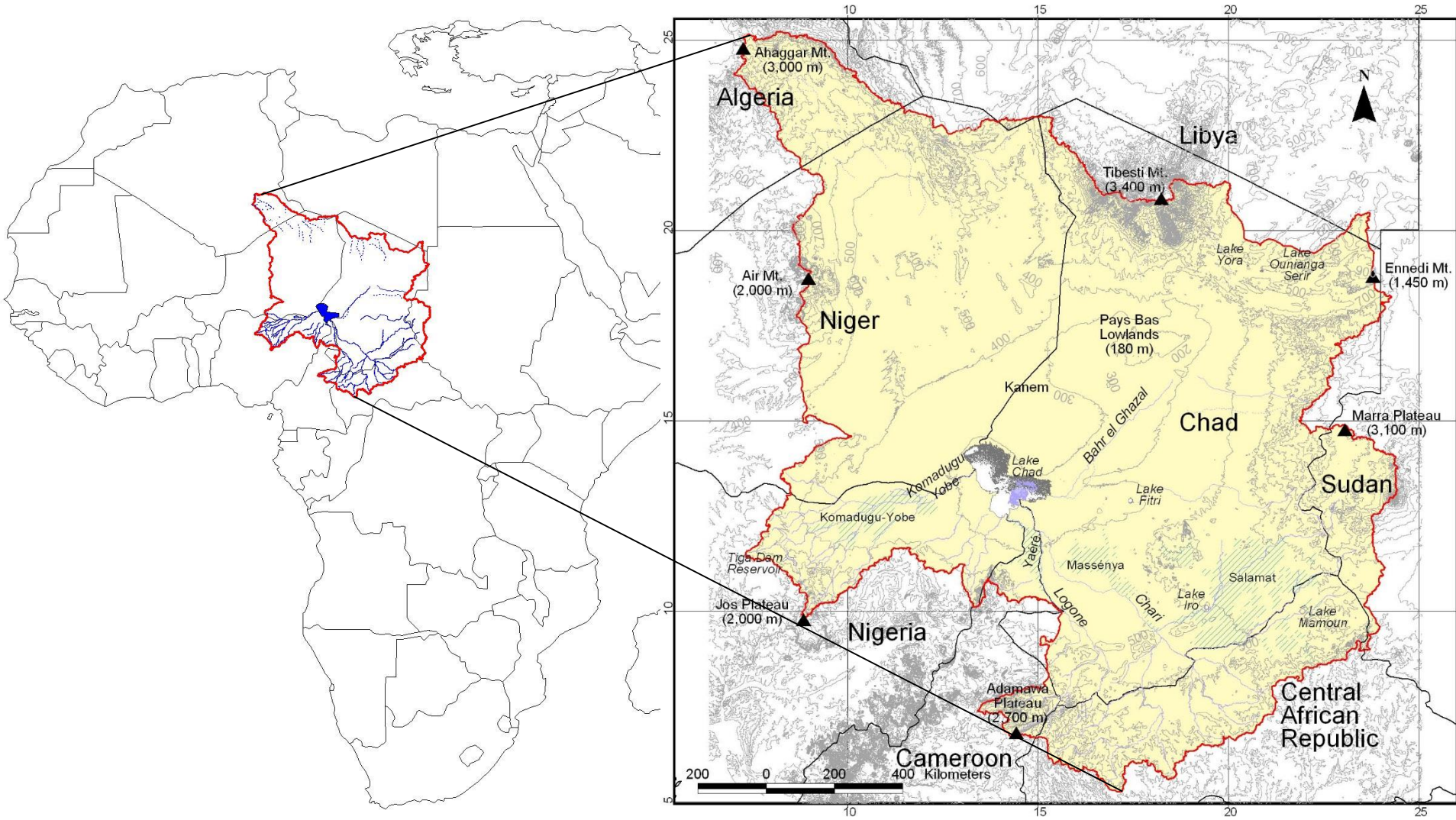

deep-rooted
savanna trees
calcrete lenses
vadose zone
AQUIFER
very limited lateral groundwater flow

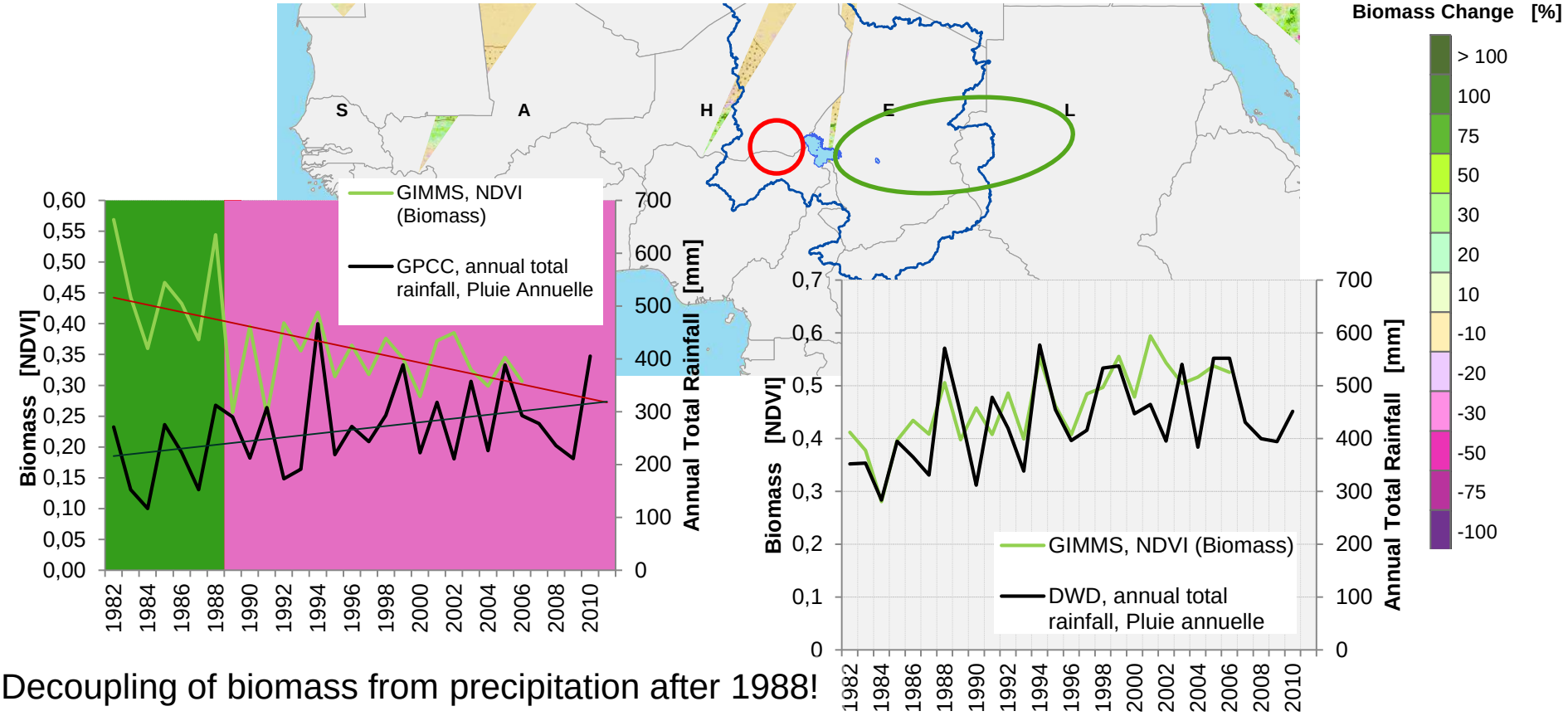


Area of 2,300,000 km²

Biomass Trends 1982-2006

Human driven

Climate driven



Decoupling of biomass from precipitation after 1988!

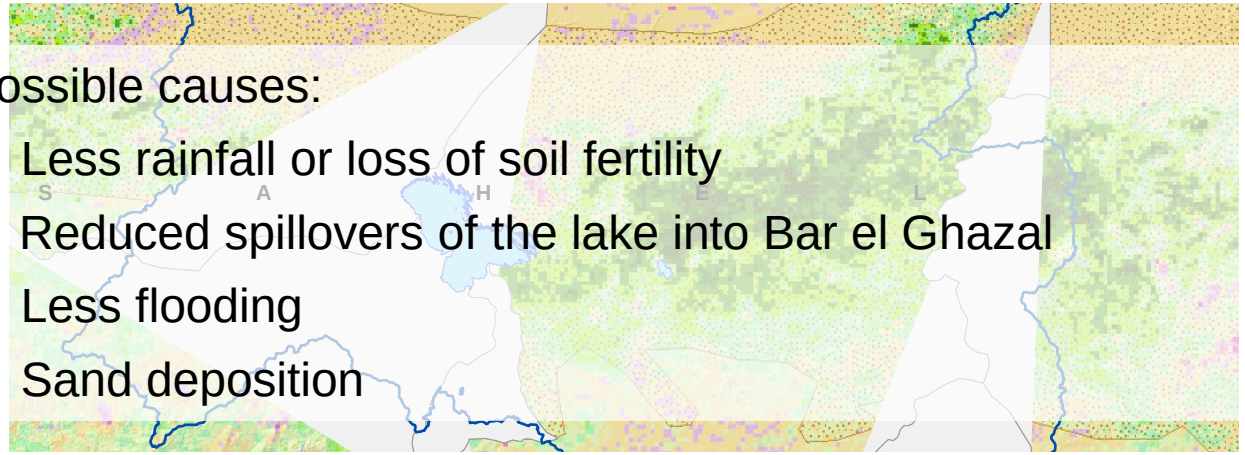
Precipitation driven biomass increase

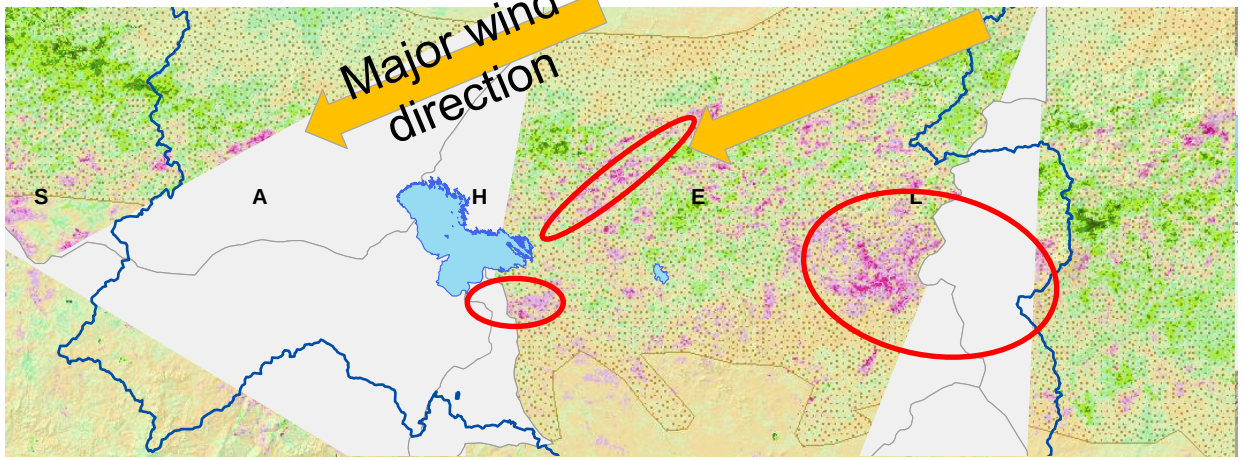
Biomass Trends

Possible causes:

- Less rainfall or loss of soil fertility
- Reduced spillovers of the lake into Bar el Ghazal
- Less flooding
- Sand deposition

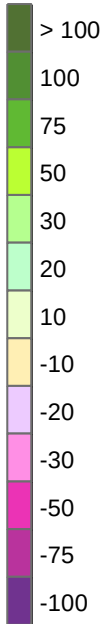
AVHRR
1982 -2006





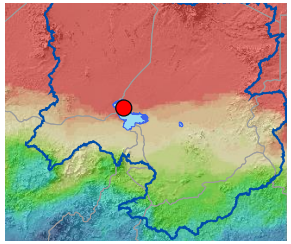
MODIS
2000 -2011

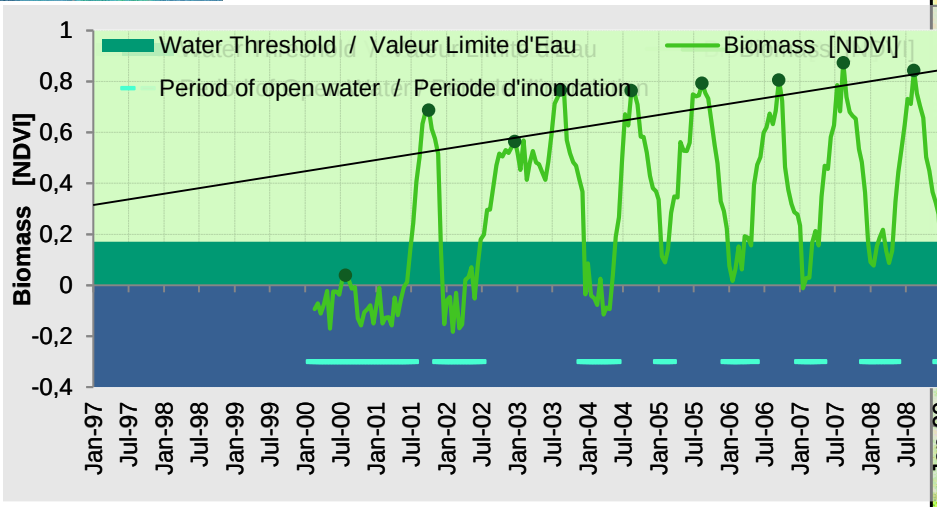
Biomass Change [%]

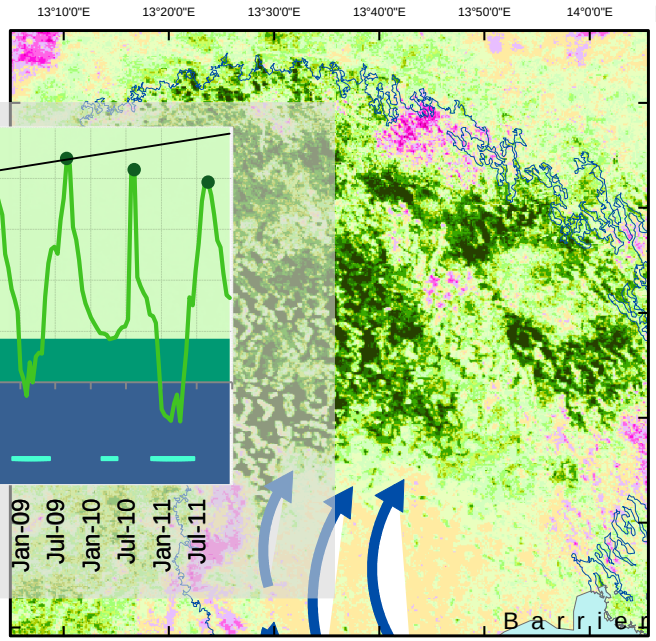


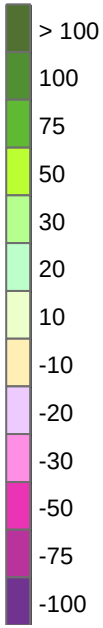
Source: R. Geerken - SiasGlobal

Trend controlled by seasonal flooding









- Annual spill over, but at variable extent
- Flooding causes a drop in NDVI, but an increase in soil moisture boosts vegetation growth

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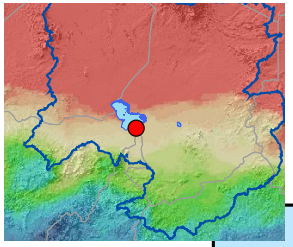
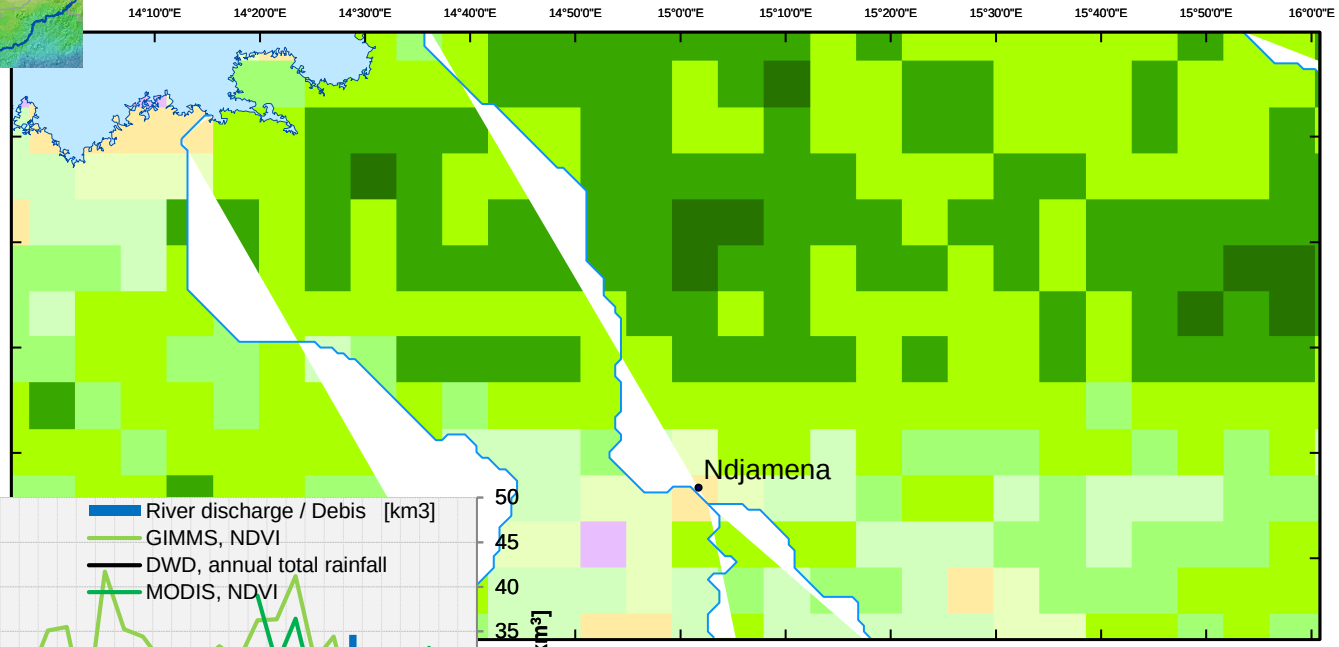
GEOZENTRUM HANNOVER

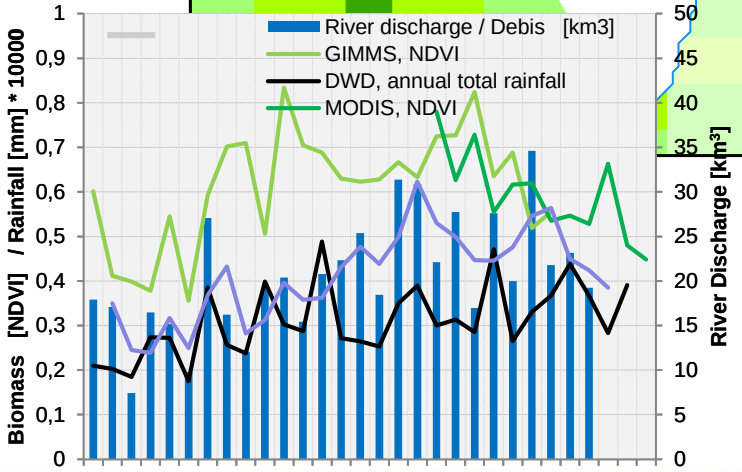
Trend controlled by local rainfall and river discharge





Biomass Change [%]

> 100
100
75
50
30
20
10
-10
-20
-30
-50
-75
-100

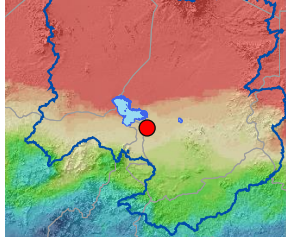


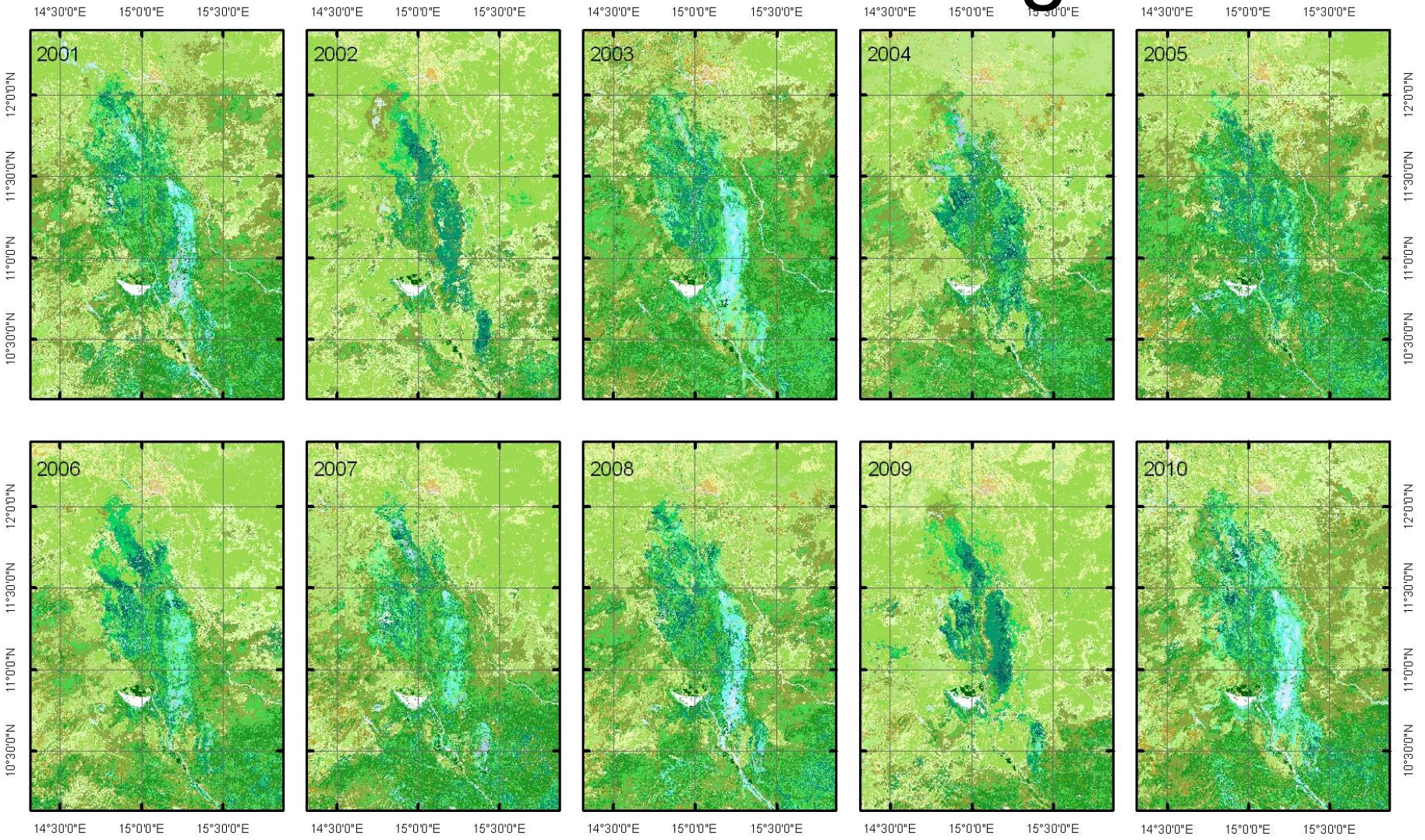
Trends 00-16 (MODIS)

Annual biomass (NDVI) maxima

Source: R. Geerken - SiasGlobal

Wetland controlled by seasonal flooding





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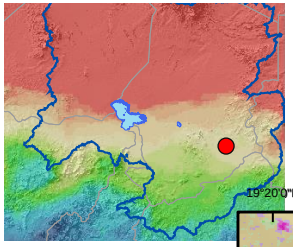
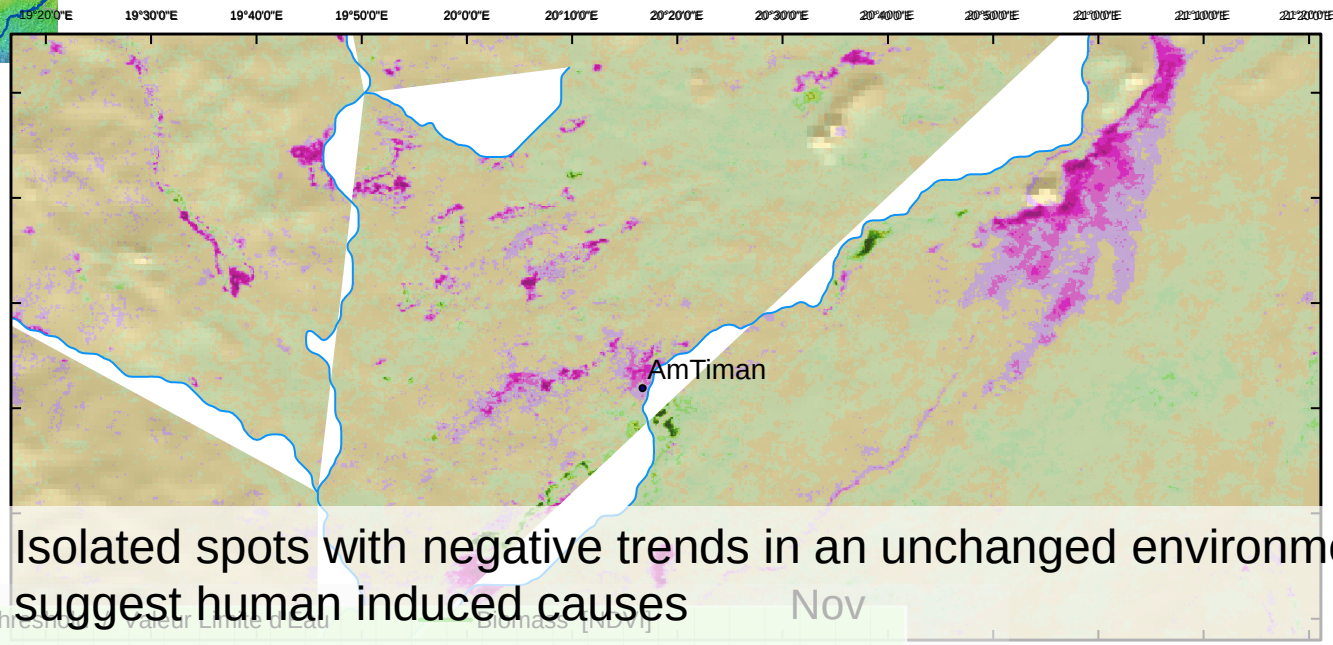
GEOZENTRUM HANNOVER

Negative trend controlled by water damming

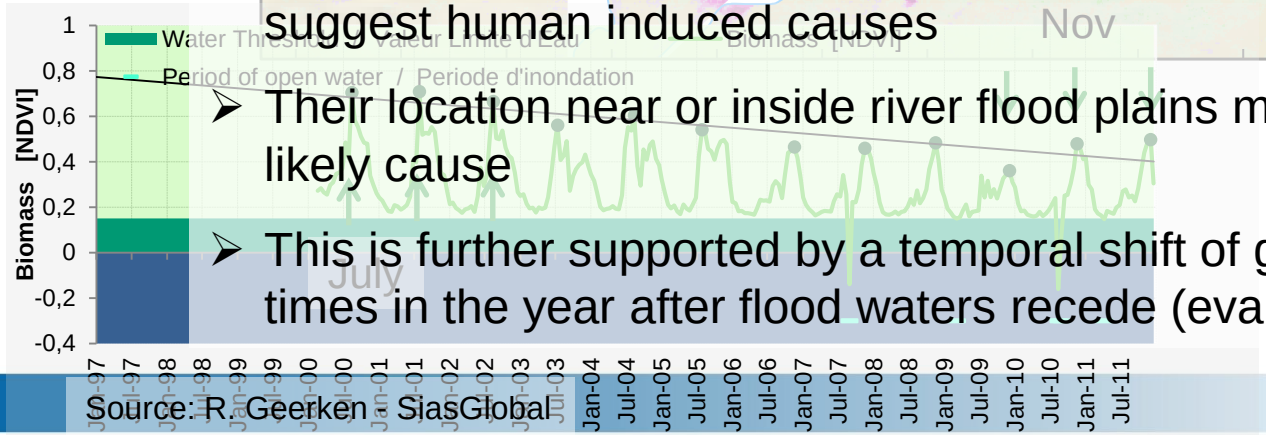




Biomass Change [%]

- > 100
- 100
- 75
- 50
- 30
- 20
- 10
- -10
- -20
- -30
- -50
- -75
- -100

- Isolated spots with negative trends in an unchanged environment suggest human induced causes
- Their location near or inside river flood plains make flooding a very likely cause
- This is further supported by a temporal shift of green peaks to later times in the year after flood waters recede (evaporate)



Source: R. Geerken - SiasGlobal

Conclusions

- Although NDVI trends are controlled mainly by surface water, vegetation is maintained by groundwater

→ Deep-rooted vegetation that extracts water from water-table

Why care?

- Lack of control over groundwater resources development and protection has a huge impact on ecosystems
- There is a need to make **groundwater use and environmental conservation more compatible**

Thanks!