Droughts, floods and erosion: Climate change in arid Southern Morocco and its challenges for a sustainable land use

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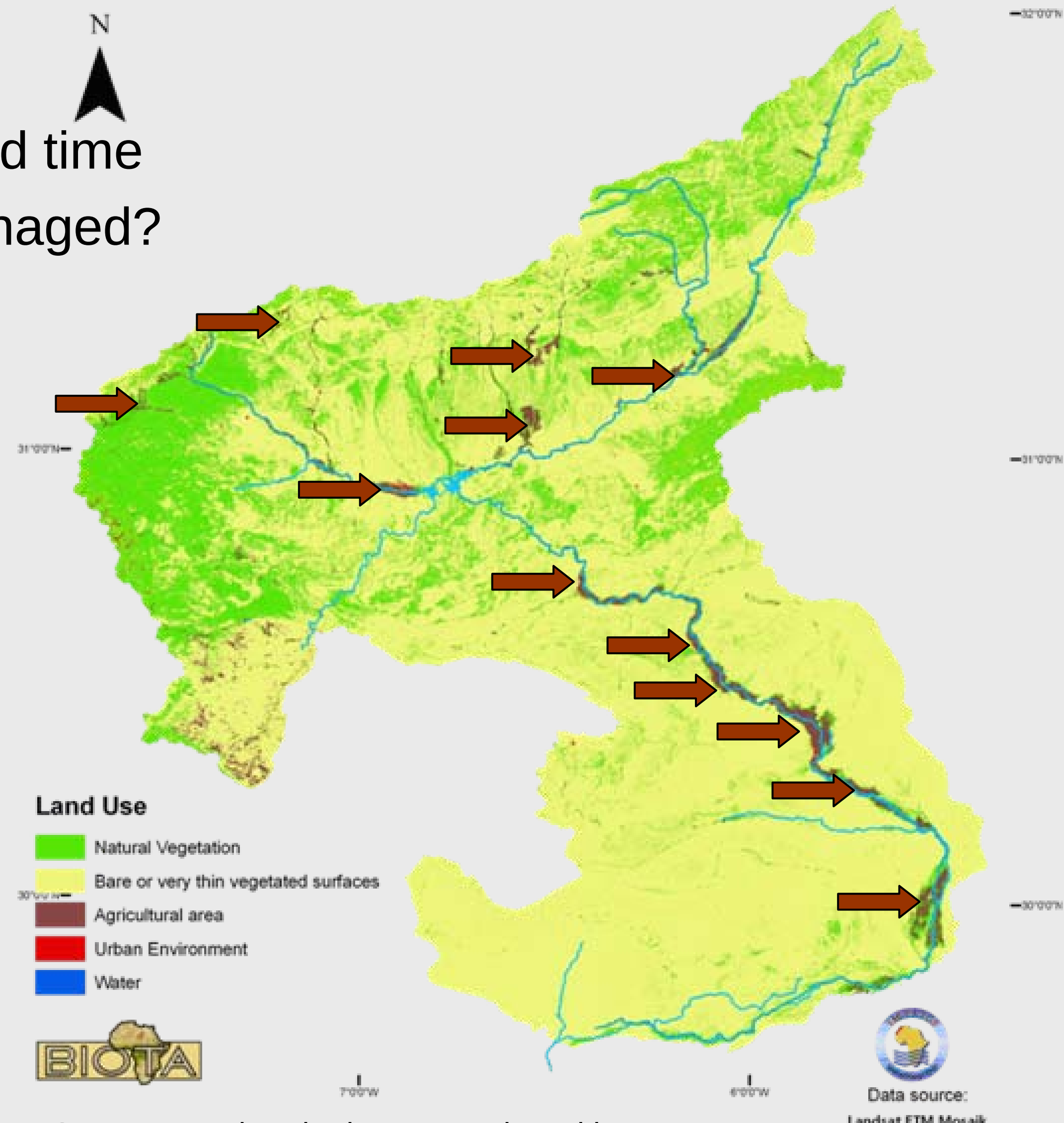
Land use and water in Morocco: Today

- Drâa region**:** Water a **highly variable resource** in space and time
- How are water resources managed?

- **Oases:** Agricultural area; water scarcity buffered by natural storage and management
- **Outside oases:** Rangelands; water resources mostly indirectly managed (by **range management**)

- Local range management is **adapted** to variable water and fodder resources



Source: P. Fritzsche in cooperation with M. Finckh (BIOTA Maroc), IMPETUS Atlas 2008

Land use and water in Morocco: Tomorrow

What changes do we expect for the future?

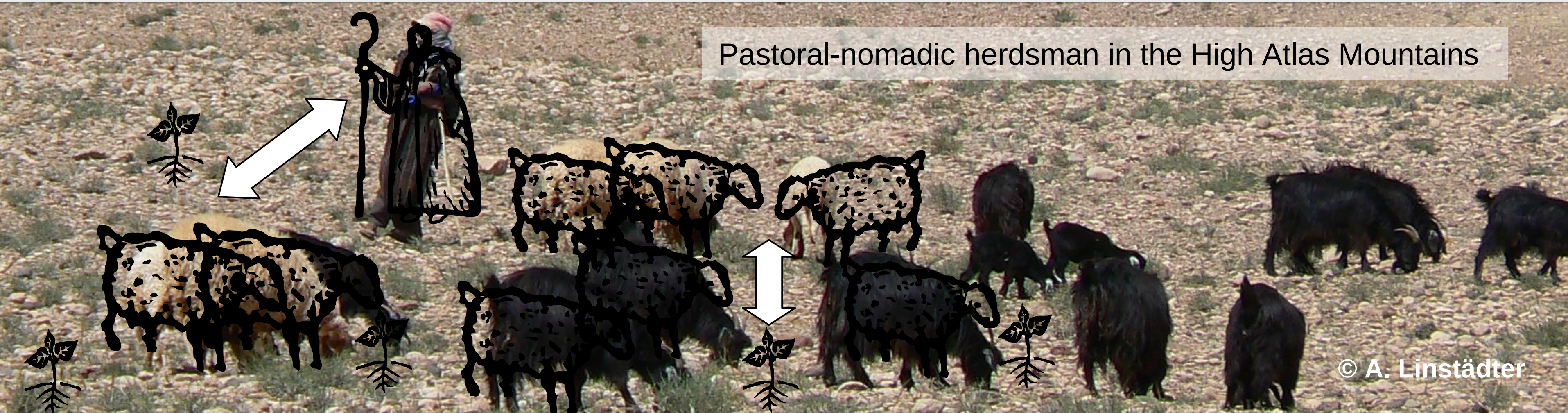
→ **Extreme weather events** will occur more often

How can land use adapt to these changes?

→ Identify **key traits of local land management** mitigating negative effects of extreme weather events; come to process-understanding

How to find key traits of a sustainable management?

- Research has concentrated on management of **resource scarcity**
- IMPETUS: Broadened, interdisciplinary approach
- Focus on local ecological knowledge and related management decisions

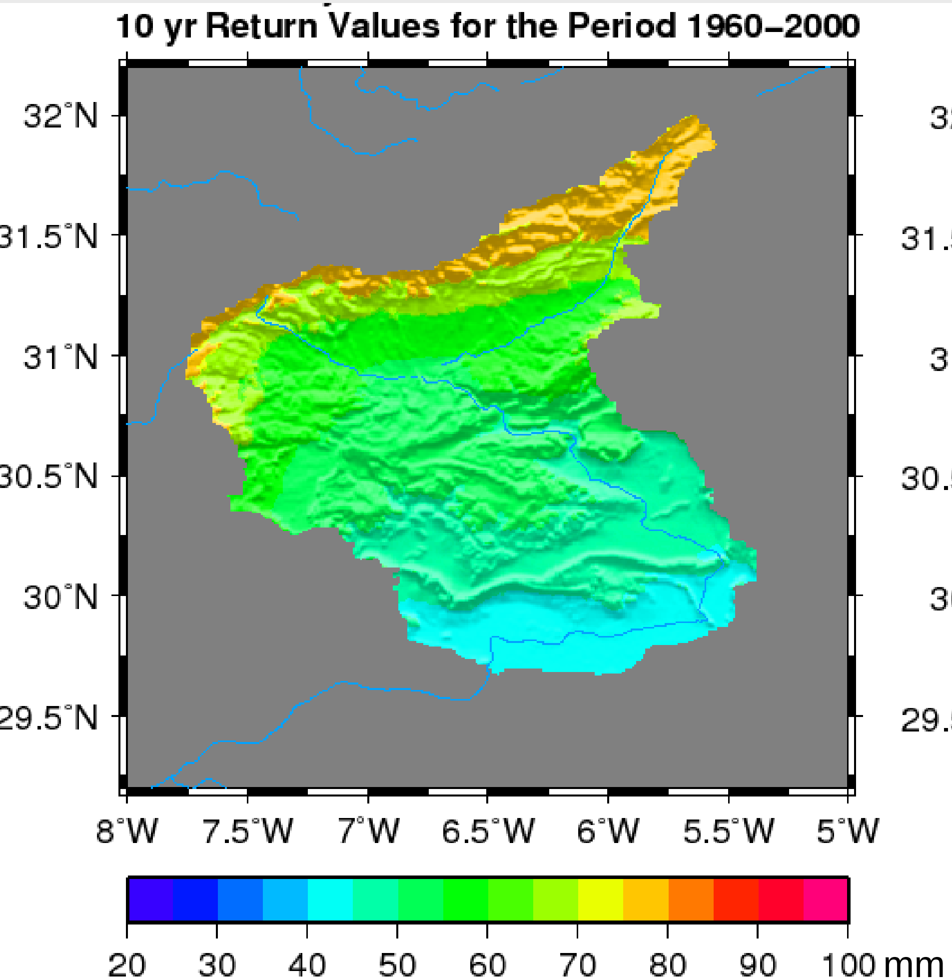


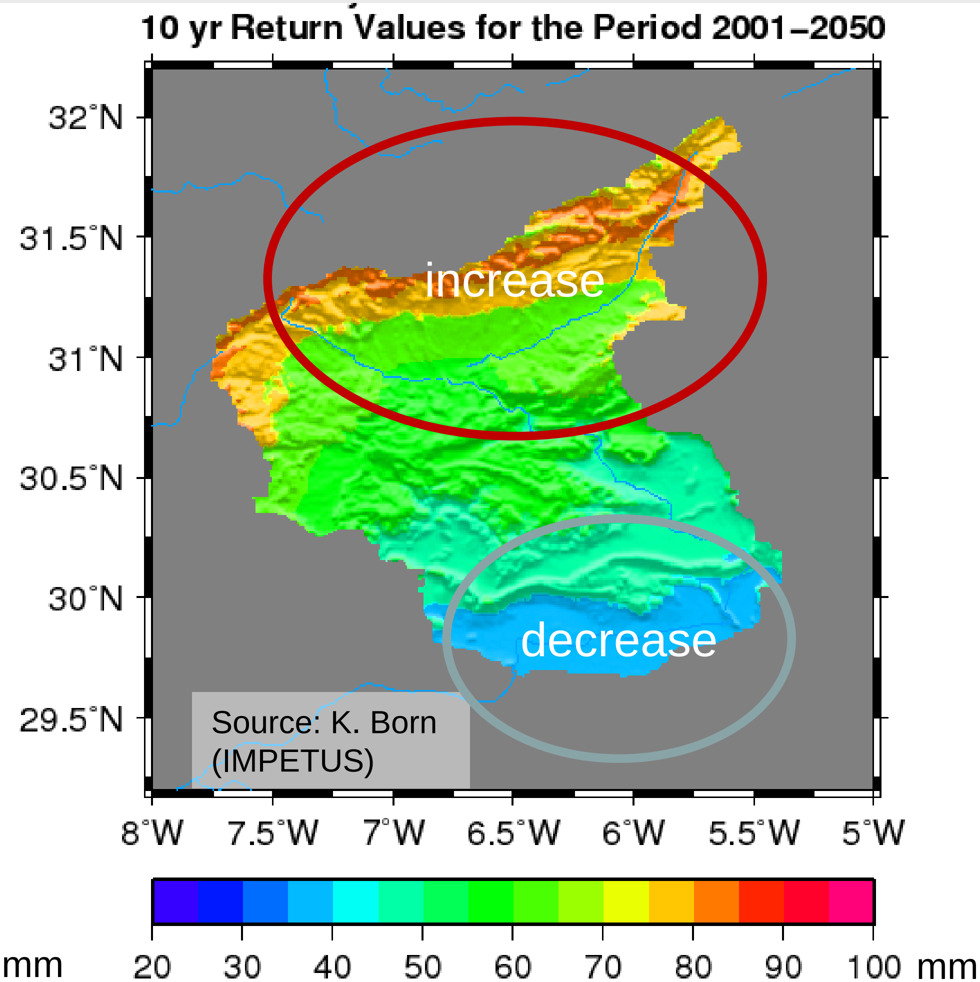
Pastoral-nomadic herdsman in the High Atlas Mountains

Extreme event: Days with severe rainfall

…will occur more often in the future

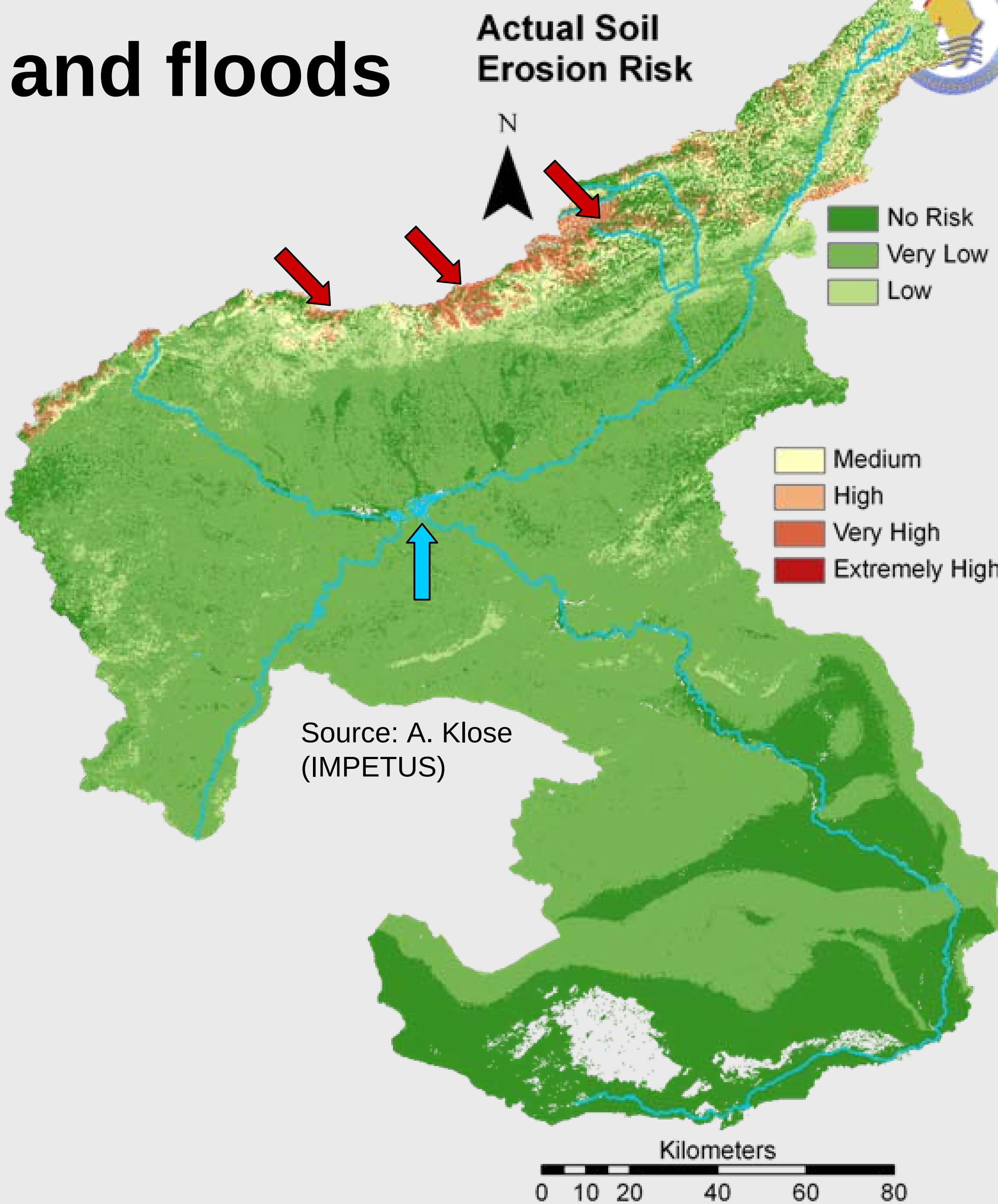
Present day… **…and future daily rainfall**





Effects: Erosion and floods

- Erosion risk is estimated with **PESERA model** (**P**an **E**uropean **S**oil **E**rosion **R**isk **A**ssessment)
- **Results:** highest erosion rates on the steep slopes of the High Atlas Mountains
- **Onsite effects:** pasture degradation in High Atlas
- **Offsite effects:** silting of reservoir Mansour Eddahbi; Reservoir lost already > 25% of its original capacity



Erosion: Climate scenario of increased rainfall variability

Scenario assumptions for 2020

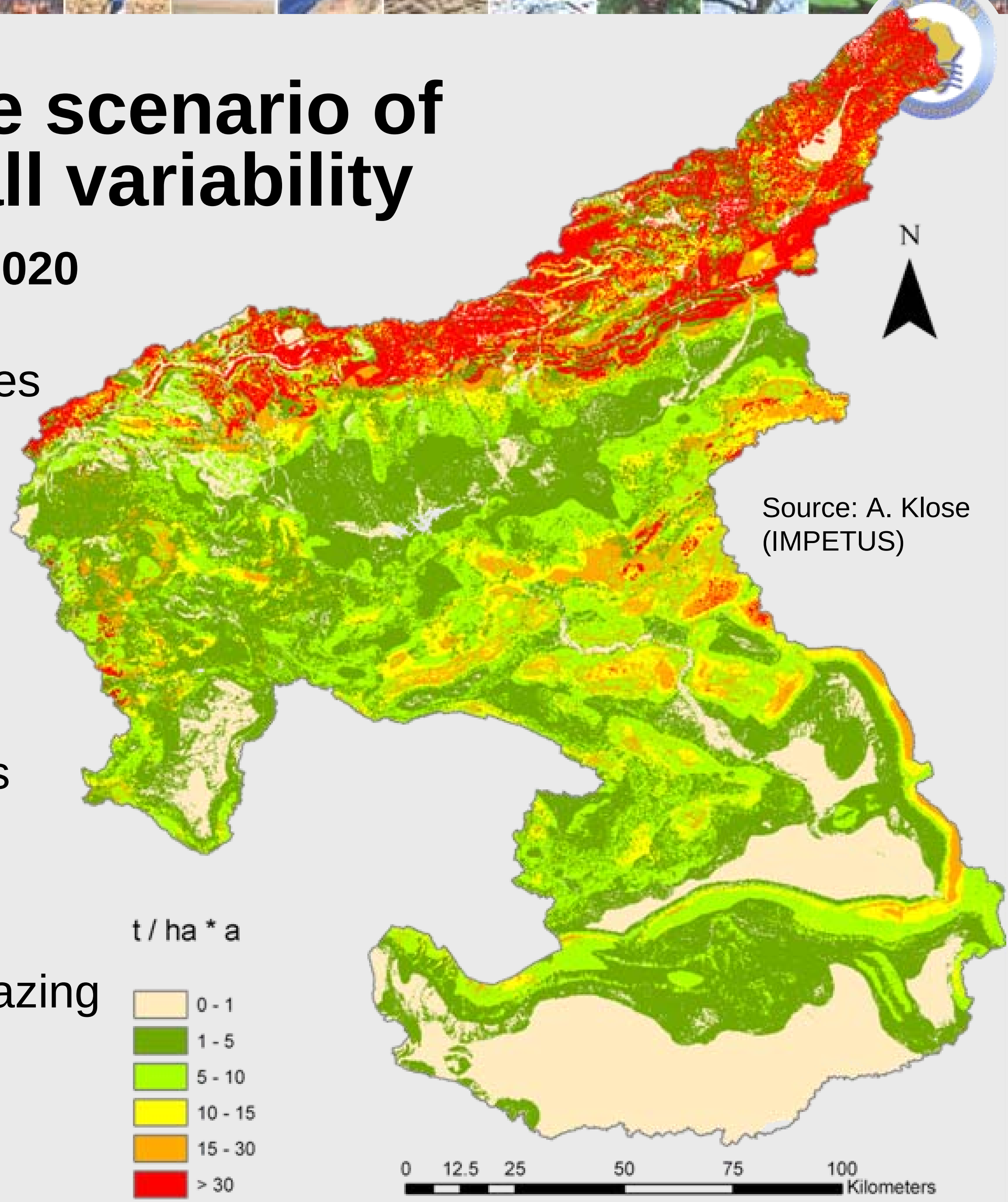
- Temperature rise of 3°C
- Precipitation: variability rises by 30%

Results

- Higher evapotranspiration
- Sparser vegetation cover
- → Overall higher erosion rates: Plus of 9.2 t/ha/a
- Main problem in High Atlas

What can we do?

- Sustainable range management in High Atlas mountains to avoid overgrazing
- Afforestation
- Small dams as buffers



Source: A. Klose (IMPETUS)

Reducing erosion via afforestation

Scenario assumptions for 2020

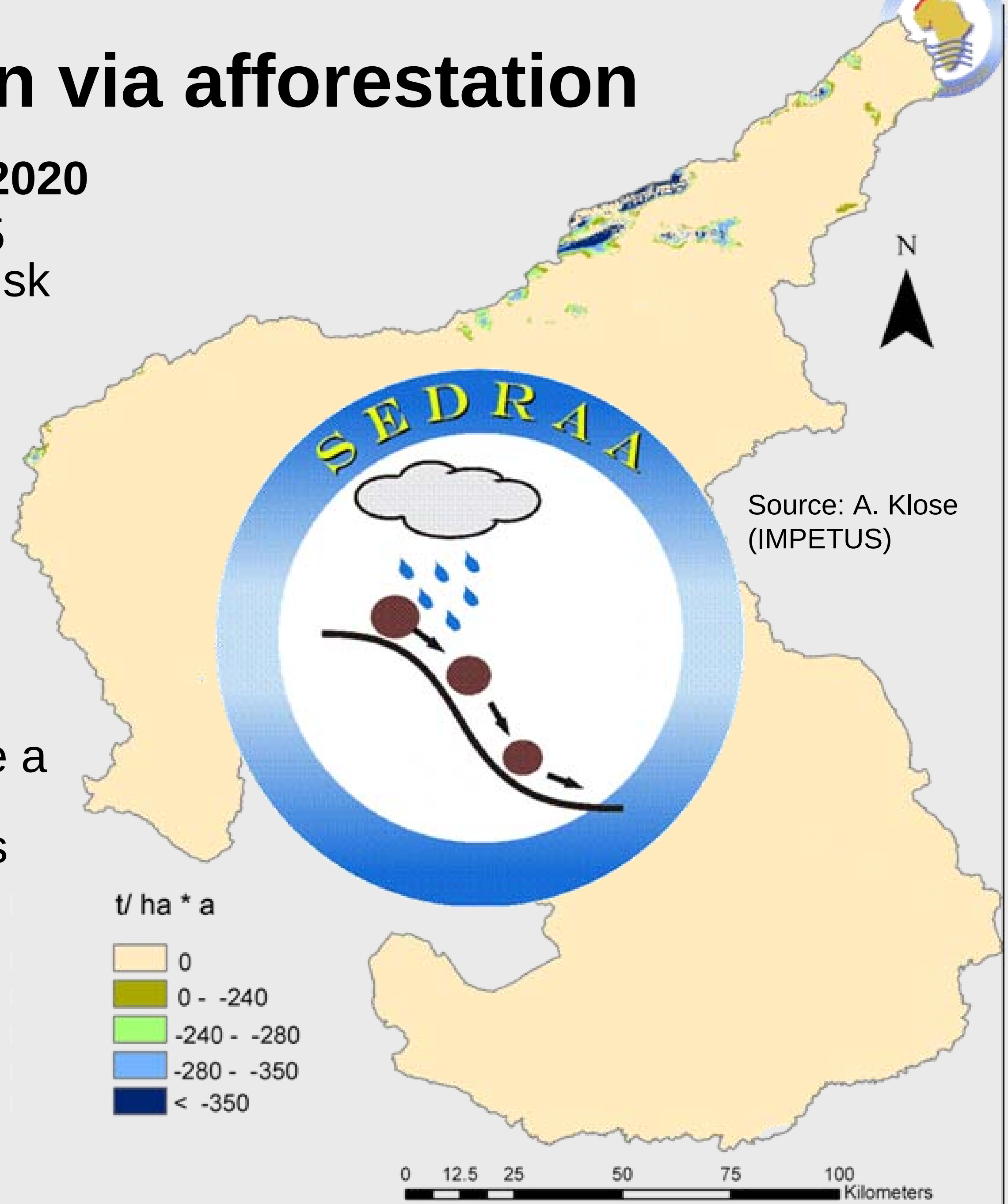
- Virtual afforestation of 275 km² with highest erosion risk

Results

- Size of the zone under extreme erosion risk can be reduced by 83 %
- In reservoir catchment: reduction of 6.1 t/ha/a

Conclusions

- Local afforestation may be a promising measure, but restricted to suitable areas
- See Posters P26, P27
- Please try related SDSS SEDRAA!`



Source: A. Klose (IMPETUS)

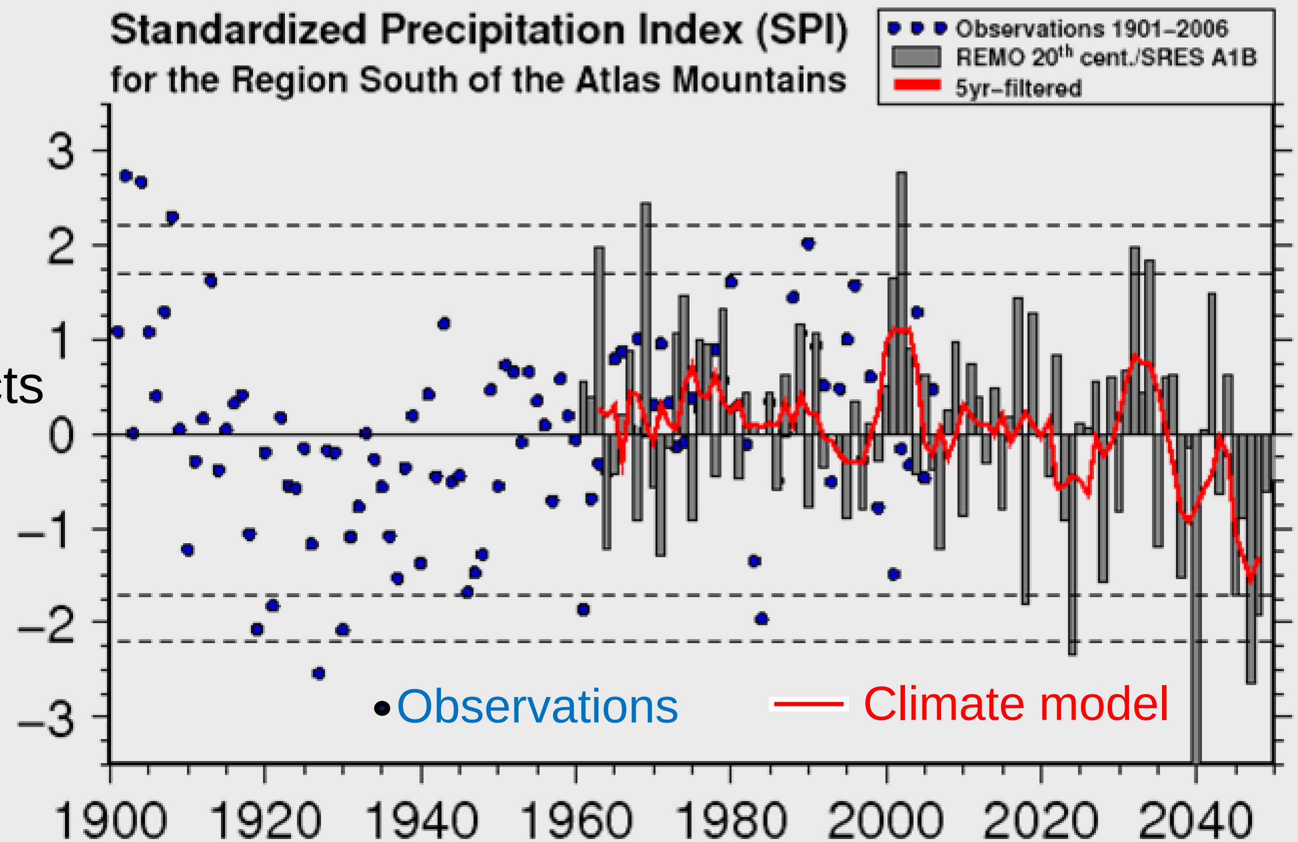
Extreme event: Drought years

…will also occur more often in the future

Meteorological drought may be translated to other levels of resource scarcity:

- to the level of available fodder/agric products **(agronomic drought)**
- to the level of economic activities **(socio-economic drought)**

In future, annual rainfall will drop more often below SPI values < -2 (severe drought)



Source: K. Born (IMPETUS)

Effect: Agronomic Drought

= Scarcity of available forage

Amount of available forage depends on:

- Plant productivity (ANPP), which highly depends on rainfall
- Storage of fodder on pastures

→ Available forage determined with methods of **vegetation ecology:**

- Long-term grazing exclosures (together with BIOTA Maroc)
- Productivity experiments
- Vegetation relevés

Detailed information on **functional changes** in the vegetation related to abiotic site conditions (climate, soil) and to grazing, but only on point scale

Long-term grazing exclosure and weather station in the High Atlas mountains (established 2001, since 2006 jointly maintained with BIOTA Maroc)

Small cages in the High Atlas mountains to measure annual productivity

Effect: Agronomic Drought

Available forage also determined with methods of remote sensing:

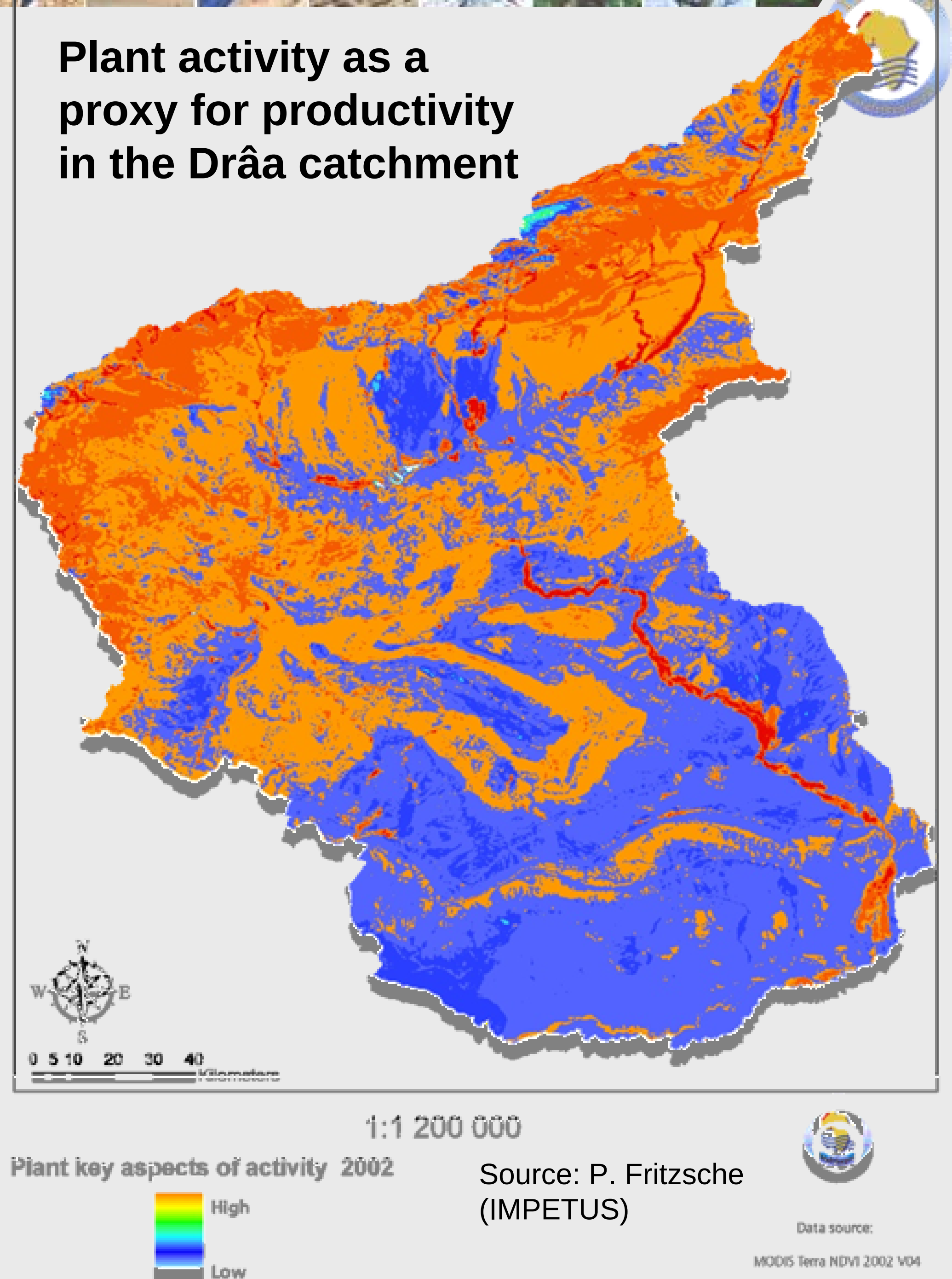
Time series analyses of NDVI using MODIS data 2000-2008

→ Spatial and temporal extrapolation of point information on vegetation

→Quantitative information on
(1) pasture productivity,
(2) pasture recovery after a drought, and
(3) forage accumulation

→Climate scenarios

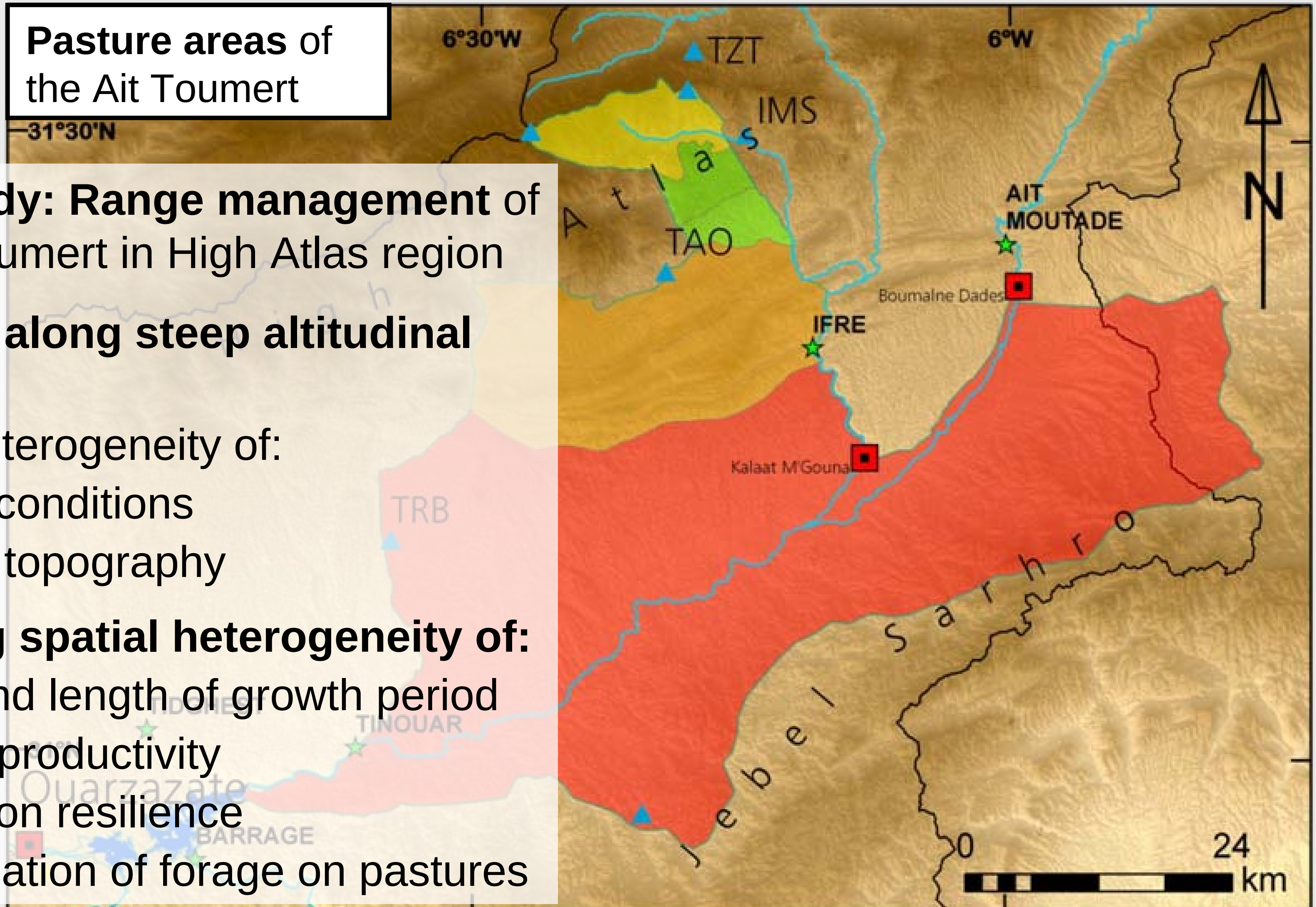
Plant activity as a proxy for productivity in the Drâa catchment



Source: P. Fritzsche (IMPETUS)

Range management as a tool to avoid or mitigate socio-economic droughts

Pasture areas of the Ait Toumert



Case study: Range management of the Ait Toumert in High Atlas region

Pastures along steep altitudinal gradient

Spatial heterogeneity of:
- Climate conditions
- Soil and topography

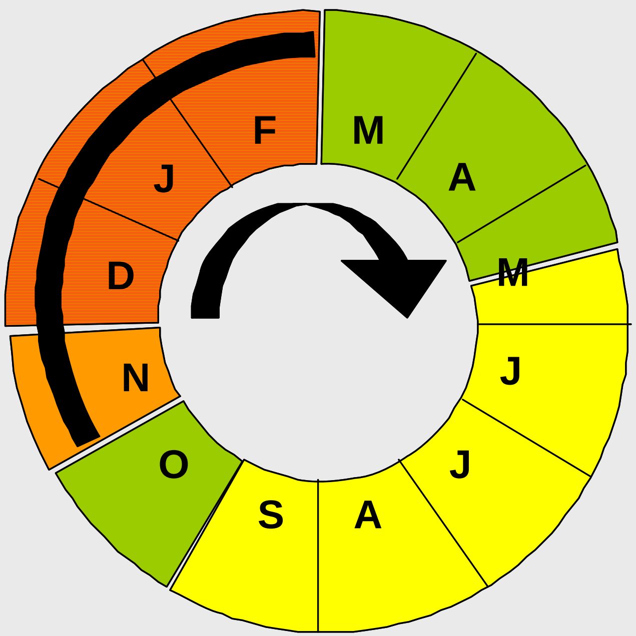
Resulting spatial heterogeneity of:
- Onset and length of growth period
- Pasture productivity
- Vegetation resilience
- Accumulation of forage on pastures

Source: B. Kemmerling 2008, cartography by P. Fritzsche (IMPETUS)

Range management of spatially variable fodder resources

• Range management is adapted to (1) pasture productivity, (2) recovery potential, and (3) forage accumulation:
Productive pastures with a high recovery potential are used more frequently and intensively

Annual transhumance cycle



Period with forage scarcity and high probability of livestock mortality

Pasture type	Productivity and recovery potential	Frequency and intensity of use
Upland pastures	intermediate	intermediate
Transition pastures	high	high
Close lowland pastures	intermediate	intermediate
Far lowland pastures	low	low

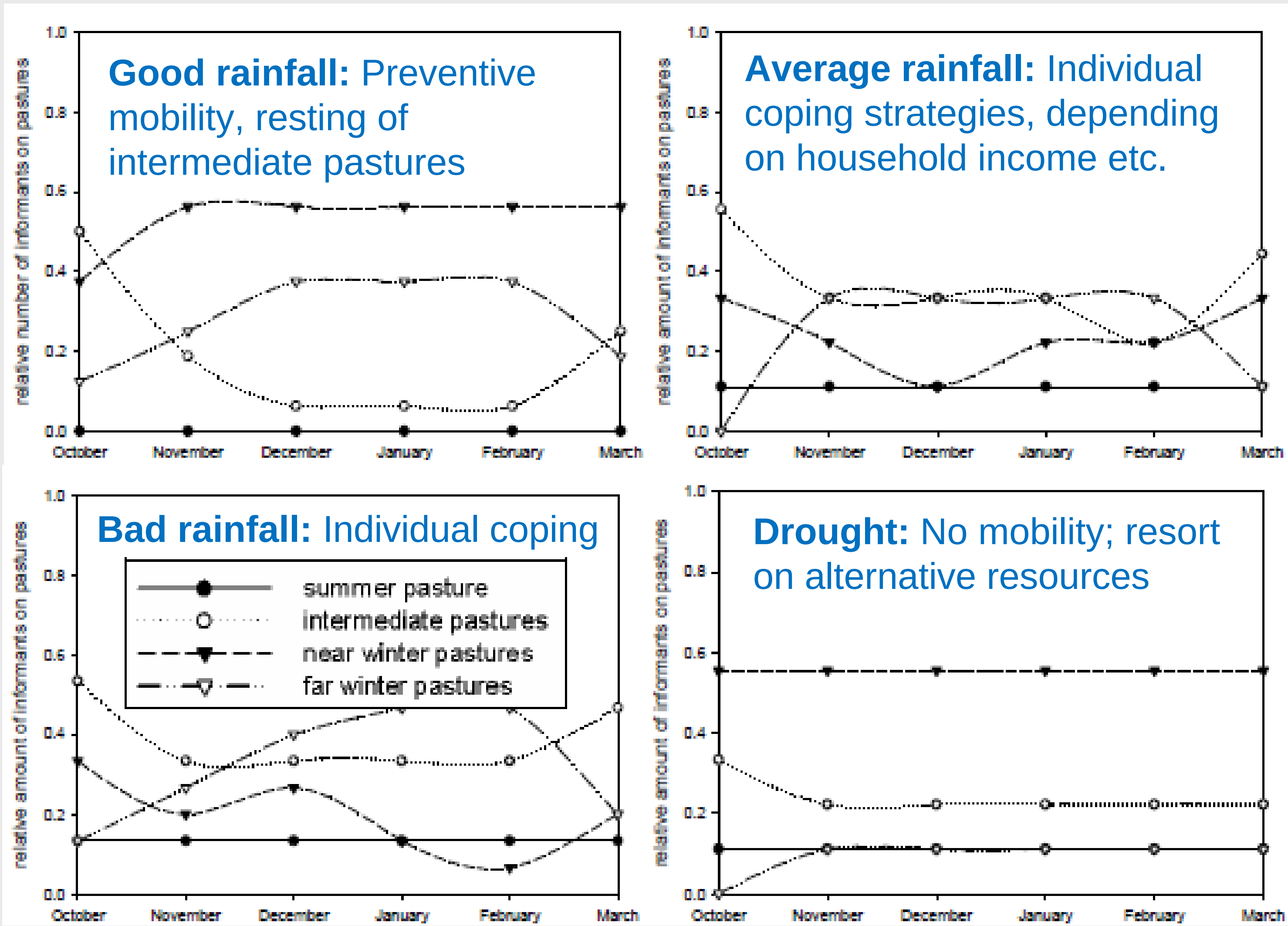
Conclusion: Not only coping strategy, but **preventive resource management** mitigating future drought effects

Mobility during the scarce time of the year: Individual decisions, functional explanations

Household mobility depends on:

- Available fodder resources
- Other economic resources (e.g. wealth)

→ complex mobility patterns



Sustainable resource management: Learning from local ecological knowledge

- Local ecological knowledge on quality and availability of fodder on pastures is important for pastoralists’ mobility decisions:

  A good fodder plant is reliable (see IMPETUS Poster P28)

- Local knowledge on fodder plants and related scientific data are integrated into **Information System PLANT** (→ please try it)

How to mitigate a drought: Conceptualization and Decision support

1. Ecological-Economic model BUFFER

Key aspects of a sustainable range management are integrated into the **ecological-economic model BUFFER**

2. Related SDSS PADRÂA:

The art of mitigating a meteorological drought

Aim: To communicate…

- how a meteorological drought is translated to a socio-economic drought
- which patterns of local range management are crucial for mitigating drought effects

Thank you for your attention!