The GLOWA-IMPETUS Approach

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and about 70 colleagues

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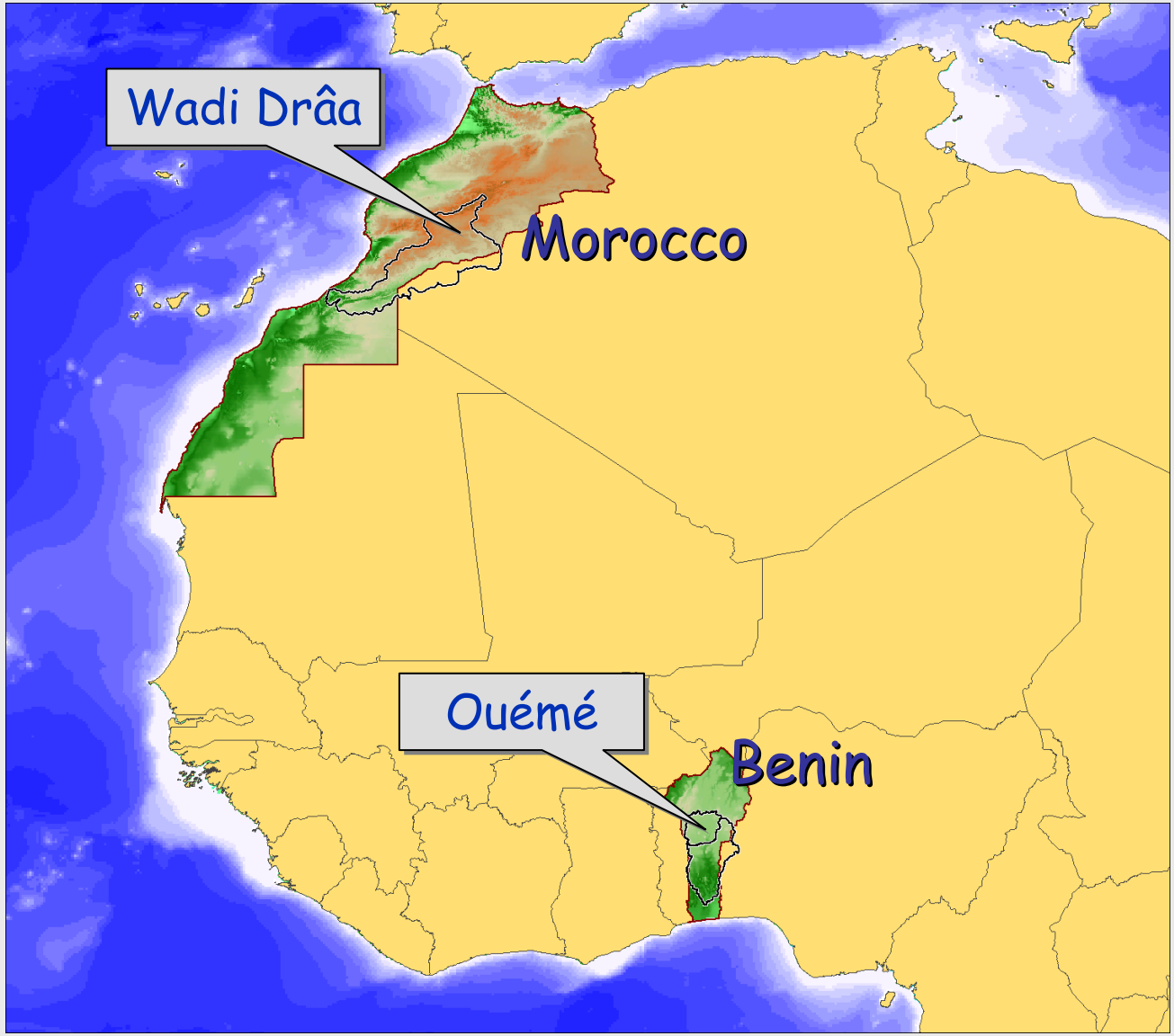
Bundesministerium für Bildung und Forschung
universitätbonn

IMPETUS

"An Integrated Approach to the Efficient Management of Scarce Water Resources in West Africa"

"Approche Intégrée pour la Gestion Efficiente des Ressources Hydriques Limitées en Afrique de l'Ouest "

Choice of Catchments



Motivation

West and Northwest Africa: "hot spots" of Global Change:

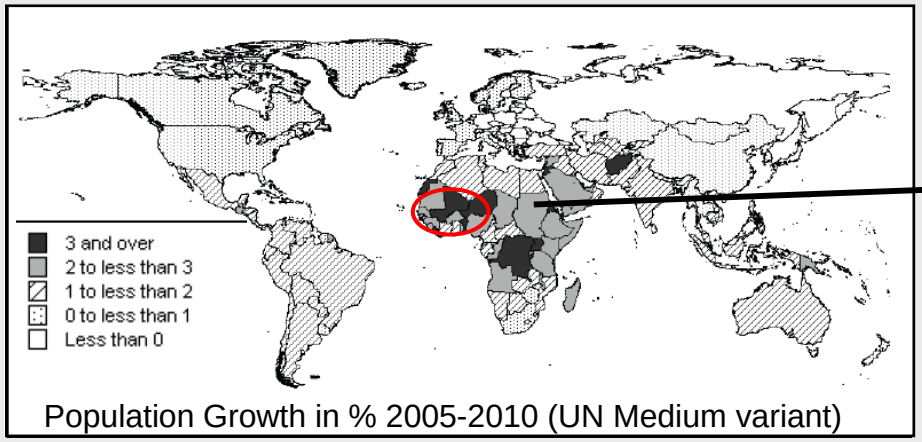
Present situation:

- High population growth & migration
- Sub-Saharan Africa: Rapid land-use change
- Maghreb: Overgrazing, erosion, and salinization of soils
- Sub-Saharan Africa: High mortality due to malaria, diarrhea, and HIV
- Strong natural rainfall variability

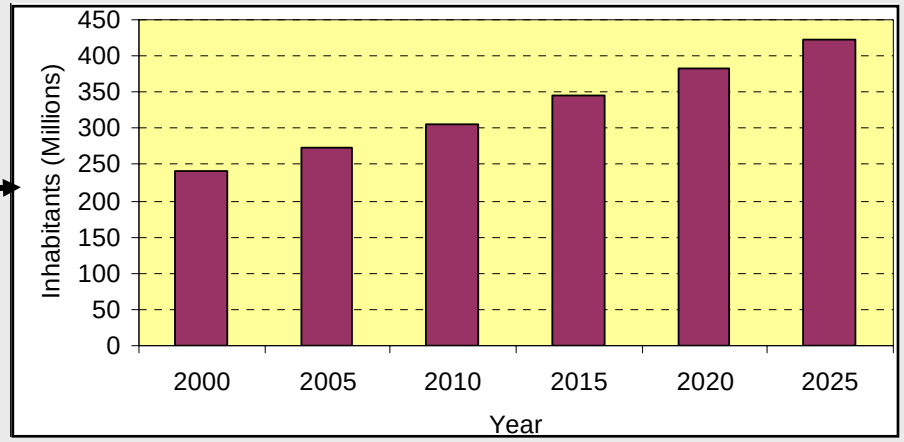
Future climate:

- Substantial drying for the Maghreb "likely"
- Rainfall trend for the Sahel and Guinea Coast is uncertain

Demographic Changes



Population Growth in % 2005-2010 (UN Medium variant)



Source: United Nations, 2006, 2007

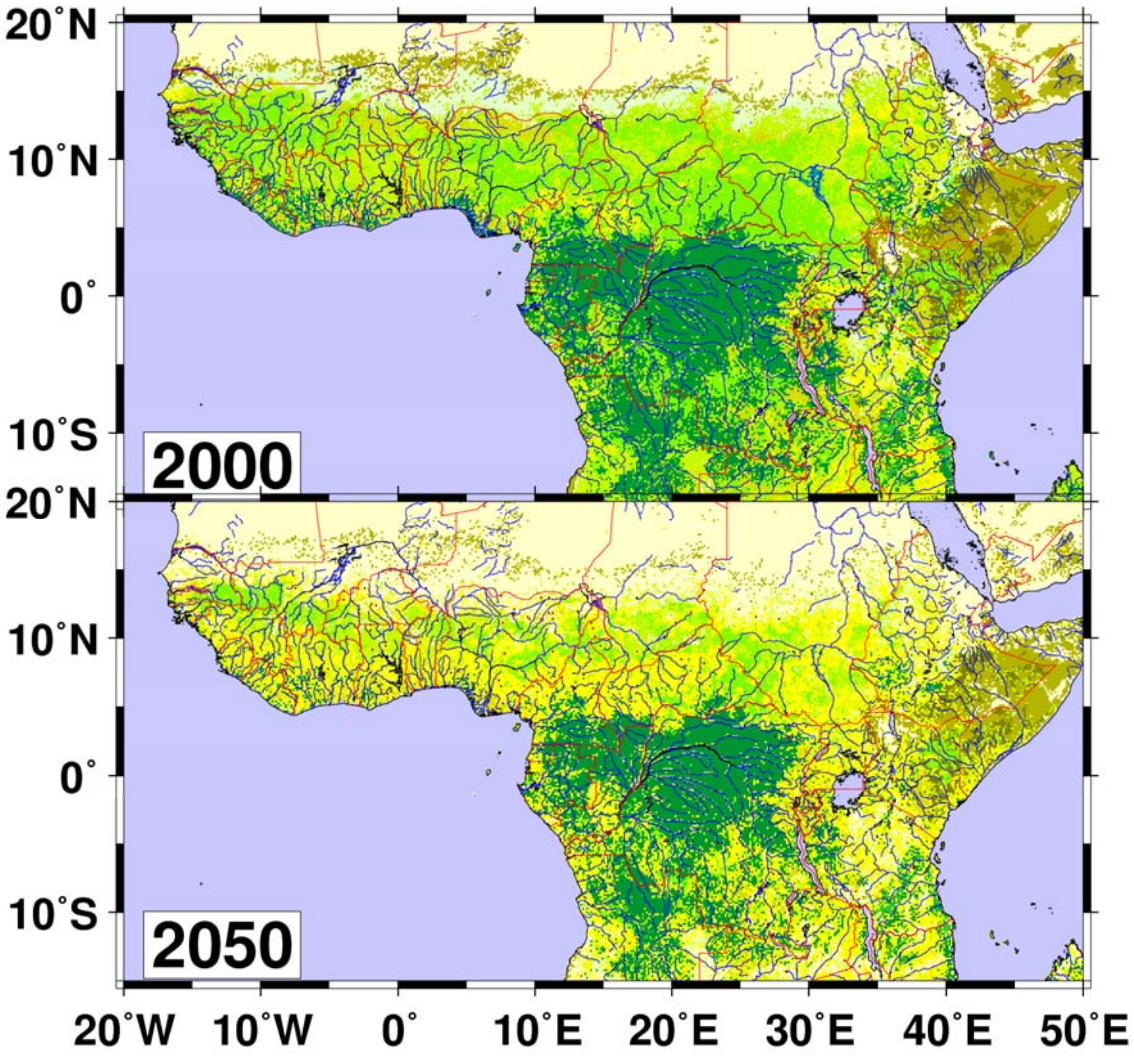
- Sub-Saharan Africa:

  Region with the strongest population increase worldwide

- West and Northwest Africa:

  Strong migration and urbanization

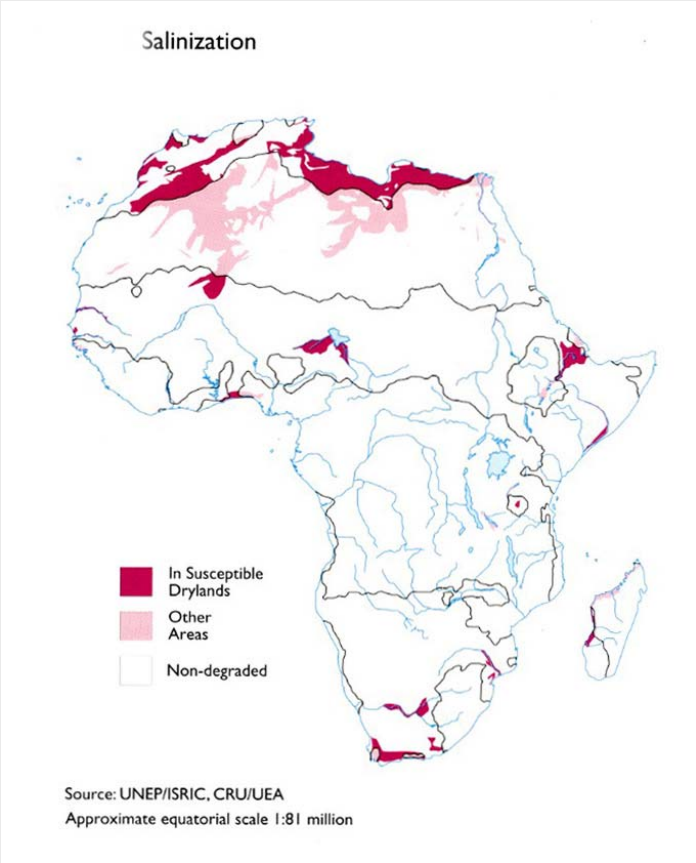
Land-use Changes in Sub-Saharan Africa

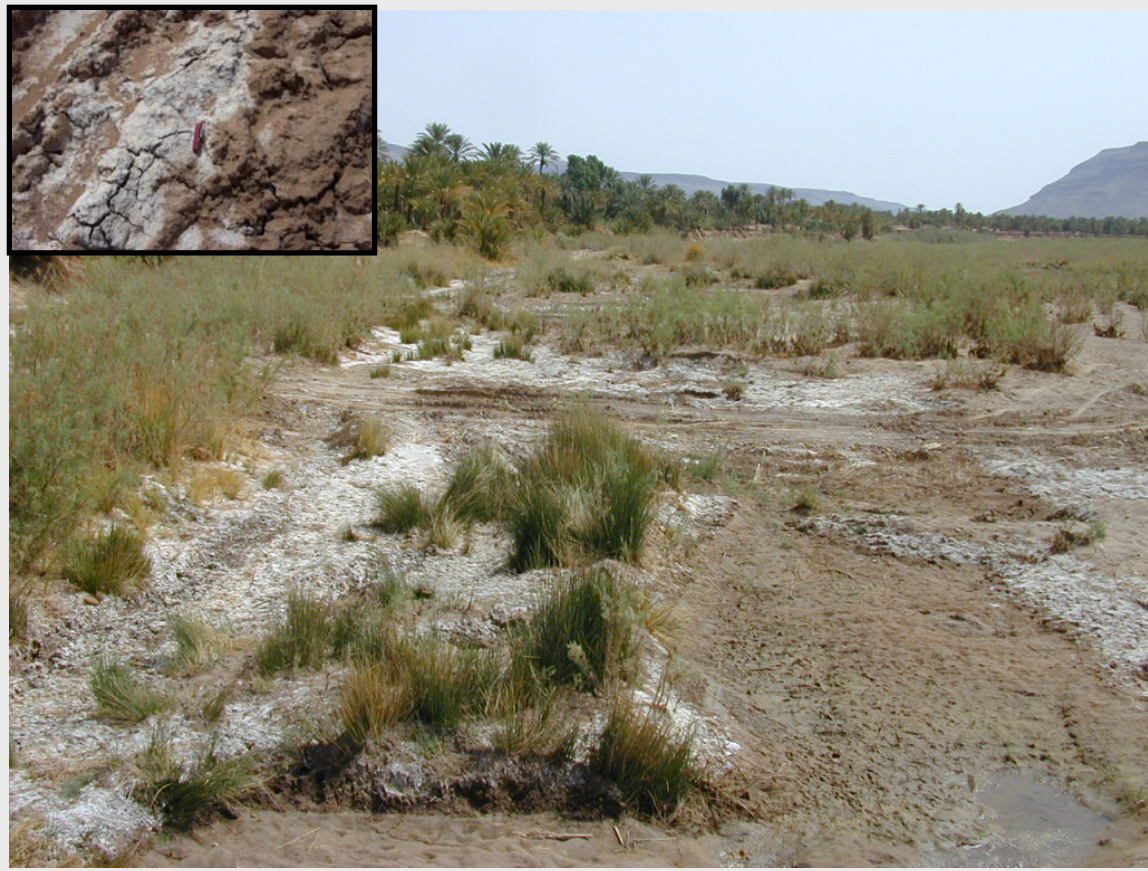


- Substantial loss of biomass and biodiversity
- Shrinking forests along with expanding croplands, especially in the savannah regions of West Africa

Source: Born, IMPETUS

Maghreb: Salinization of Soils and Ground Water

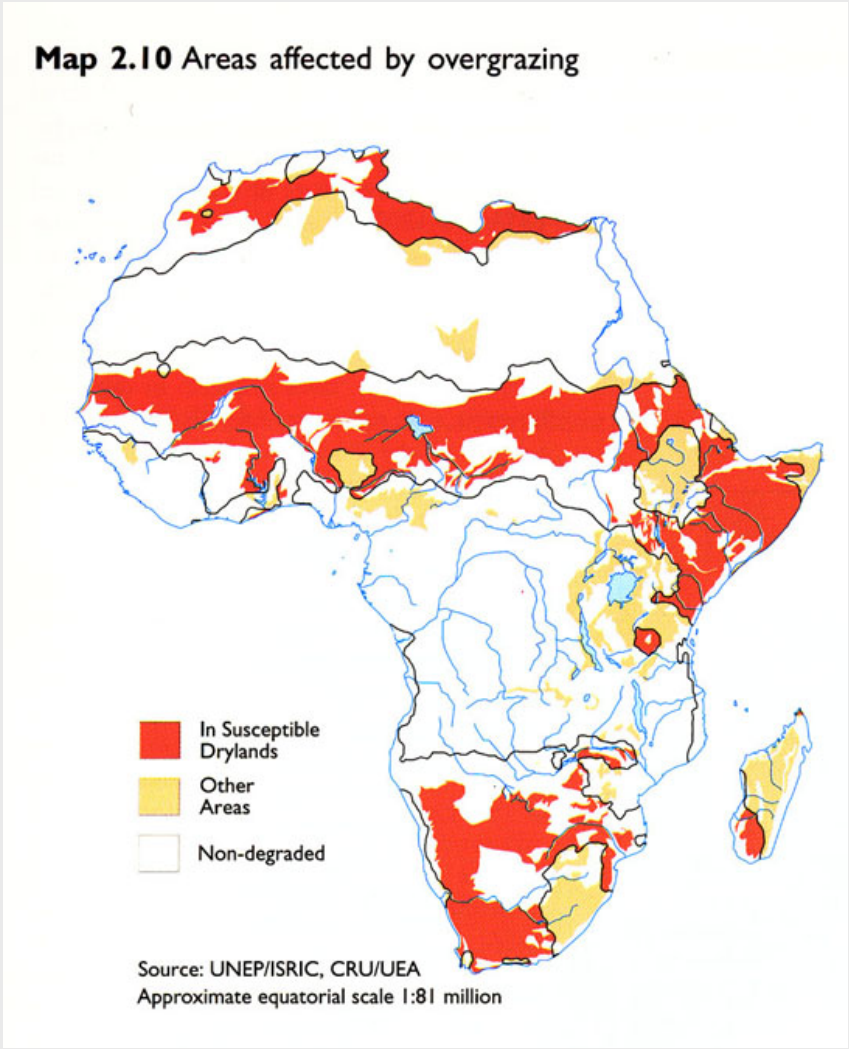




Drâa valley, southern oases

- Irrigation and high evaporation fosters salinization of soils and ground water

Maghreb: Overgrazing and Soil Erosion

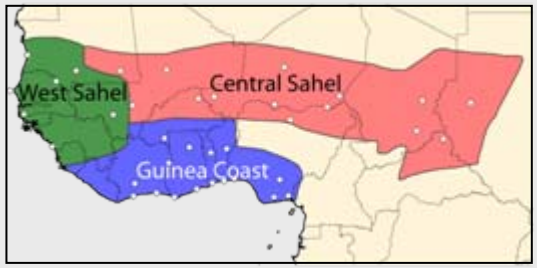


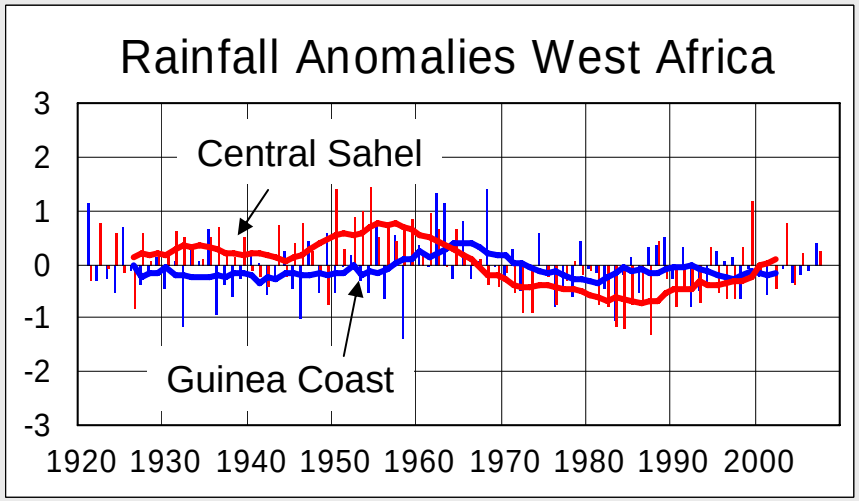
Flood in the High Atlas Mountains

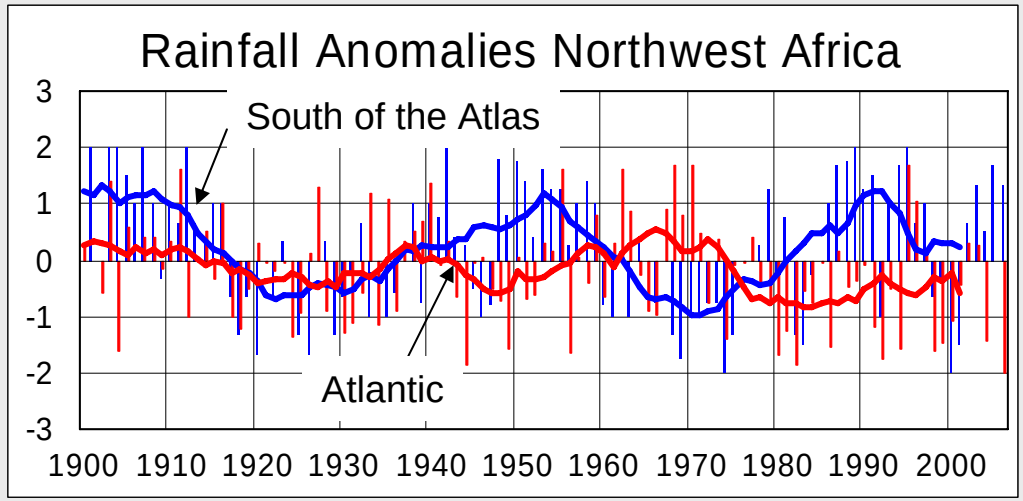
Destroyed bridge in the Anti-Atlas Mountains

Overgrazing -> higher erosion after extreme rainfall -> siltation of reservoirs

Rainfall Variability in Northwest and West Africa





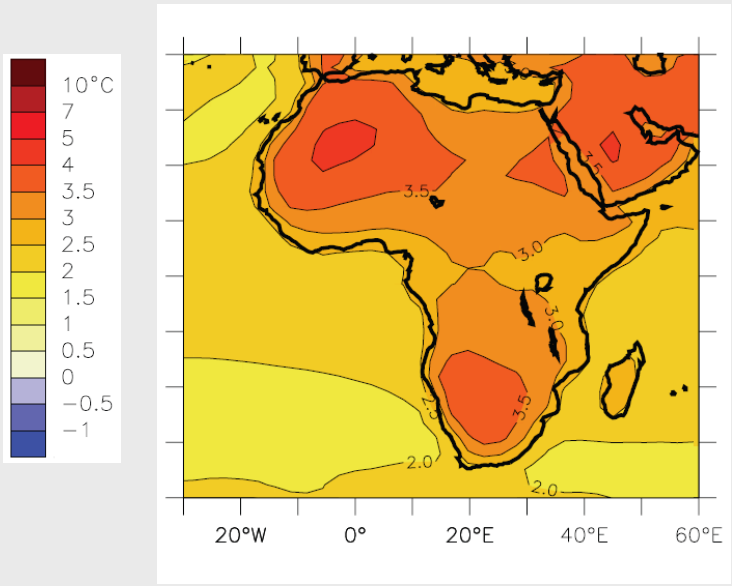


Source: after Fink et al. 2008, IMPETUS Atlas

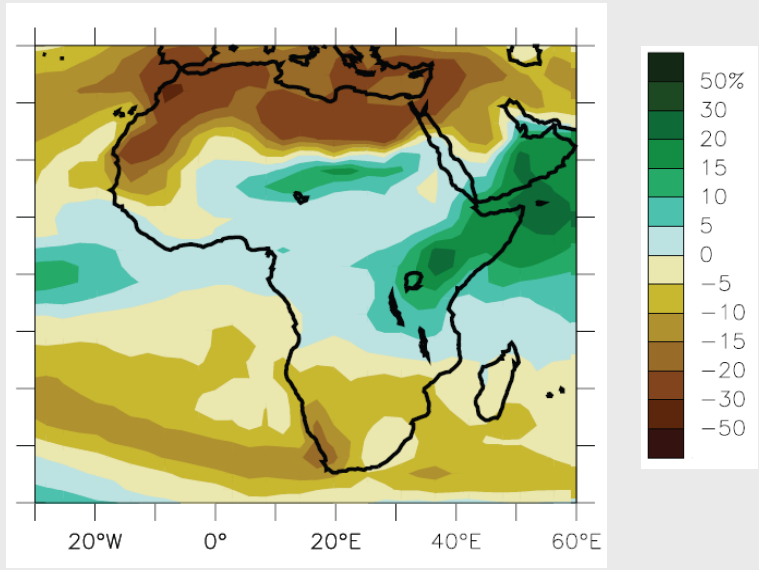
- The regions north and south of the Sahara exhibit a very pronounced, largely natural rainfall variability

IPCC 4th AR Climate Projections

Change in annual temperature (°C)



Change in annual precipitation (%)



Source: IPCC 4th AR 2007

- A warming is “very likely” to be larger than the global annual mean warming throughout the continent and in all seasons
- A “likely” drying trend for North Africa and an uncertain trend in West Africa

Consequences

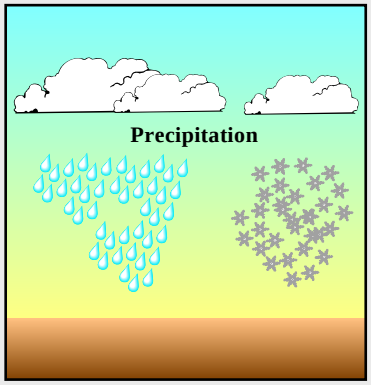
- Reduction of freshwater availability per capita
- Vulnerable food and livelihood security
- Potential changes in the spread of diseases like malaria, meningitis, and diarrhea
- Growing potential of conflicts

GLOWA-IMPETUS GOALS

- Investigation of complex water-related problems in a true and broad interdisciplinary approach
- Development of DSS based on reliable data, well-adapted models, and on an continuous stakeholder dialogue
- Capacity development with respect to the use of
  - the IMPETUS DSS in integrated water management
  - the rich IMPETUS data base
  - the broad IMPETUS research results

Involved “Spheres” and Disciplines

Atmosphere

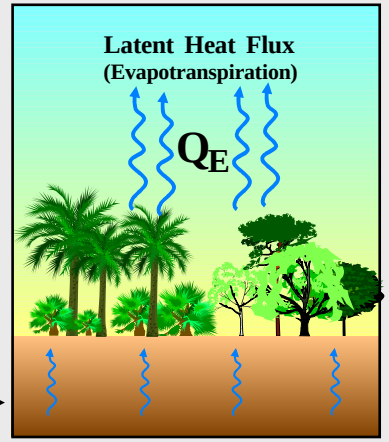


Meteorology

Anthroposphere

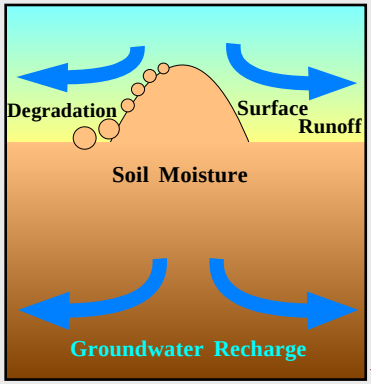
Anthropology
Medicine
Socio-Economy

Biosphere



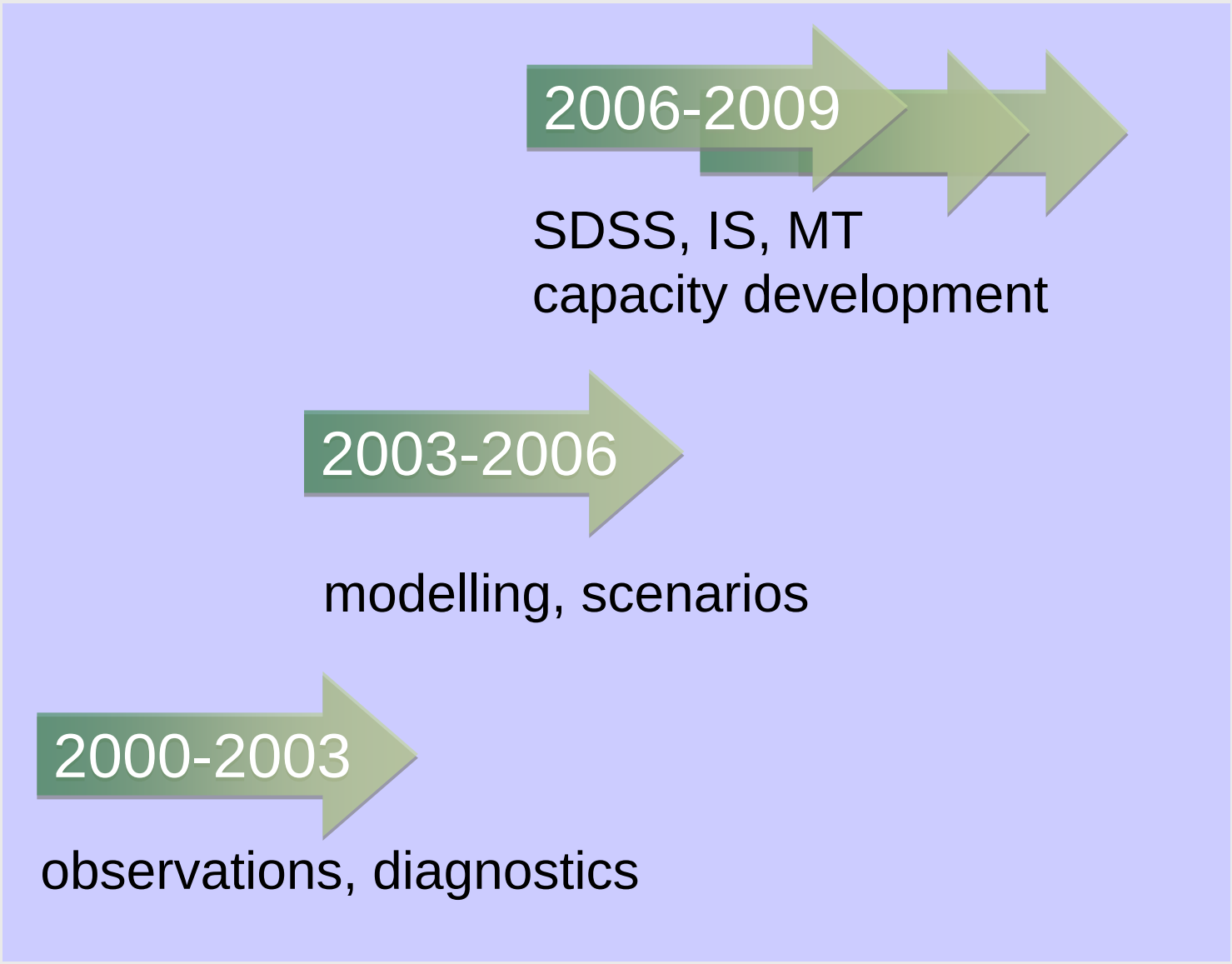
Agriculture
Vegetation Ecology
Geography

Continental hydrosphere

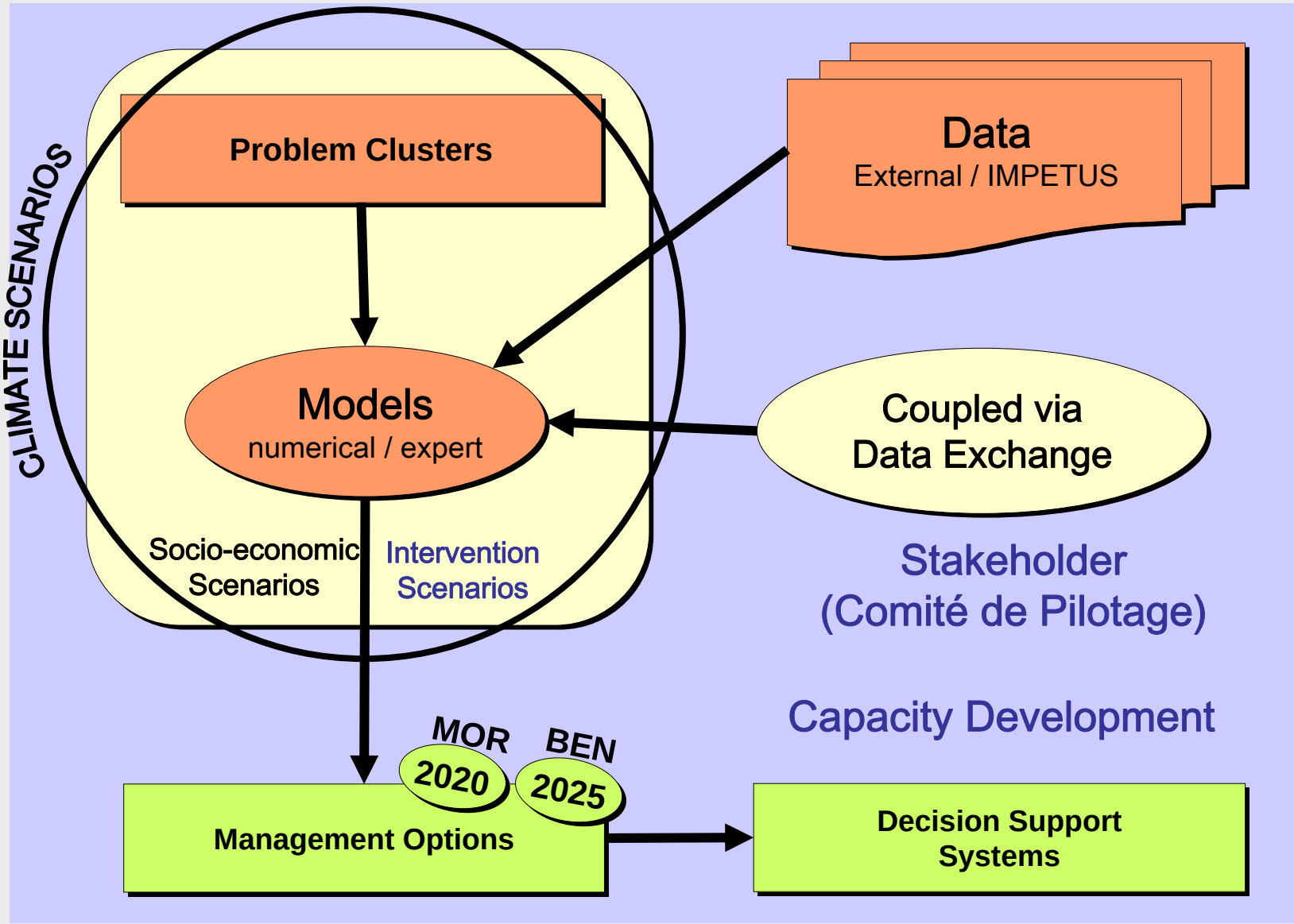


Hydrology
Hydrogeology
Soil Science

Project Phases: from Science to Application



The GLOWA-IMPETUS Approach



Problem Clusters

- **Meta-problems** that require a **multi-disciplinary analysis** in order to allow for drawing conclusions with respect to possible future developments
- Each problem cluster is composed of many single "**thematic complexes**" (= processes or process chains) that reflect the different **disciplinary approaches** involved in this project

➔ **19 (11) Problem Clusters for Benin (Morocco)**

Problem Clusters

The Problem Clusters were stratified into four subject areas:

(1) Livelihood/Food Security

(2) Hydrology

(3) Land Use

(4) Society and Health

The IMPETUS Socio-economic Scenarios

Benin:

B1*:* Economic growth and consolidation of decentralization

B2: Economic stagnation and institutional instability

B3: Business-as-usual

Morocco:

M1*:* Marginalization – non-support of the Drâa region

M2: Rural development in the Drâa region through regional funds

M3: Business-as-usual

The Impetus Climate Scenarios

Scenario X: Process understanding

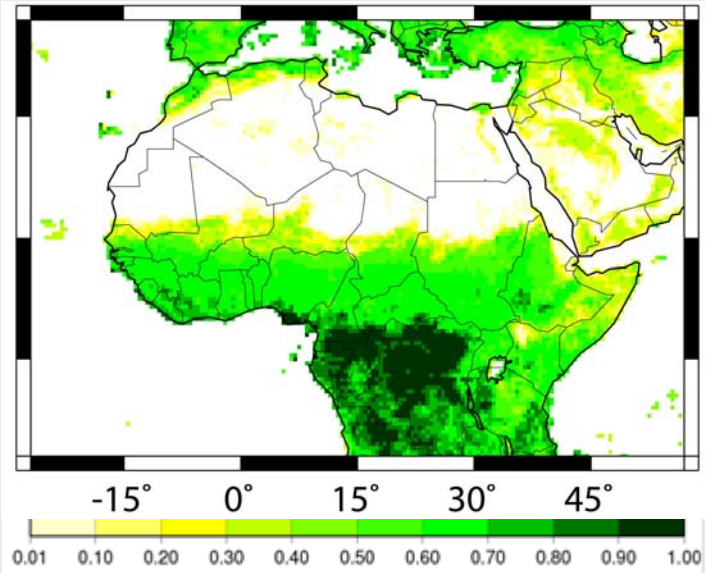
Scenario Y: Transient climate model predictions
including statistical-dynamical downscaling

Scenario Z: Persistence of recently observed trends

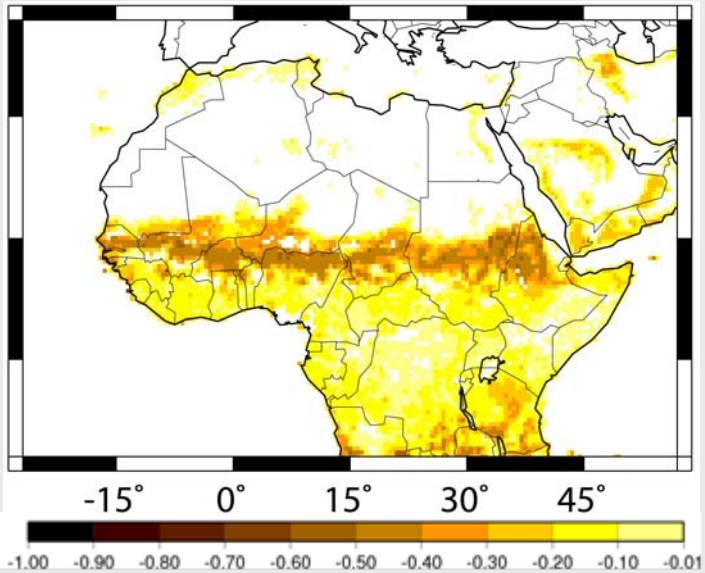
➔ **State-of-the art regionalization of climate change and "post-processing" of climate model data for use in impact modeling**

REMO* Land-Use Scenarios

Fractional vegetation cover 2000



Vegetation reduction until 2050



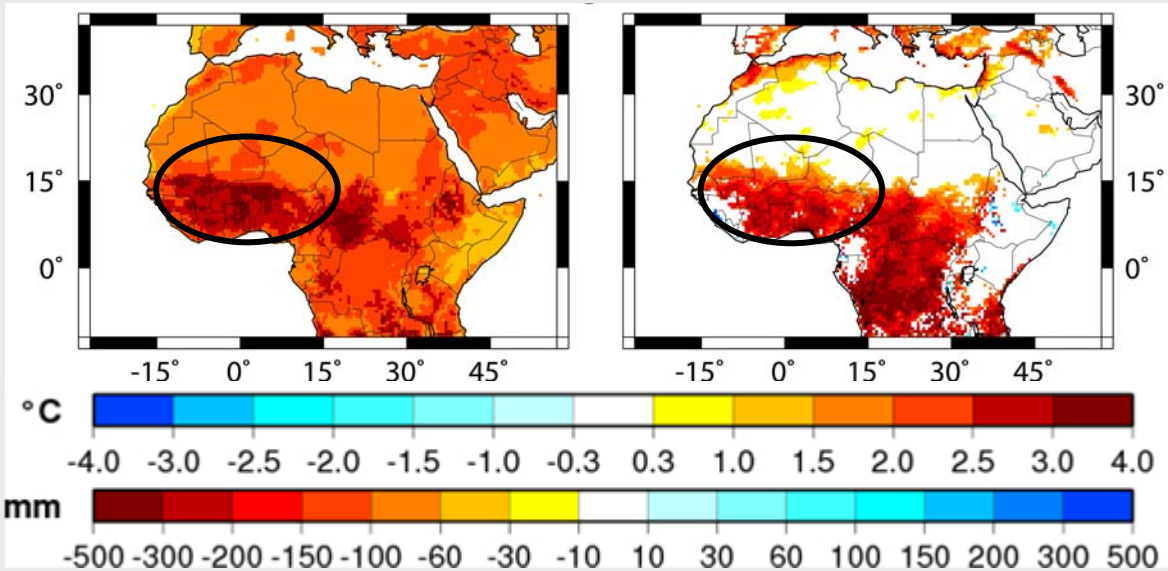
Source: Paeth et al. 2008

Basis of land-use modeling is the reduction in vegetation projected by FAO until 2050

*REMO: Regional Model

REMO Climate Projections until 2050

Temperature change (°C) Precipitation change (mm)



Source: Paeth et al. 2008

The IPCC A1B climate projections were substantially modified:

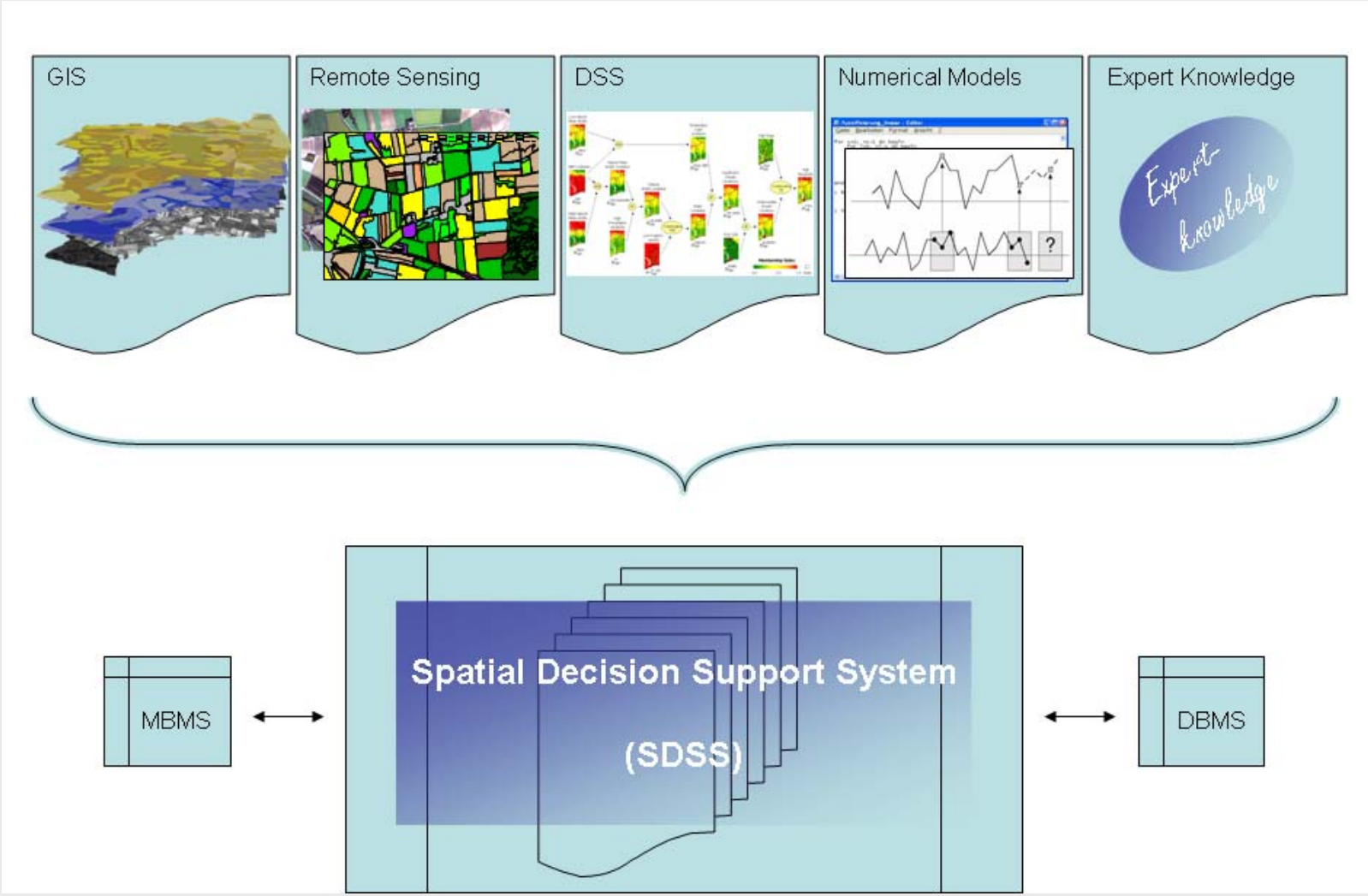
West Africa exhibits a stronger significant warming and a significant drying trend

A Major Project Outcome

- Spatial Decision Support System (SDSS)
- Information System (IS)
- Monitoring Tool (MT)

- 19 SDSS / IS / MT have been developed for Benin
- 11 SDSS / IS / MT have been developed for Morocco

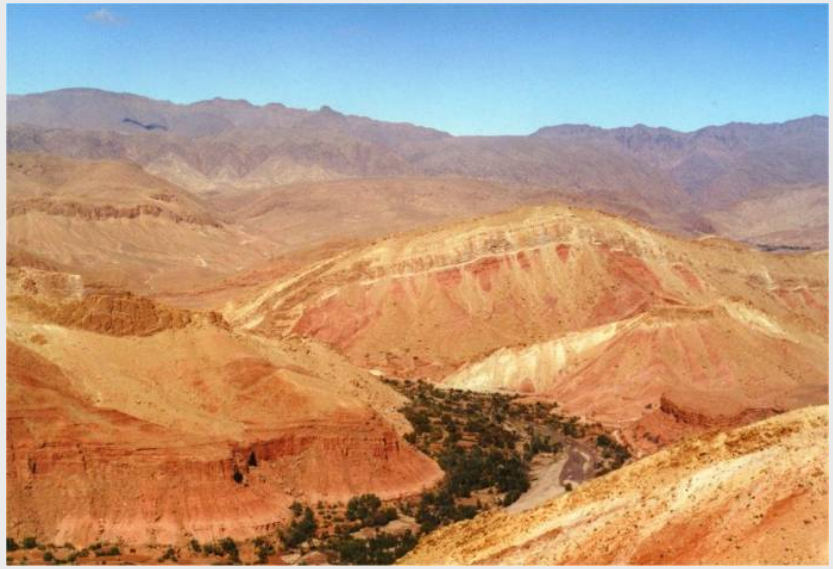
Modules of a SDSS



Source: Laudien and Bareth 2007

Natural Environment

Upper Ouémé: Forest savannah with inselbergs



Upper Drâa: River oasis and High Atlas divide

Ouémé (Benin)

- sub-humid to humid, bi- / unimodal rainy seasons
- weakly undulated pediplain with isolated inselbergs
- vegetation: forest-savannah mosaic, mostly degraded

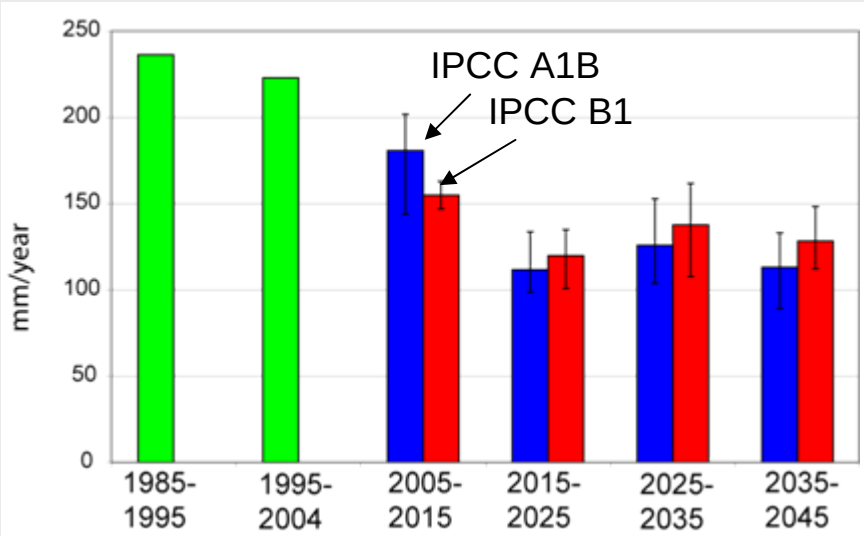
Drâa (Morocco)

- arid to semi-arid climate
- heterogonous geologic setting (High Atlas, sedimentary basins, Anti-Atlas)
- sparse vegetation cover (acacia, shrubs, juniperus trees) only dense in the oasis

What has the IMPETUS approach achieved in the subject area “Hydrology”?

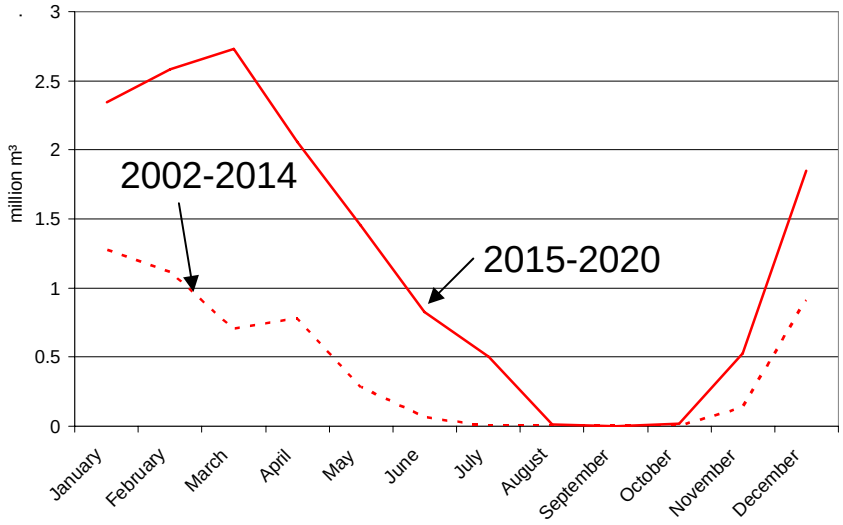
Renewable Water Resources in the Ouémé

Renewable water resources



Source: Giertz & Diekkrüger, IMPETUS

Unmet freshwater demand
(IPCC A1B / IMPETUS B1 scenarios)



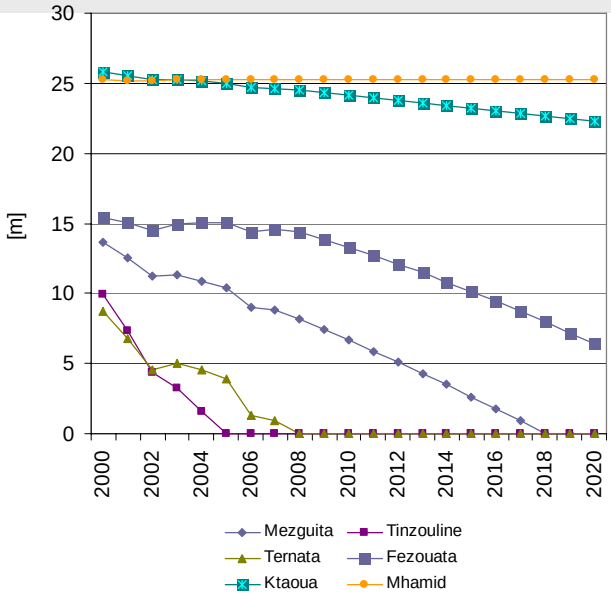
Source: Höllermann & Diekkrüger, IMPETUS

- The renewable freshwater resources in the Ouémé catchment will decline by more than one third until the mid 21st century
- The amount and period of an unmet freshwater demand will increase

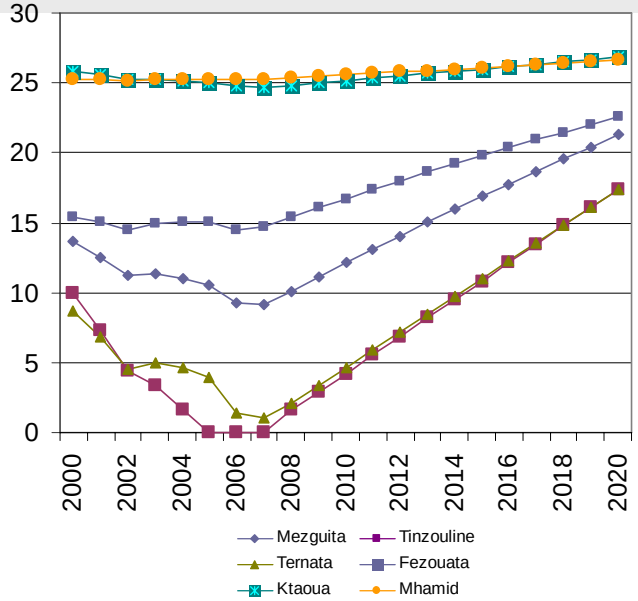
Groundwater Levels in the Drâa Oases

Saturated aquifer thickness for a 10% rainfall reduction until 2020

No intervention



Changed management of reservoir

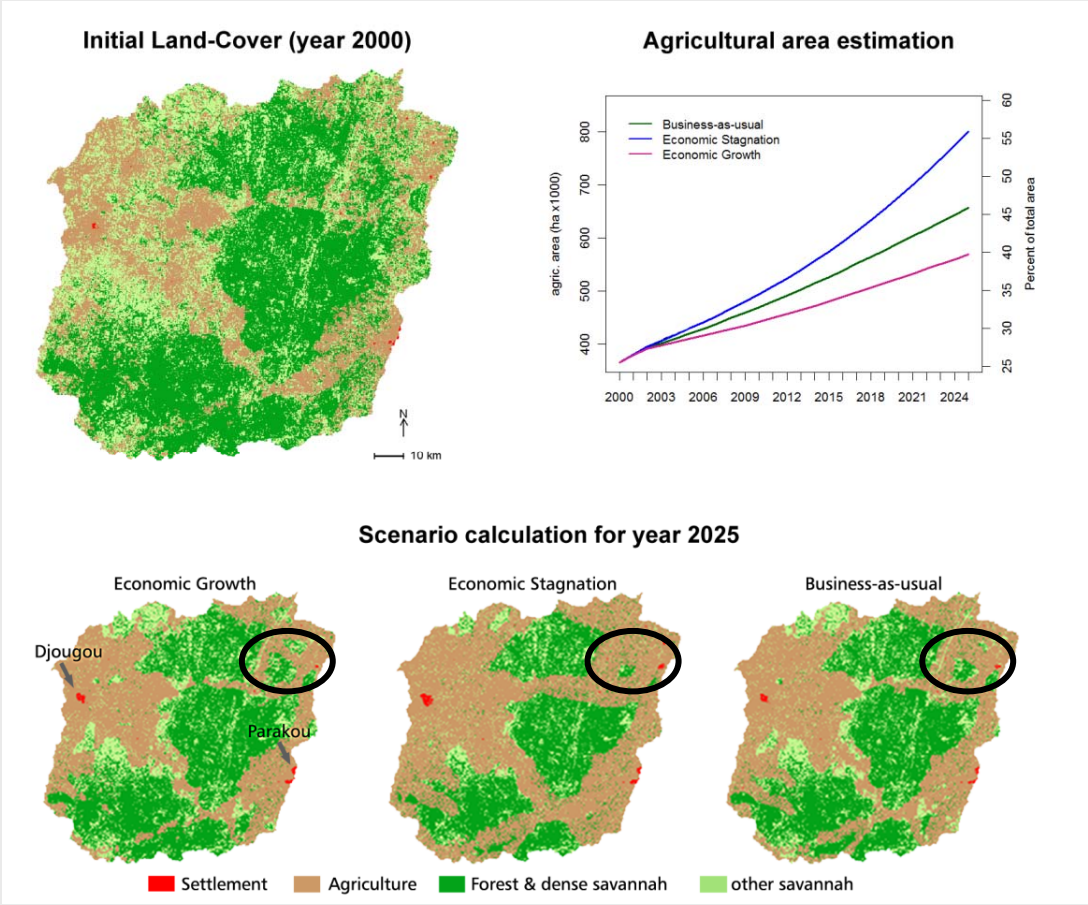


Source: Reichert & Klose, IMPETUS

- Complete depletion in the two southern oases of the Middle Drâa valley
- Intervention scenario: Adverse impacts can be mitigated by transferring flood runoff directly into the oases without reservoir storage

What has the IMPETUS approach achieved in the subject area “Land-use”?

Land-Use Change in the Upper Ouémé

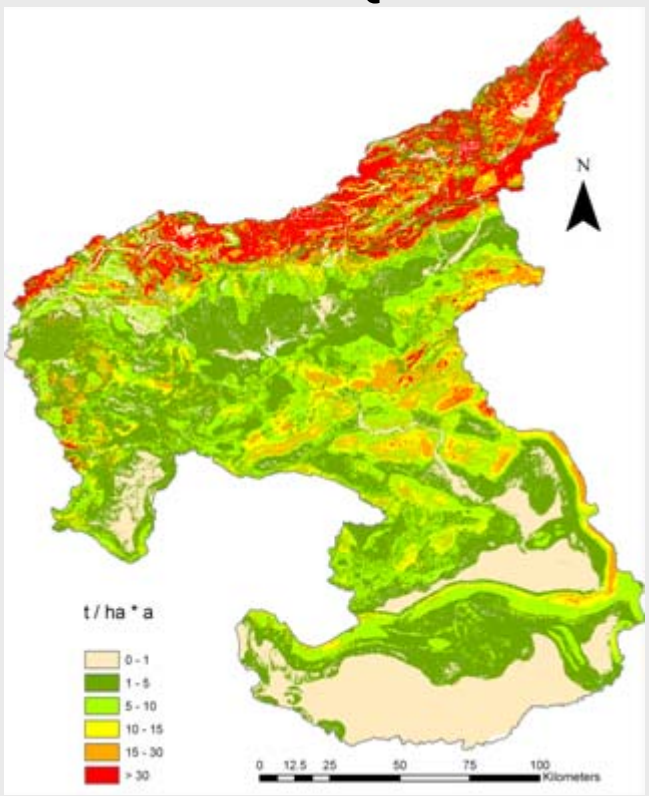


Source: Judex and Thamm, IMPETUS

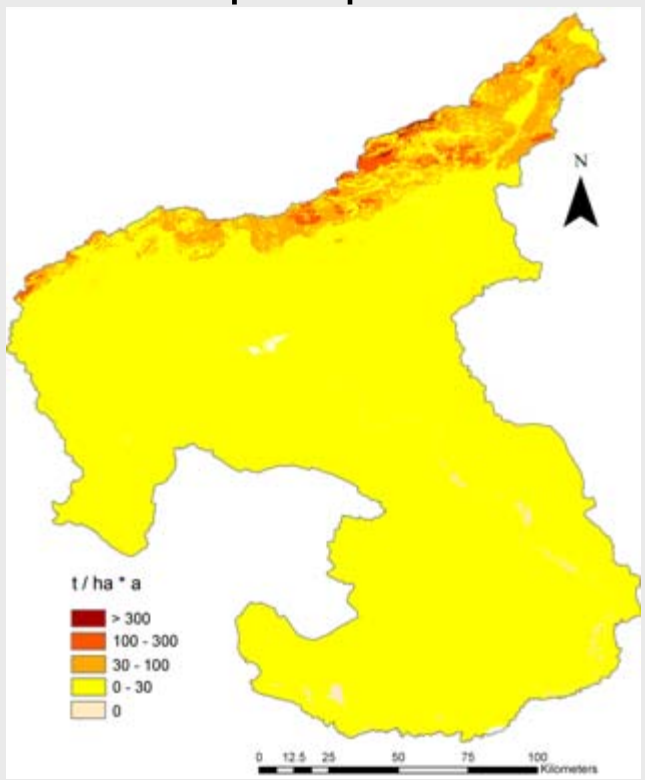
- Modeled increase in agricultural area and a high rate of deforestation near cities and along roads
- Substantial differences among the IMPETUS socio-economic scenarios

Soil Erosion Risk in the Drâa Valley

Status Quo



Increased precipitation variability



Source: Klose and Diekkrüger, IMPETUS

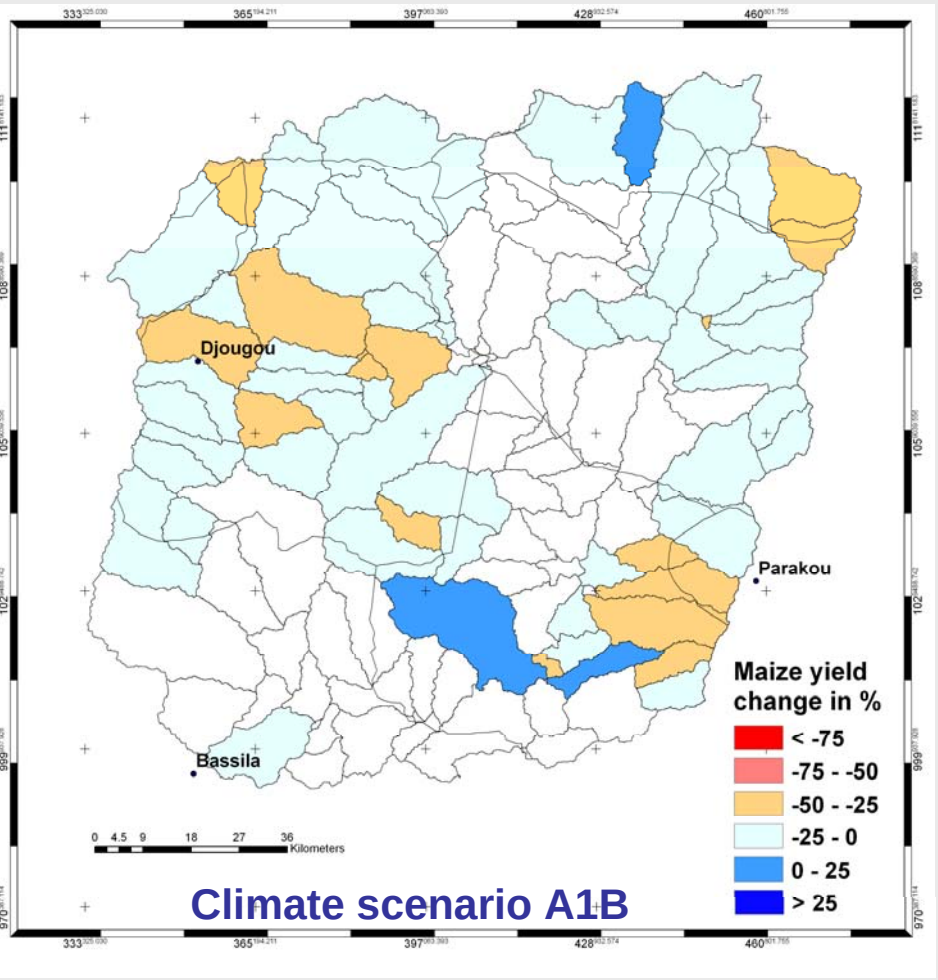
Intervention scenario: Afforestation of 2% of the Upper Drâa catchment with the highest erosion risk yields a reduction of erosion of 1/3.

What has the IMPETUS approach achieved in the subject area “Food Security”?

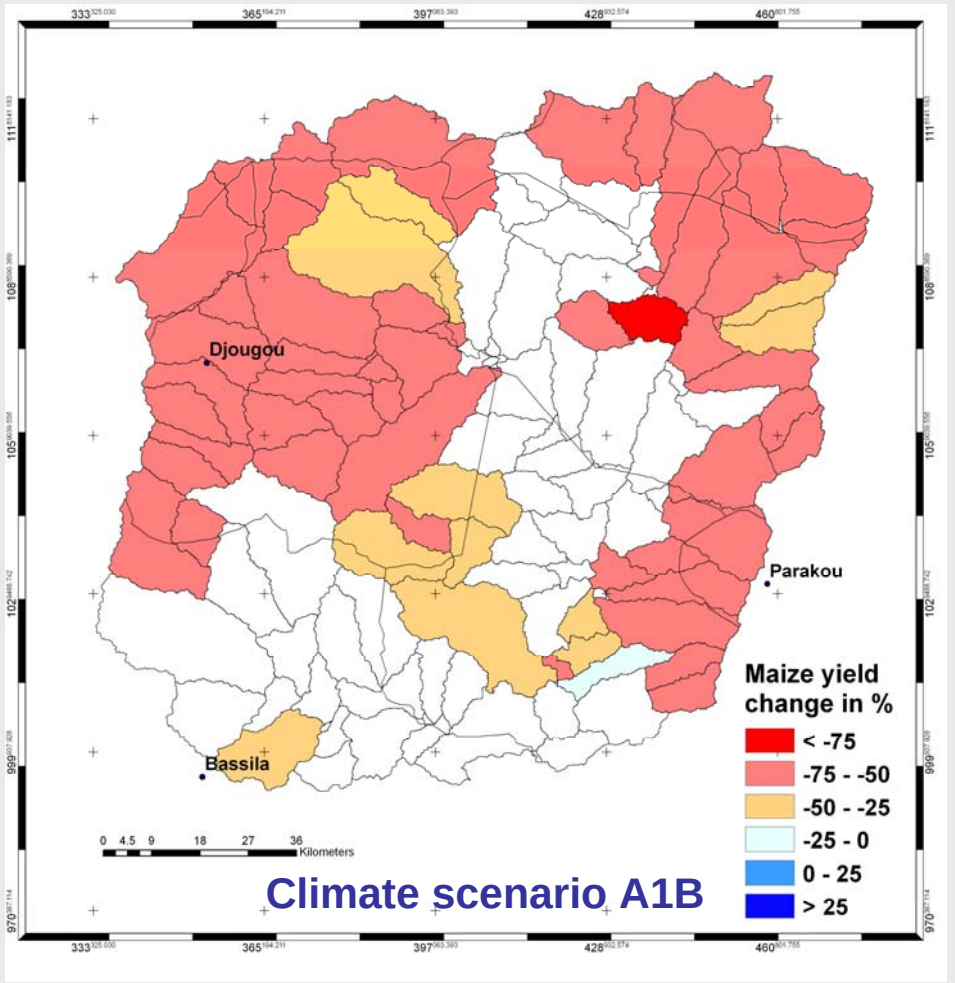
Projections of Maize Yield

(Base period: 2001–2010)

2021–2030



2041–2050



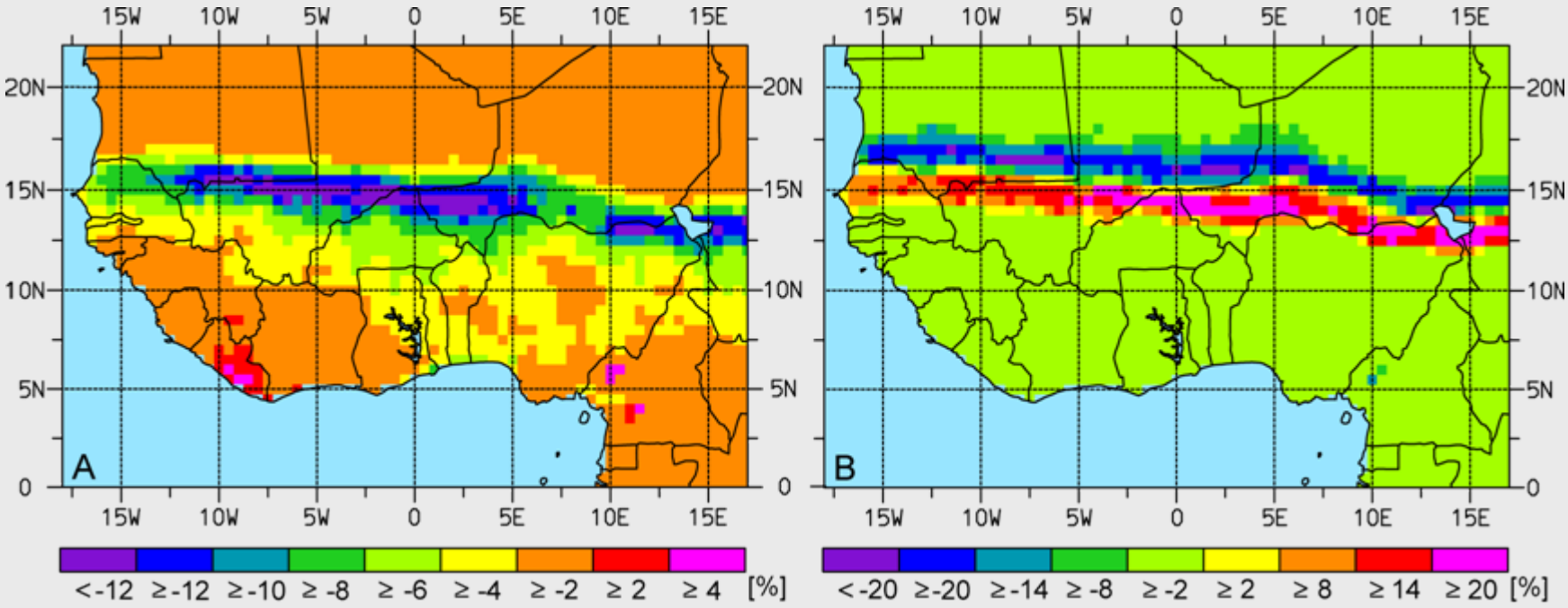
Source: Gaiser et al., IMPETUS

What has the IMPETUS approach achieved in the subject area "Society and Health"?

Malaria Occurrence and its Seasonal Variation

Change in prevalence

Shift in epidemic belt



Source: Fink & Ermert 2008, IMPETUS Atlas

- The malaria belt in West Africa will retreat southward
- The epidemic belt moves into the more densely populated, presently endemic area where people may loose their partial immunity

Partners and Research Collaborations

Collaboration with:

- more than 16 (23) partner organizations in Benin (Morocco)
- the major national and international development agencies, as well as with NGOs
- several major (inter-)national research activities
  - HELP
  - AMMA and WARDA in Benin
  - CBTHA and BIOTA-Maroc in Morocco

Stakeholder Dialogue and Capacity Development

- Multi-level stakeholder dialogue
- Sustainable implementation of the achieved knowledge & tools
- Capacity development at various levels
- In total 54 capacity development measures with 891 participants
- About 38 colleagues from partner institutions visited German counterparts or graduated from a German university

Methods and Cooperation: Lessons Learned

- The IMPETUS approach was successful
- Perception of IMPETUS in Benin and Morocco as a “showcase project” of interdisciplinary research
- The IMPETUS approach can be applied to other catchments but it has to be adapted to the local conditions
- Multi-level capacity development of political decision makers, of academic users, and of individuals

Impact of IMPETUS: Past, Present, and Future

Examples of results already applied:

- Agricultural consultants in Benin used the IMPETUS results to enhance potato farming and to identify suitable locations for micro-reservoirs
- HELVETAS constructed several pump wells in Benin – an immediate response to the IMPETUS finding of the large bio-geochemical contamination of traditional wells
- IMPETUS climate projections were utilized by the “GTZ” in Benin

Impact of IMPETUS: Past, Present, and Future

Present activities:

- Intense capacity development in both countries in collaboration with our partners to implement and fine-tune the about 30 SDSS/IS/MT
- Handing over the unique bio-geochemical laboratory in Parakou to DGEau to meet their identified demand for this infrastructure in northern Benin

Future:

- Need of sustainable implementation and further development of the IMPETUS SDSS and the models embedded therein

Long-lasting project heritage

- About 30 SDSS/IT/MT
- The digital and print versions of the IMPETUS atlases
- The rich IMPETUS data base mirrored in the partner countries
- Expertise and education gained among African partners

Thank you for your attention

A warm thanks to the numerous IMPETUS colleagues and research partners in Morocco and Benin without whom these achievements would not have been possible

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Ministry of Innovation, Science, Research and Technology of the German State of North Rhine-Westphalia
Bundesministerium für Bildung und Forschung
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