Earth observation contributions to flood and drought risk assessment

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Expert Meeting Space-Based Information for
Flood and Drought Risk Reduction
5-6 June 2014
Bonn, Germany

EO potential to describe “Risk” components for floods and droughts

Risk = ƒ {Hazard, Exposure, Vulnerability}

Potentially damaging process

- Likelihood
- Magnitude
- Duration
- Speed
- Spatial extent
- …

Objects/goods potentially adversely affected

- People
- Property
- Infrastructure
- …

Attributes that describes possible future harm

- Physical
- Social
- Economic
- …

EO potential:
- high
- medium
- low

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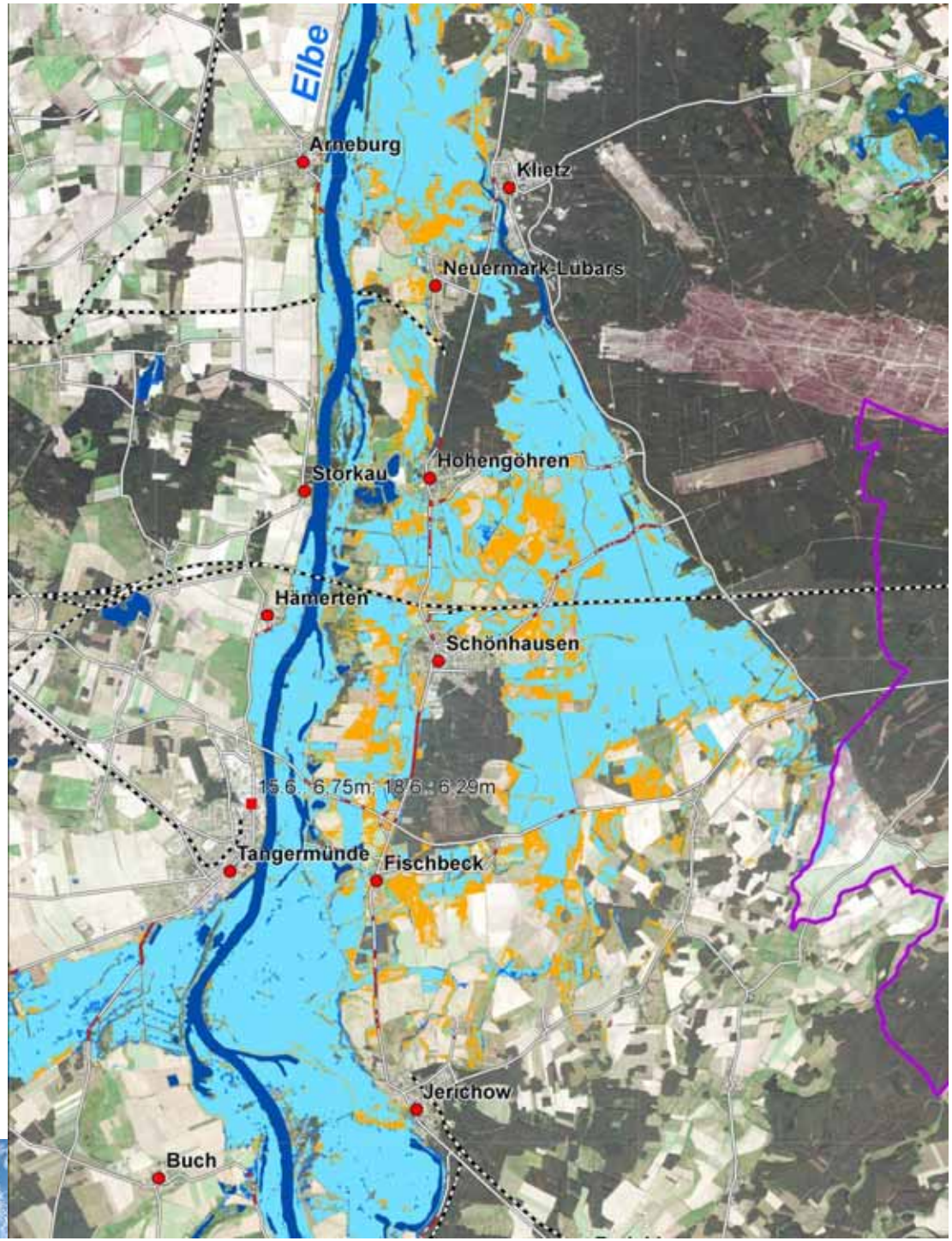
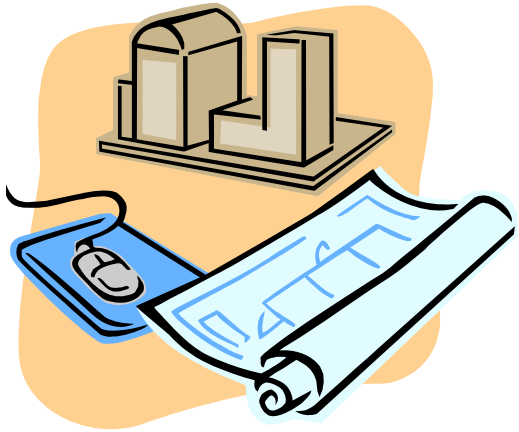
Satellite based flood map
June 15, 2013

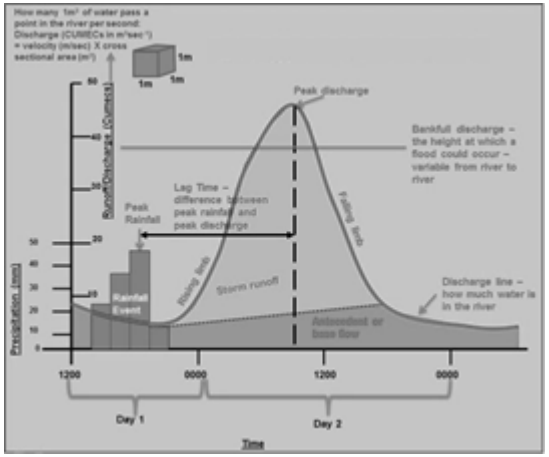
Elbe-River, Germany



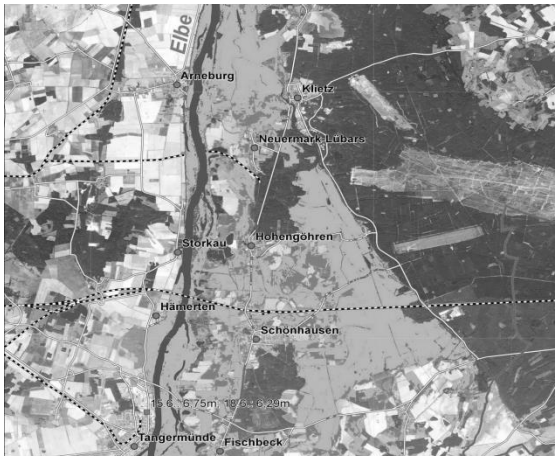
Combination of satellite observations and modelling!

Model





Satellite



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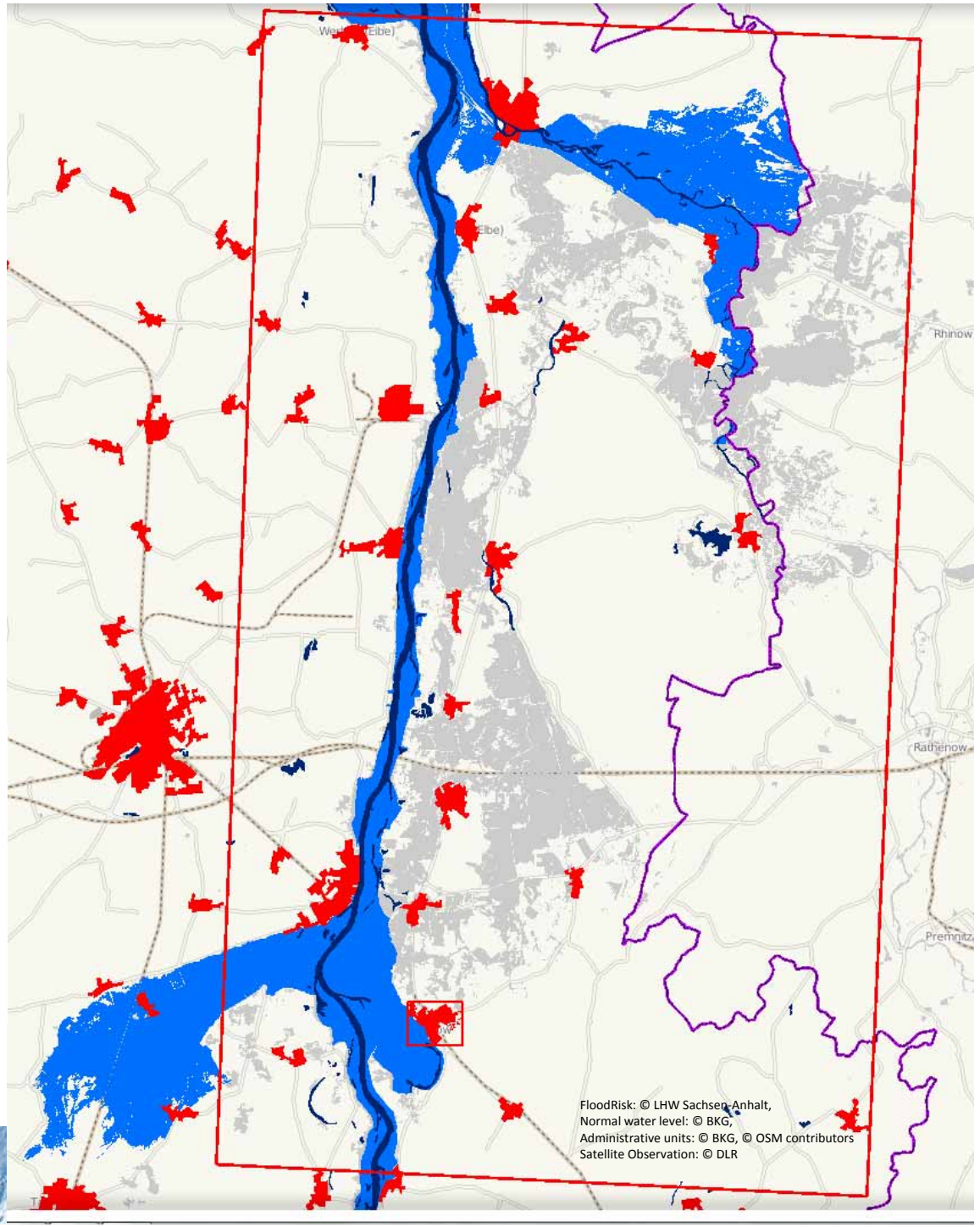
Flood Risk Modelling and Satellite Observations

Elbe-River, Germany



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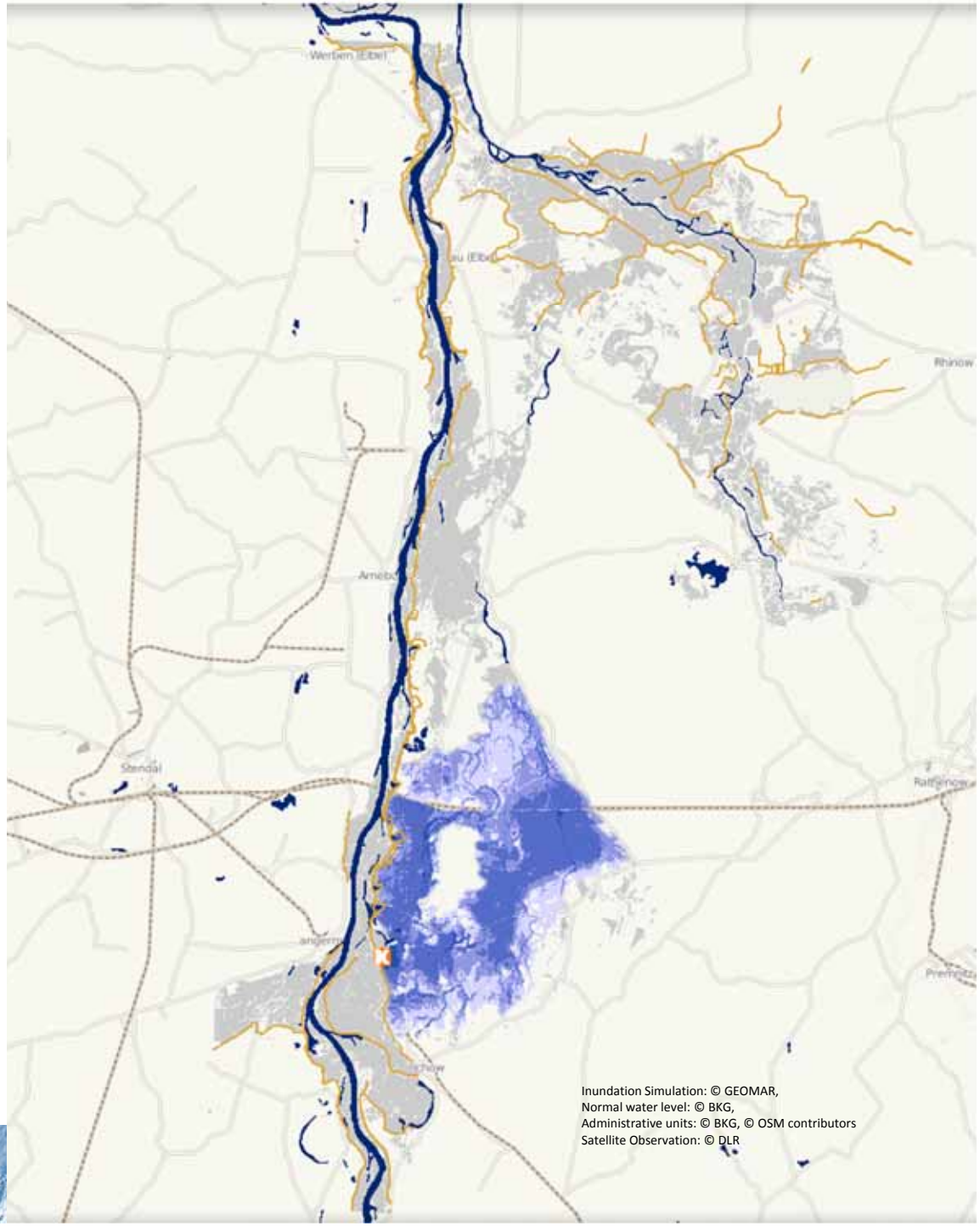
Improved flood risk assessment by fusion of hydrological modelling and satellite observation

Elbe-River, Germany



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Improved Risk Assessment through synergistic use of Earth Observation and Modelling

Synergy	Hydrological Model	Earth Observation
Interpolation	Initialise by observation	Fill the gap between observations
Extrapolation	Now casting / Forecasting	Fit scenarios/ Plan future acquisitions
Validation	Validate Model	Validate Retrieval/Mapping
Confirmation	“Second Opinion”	“Second Opinion”
Assimilation	Force/drive by observation	Support for Modelling
Calibration	Model set up / building	Support for Modelling / Optimisation of Retrieval/ Mapping

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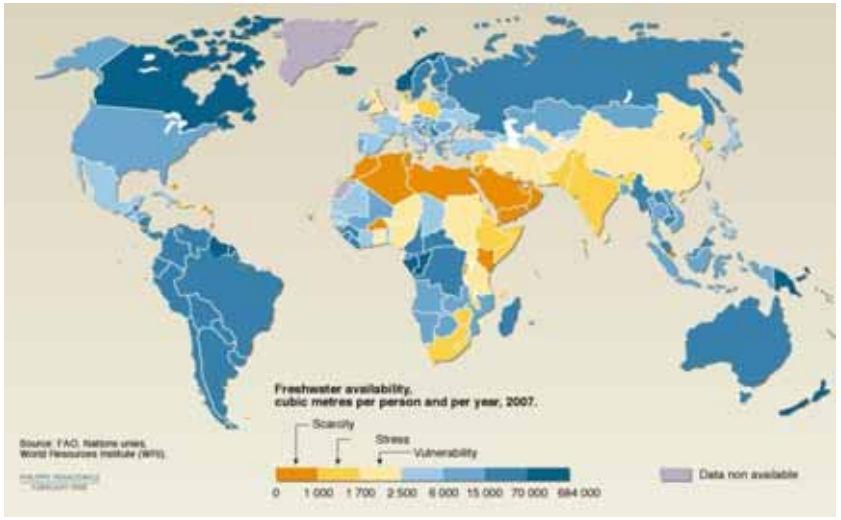
Earth Observation and Drought risk

- **Water Stress:**
  - Physical water stress
  - Economic water stress

- here considered as **critical lack of available water for livelihoods**

The use of Satellite Data…

- Existing indices:
  - Water indices (some incl. land cover)
  - Drought, desertification, land degradation indices (are not focus of this work).



Falkenmark Water Stress Index (Freshwater availability per m³, per person, per year): © Rekacewicz, 2008; accessed at UN, Aug 2012: http://www.un.org/waterforlifedecade/scarcity.shtml

Water Poverty Index 2002: © FAO, Aug 2012, UNEP/GRID-Arendal: : http://www.grida.no/graphicslib/detail/water-poverty-index-by-country-in-2002_d6db

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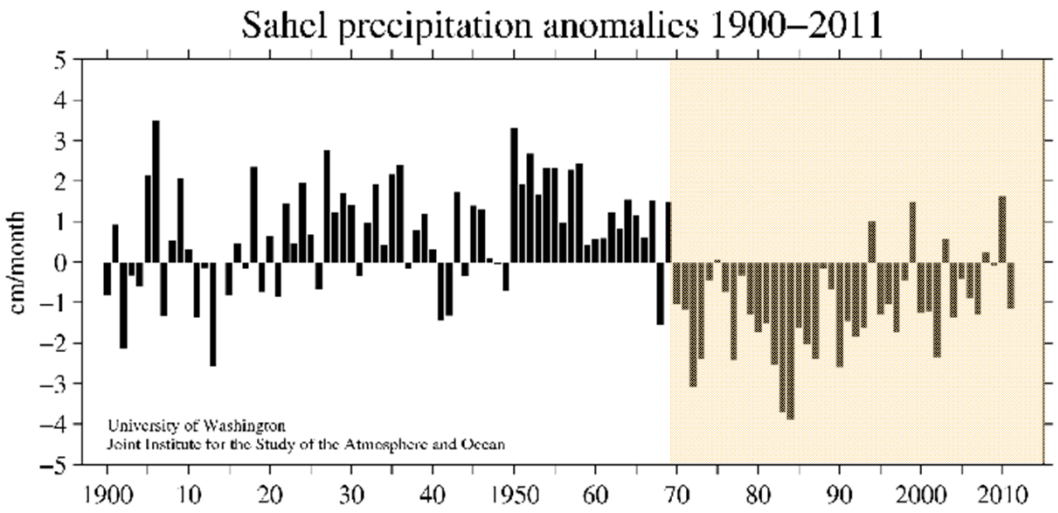
Example: Droughts in Sahel



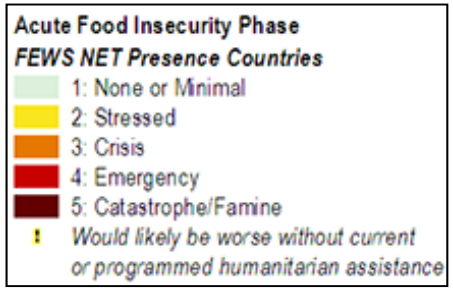
Mean Sahel precipitation anomaly during the rain season (June–October). Averages over 20-10N, 20W-10E, 1900–2010 climatology. NOAA NCDC Global Historical Climatology Network data. © Joint Institute for the Study of the Atmosphere and Ocean at the University of Washington, USA. http://jisao.washington.edu/data/sahel/#analyses.

Drought history:

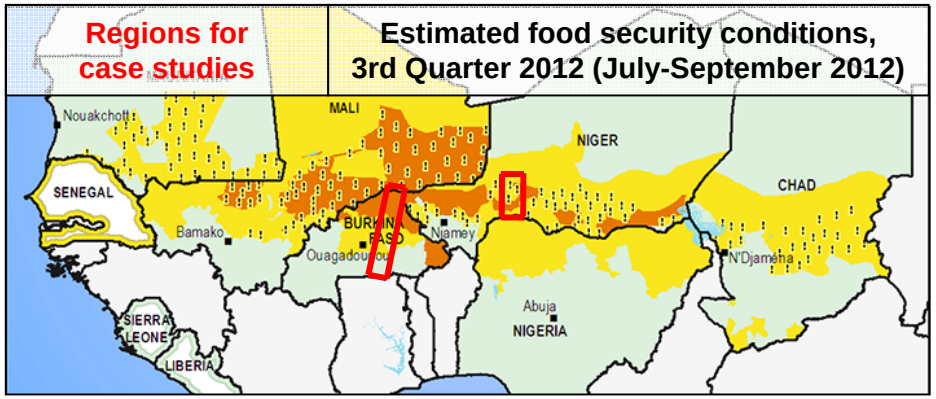
- **Mid-1970s** (e.g. 72-73)
- **Mid-1980s** (e.g. 84-85)
- 20-year dry period (1970-89)
- Then increase of annual rainfall, never reached pre-drought conditions.

Droughts in the last decade:

- **2005, 2008, 2010, 2012**



© Famine Early Warning Systems Network (FEWSNET), July 2012: http://www.fews.net/



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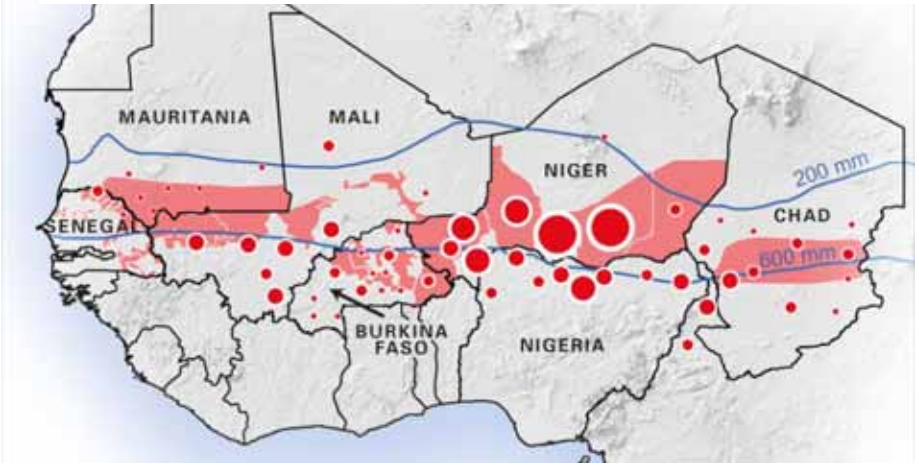
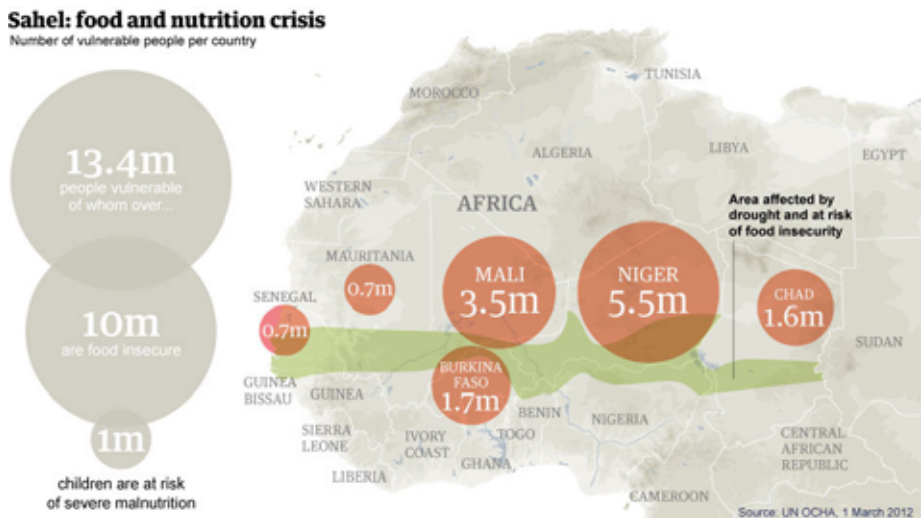
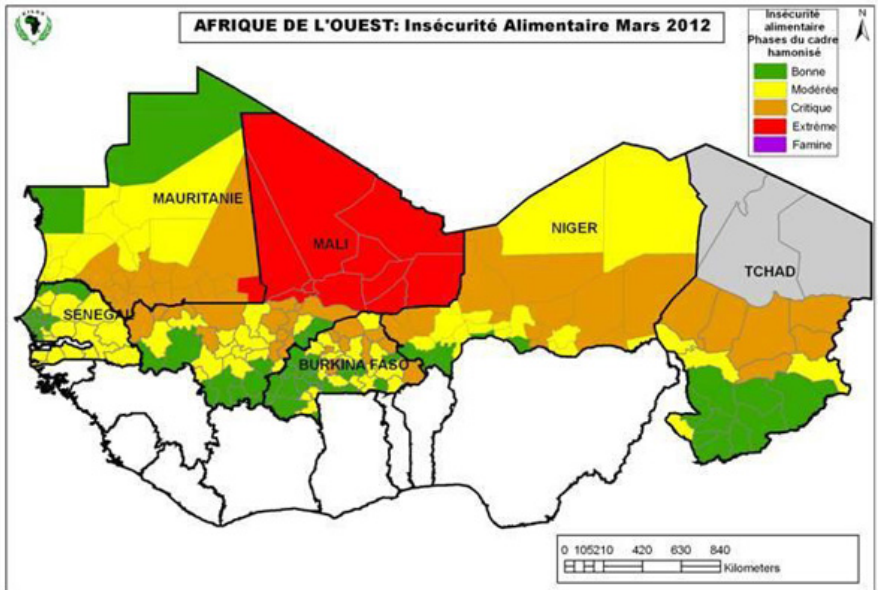
General Drought Info Sahel



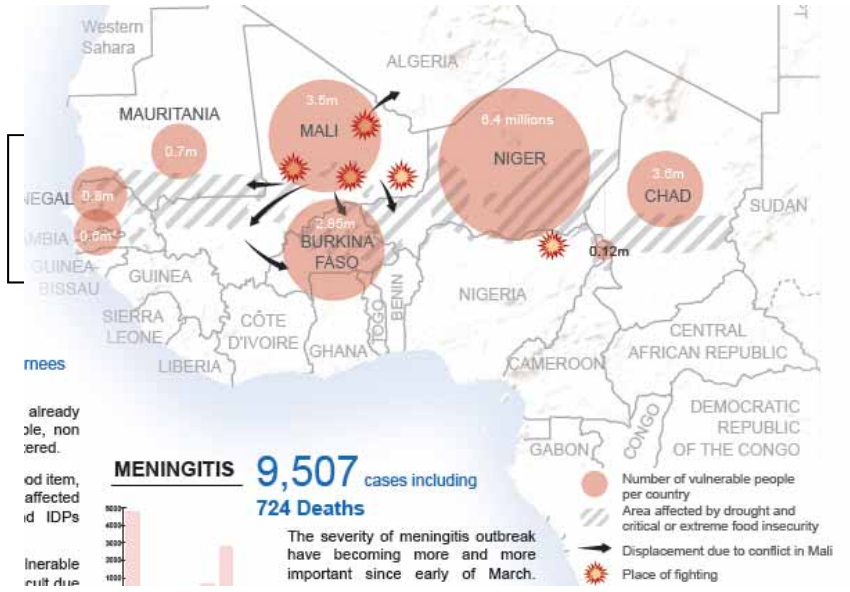
© Humanitarian Aid and Relief, May 2012:
http://humanitarian.worldconcern.org/2012/04/03/crisis-is-brewing-in-the-sahel/



© UN OCHA, 2012, accessed May 2012: http://static.guim.co.uk/sys-images/Guardian/Pix/maps_and_graphs/2012/3/9/1331299647277/Map---Sahel-food-crisis-001.jpg



© FAO, May 2012: http://www.fao.org/crisis/sahel/the-sahel-crisis/ar/



© Reliefweb, May 2012:
http://reliefweb.int/sites/reliefweb.int/files/resources/map_2079.pdf

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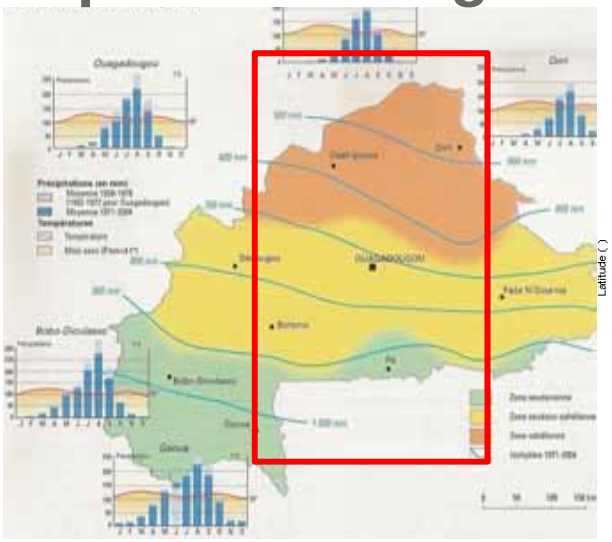
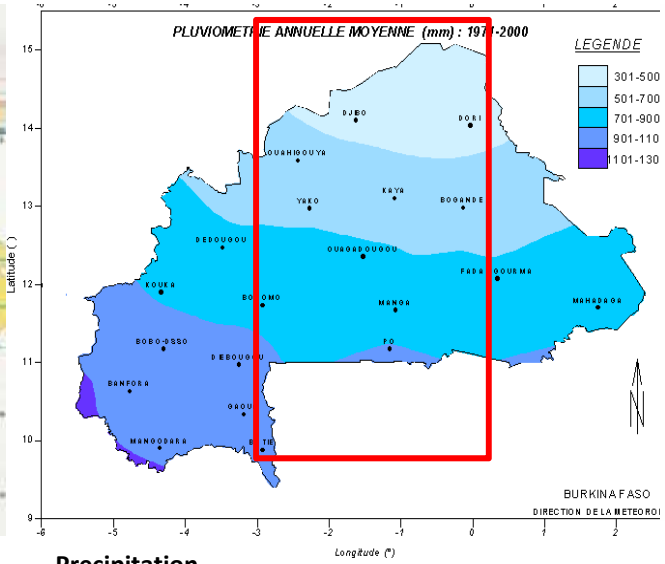
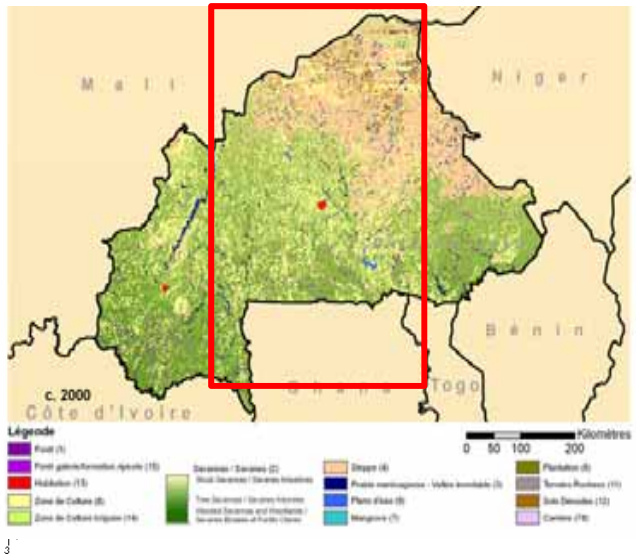
Specific Background Info Burkina Faso



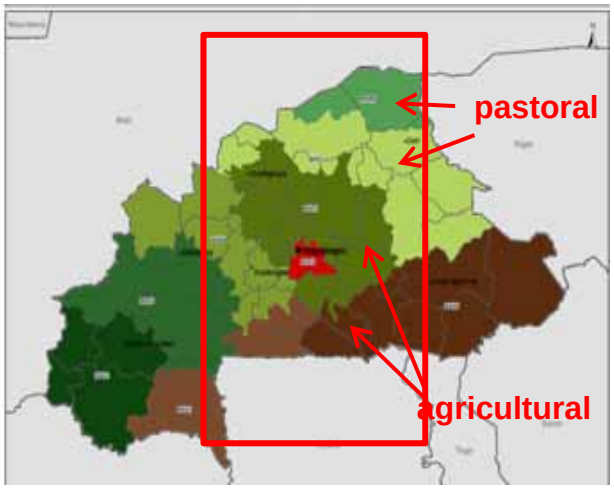
Climatic Zones / Precipitation
© Atlas de l'Afrique – Burkina Faso, 2005



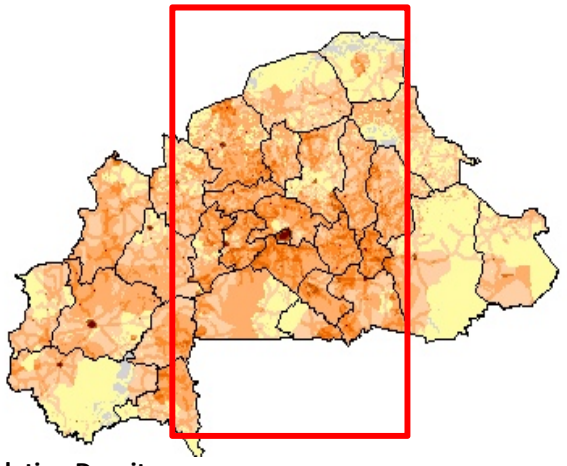
Precipitation
May, 2012: © http://www.planete-burkina.com/geographie_burkina.php



LULC Classification
© West Africa Land Use and Land Cover Trends Project, May, 2012: http://lca.usgs.gov/lca/africalulc/results.php



Livelihood Zones
© FEWSNET, May 2012:
http://www.fews.net/docs/Publications/BF_Livelihoods.pdf



Population Density
May 2012: © http://www.catsg.org/cheetah/07_map-centre/7_4_North-African-region/thematic-maps/thematic-maps.htm

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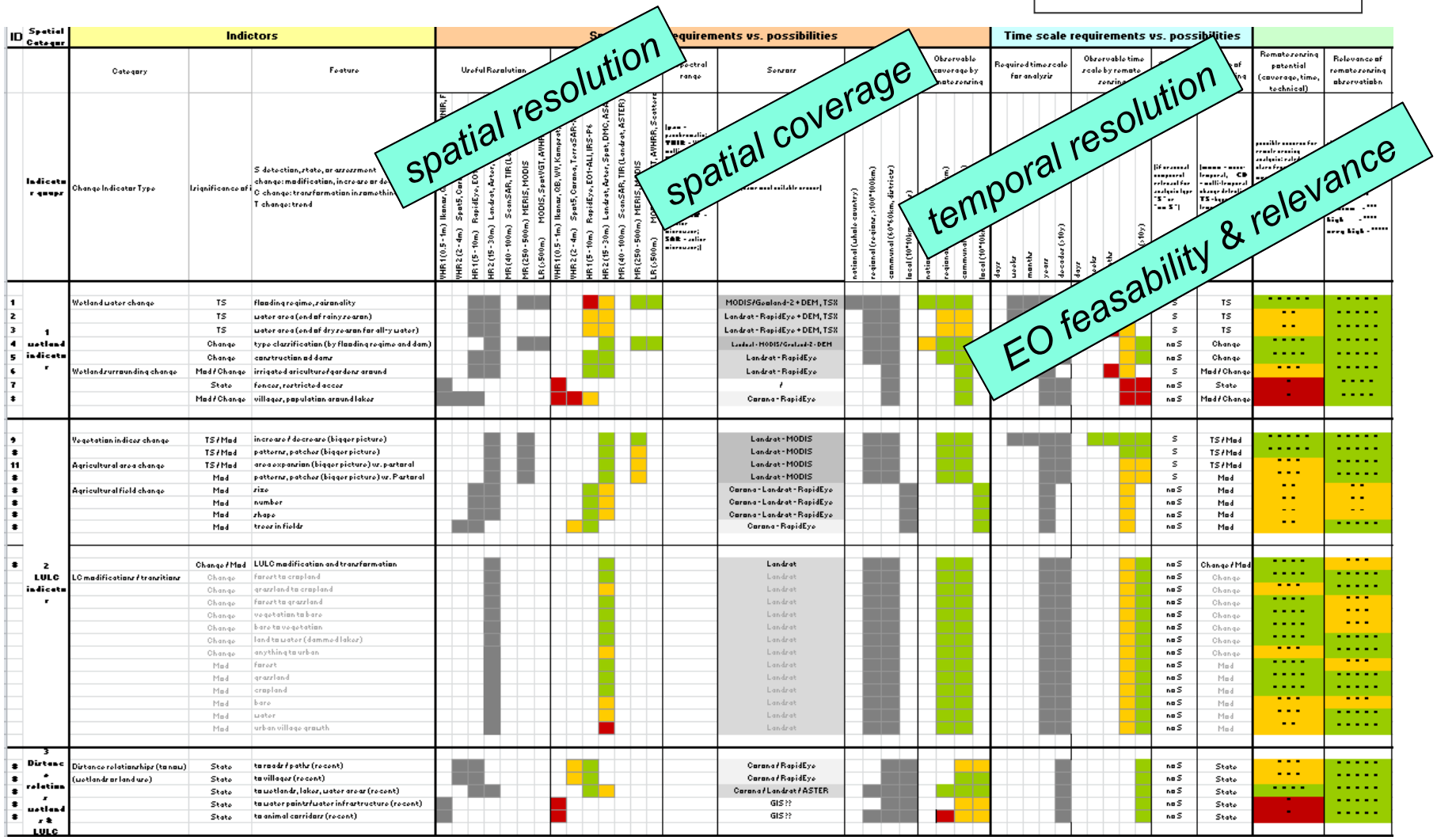
Observable Parameters – EO potential

Traffic light system:
Green = feasable
Yellow = challenging
Red = not feasable



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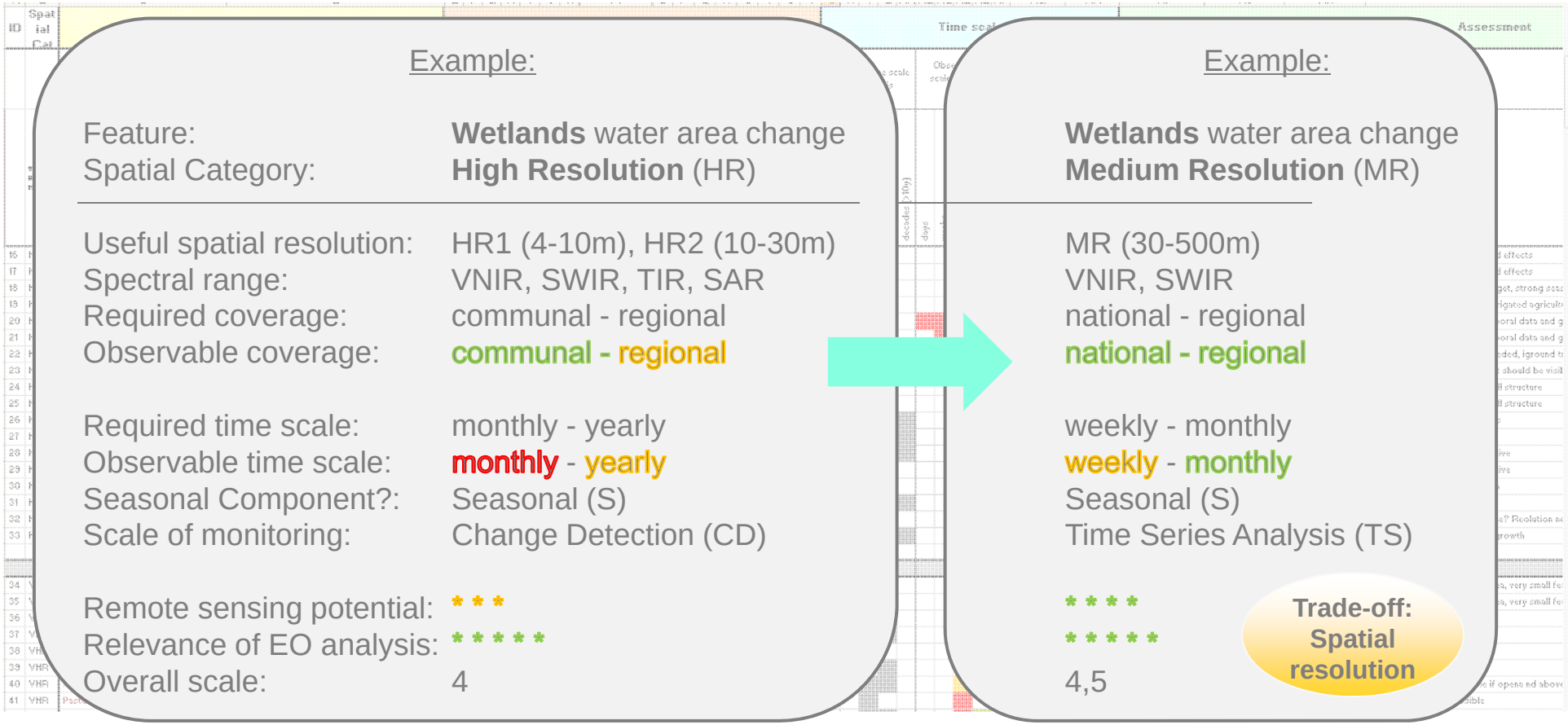

Example:

Feature:	**Wetlands** water area change
Spatial Category:	**High Resolution** (HR)
Useful spatial resolution:	HR1 (4-10m), HR2 (10-30m)
Spectral range:	VNIR, SWIR, TIR, SAR
Required coverage:	communal - regional
Observable coverage:	communal - regional
Required time scale:	monthly - yearly
Observable time scale:	monthly - yearly
Seasonal Component?:	Seasonal (S)
Scale of monitoring:	Change Detection (CD)
Remote sensing potential:	* * *
Relevance of EO analysis:	* * * * *
Overall scale:	4

Example:

	Wetlands water area change
	Medium Resolution (MR)
	MR (30-500m)
	VNIR, SWIR
	national - regional
	national - regional
	weekly - monthly
	weekly - monthly
	Seasonal (S)
	Time Series Analysis (TS)
	* * * *
	* * * * *
	4,5

Trade-off: Spatial resolution

Observable parameters: spatial resolution, spatial coverage, temporal coverage, and relevance

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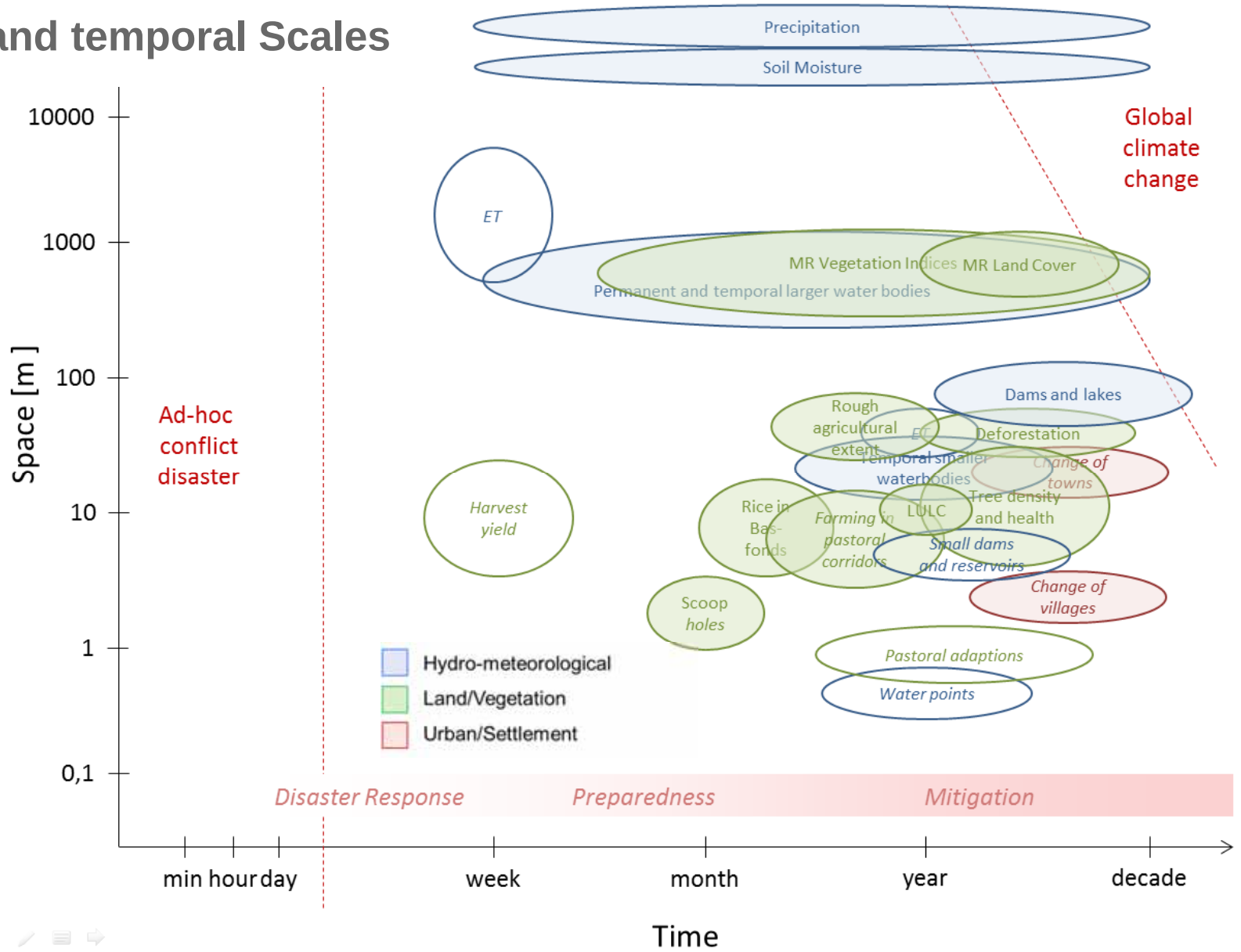
Observable Parameters
Spatial and temporal Scales



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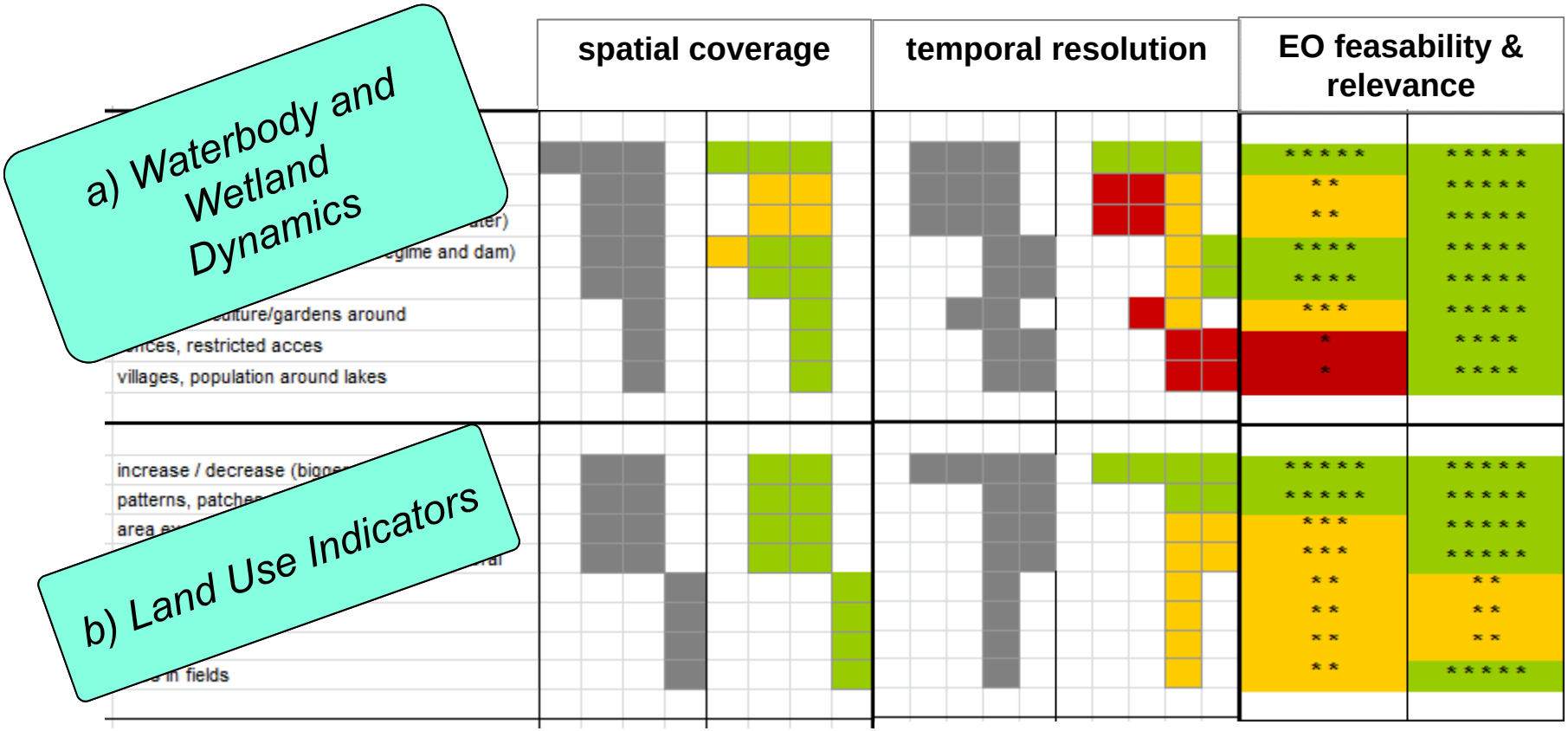
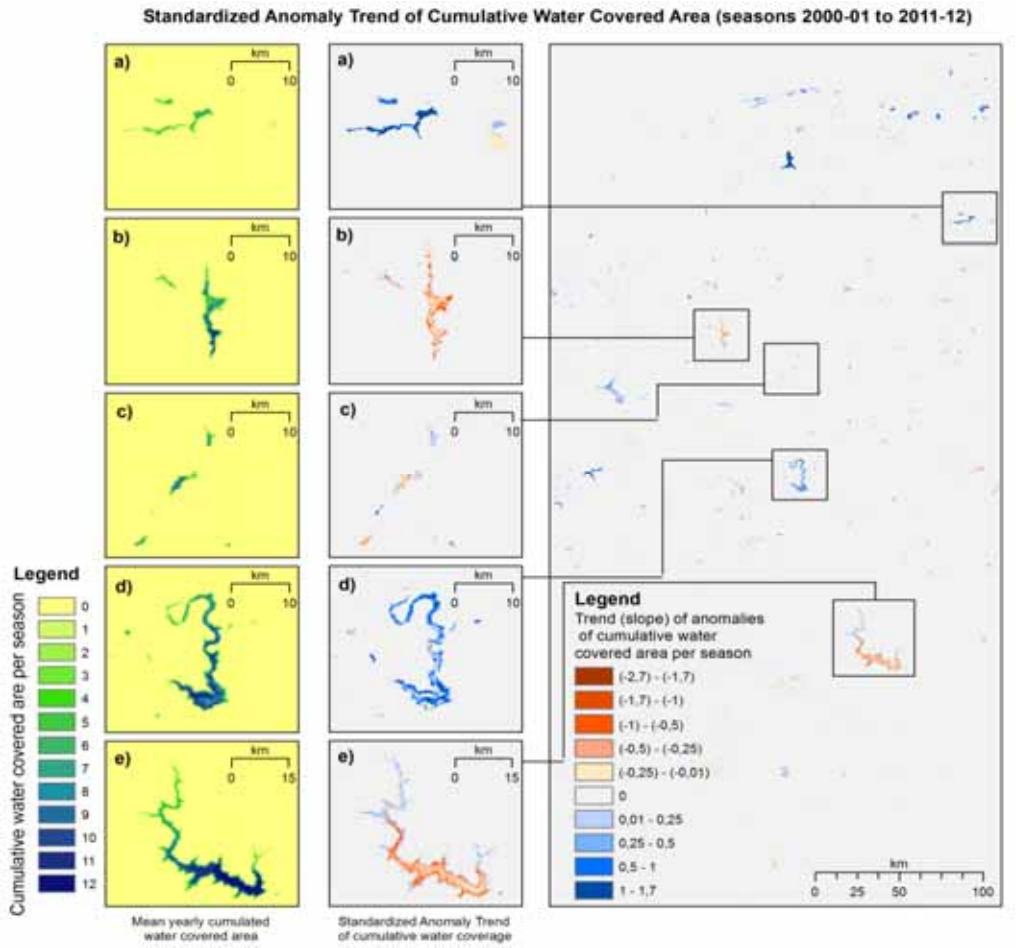
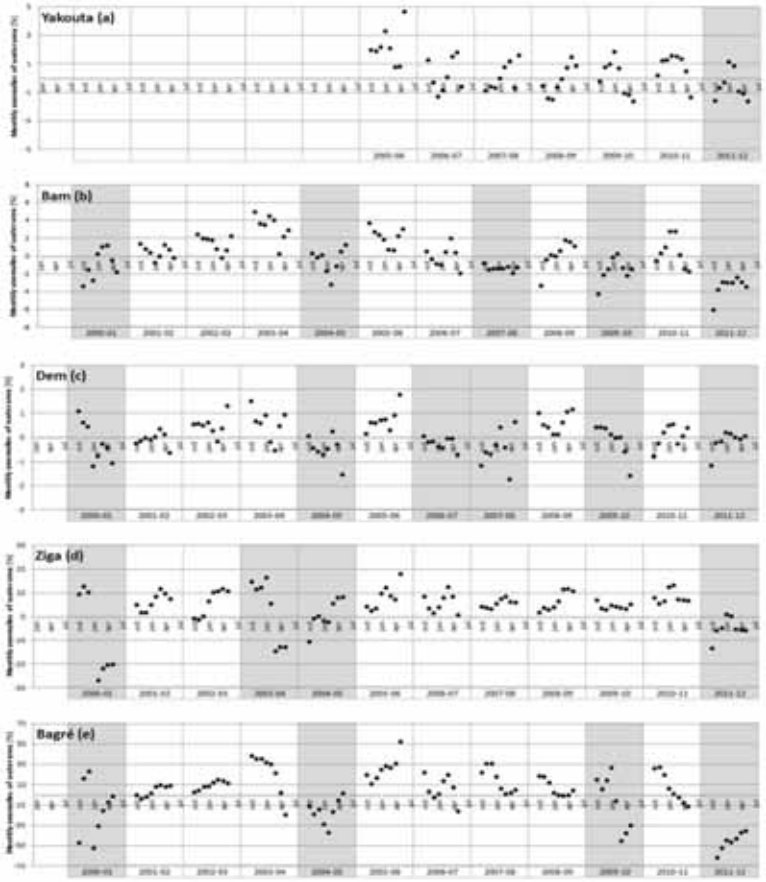


Satellite based monitoring of water bodies and wetlands as indicator for critical water shortage and drought risk in the Sahel



Monthly anomalies of water body size, with respect to the 13-year mean displayed for the dry season (October – May) 2000-20012



Moser et al. 2014

Concluding Remarks

- **Earth Observation can contribute in multiple ways to risk mapping** and assessment. Flood, drought and beyond.

- The **combination/synergy of Earth Observation and Modelling** of risks (all components) still bares great potential, not fully developed yet. Especially for flood risk assessment / hydrological risks.

- **Temporal and spatial scales**, as well as observational limitations, have to be respected when incorporating EO for any kind of risk assessment.

- EO provides time series of observations up to 30years. We can start to work on **satellite climatology for "coarse" risk phenomena** and assess statistical parameters of natural hazards for risk assessment - even though satellites.

- Can we start thinking of ways **use EO for documentation of avoided or mitigated disasters?**

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