



VIENNA  
UNIVERSITY OF  
TECHNOLOGY  
  
INSTITUTE OF  
PHOTOGRAMMETRY  
AND REMOTE SENSING

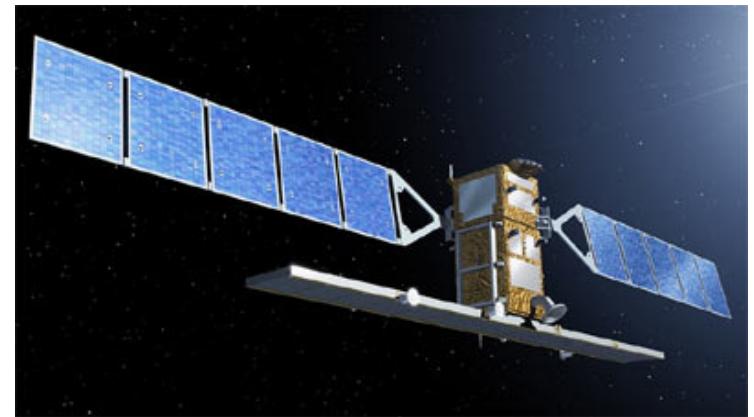
## Satellite-based Soil Moisture Information for Flood Risk Assessment – the case of the 2010 Pakistan floods.

The Global Monitoring of Soil Moisture for Water Hazards Assessment (GMSM) project funded by the Austrian Research Promotion Agency (FFG)

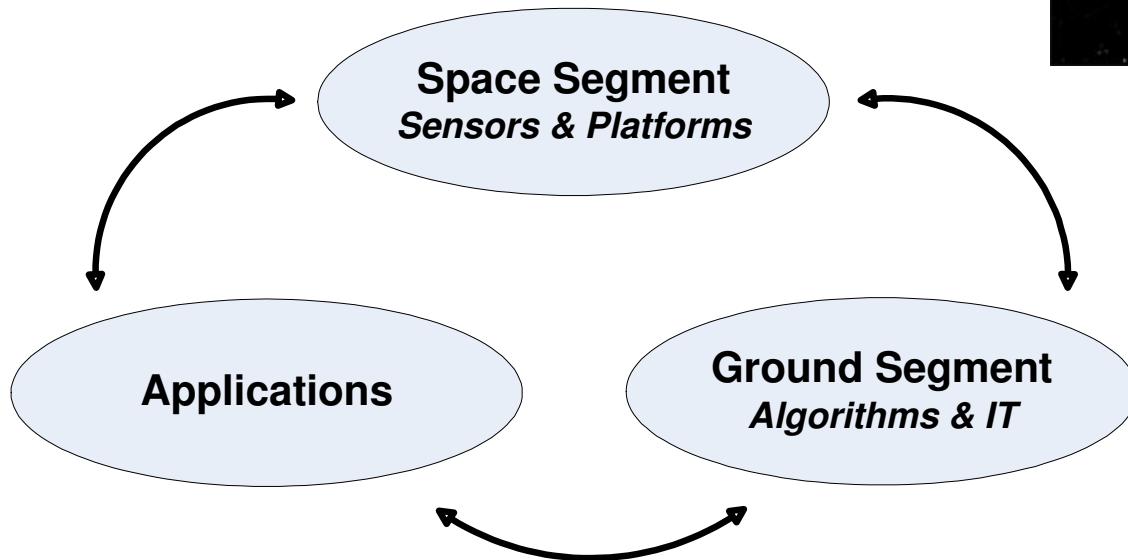
Richard Kidd, Wolfgang Wagner  
[rk@ipf.tuwien.ac.at](mailto:rk@ipf.tuwien.ac.at)

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Vienna University of Technology (TU Wien)  
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Sentinel-1



# Remote Sensing Process



$$\Phi = \int_0^{\infty} x \exp(-x\xi) dx$$

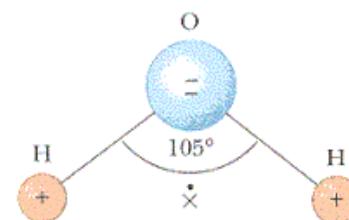
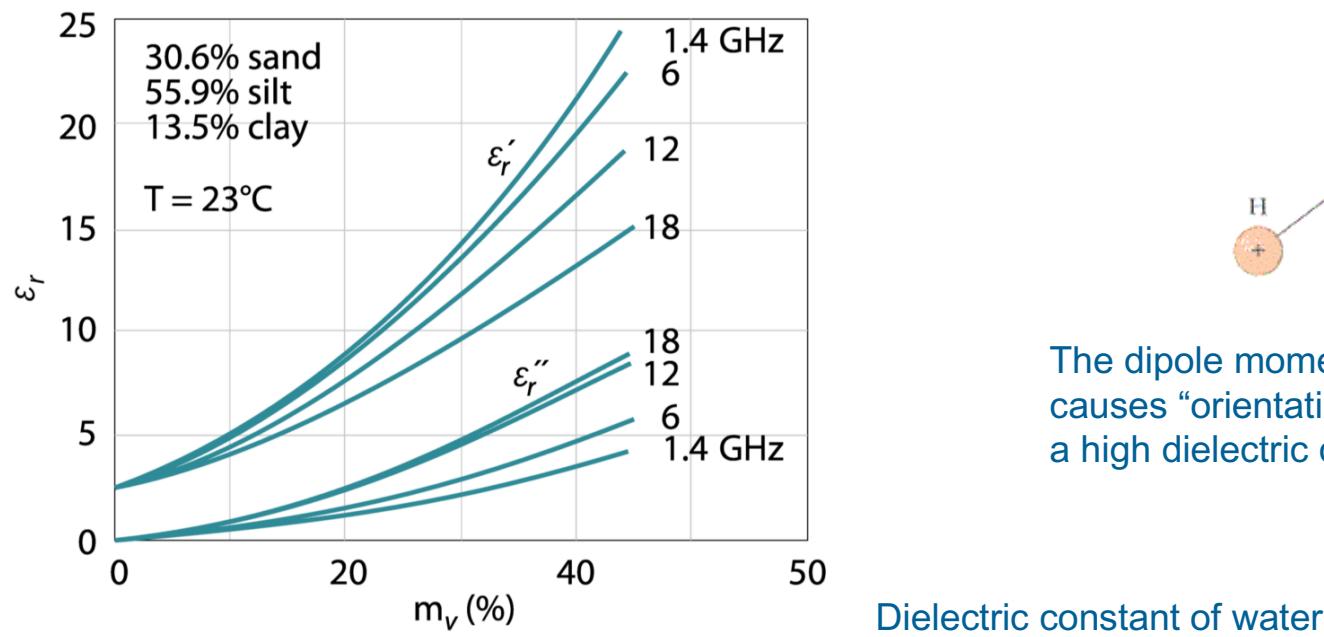
Geometric Models  
Physical Models  
Data Processing



Flood Forecasting

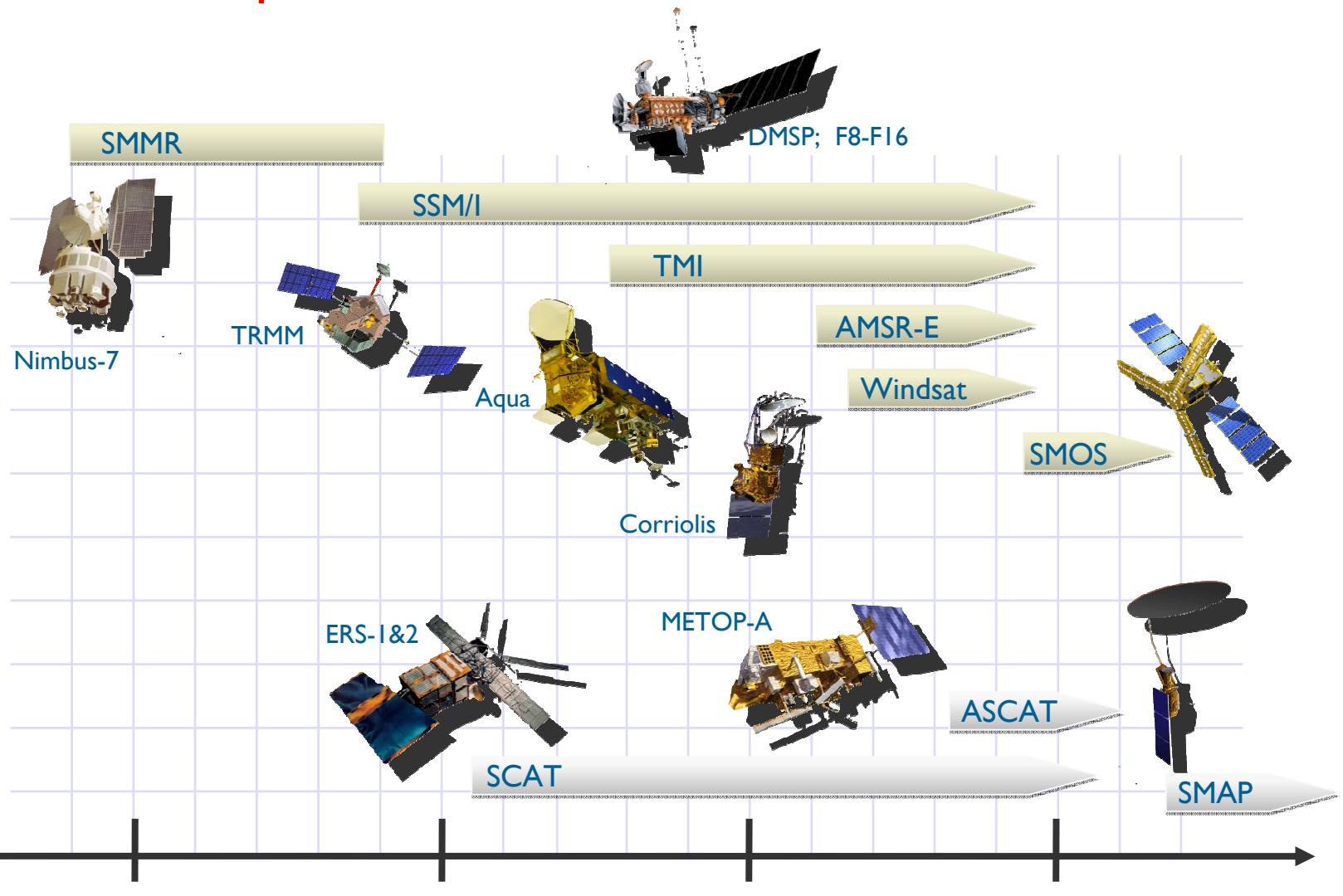
# Microwaves for Monitoring of Soil Moisture

- Microwaves (1 mm – 1 m wavelength)
  - All-weather, day-round measurement capability
  - Very sensitive to soil water content below 10 GHz
  - Penetrate vegetation and soil to some extent
    - Penetration depth increases with wavelength



The dipole moment of water molecules causes “orientational polarisation”, i.e. a high dielectric constant

# Microwave Space Missions Suitable for Soil Moisture



# State of the Art - Soil Moisture

- Significant advances over the last few years
  - Sensor technology
    - Soil Moisture and Ocean Salinity (SMOS): launch in November 2011
    - Soil Moisture Active/Passive (SMAP): launch in 2014/15
  - Improvements in physical understanding and retrieval
    - Made possible by computing power capacities
- Several global soil moisture data sets derived from different sensors and algorithms have been released over the past few years
  - Multi-frequency radiometers, scatterometers, SAR
- Applications
  - Positive impact of real data was demonstrated in several applications
    - Meteorology, hydrology, agronomy, etc.

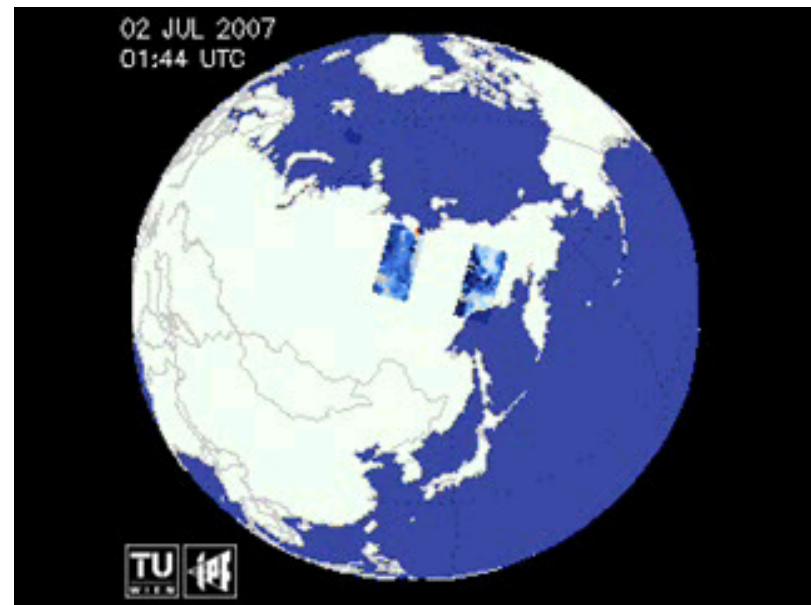
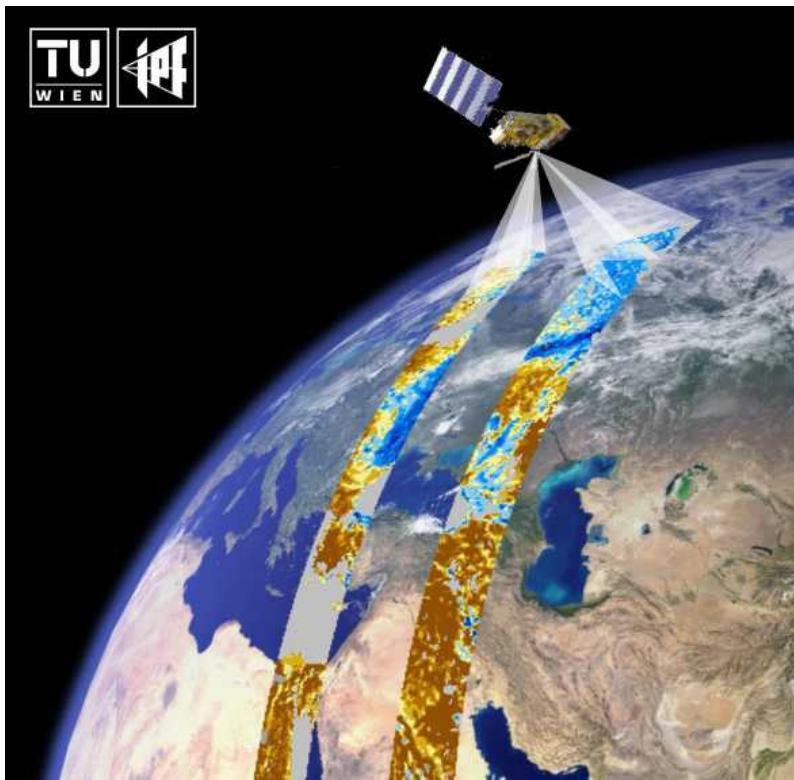
# SMOS: Dedicated to Soil Moisture

- Passive interferometer operated in L-band (21 cm)
- Brings a measurement concepts developed in radio astronomy up to space
  - Daily global coverage 82 % at 40 km resolution

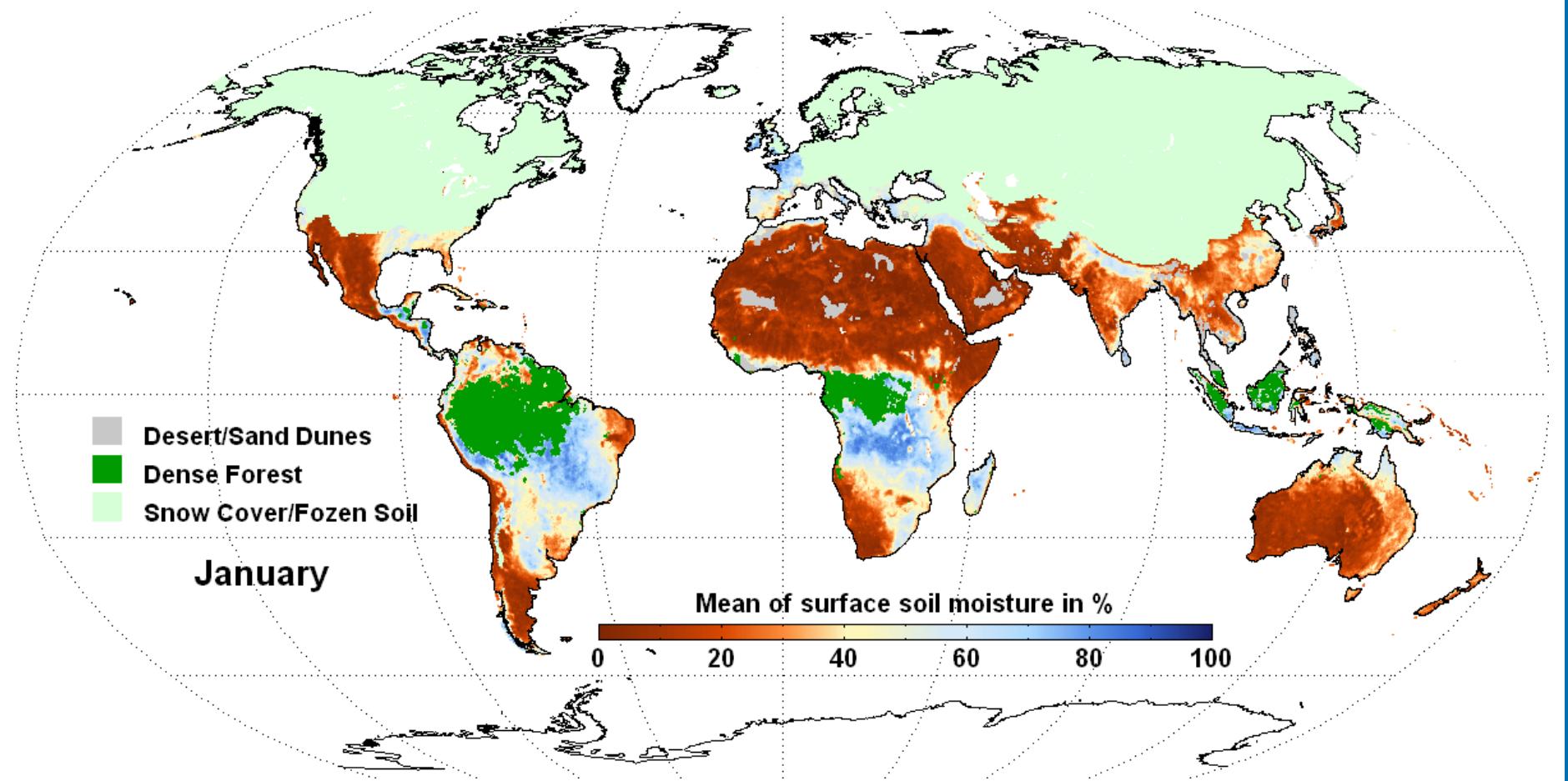


# METOP ASCAT

- First operational global soil moisture service (EUMETSAT)
  - Data available to users 130 min after sensing
  - Daily global coverage 82 % with 25 km resolution



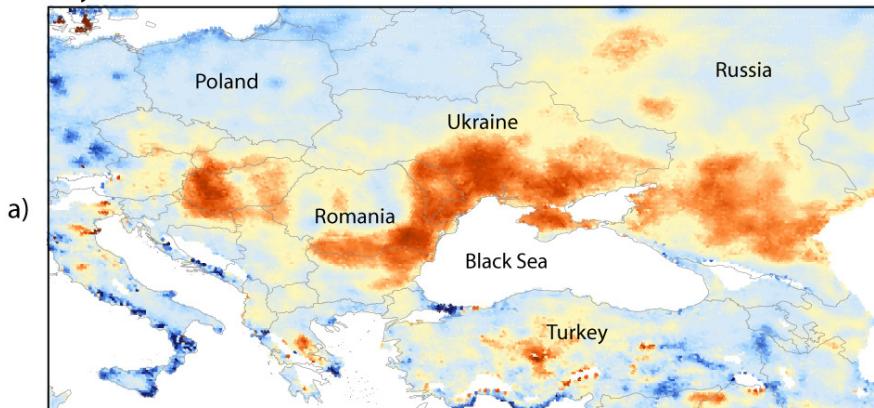
# SCAT Seasonal Soil Moisture Cycle



Mean ERS scatterometer surface soil moisture (1991-2007)

# Soil Moisture Anomalies

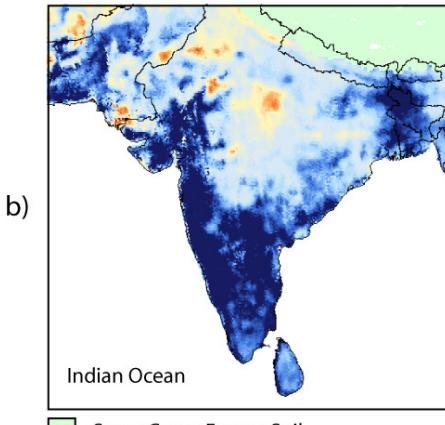
July, 2007



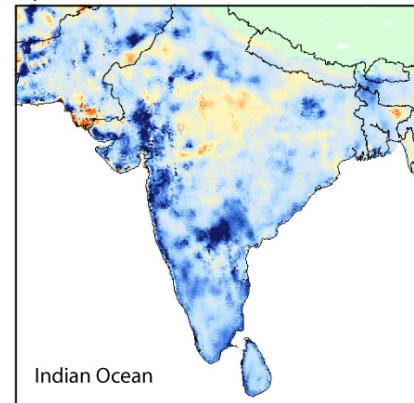
July 28 - August 12, 2007



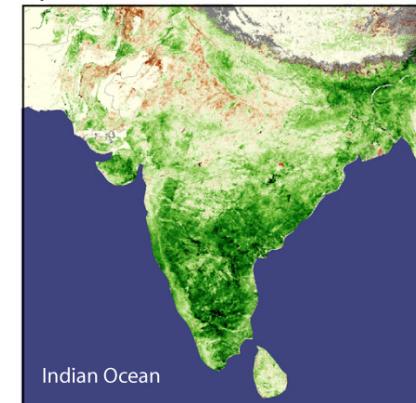
March, 2008



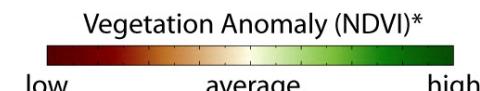
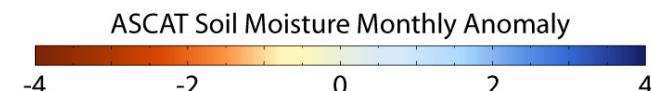
April, 2008



April 1-10, 2008

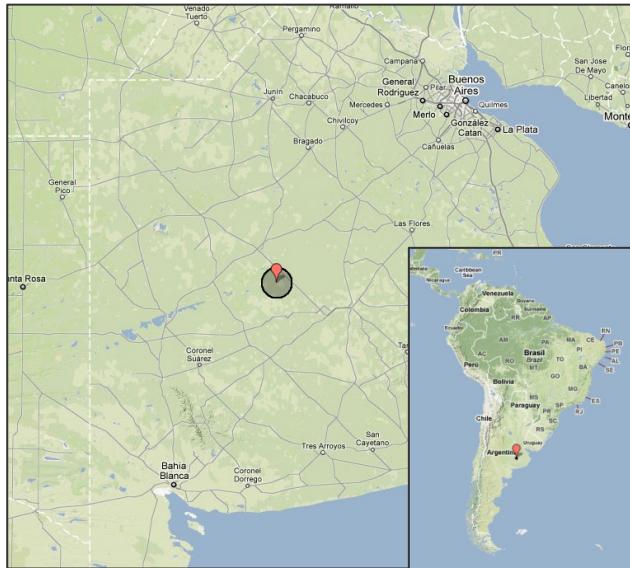


Snow Cover, Frozen Soil



\* NASA's Earth Observatory (MODIS instrument)

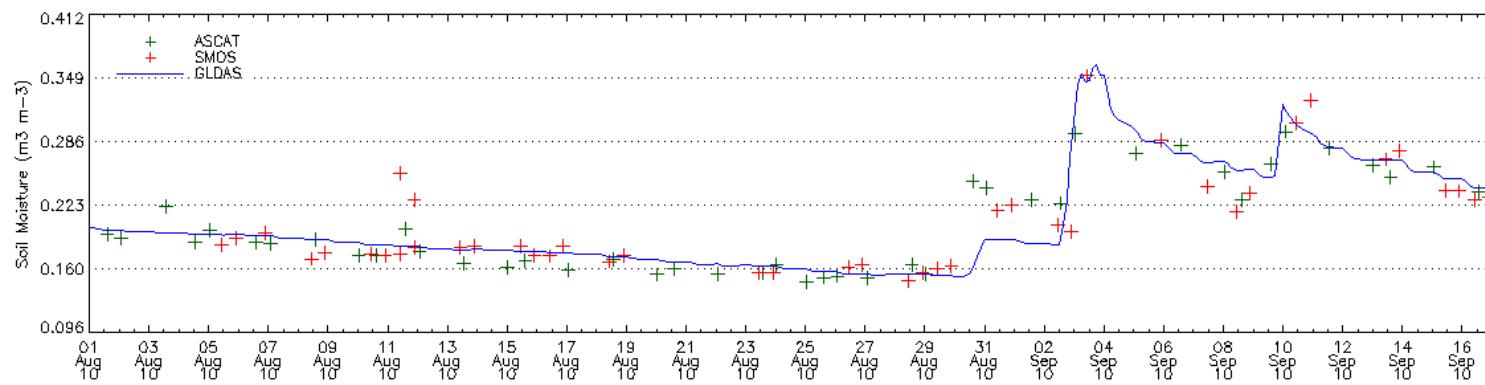
# SMOS & METOP ASCAT Timeseries



Comparison over an agricultural area in Argentina (2010)

- METOP Operational soil moisture product
- SMOS Soil Moisture product
- Modelled soil moisture data from GLDAS

But, satellite methods capture rainfall events missed by the modelled data.

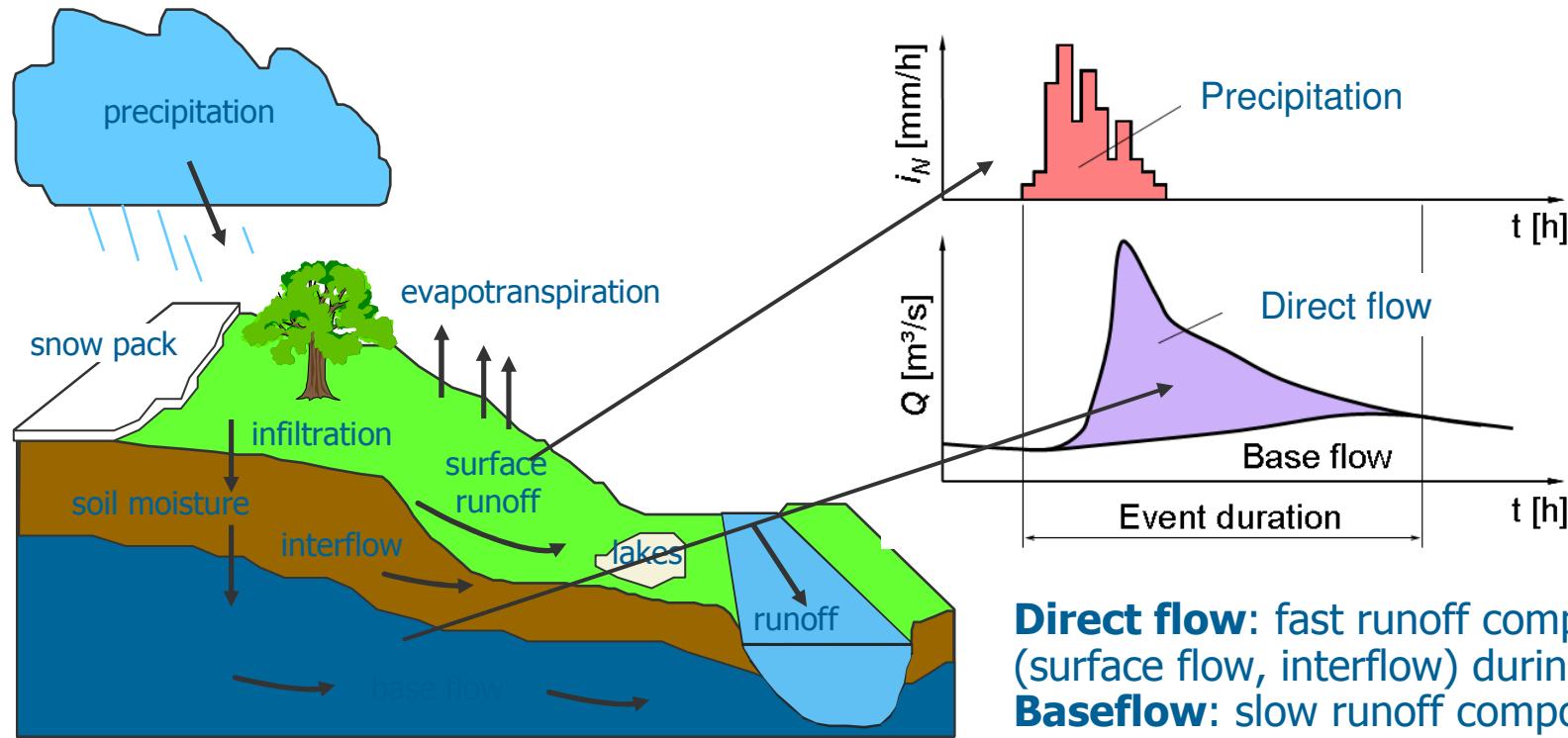


# Soil Moisture Controls on Runoff

The amount of water stored in the soil strongly influences how much water runs off directly from a precipitation event

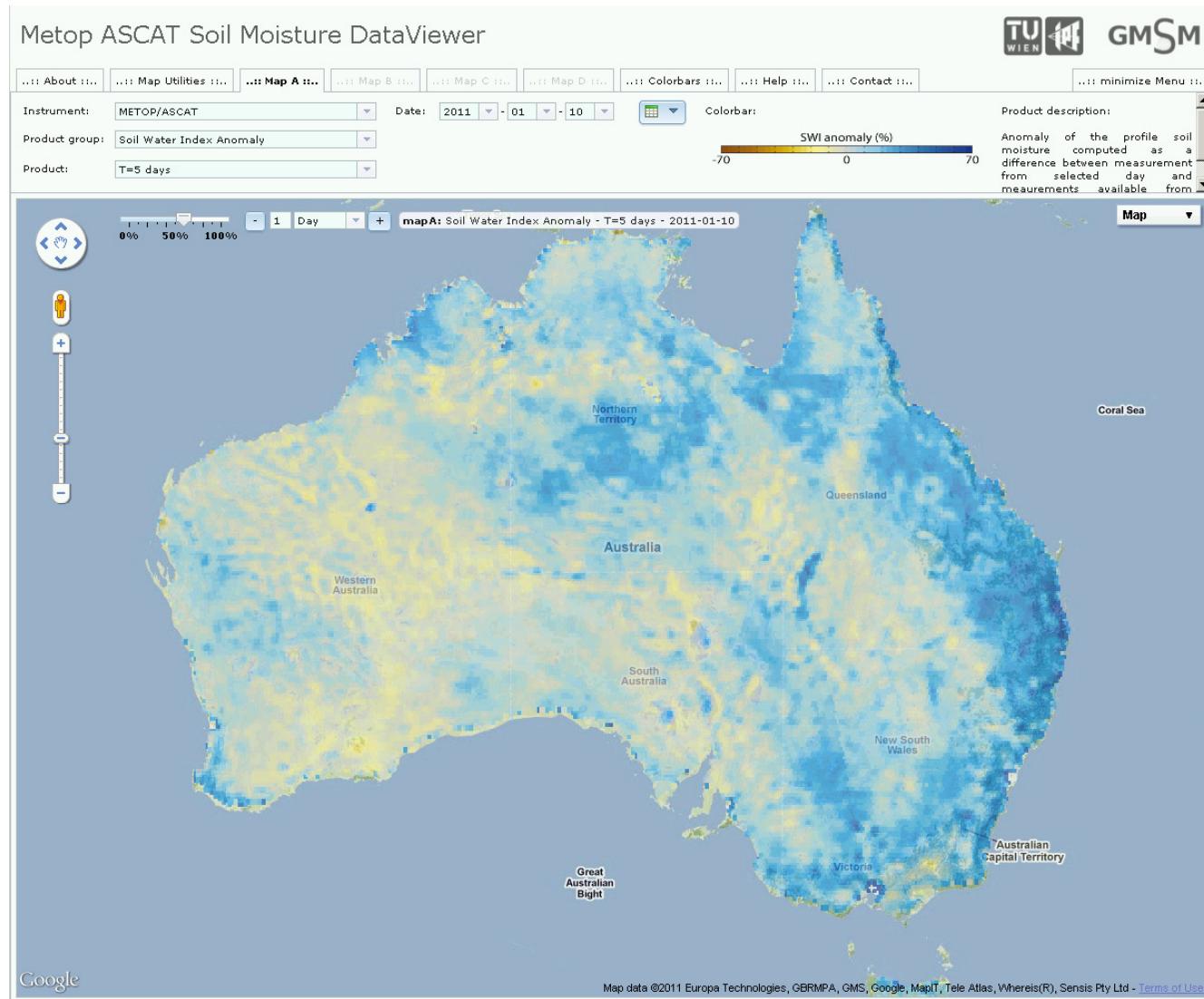
Low soil moisture -> lower direct flow

High soil moisture -> higher direct flow

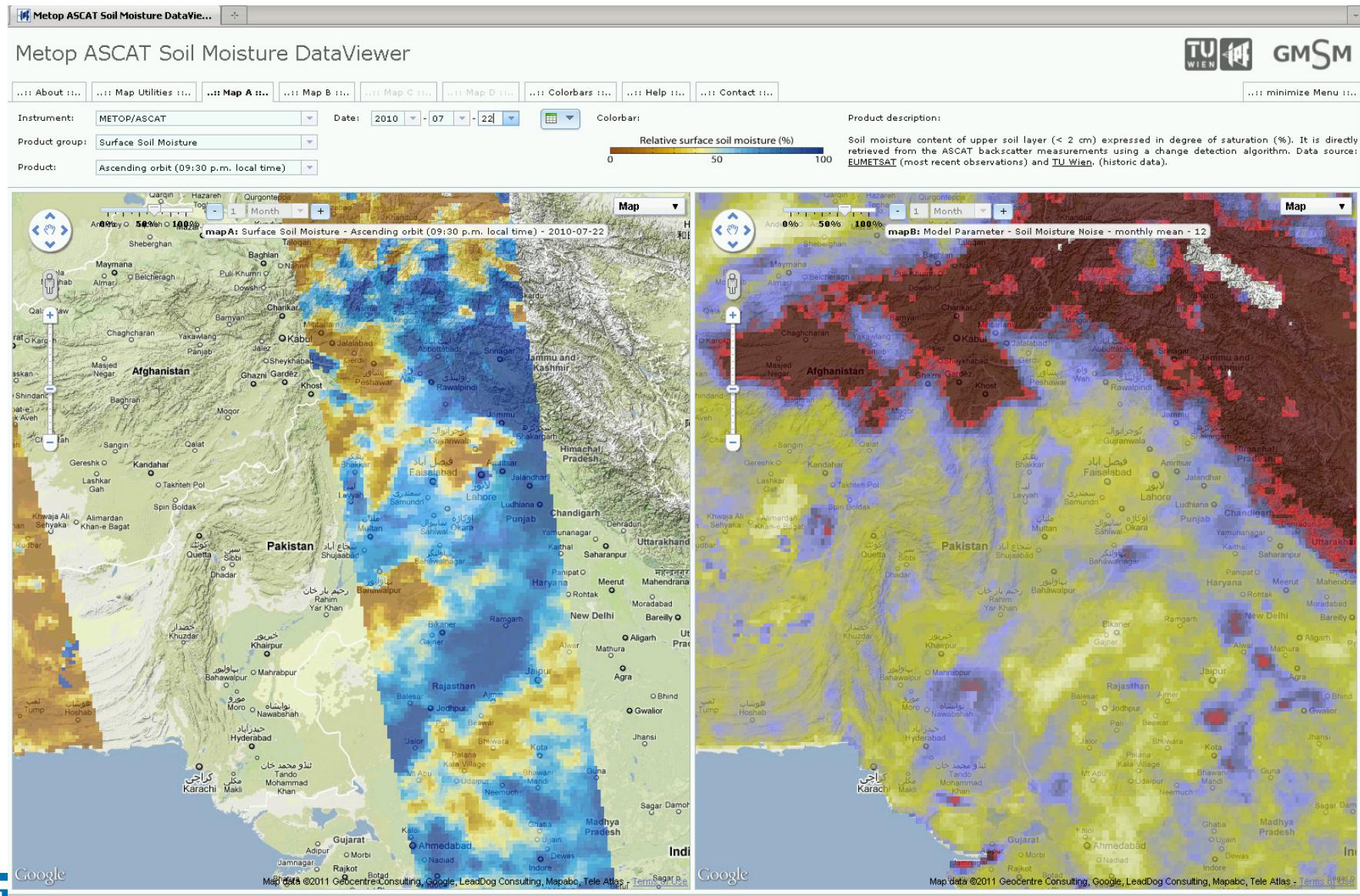


**Direct flow:** fast runoff component (surface flow, interflow) during an event  
**Baseflow:** slow runoff component (subsurface flow) between events

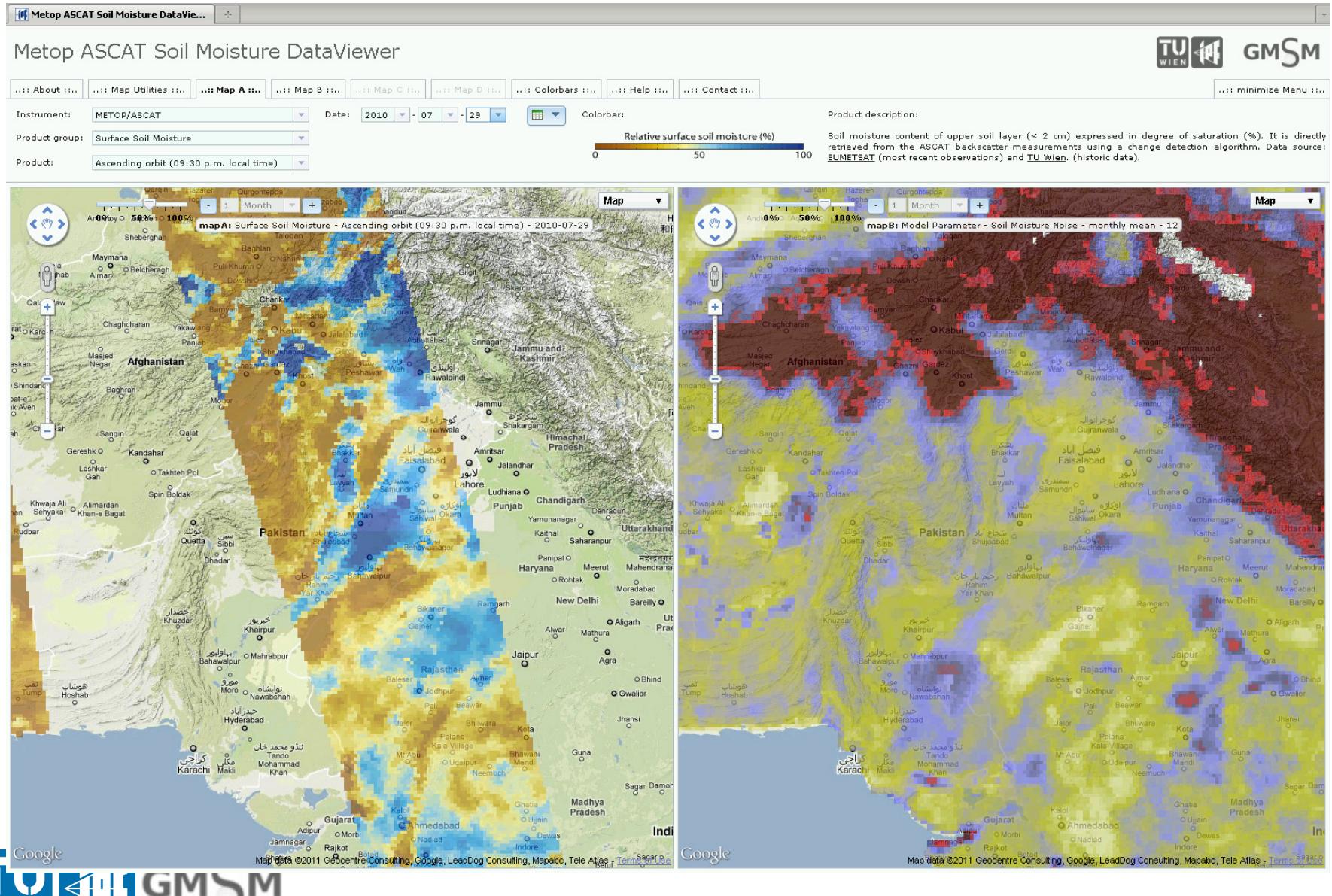
# Soil Water Index Anomaly: Australia 10-Jan-2011



# Surface Soil Moisture: Pakistan 22-Jul-2010

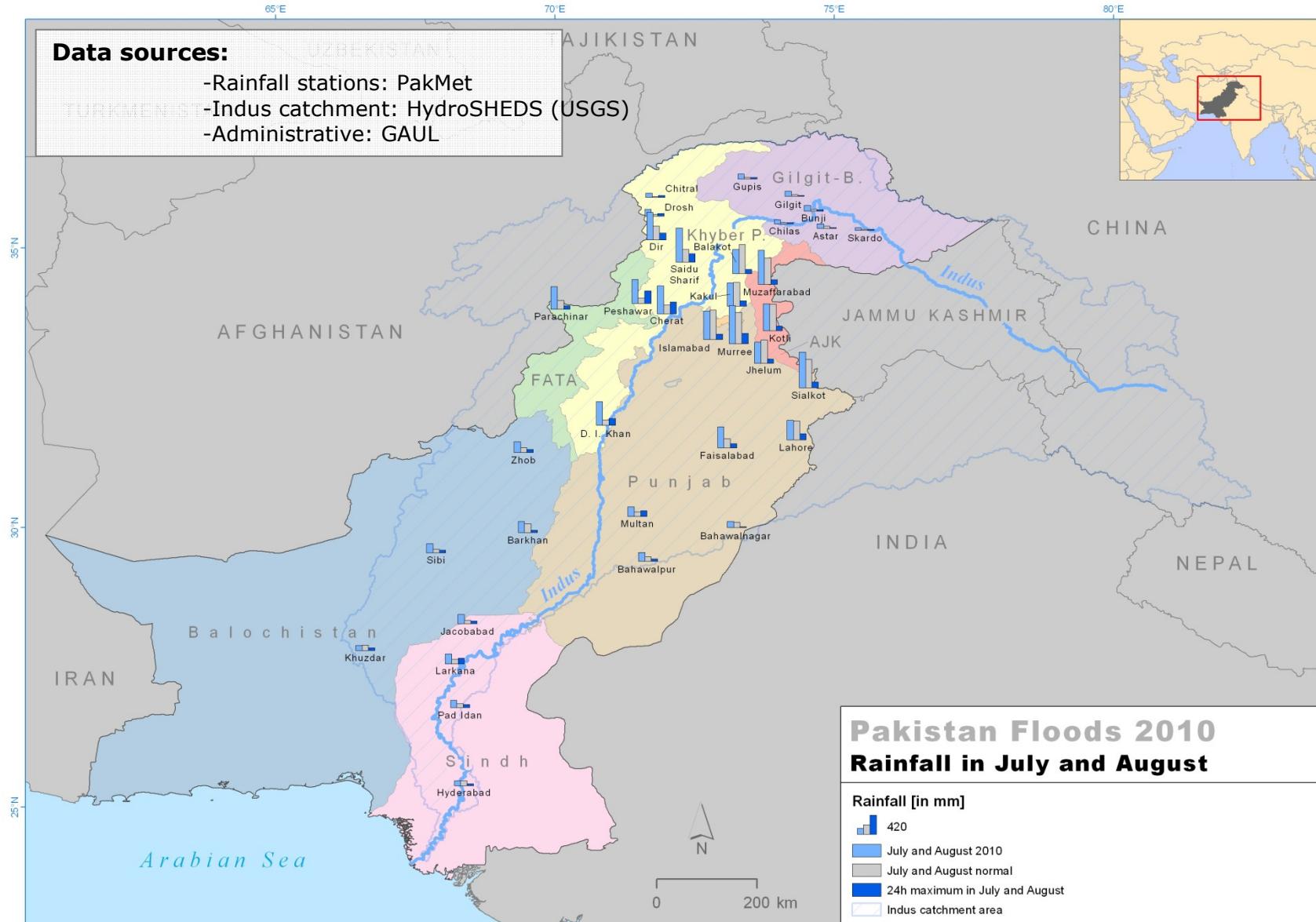


# Surface Soil Moisture: Pakistan 29-Jul-2010



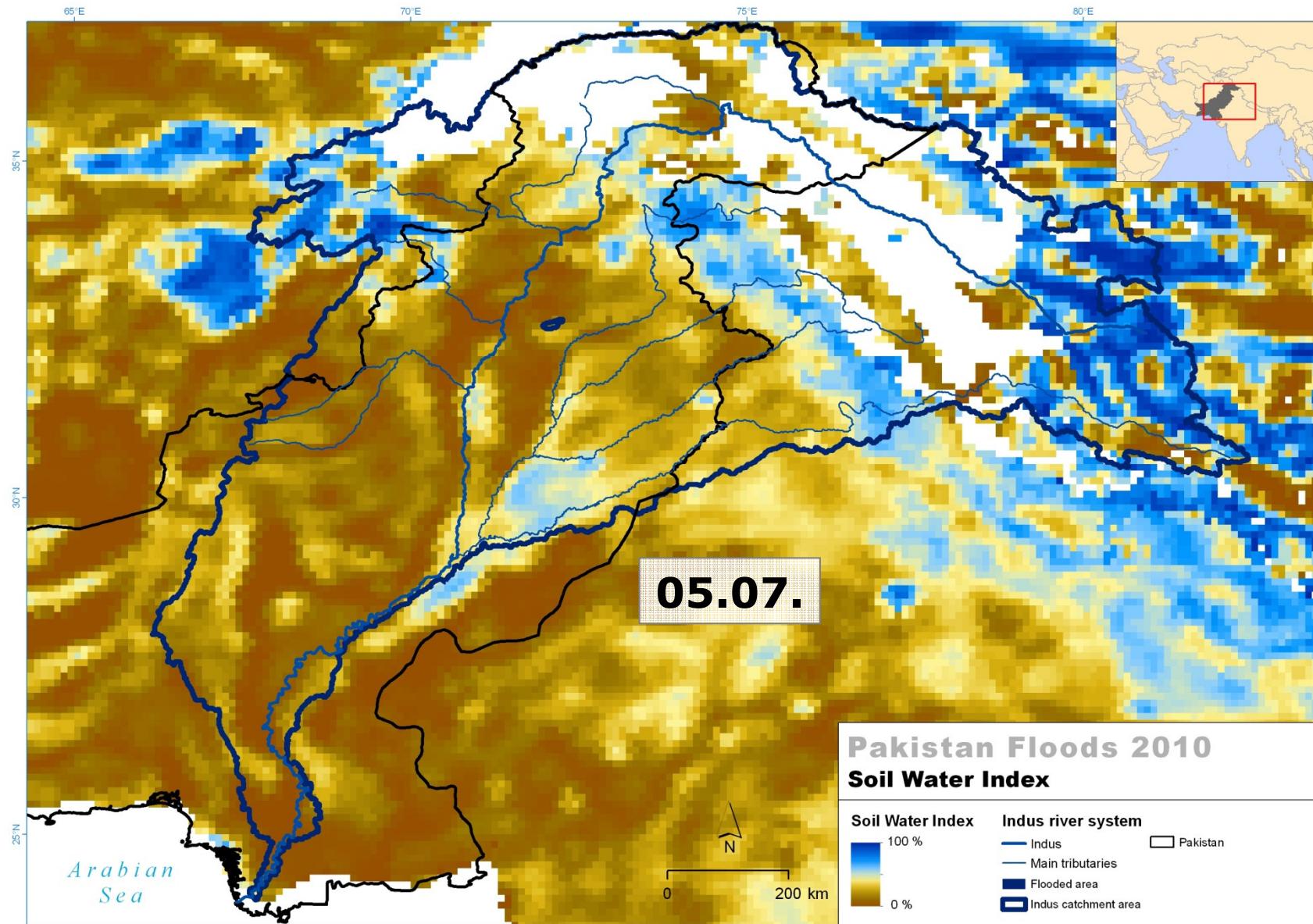
# **Case Study: Floods in Pakistan 2010**

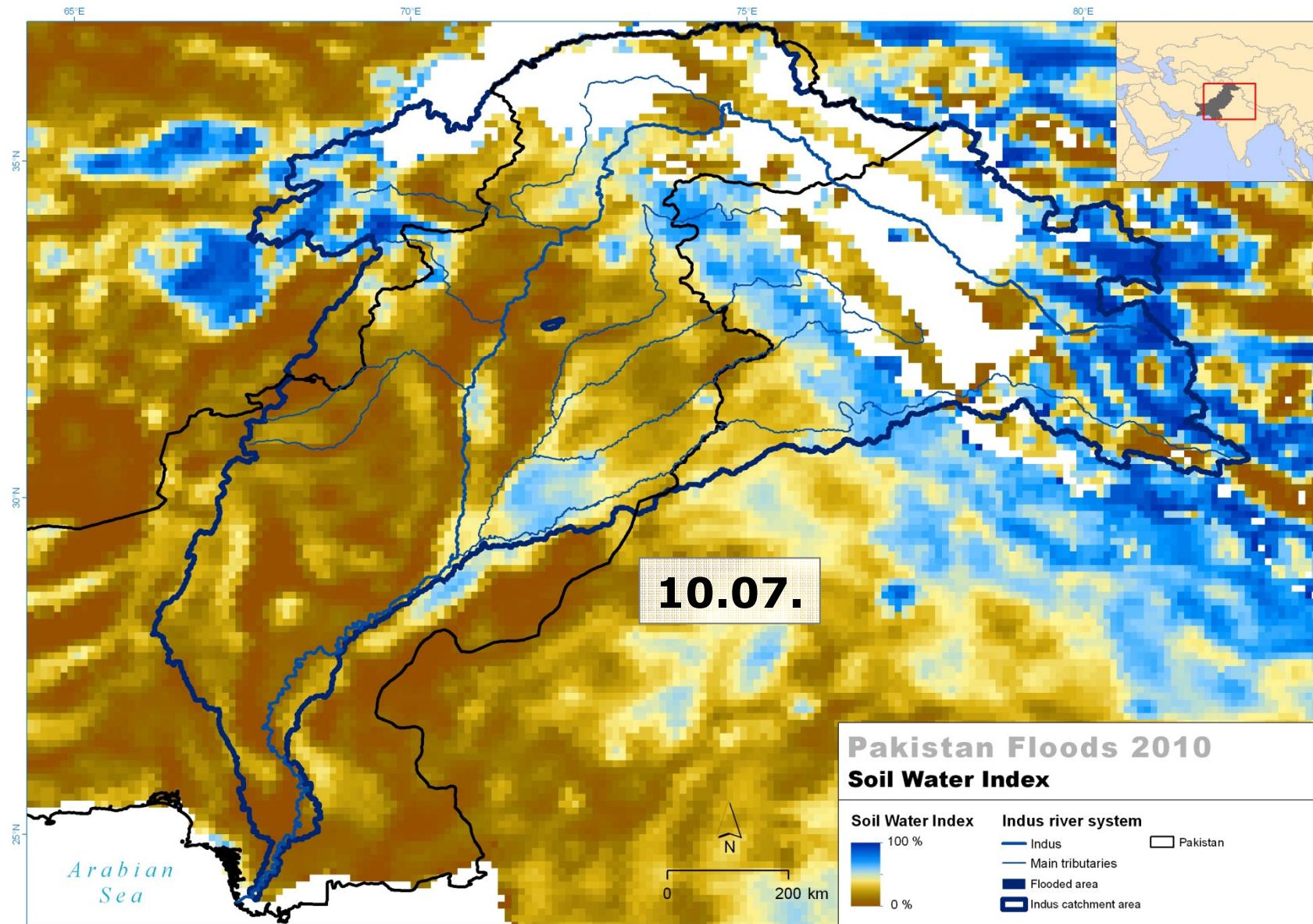
**Markus Fleiss, Stefan Kienberger, Peter Zeil**

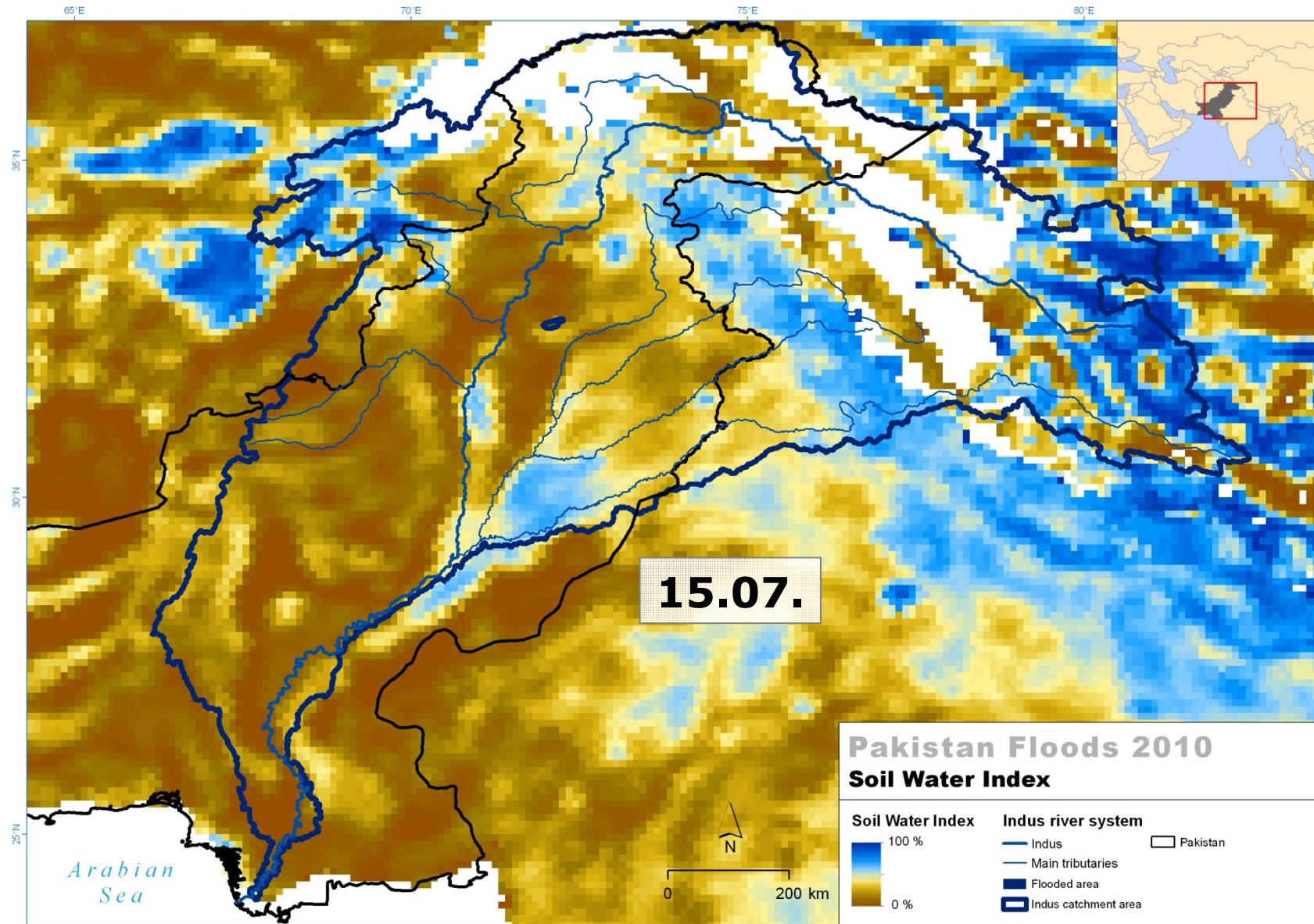


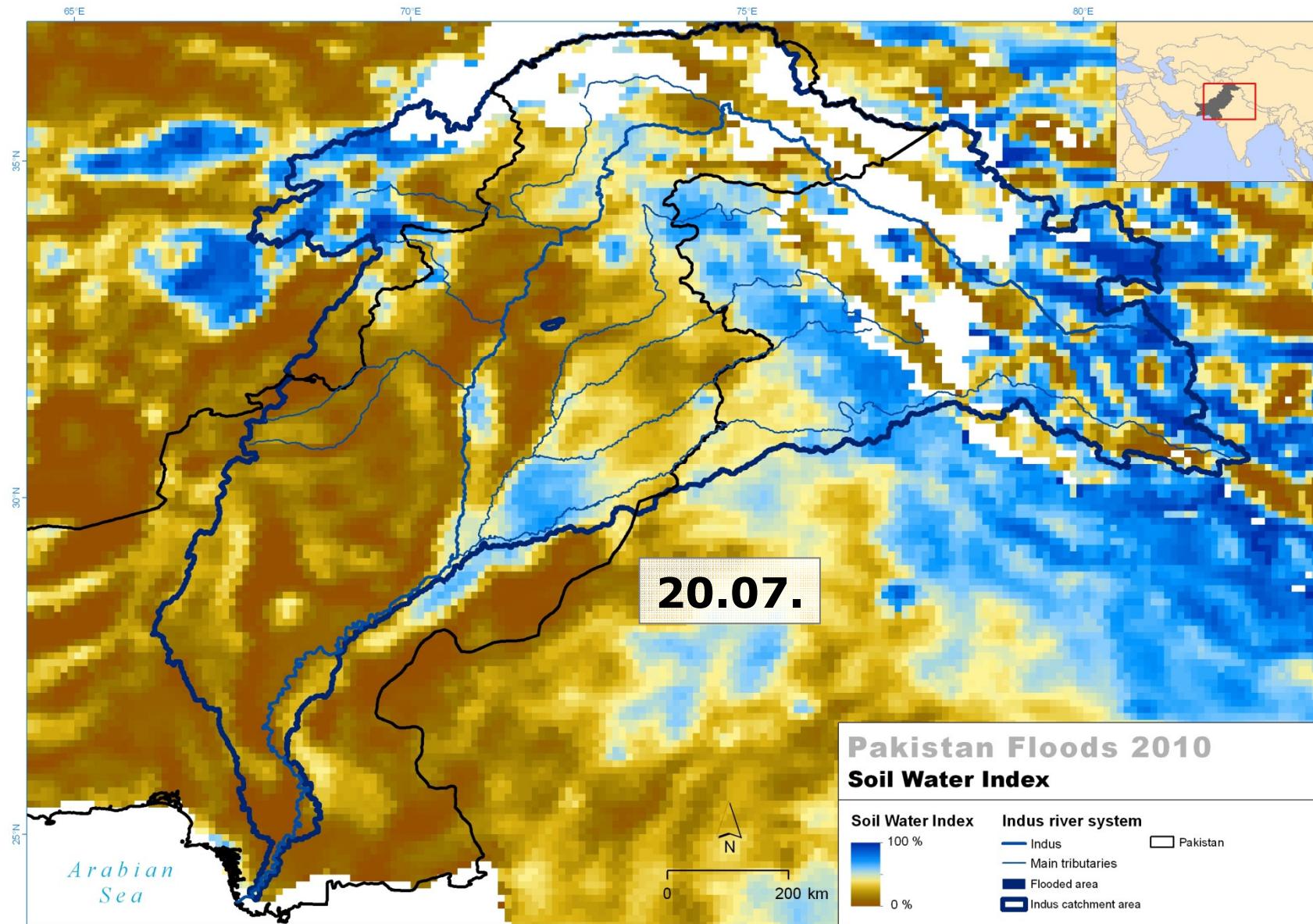
# **Time Series of SWI and Flood Extent**

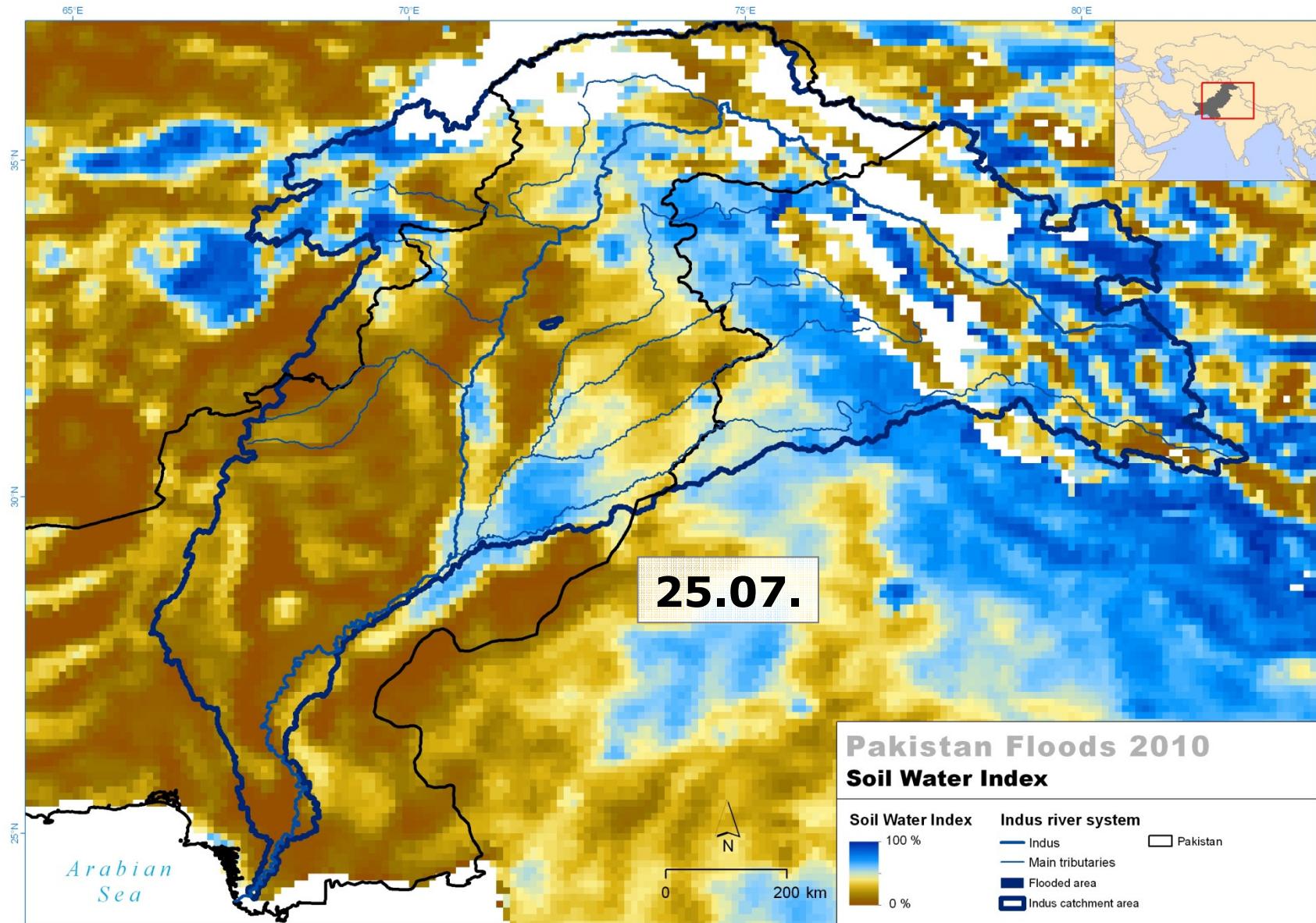
**(5<sup>th</sup> July – 13<sup>th</sup> Sept. )**

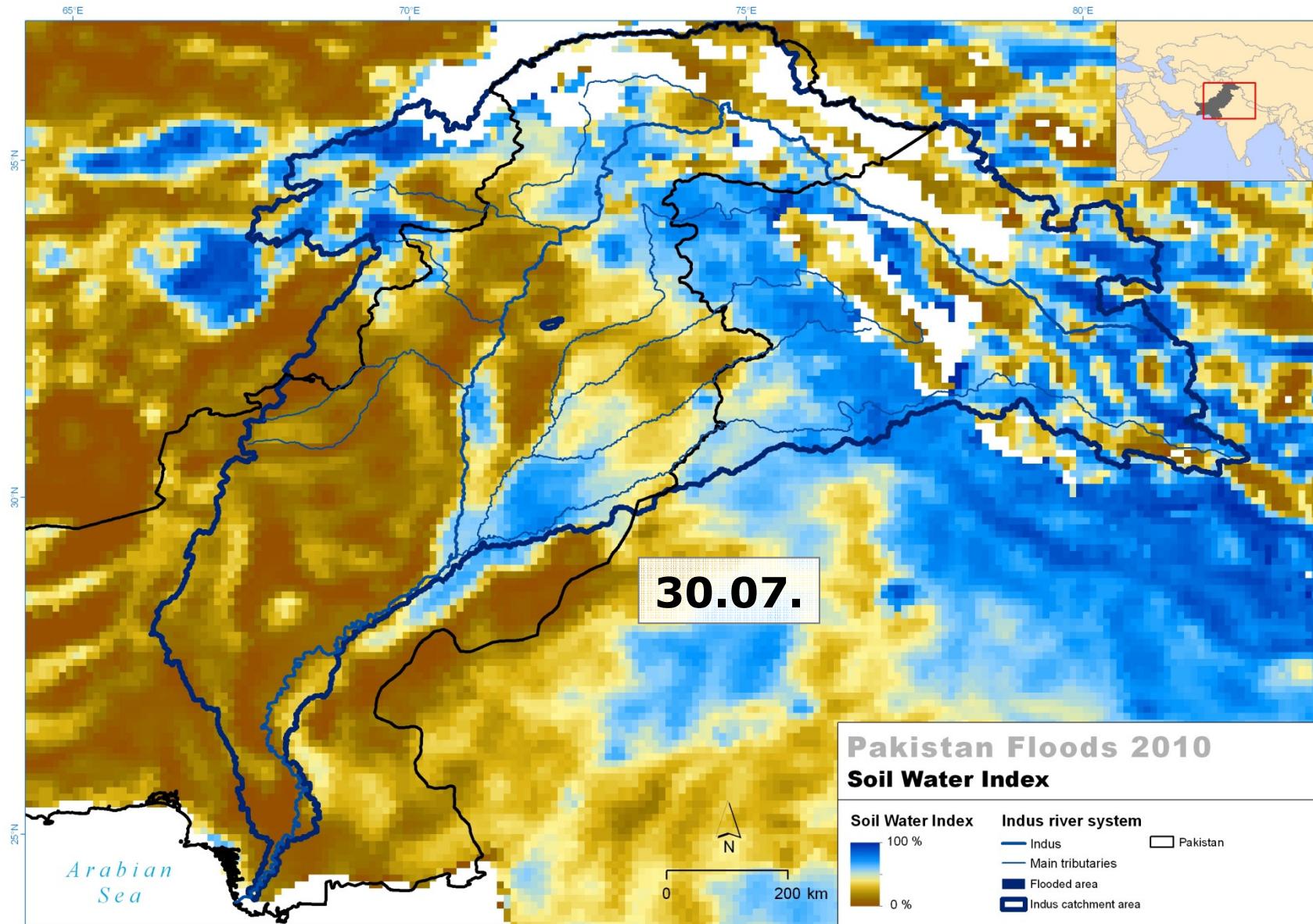


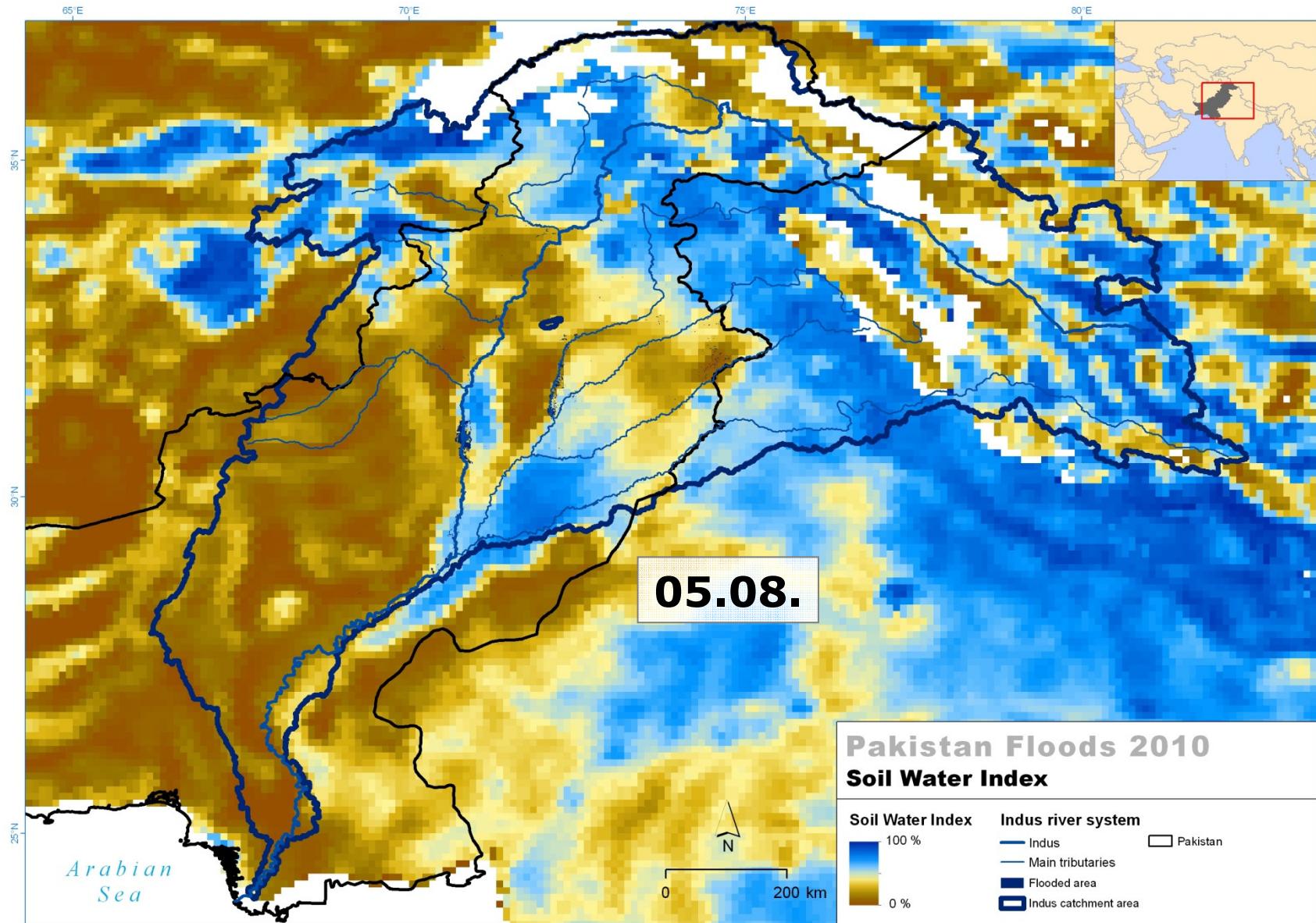


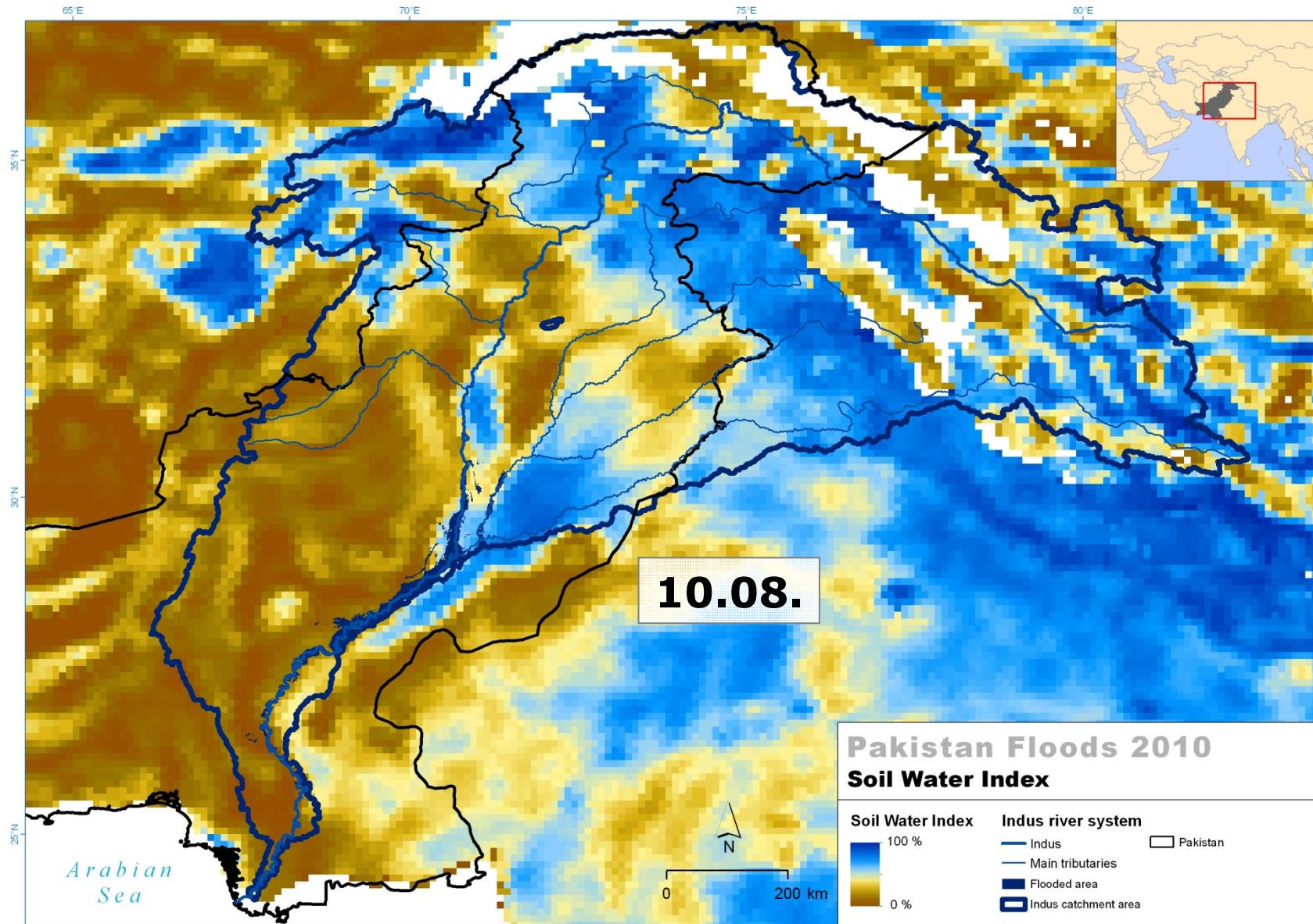


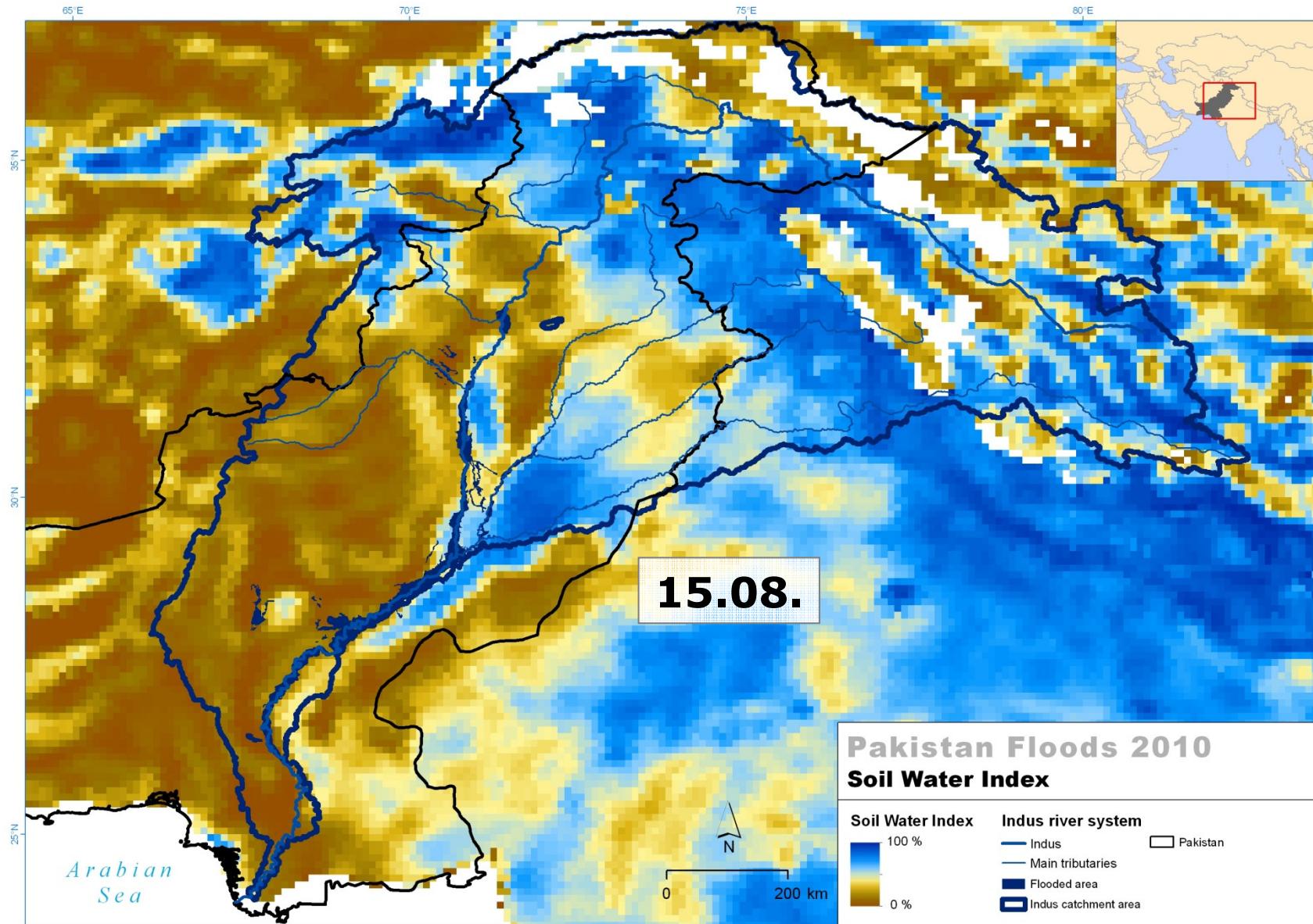


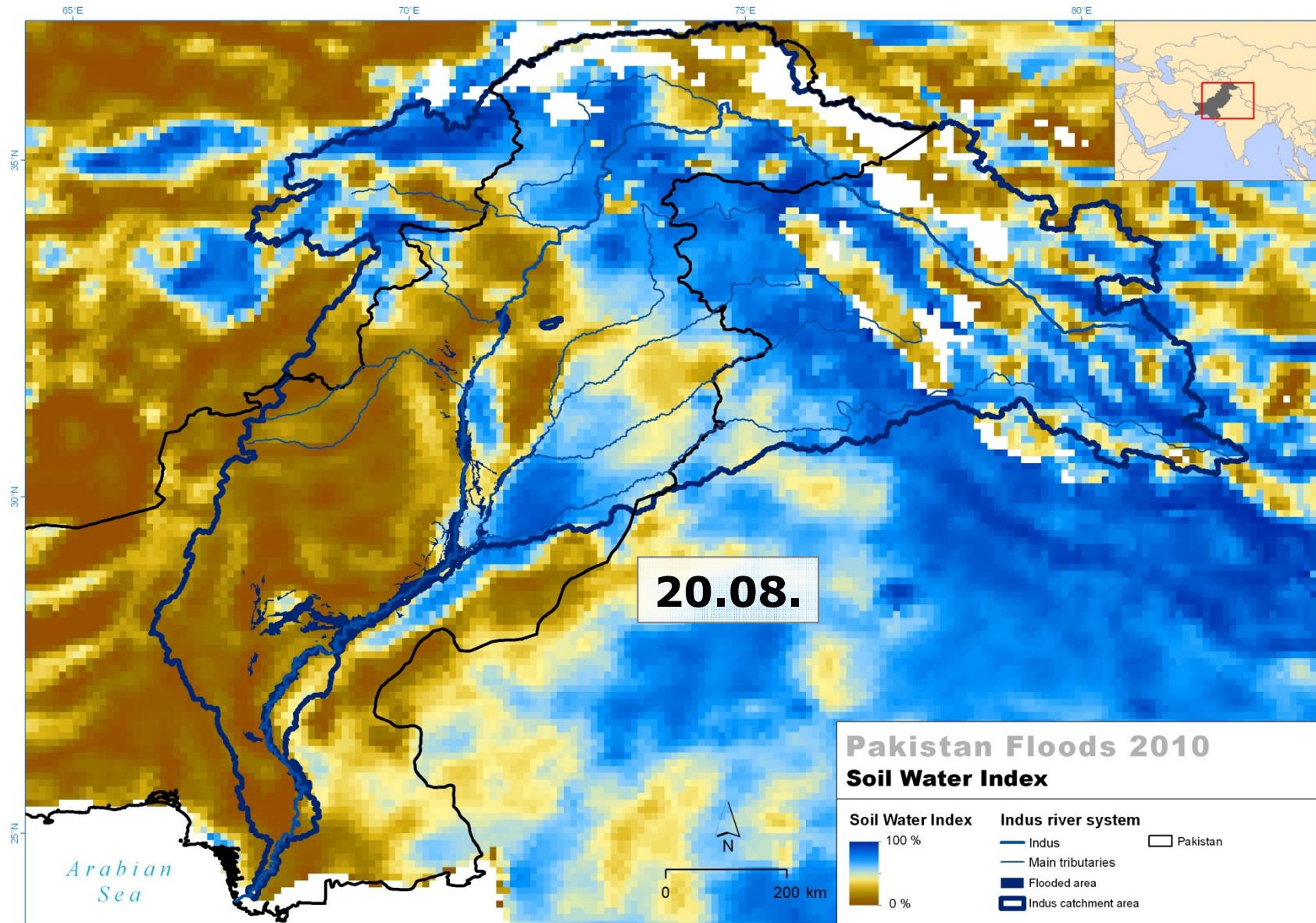


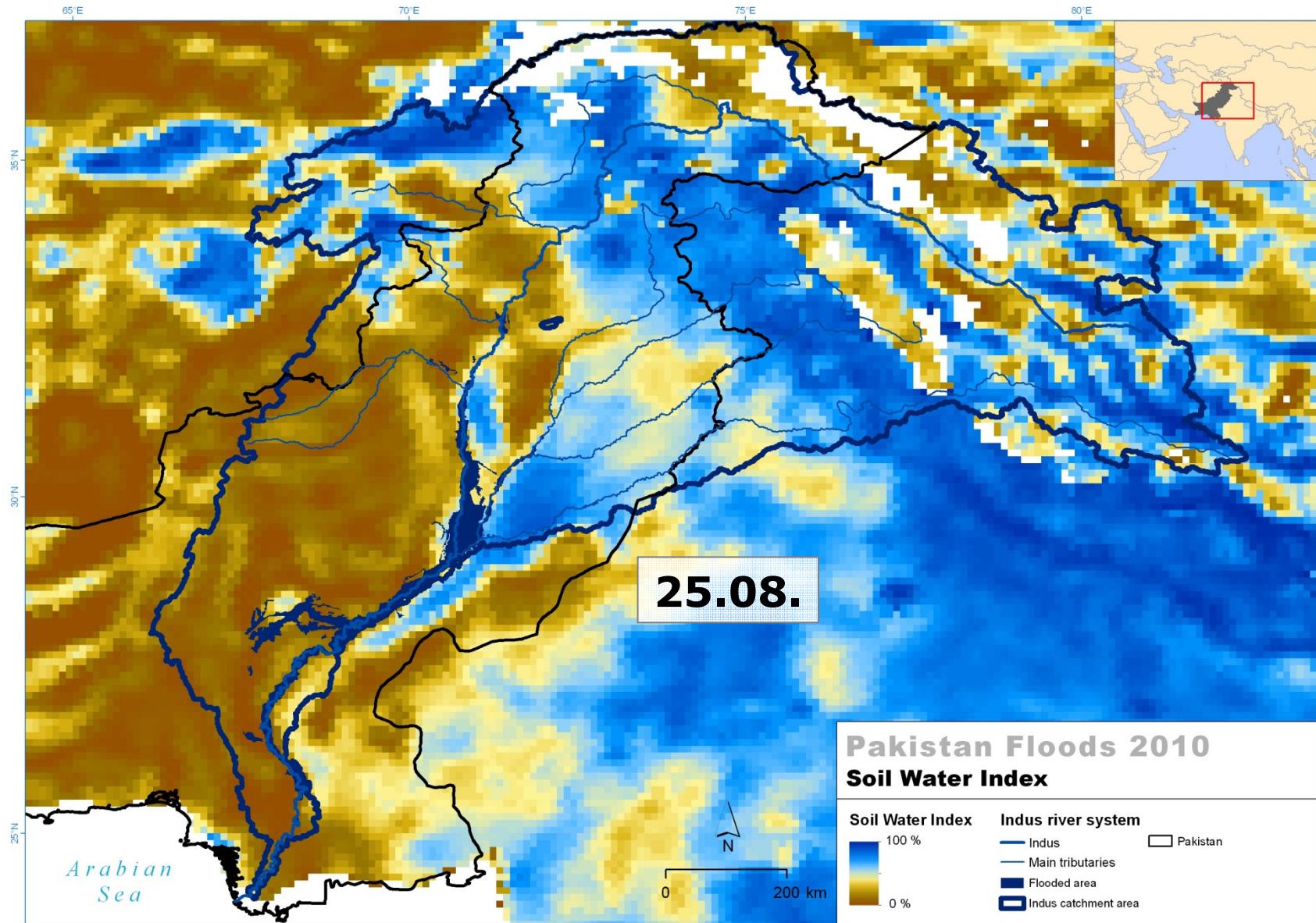


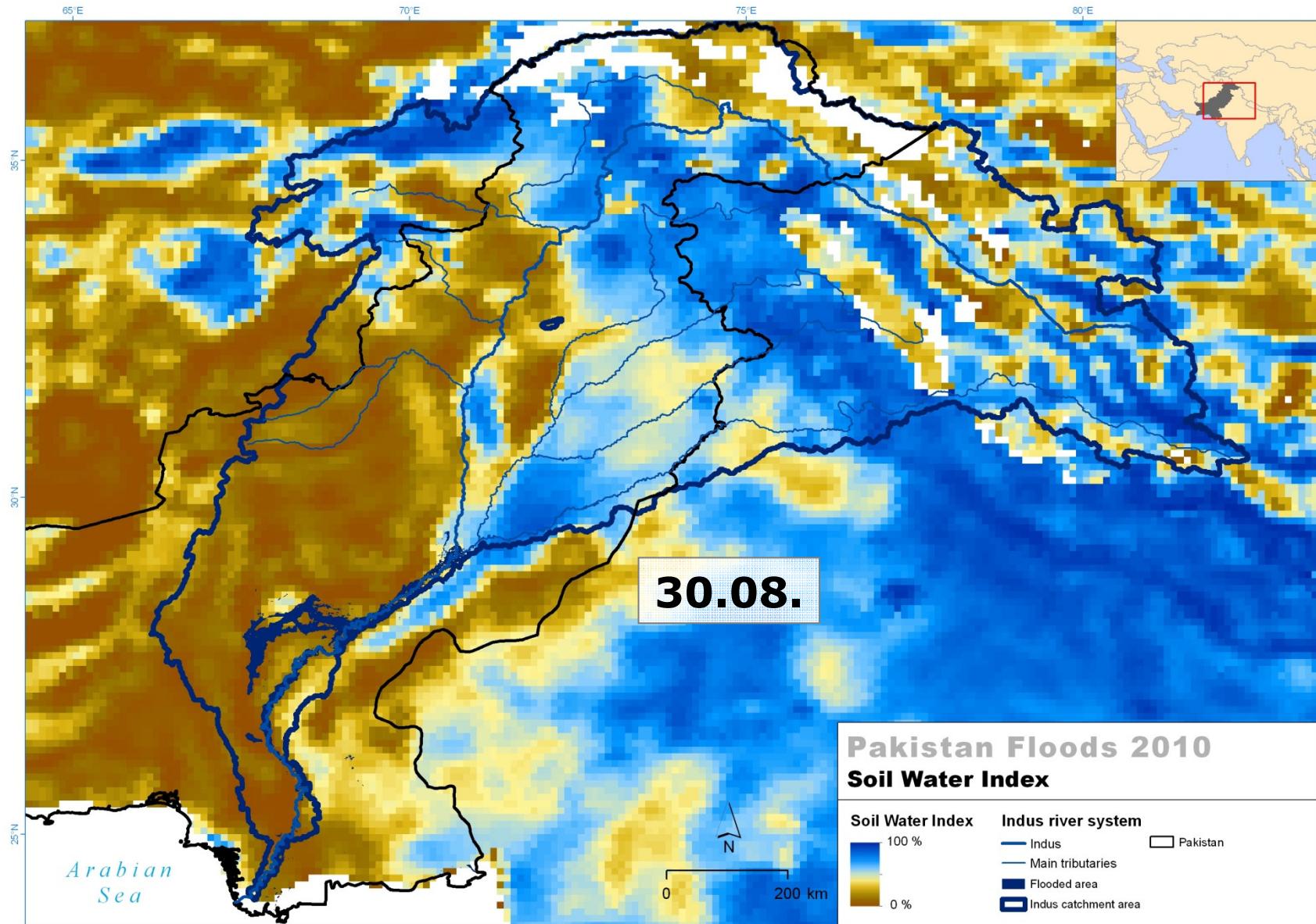


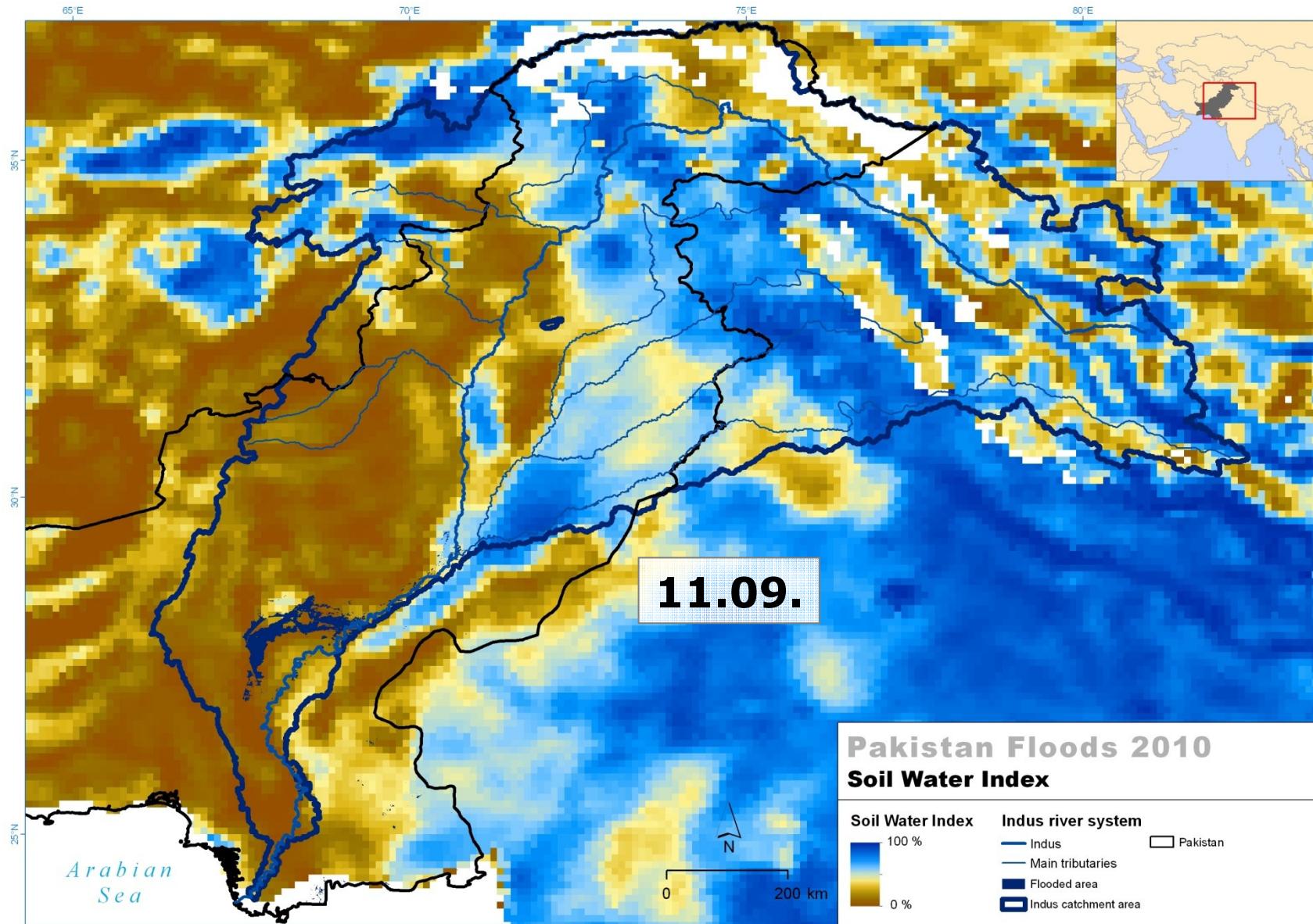


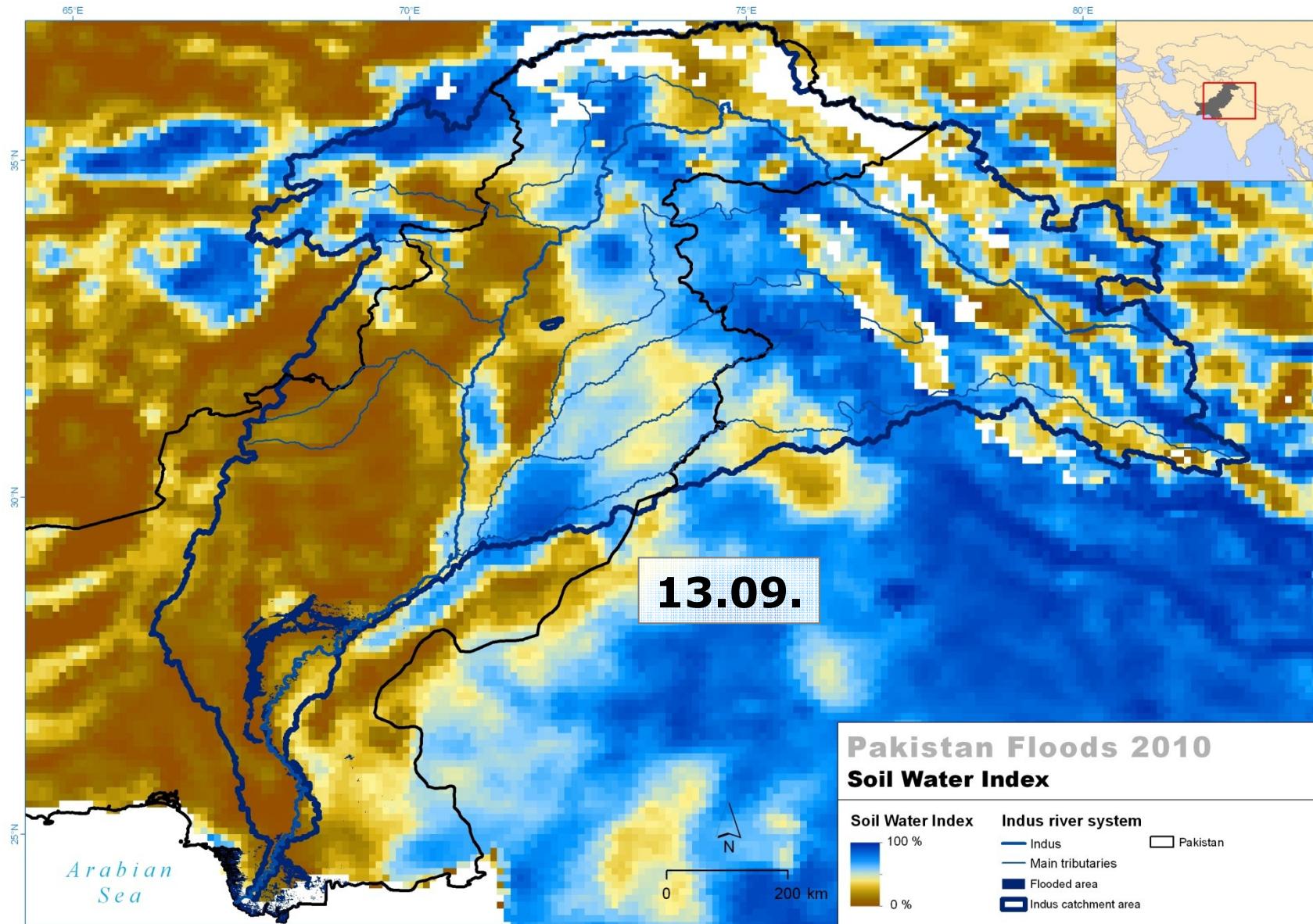


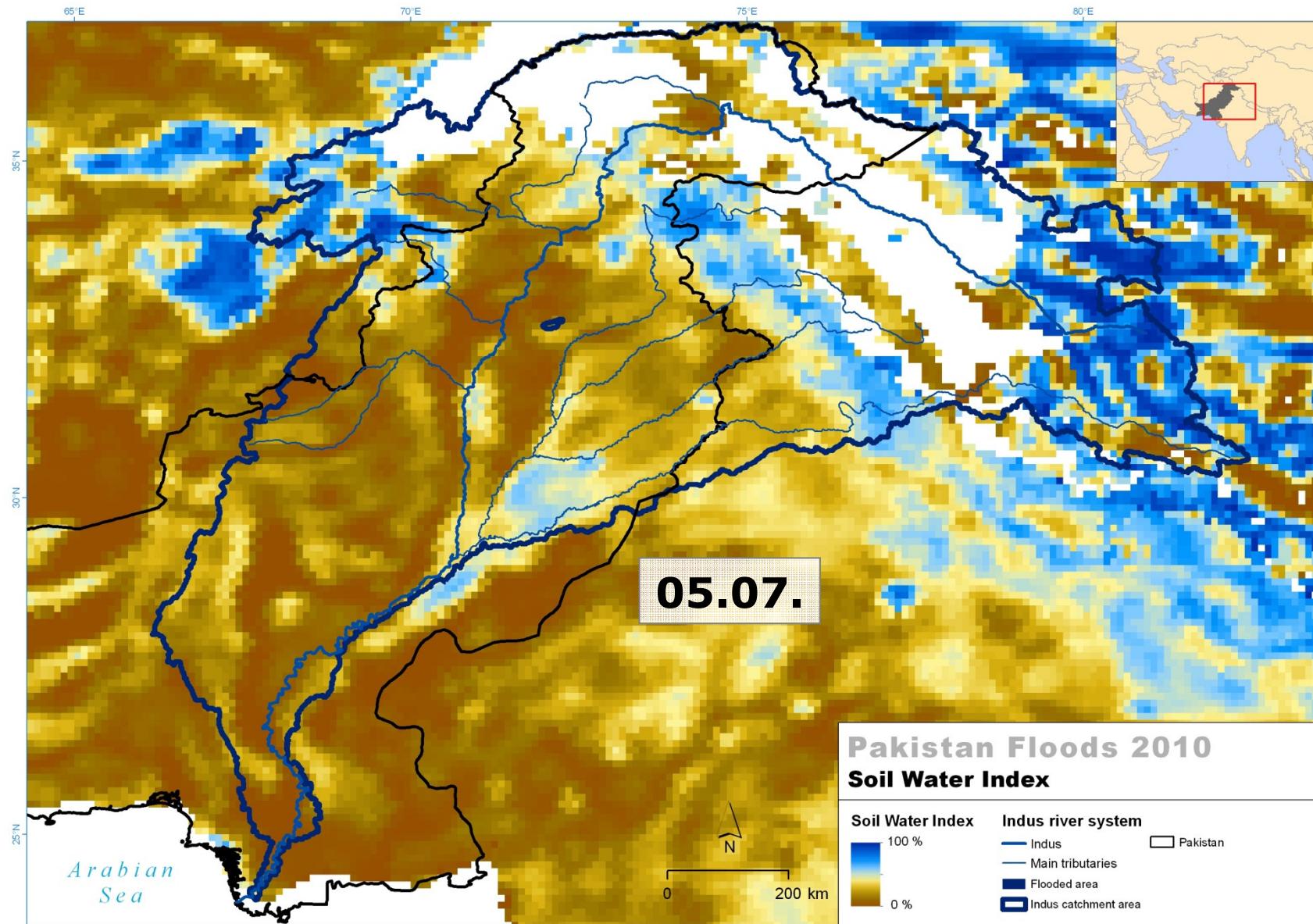


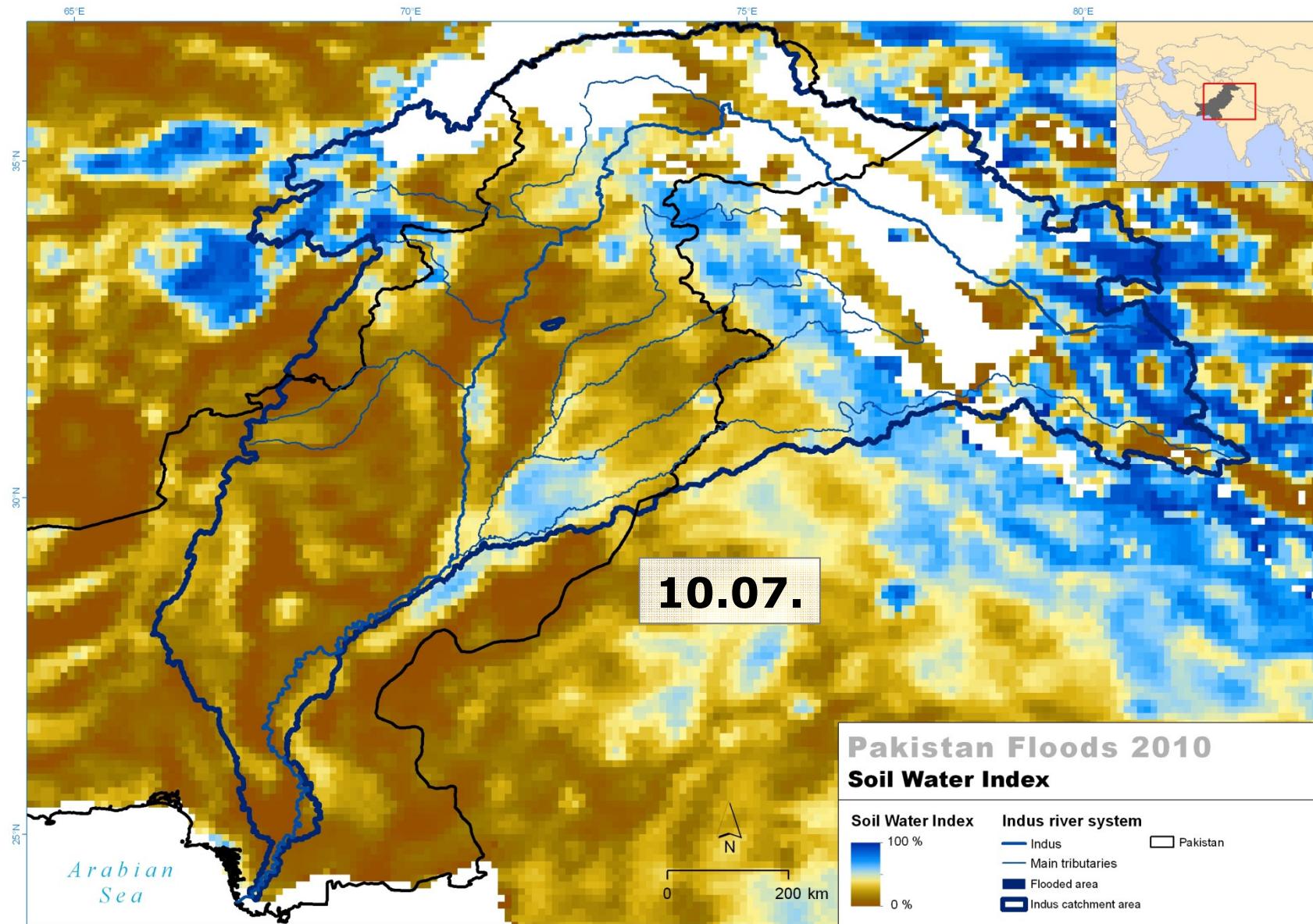


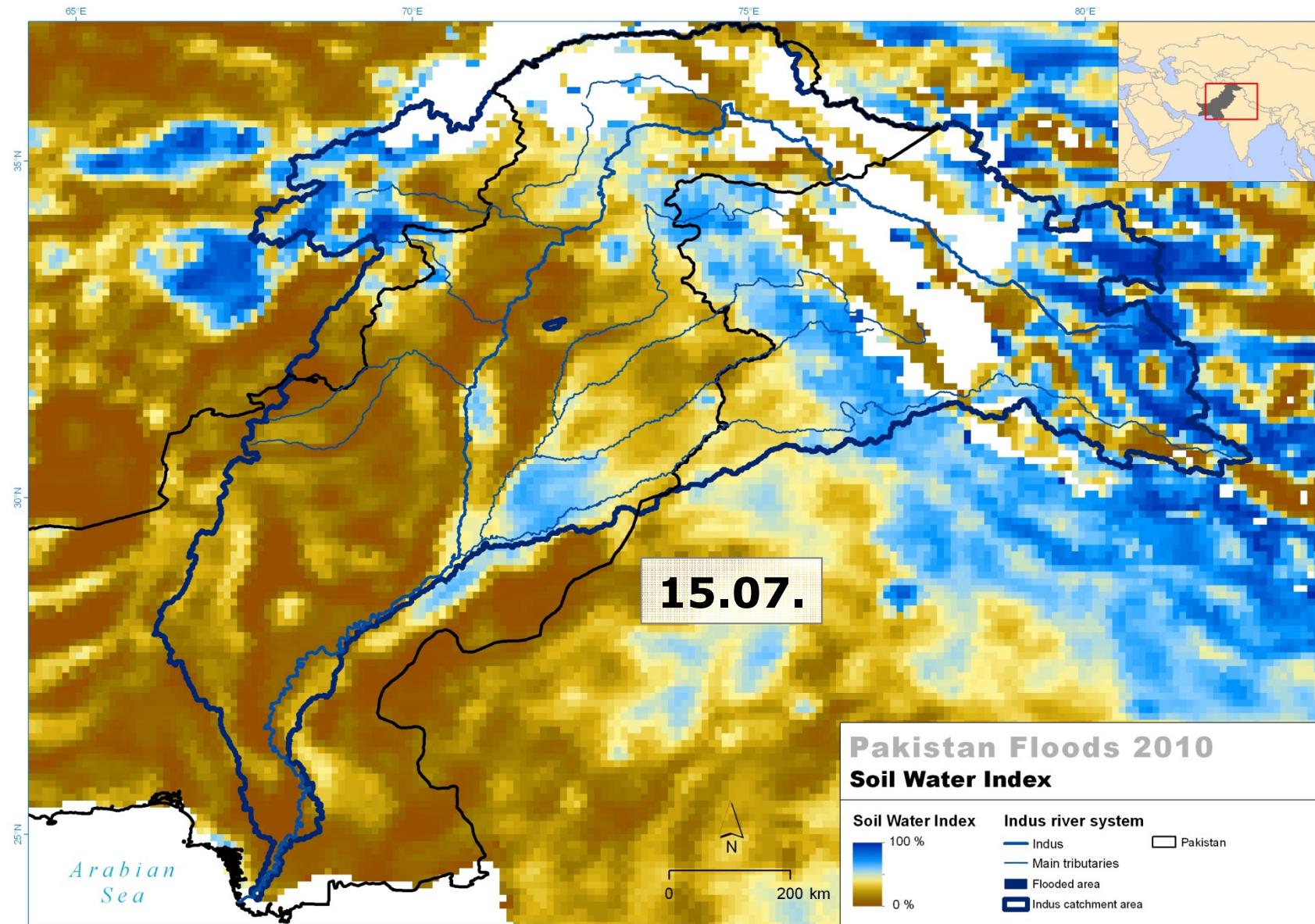


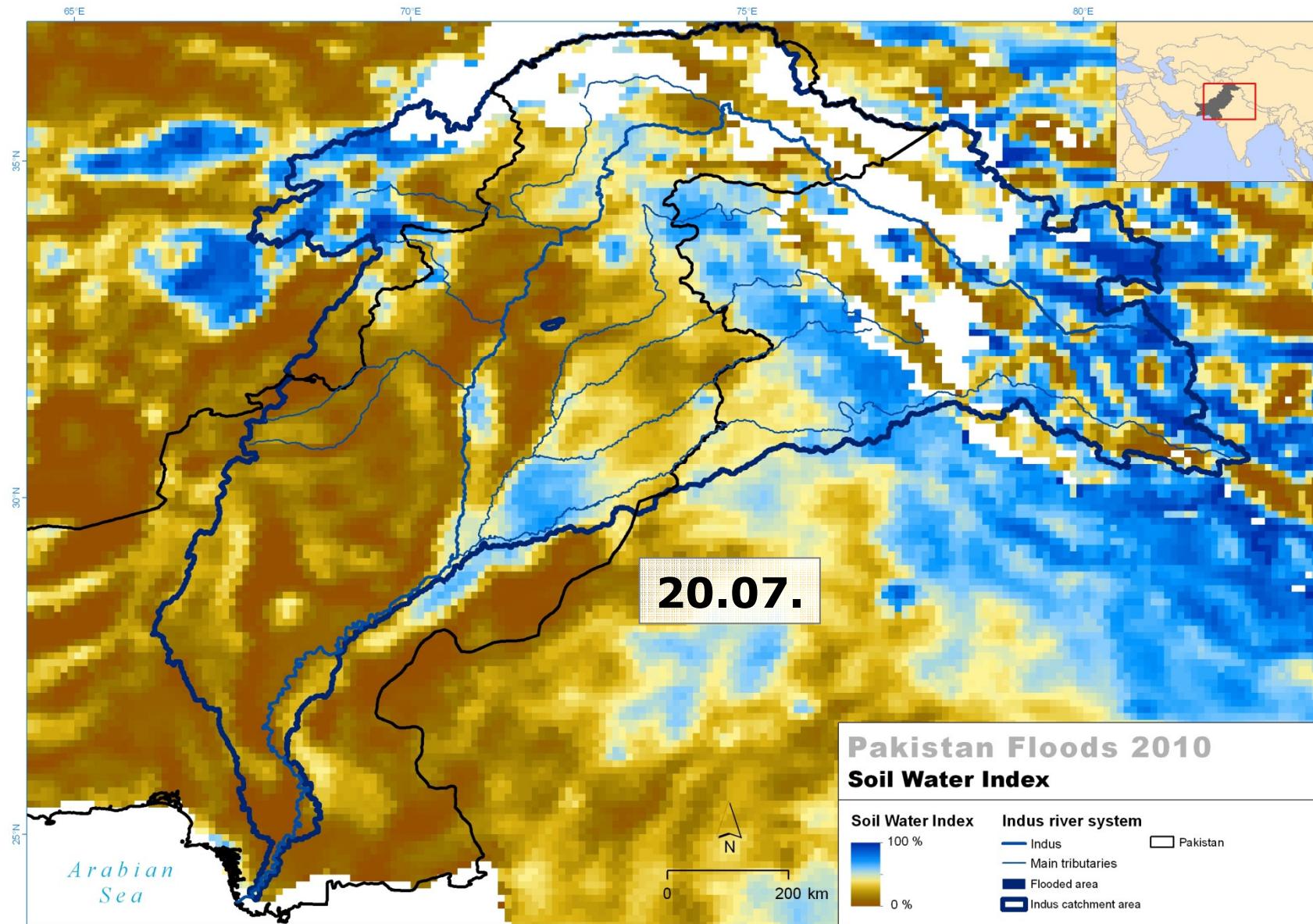


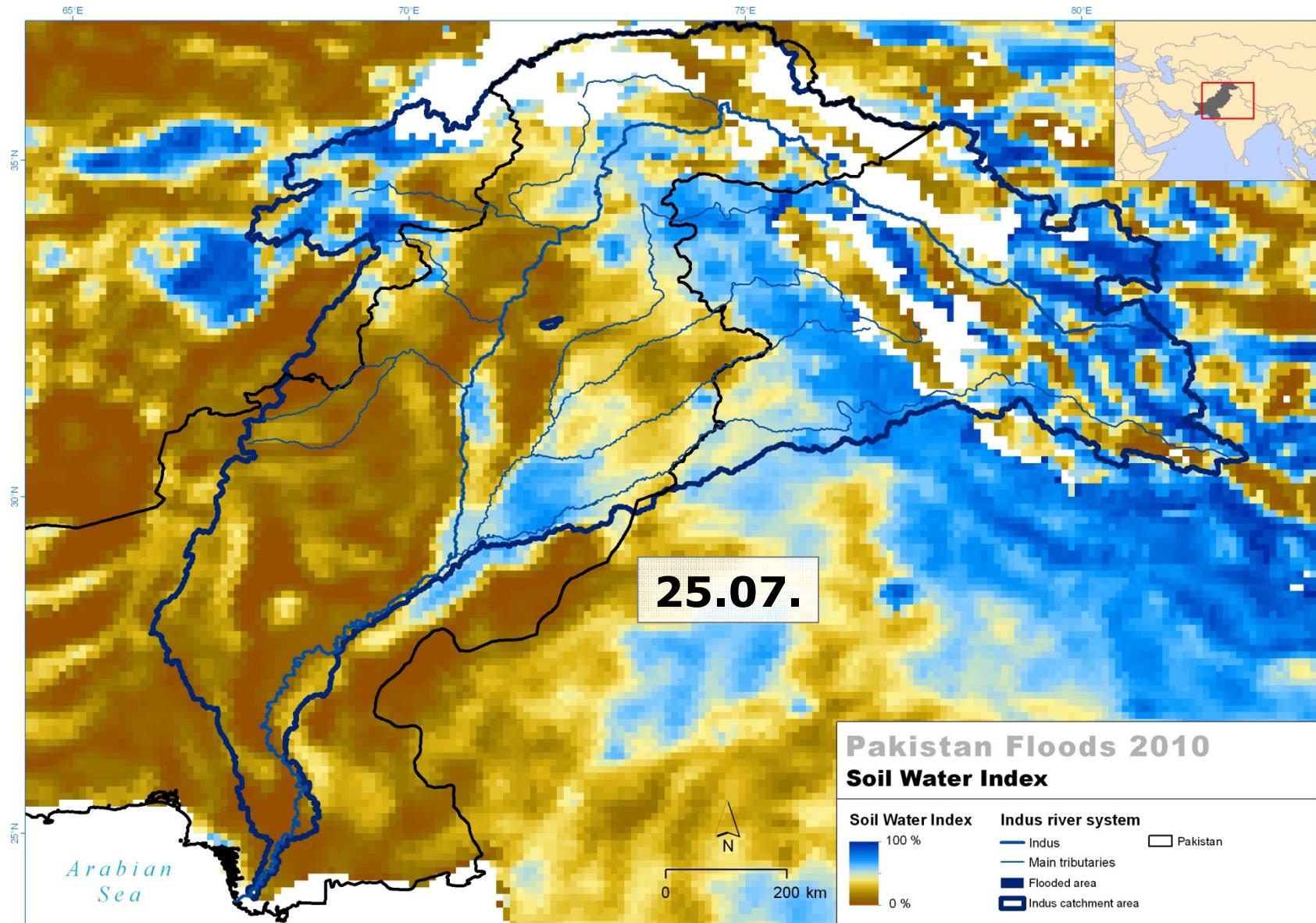


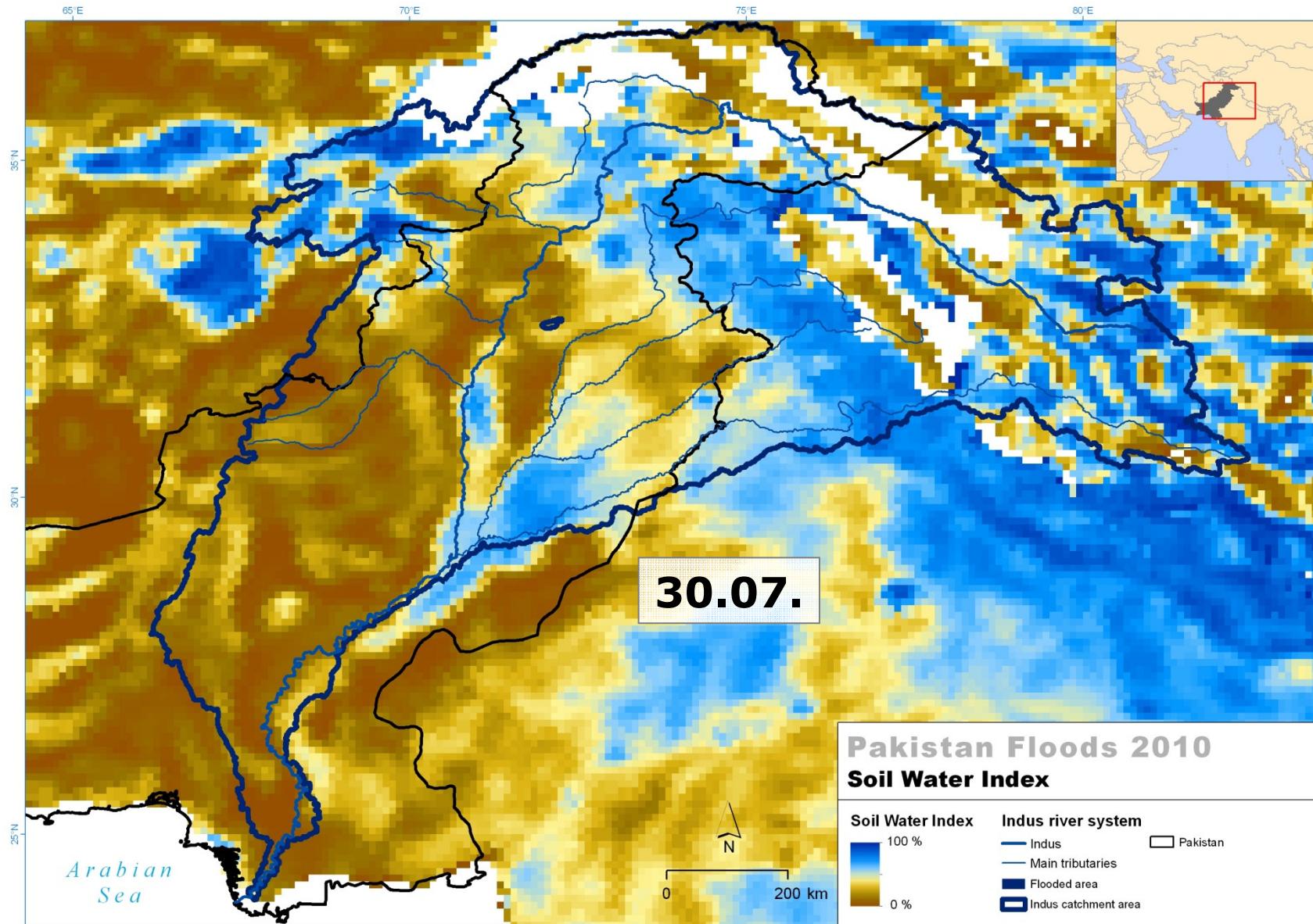


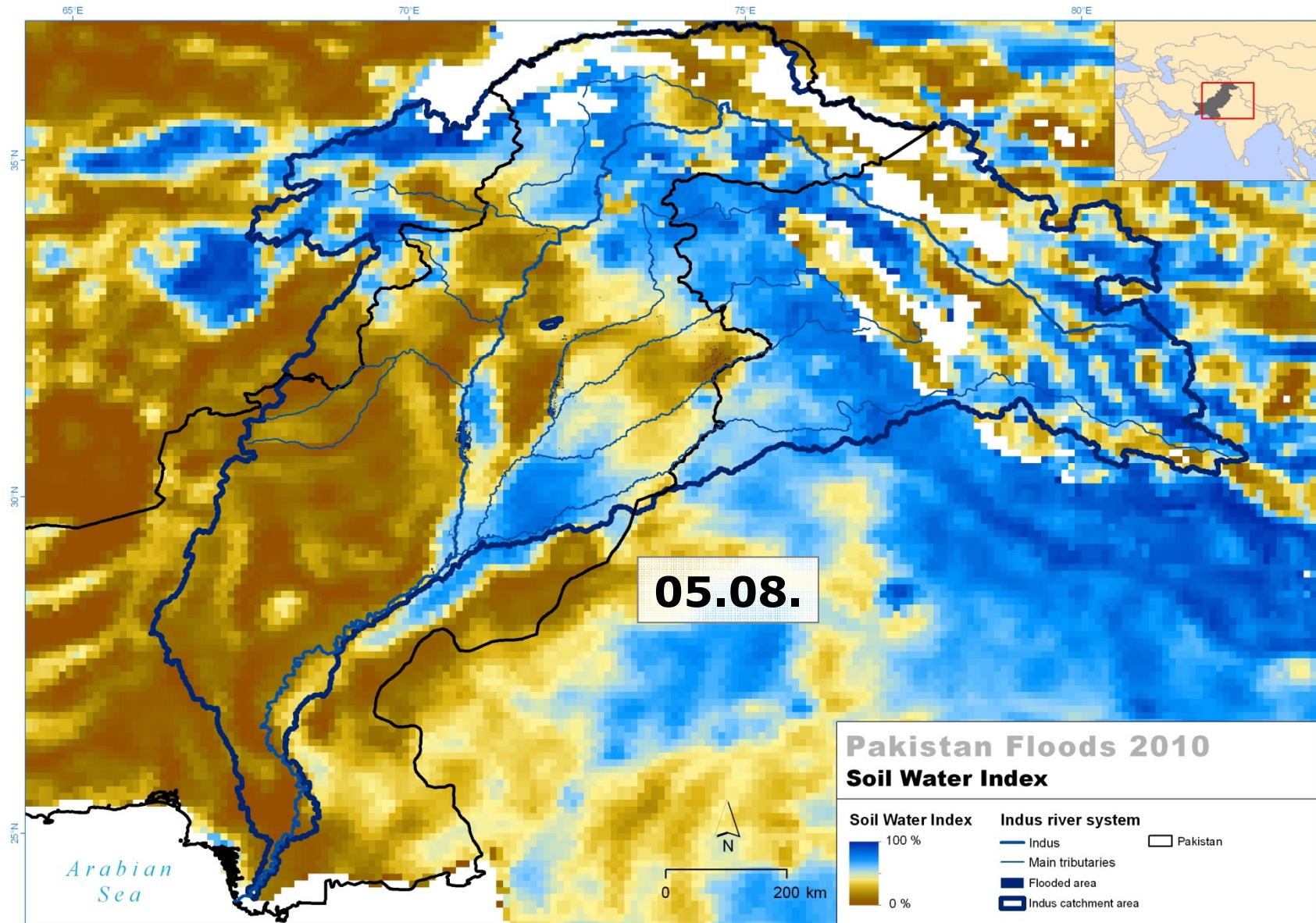


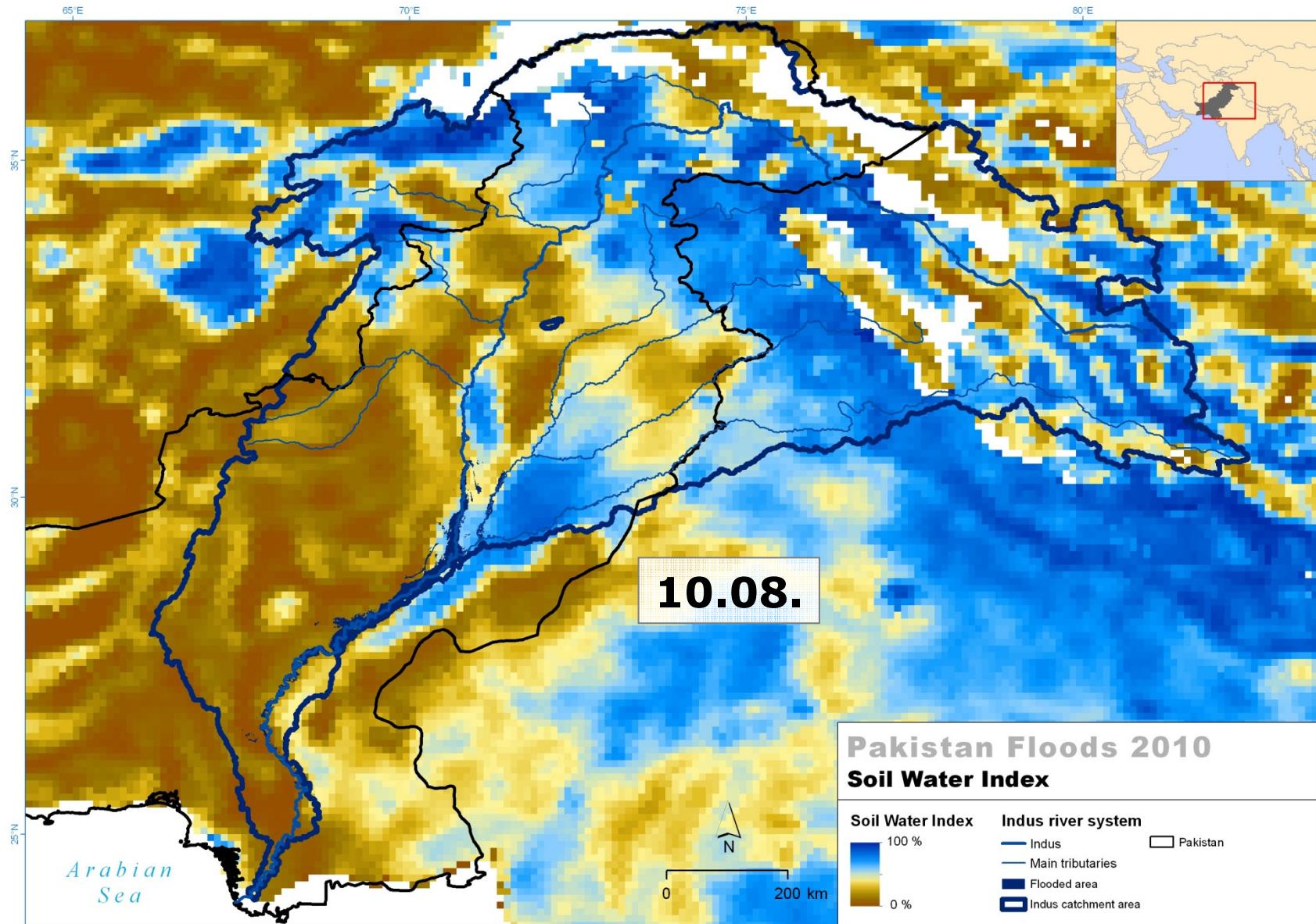


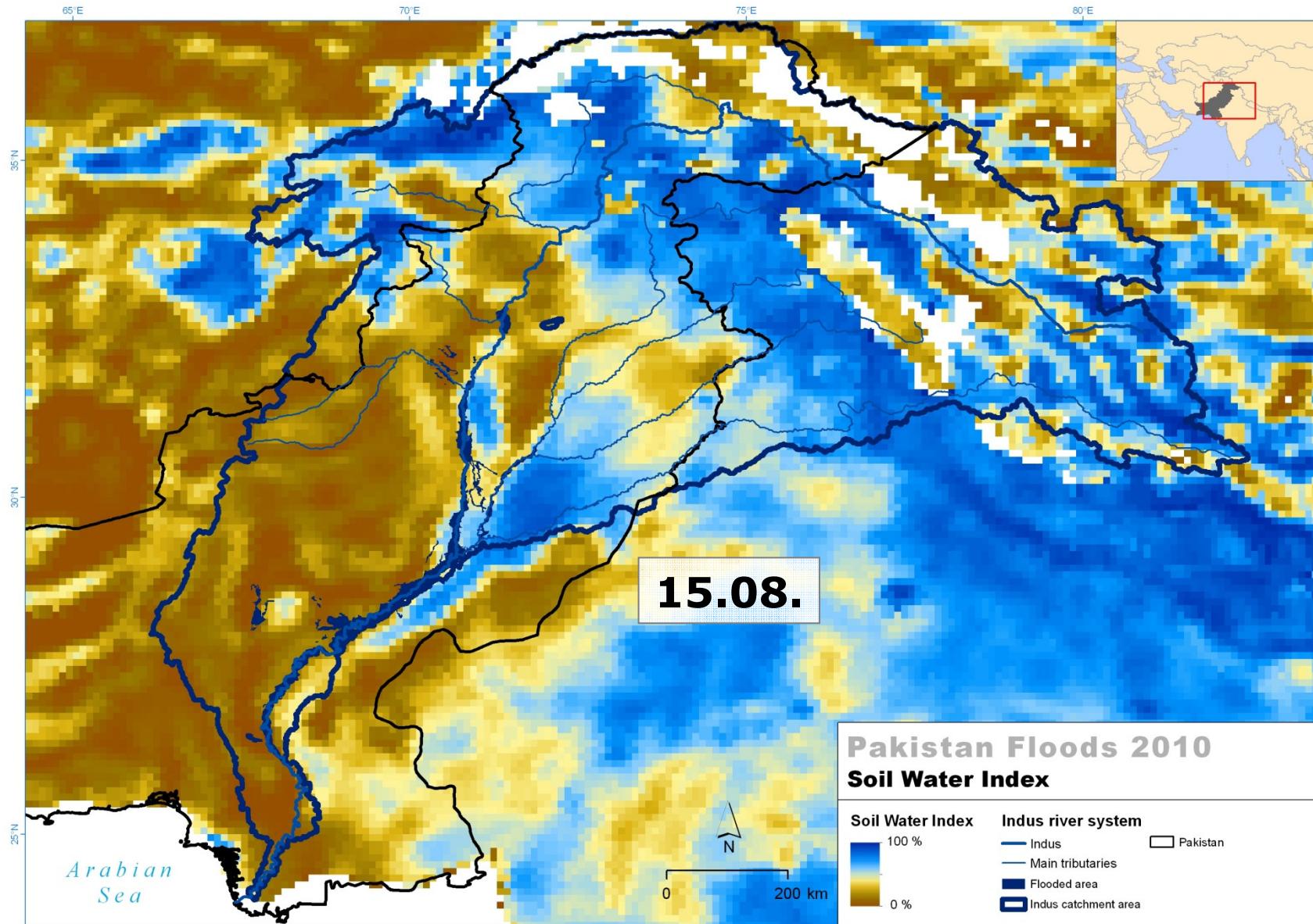


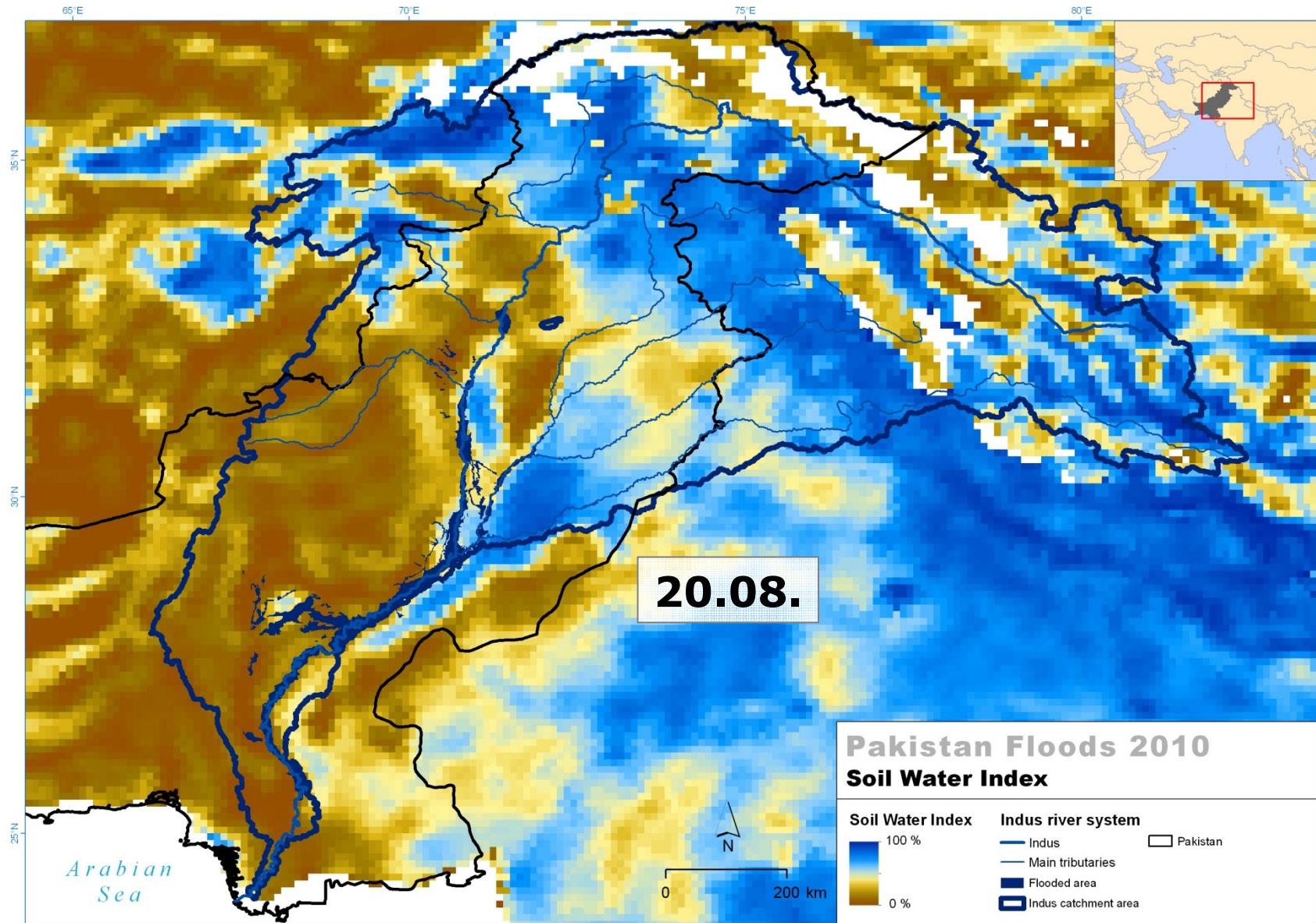


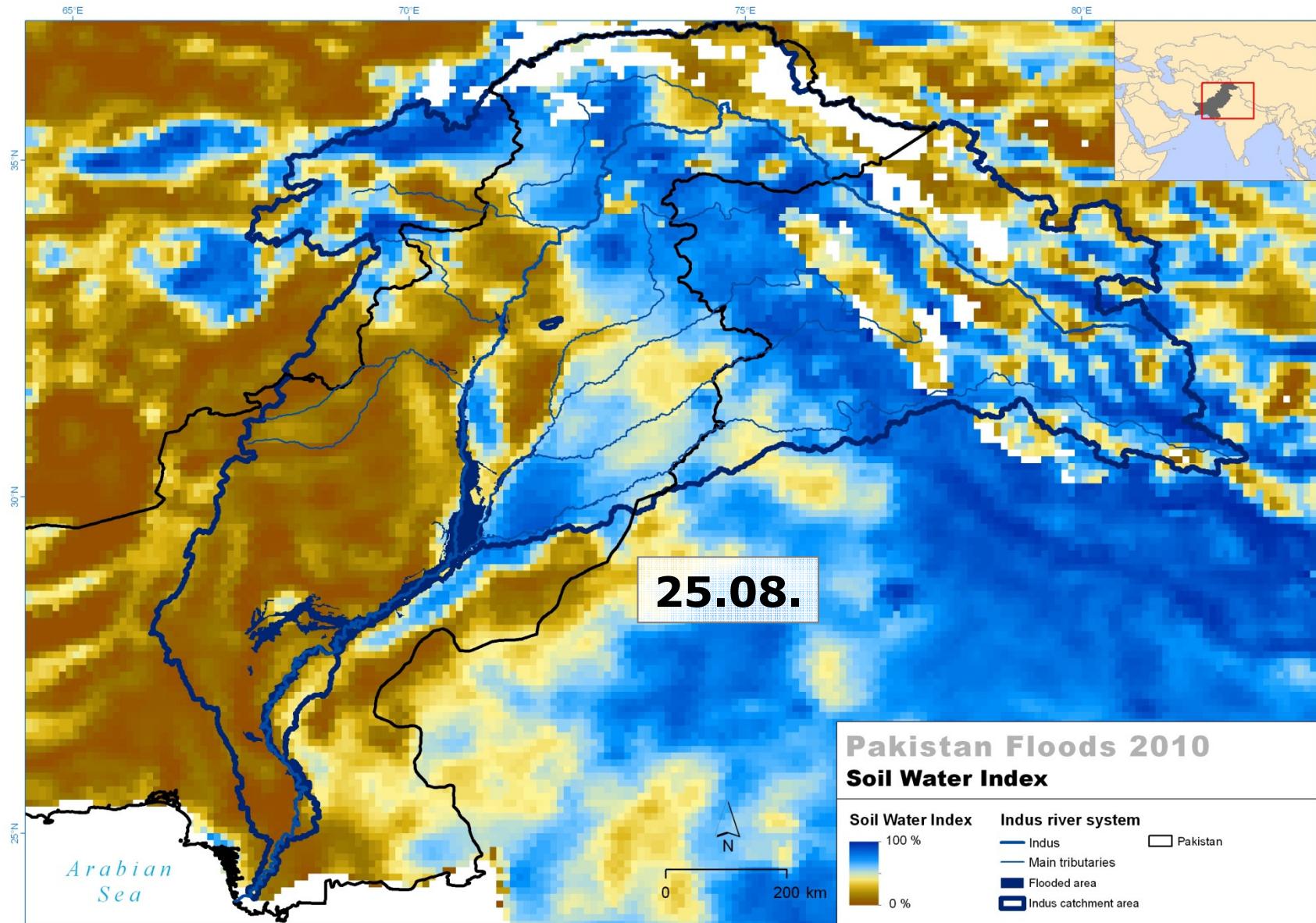


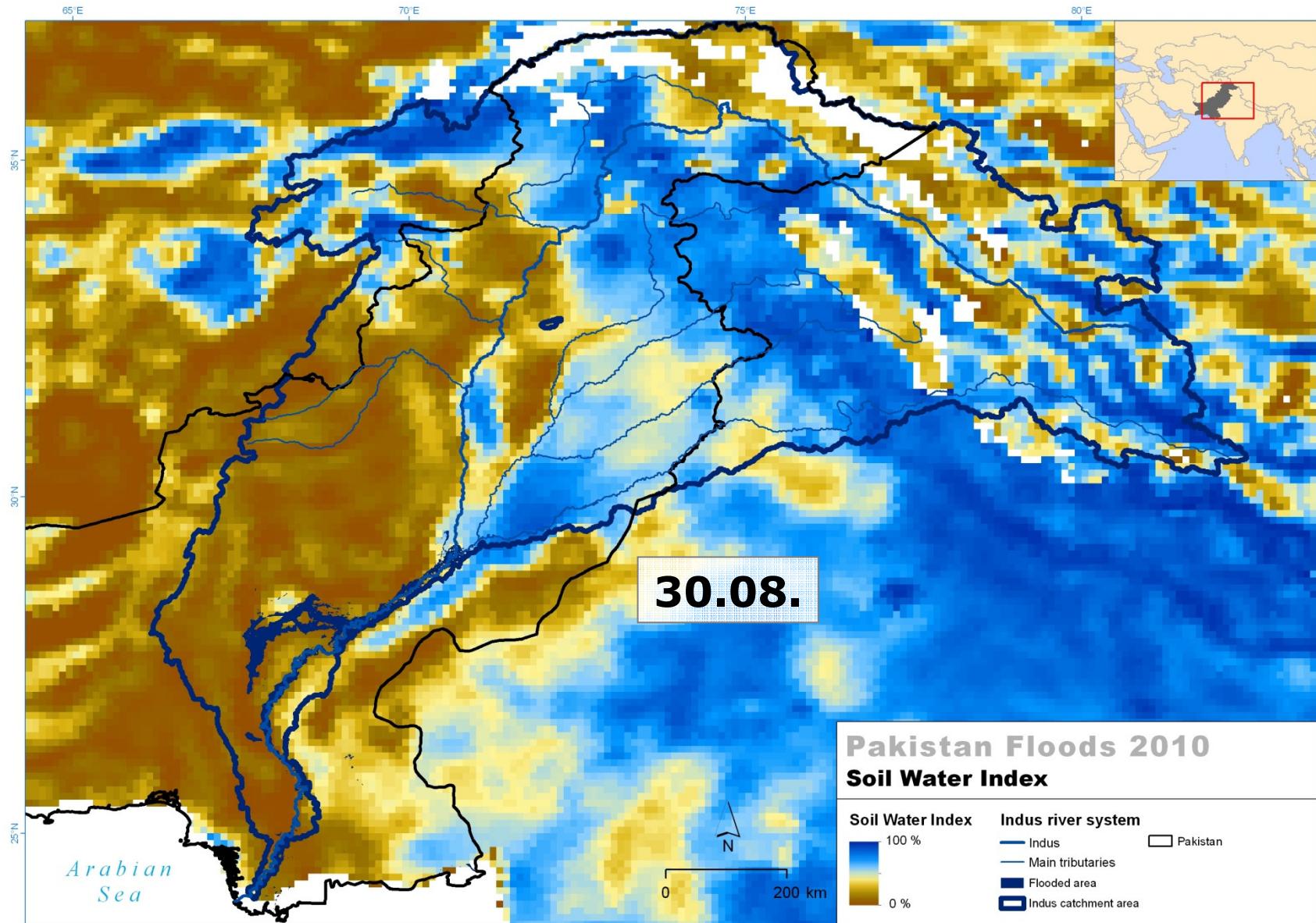


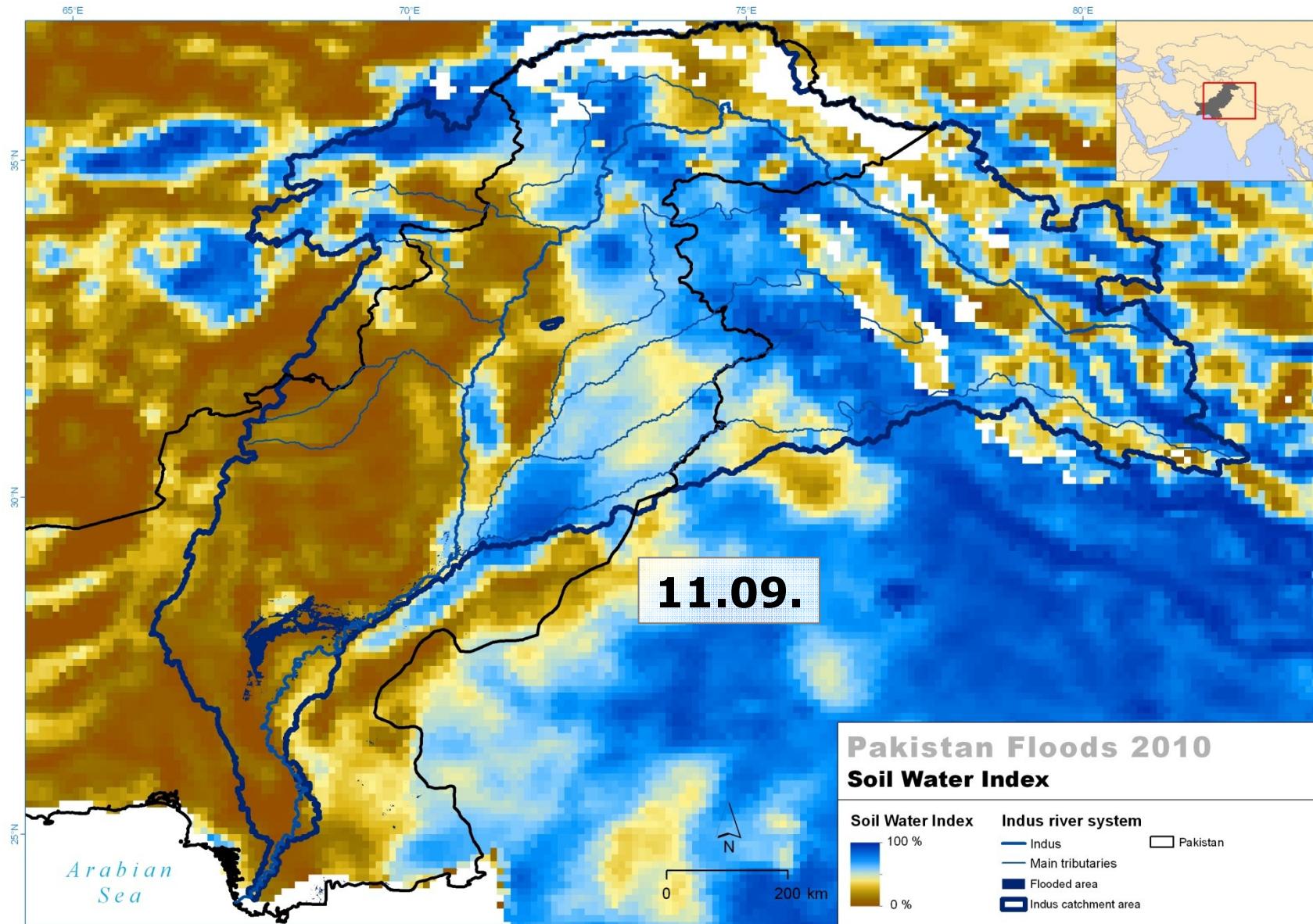


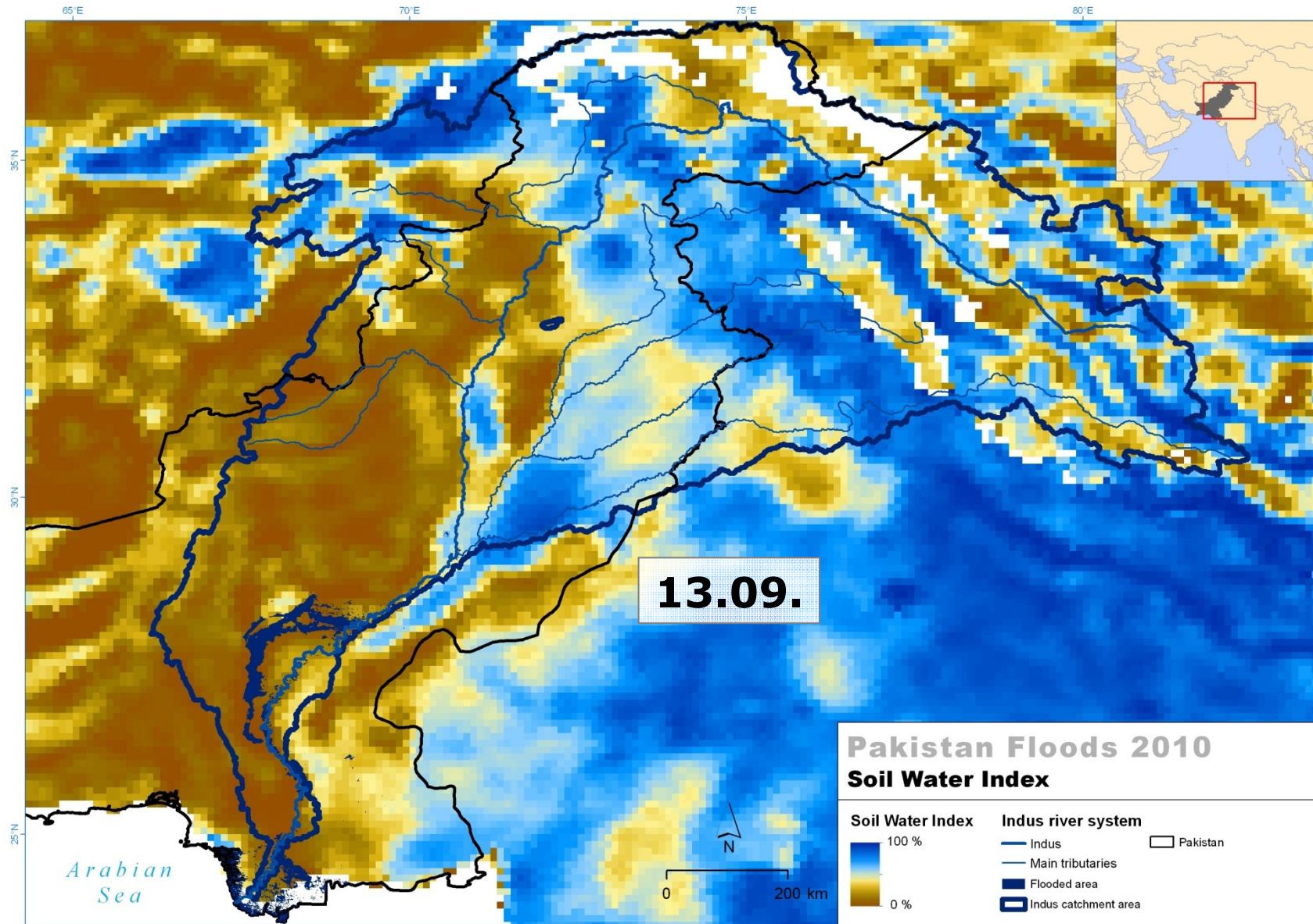


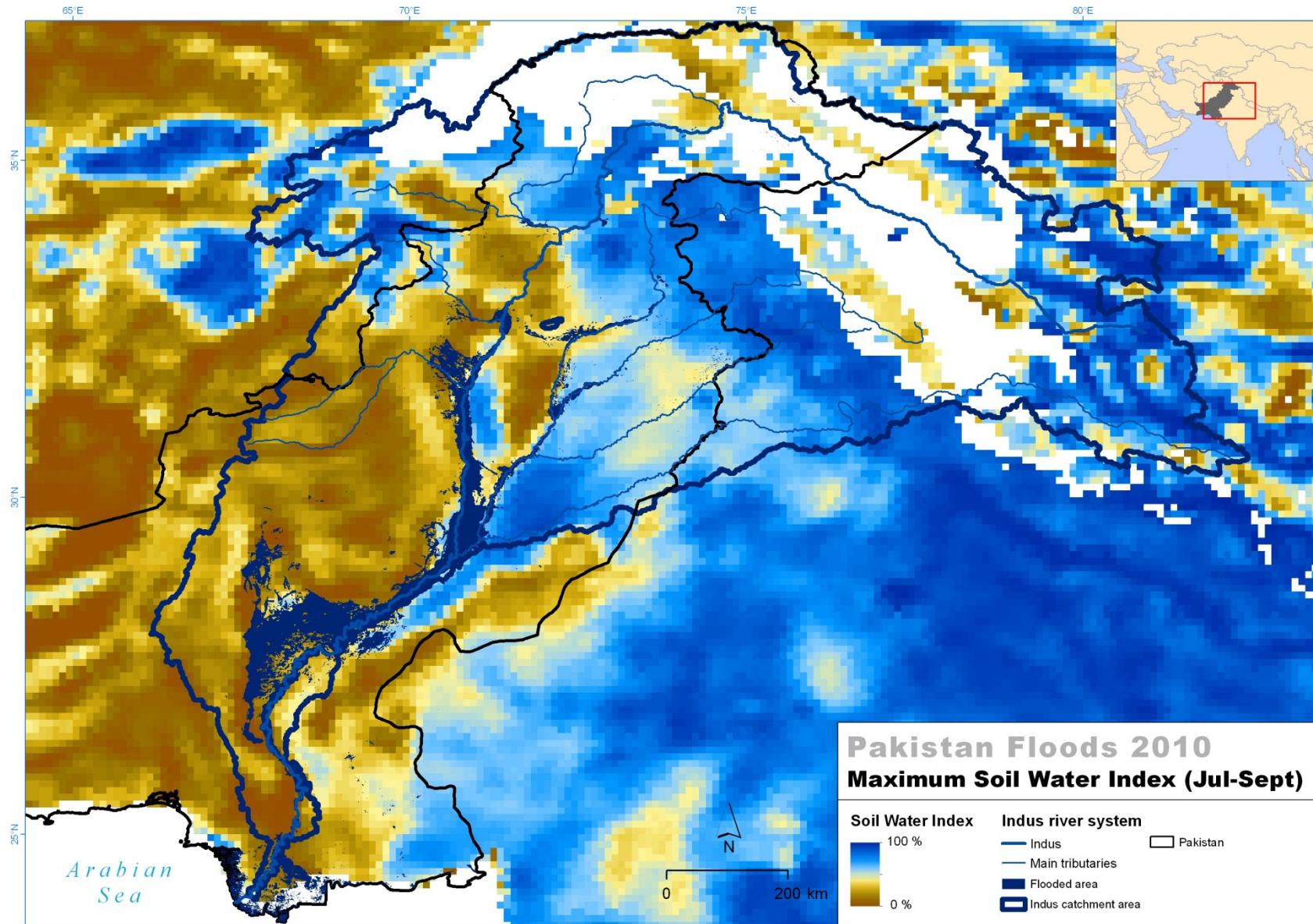




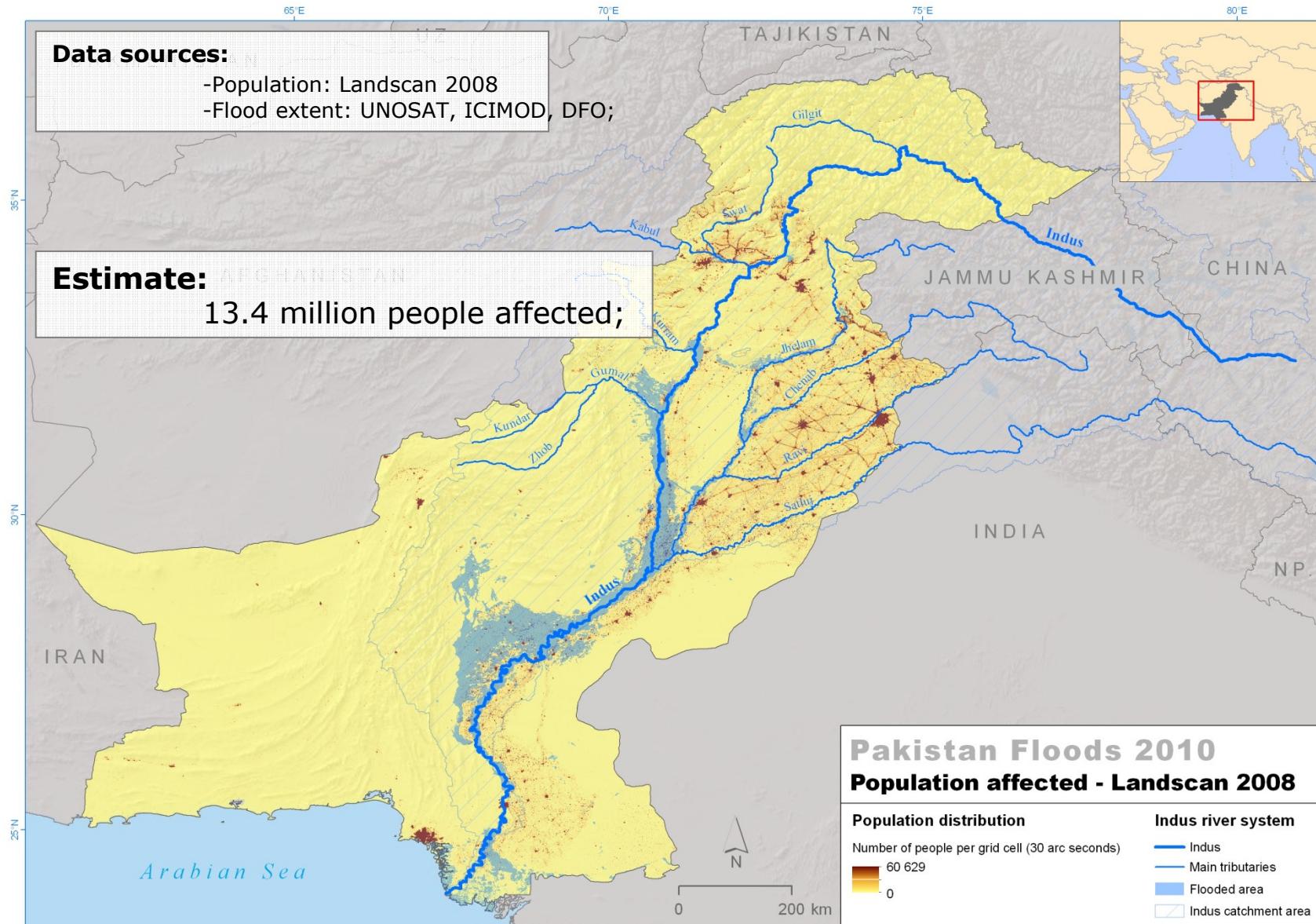


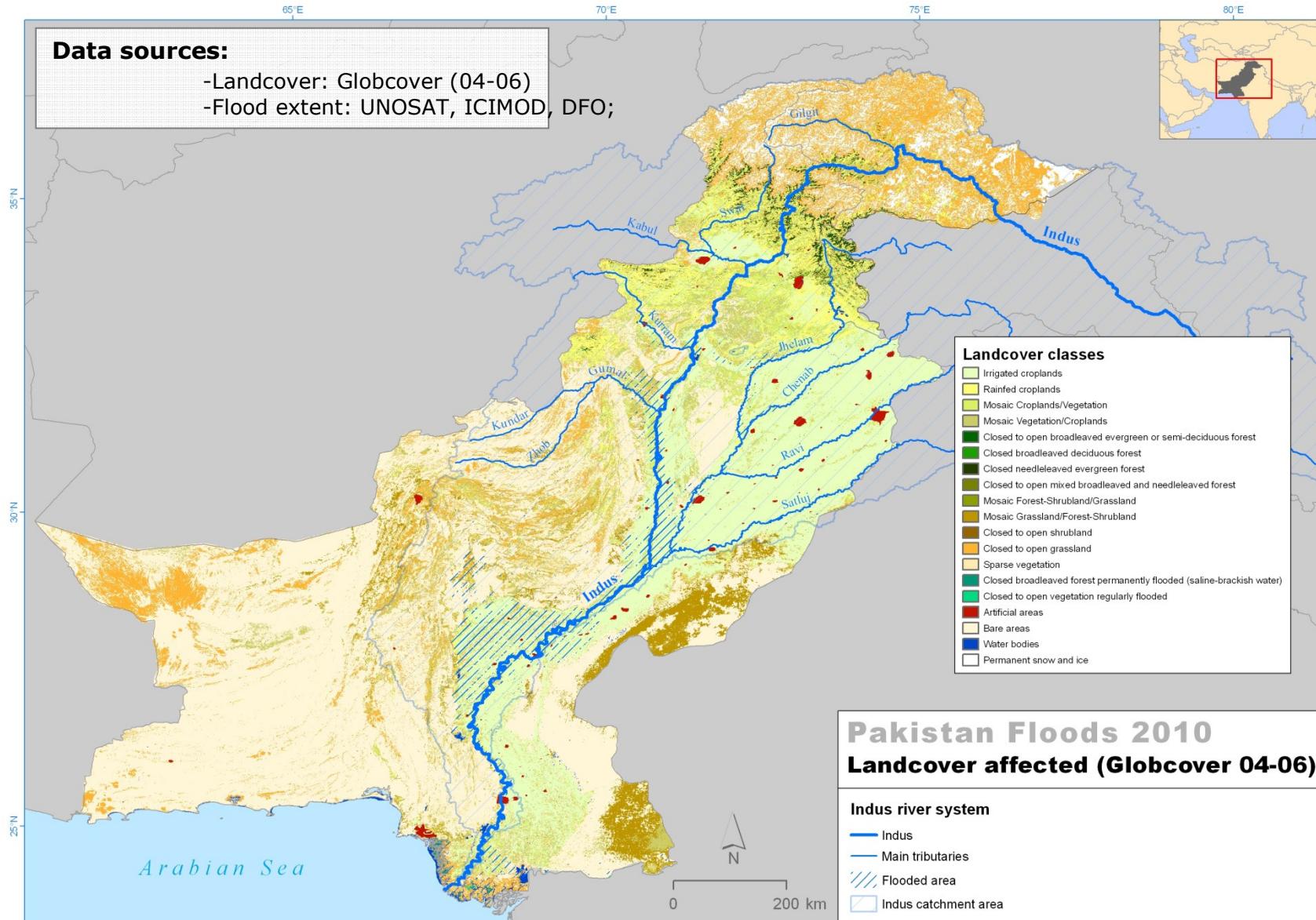


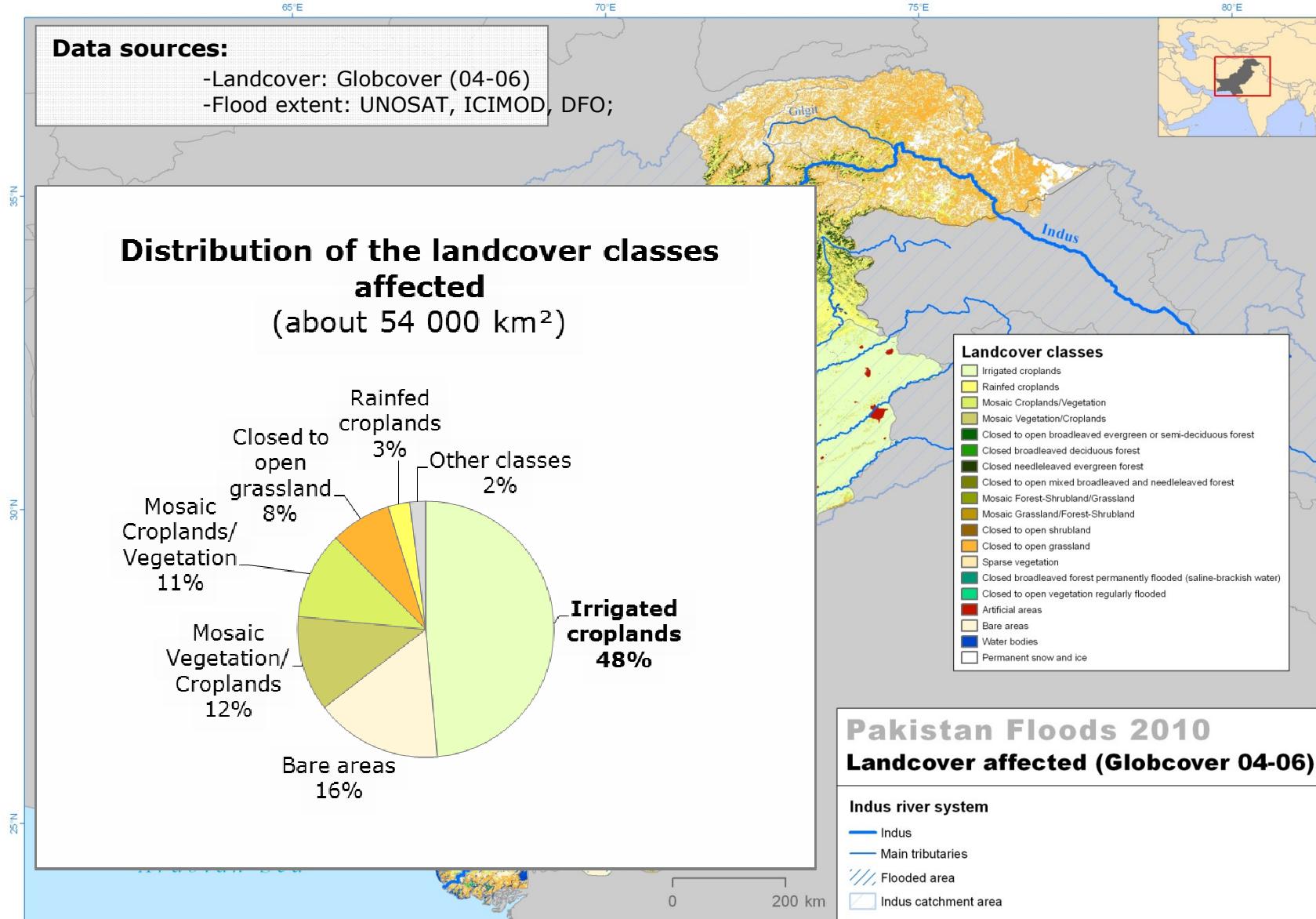


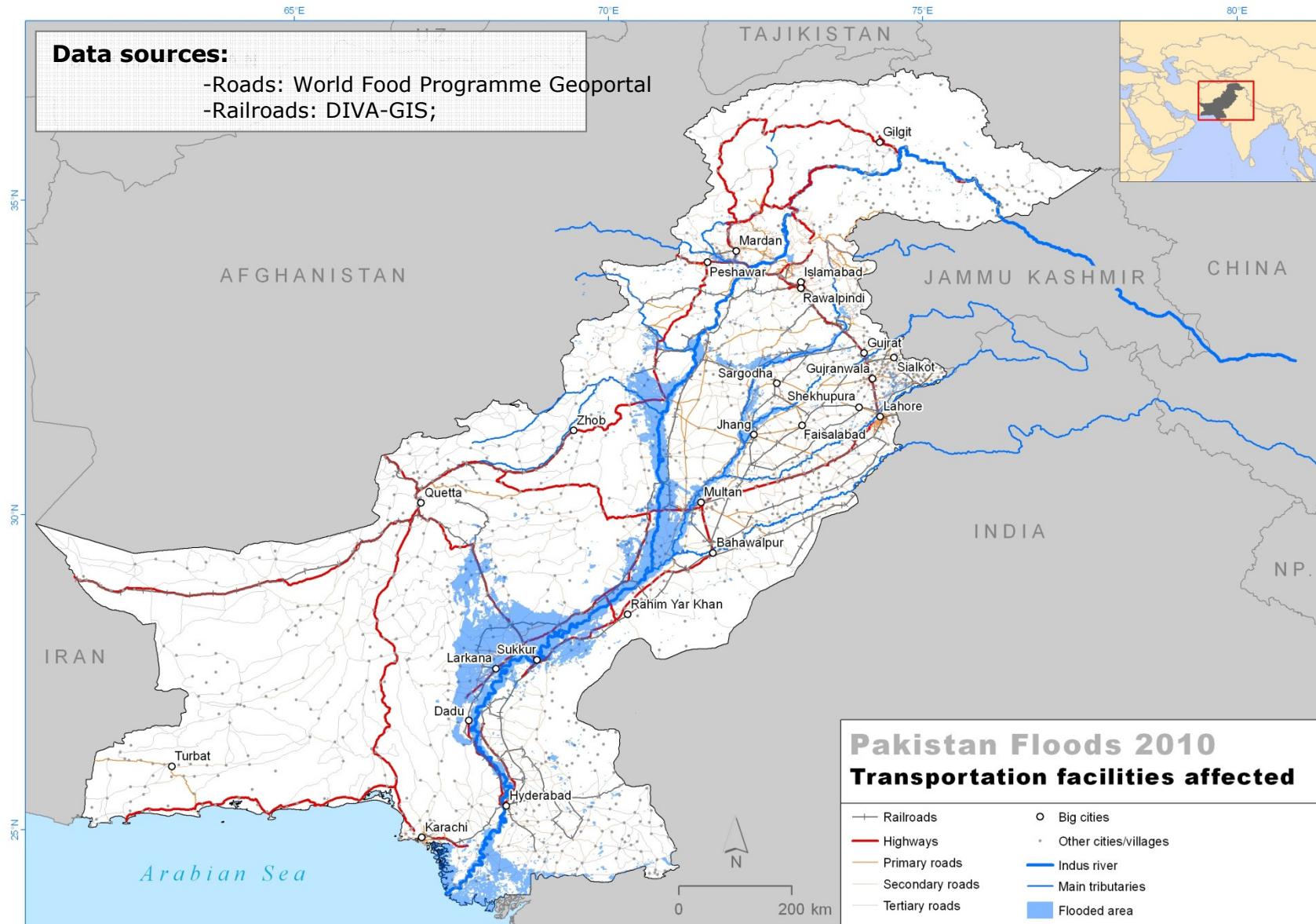


## **Impact on different socio-economic dimensions**









# Conclusions

- With ASCAT established as an **operational service**, an effective **element for early warning** for floods (and drought) is available.
- Key dimensions of vulnerability can be used to **monitor elements at risk** in support of emergency response and reconstruction. Vulnerability data are best maintained on national level.
- Current **scientific advances** in **hydrological modelling** enables integration of satellite based soil moisture towards operational flood prediction.