Flood mapping for index-based disaster risk transfer and insurance mechanisms

Atmospheric and Environmental Research (AER)
African Risk Capacity (ARC)

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ARC: Elke Verbeeten*, Joanna Syroka
*** See poster**

Global Flood Partnership 2017 Conference
27 June 2017

aer
Atmospheric and Environmental Research

African Risk Capacity
Sovereign Disaster Risk Solutions
A Specialized Agency of the African Union

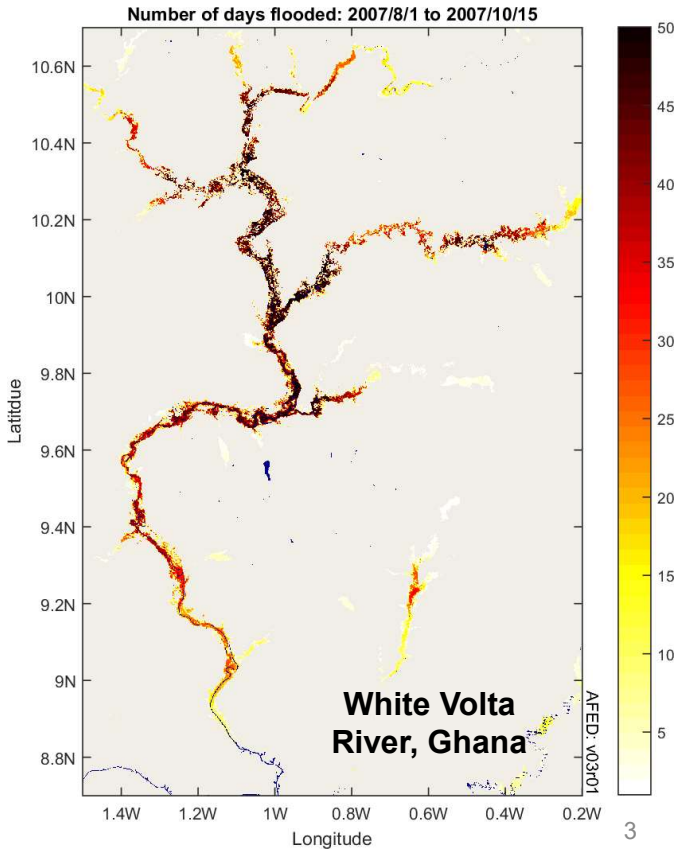
- **ARC uses *index-based insurance* mechanisms to cover national loses from extreme weather events**
  - **Serves African Union Member States**

- **Different from conventional assistance:**
  - Early response - payouts triggered by index
  - Risk transfer across countries

- **ARC has covered drought since 2014**
  - Index: *cumulative rainfall deviation* at the end of the rainfall season

AER produces the ARC flood extend depiction: AFED

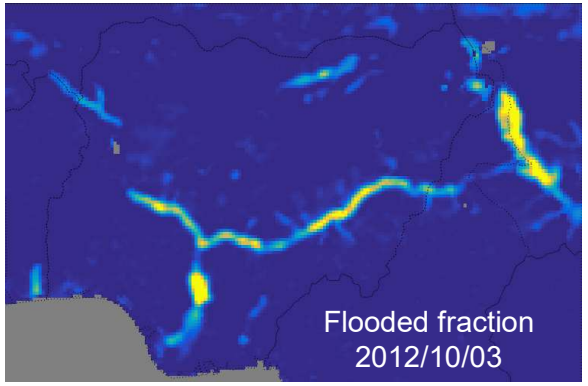
- **Intended to underpin ARC's index-based river flood insurance product**
- **Produced from**
  - Microwave remote sensing
  - Downscaling
- **Features**
  - Large, long-lasting flood detection
  - Flood depiction at 90-m
  - All-Africa coverage
  - Daily historical coverage, 1992-present
  - Daily updates in near real time
  - NRT coverage from two satellite sensors (AMSR2 & GMI)
- **Global application**
  - S. America now running in NRT – N. America coming soon



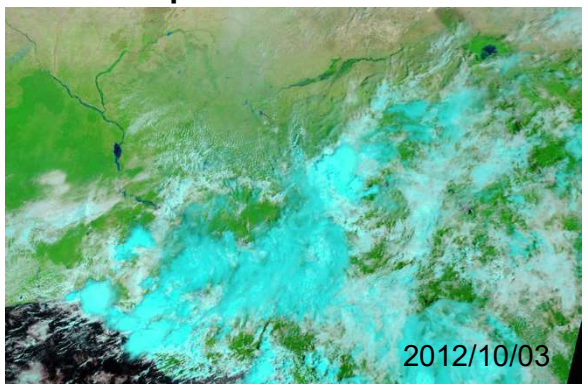
Why choose microwave sensors for insurance applications?

- **Typically provide twice-daily measurements**
  - More likely to capture peak flood extent and flood duration
- **Historical record from 1992 to the present from multiple satellite sensors**
  - SSM/I, AMSR-E, AMSR2, GMI
- **Continuing NRT observations from multiple satellite sensors**
  - AMSR2, GMI
- **The AFED algorithm overcomes their limitations**
  - **Coarse resolution**: AFED uses terrain data to downscale microwave data to depict floods at a finer scale
  - **Rain interference**: AFED uses rain detection to produce flood depictions from the best-quality data

Microwave sensor data



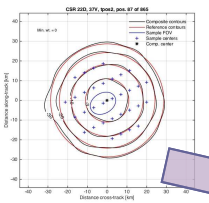
Optical sensor data



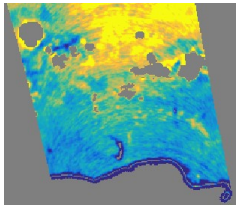
Microwave remote sensing of flooded fraction

[AFED Algorithm Description Document, AER 2017]

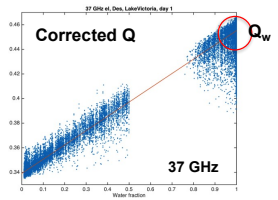
Footprint matching & regridding to circularized footprints (22-50 km)



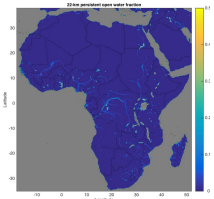
Atmospheric correction and aggressive rain flagging



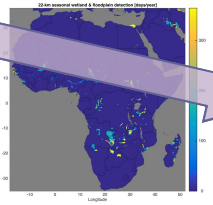
Linearized Polarization Ratio Index (PRI): “Q”

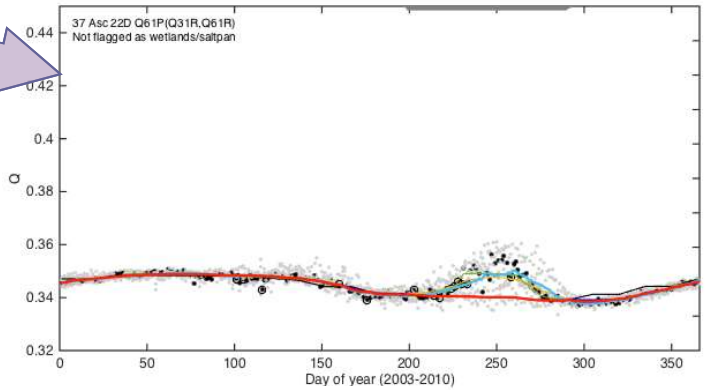


Open water mask: Hansen+SWBD



Seasonal wetlands mask (detected days)

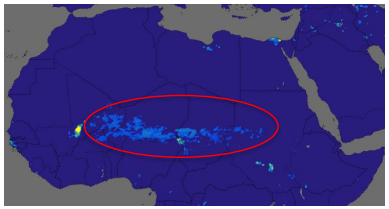




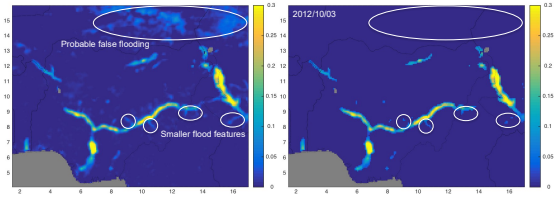
Footprint-weighted dry-land end-member prediction model:

- Q climatology: 8-year mean/variance
- Q retrospective medians: 31- & 61-day
- Q LUT: where regular seasonal flooding biases climatologies

Temporal/spatial false positive filtering



Minimum detectable water fraction filtering



Flooded fraction algorithm: time series analysis

Atmospheric and Environmental Research

African Risk Capacity
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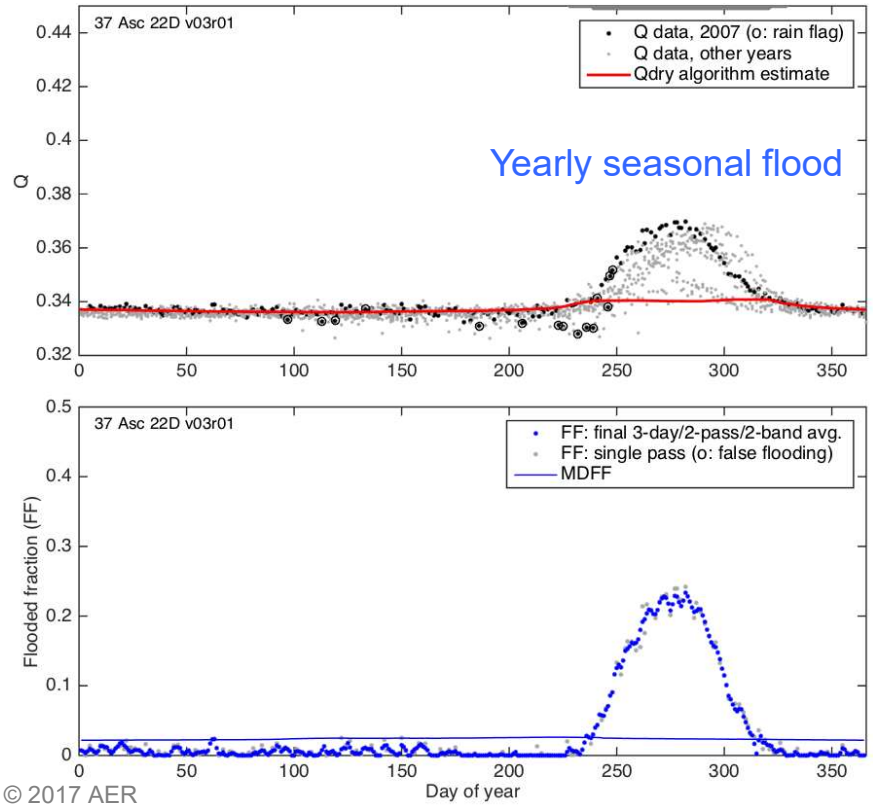
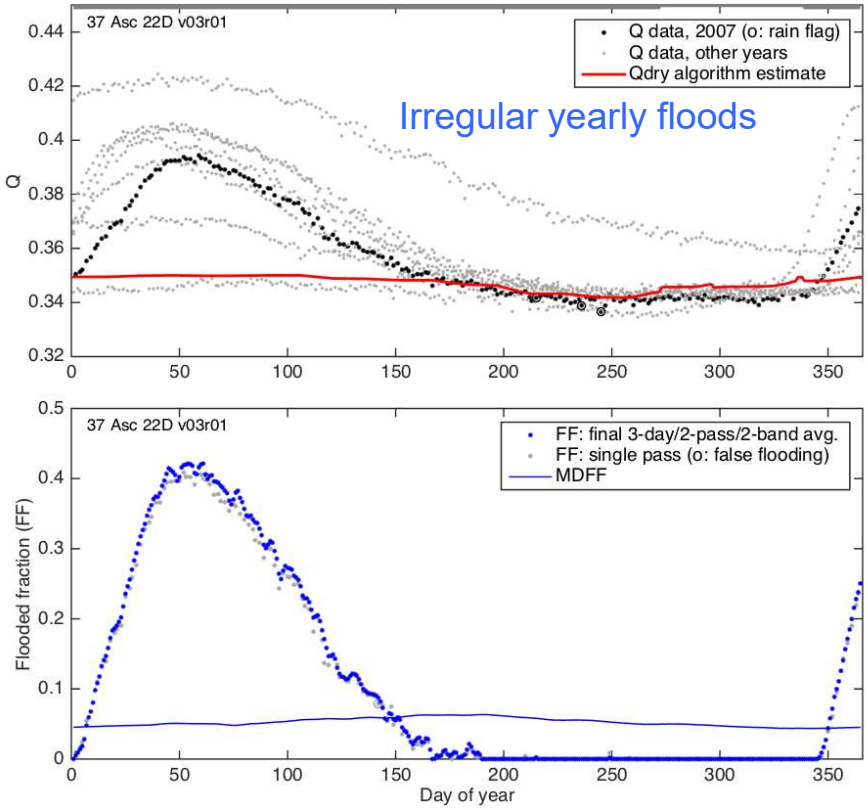
Nigeria, Niger Onitsha, 2007

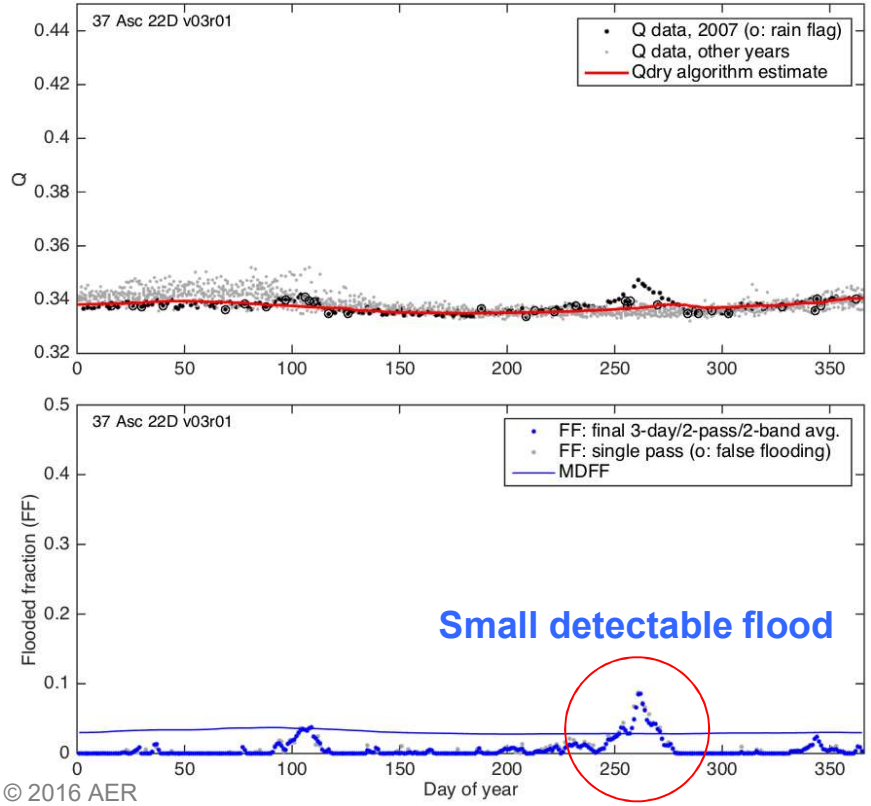


Chad, Lake Chad, north lobe, 2007

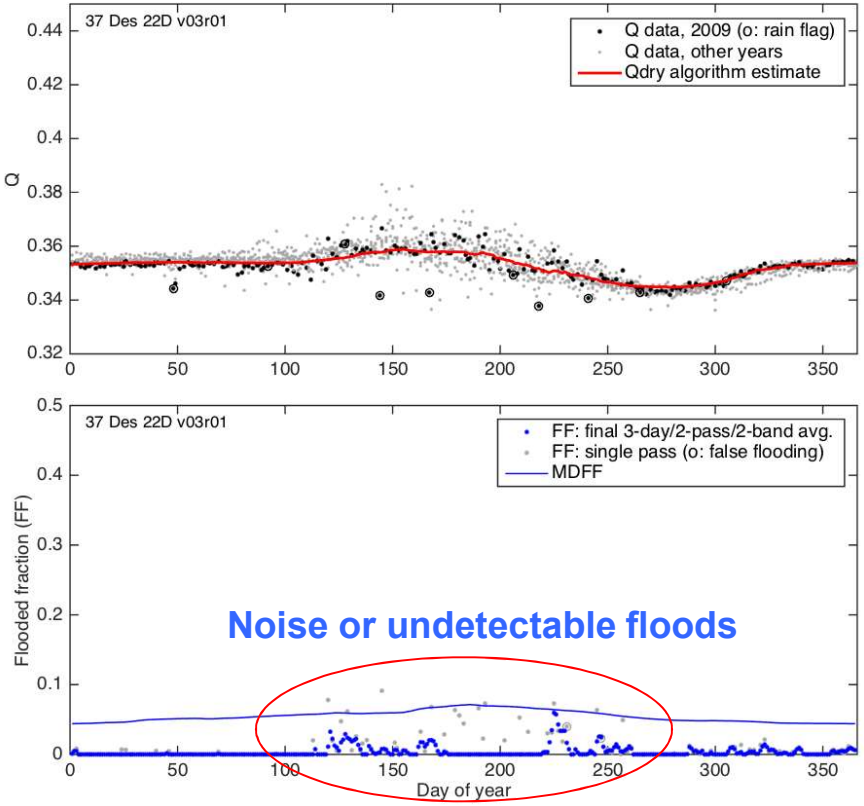


Flooded fraction algorithm: time series analysis

Uganda, Okok and Okere Rivers, 2007



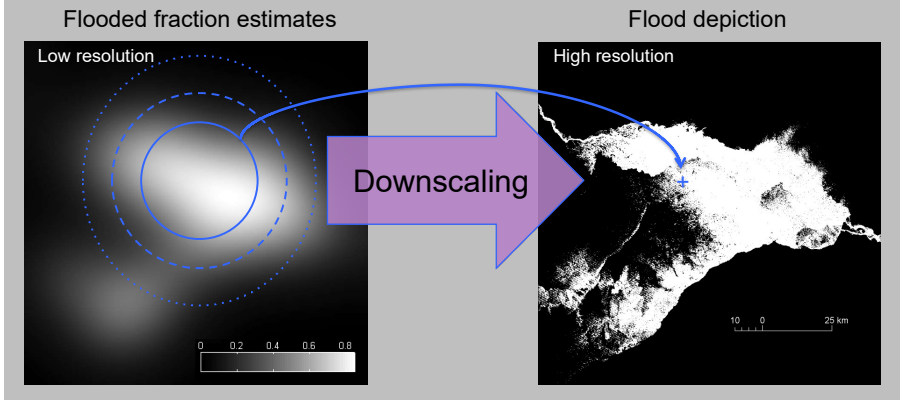
Burkina Faso, Plateau-Central, 2009



Flooded fraction downscaling

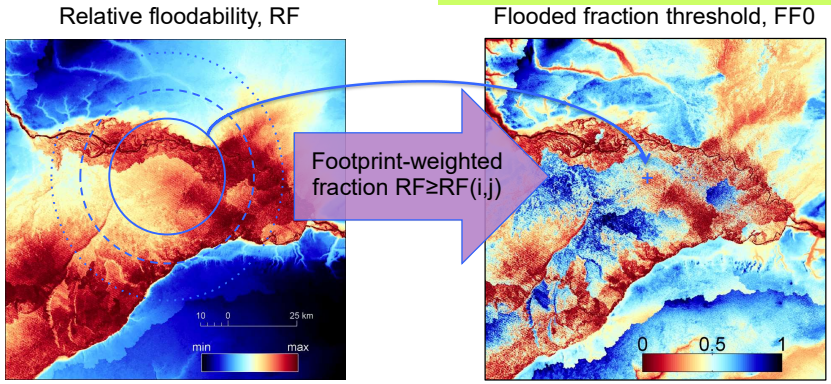
[AFED Algorithm Description Document, AER 2017]

90-m flood mapping from 22-50 km flooded fraction

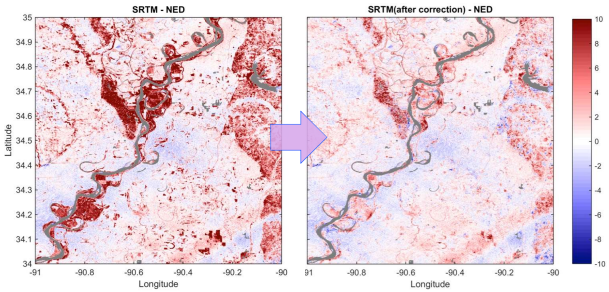


90-m floodability index

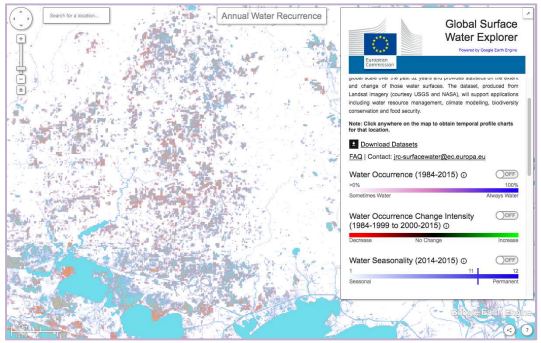
Footprint-weighted flooded fraction threshold



SRTM DEM with tree bias correction



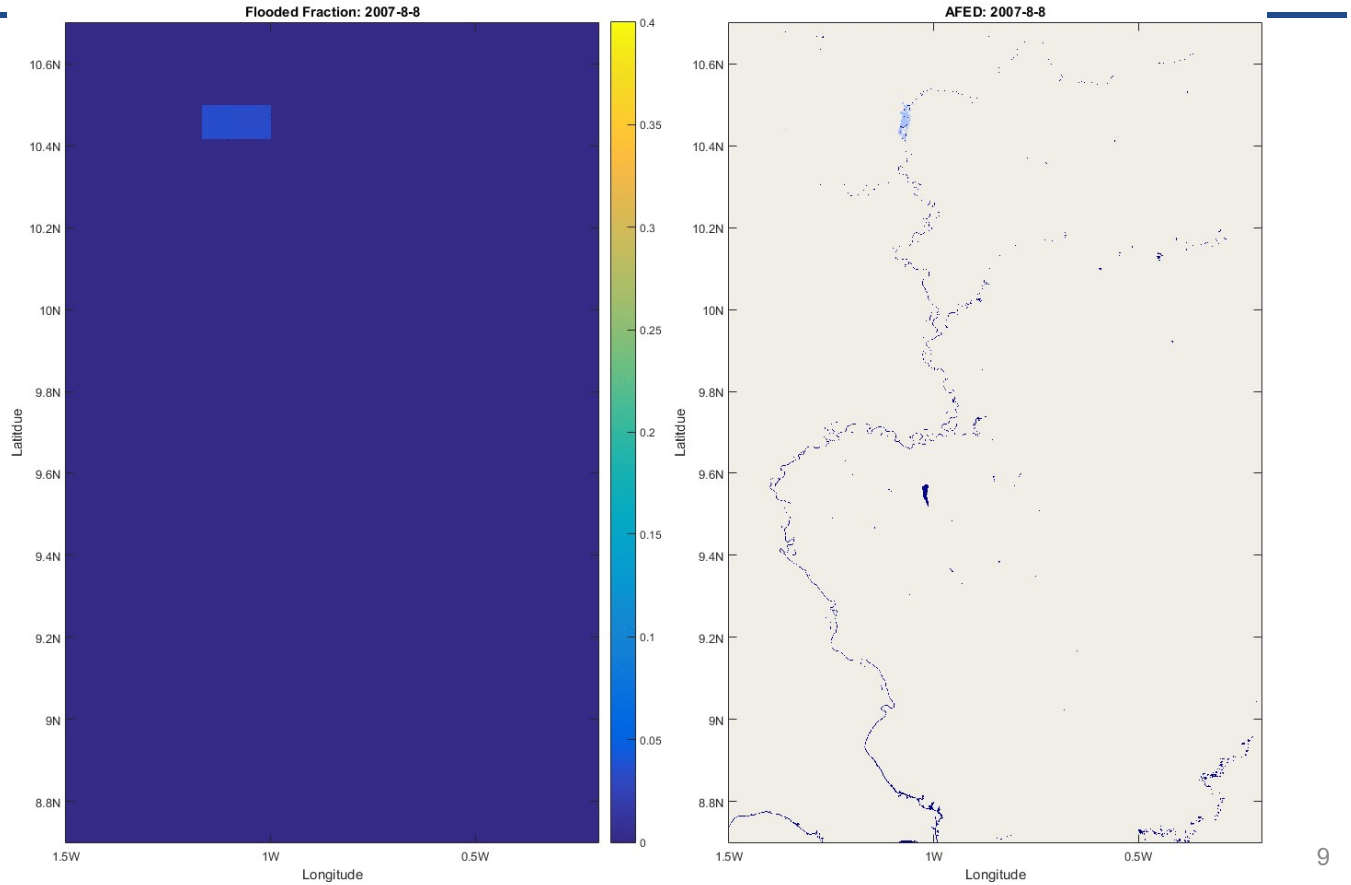
Global Surface Water dataset: Historical water recurrence



Daily flood extent evolution

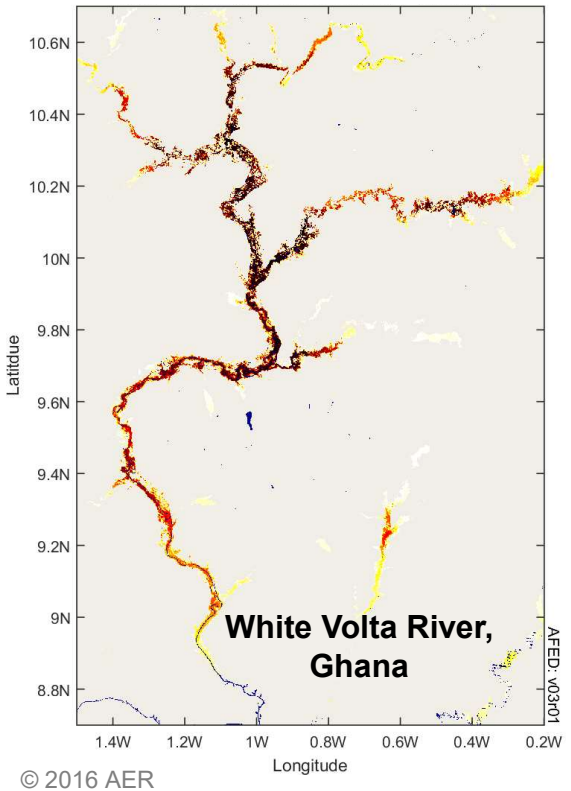
Event:

- **White Volta River, Ghana**
- **2007/08/08 – 2007/10/15**

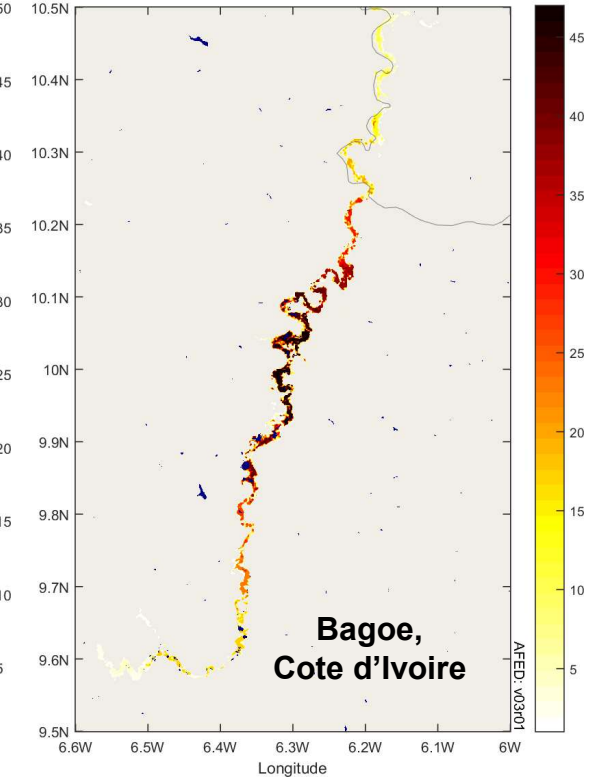


Number of days flooded

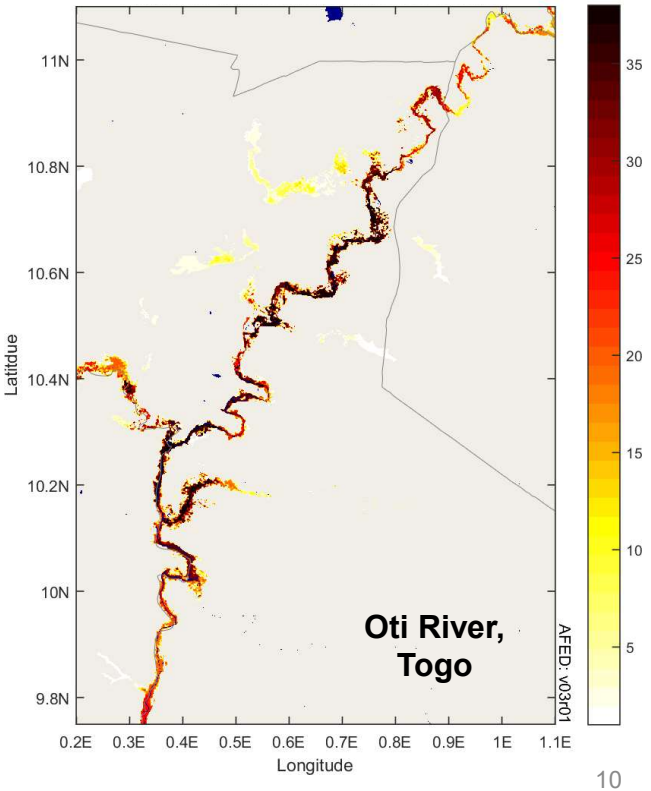
2007/8/1 to 2007/10/15



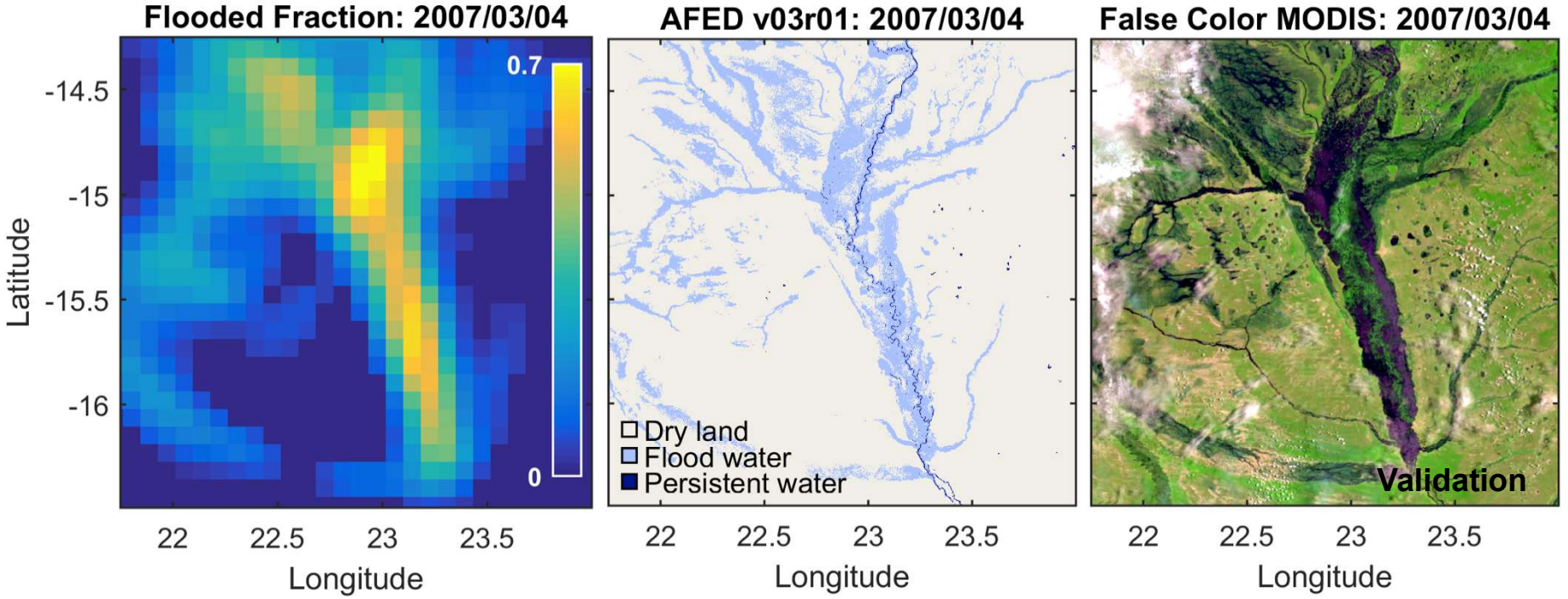
2007/8/6 to 2007/10/9



2007/8/22 to 2007/10/14

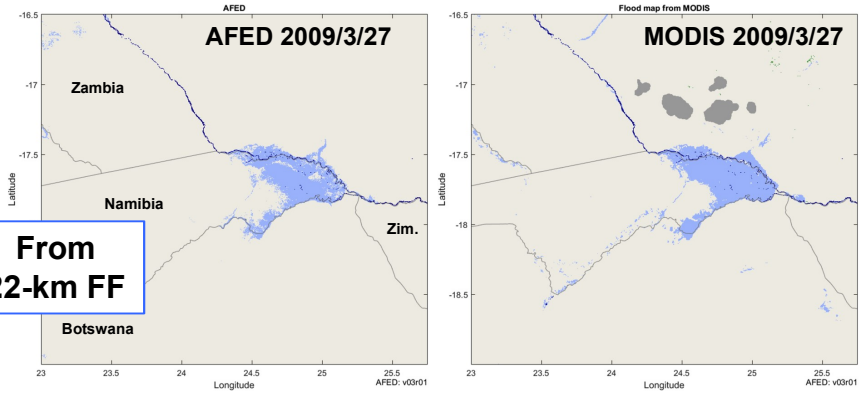


Flood depiction:
Barotse Floodplain, Zambia, 2007/03/04



Validation vs. MODIS

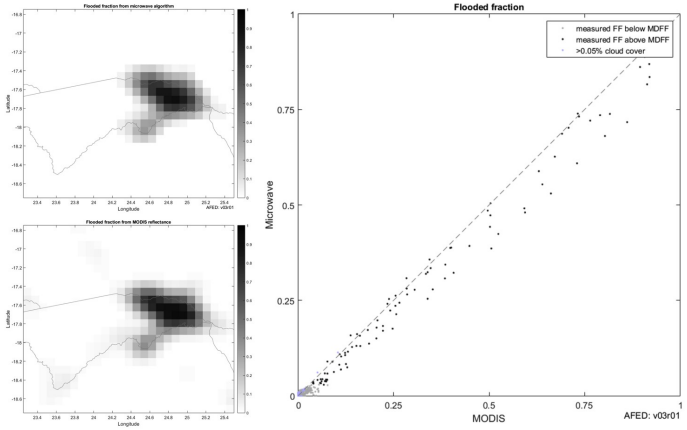
[AFED Algorithm Performance Document, AER 2017]

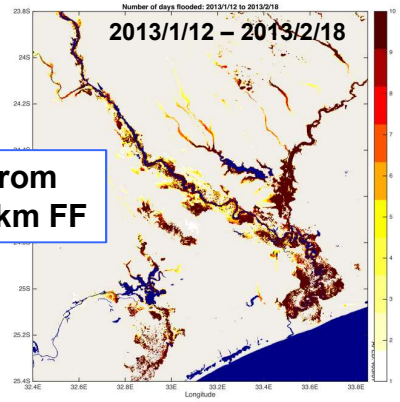


From 22-km FF

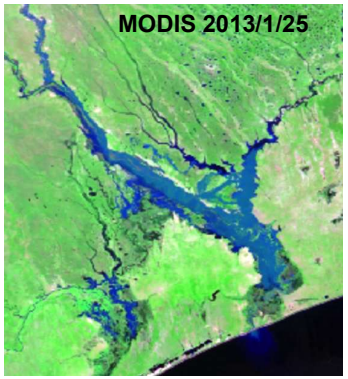
Microwave 22-km FF

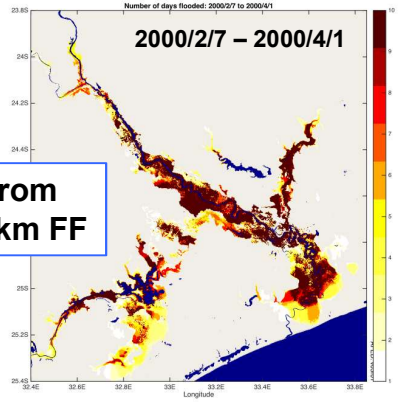
MODIS 22-km FF



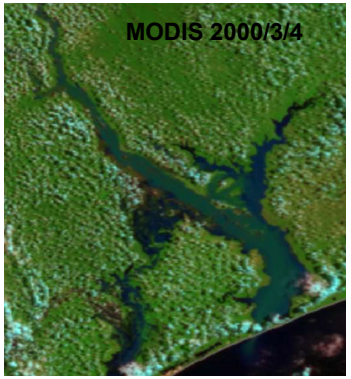


From 22-km FF



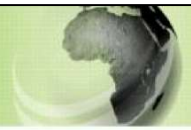


From 50-km FF



How does AFED meet risk transfer requirements?

ARC Insurance Product Requirements



ARC index-based insurance products must satisfy the following principles to ensure credibility and sustainability of the insurance pool:

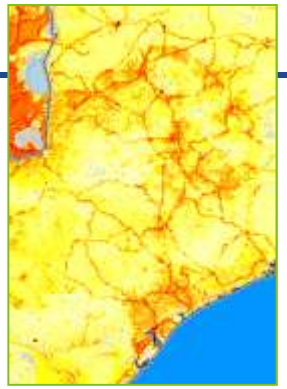
- ✓ Be pan-African – available to all potential ARC Member States
- ✓ Be based on objective, independently produced data — Fully automatic process
- ✓ Use transparent calculations and be fully replicable by third parties
- ✓ Have a sufficient consistent historical record for underwriting — 1992 – present daily products
  - ✓ Ideally 30 years but at least 10 years
- ✓ Use data that is available reliably and consistently in near real-time — Historical process = NRT process
  - ✓ Based on exactly the same data and calculations as used to construct the historical record
- ✓ Have data fall-back methodologies defined and faithfully implemented — Data fallback: AMSR2 GMI
- ✓ Parameters and settings used must remain fixed during an insurance contract period
  - ✓ No manual manipulation
- ✓ Must successfully undergo ARC internal due diligence
  - ✓ To ensure consistency and full reliability of the results under a range of scenarios

ARC River Flood Insurance Risk Quantification

African Risk Capacity
Sovereign Disaster Risk Solutions
A Specialized Agency of the African Union

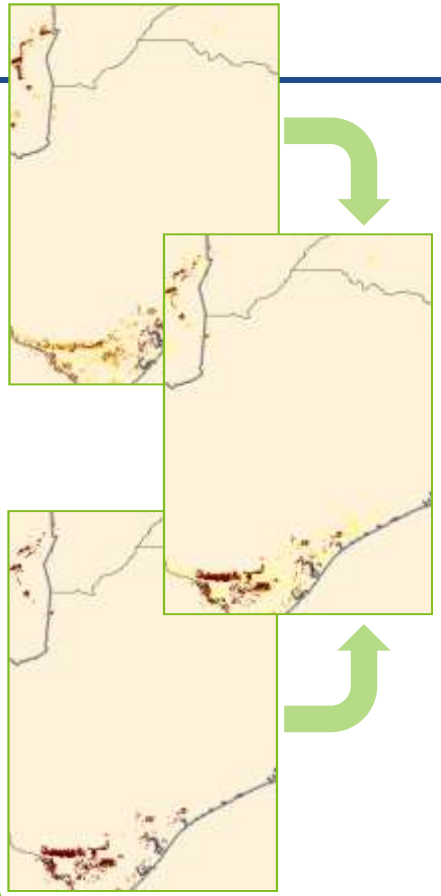
DAILY FLOOD DEPICTION (AFED)

POPULATION

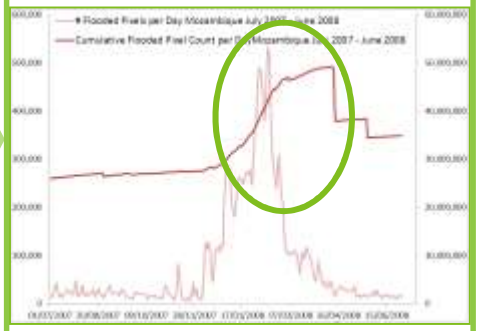


TEMPORAL MASK

MODELLED IMPACT

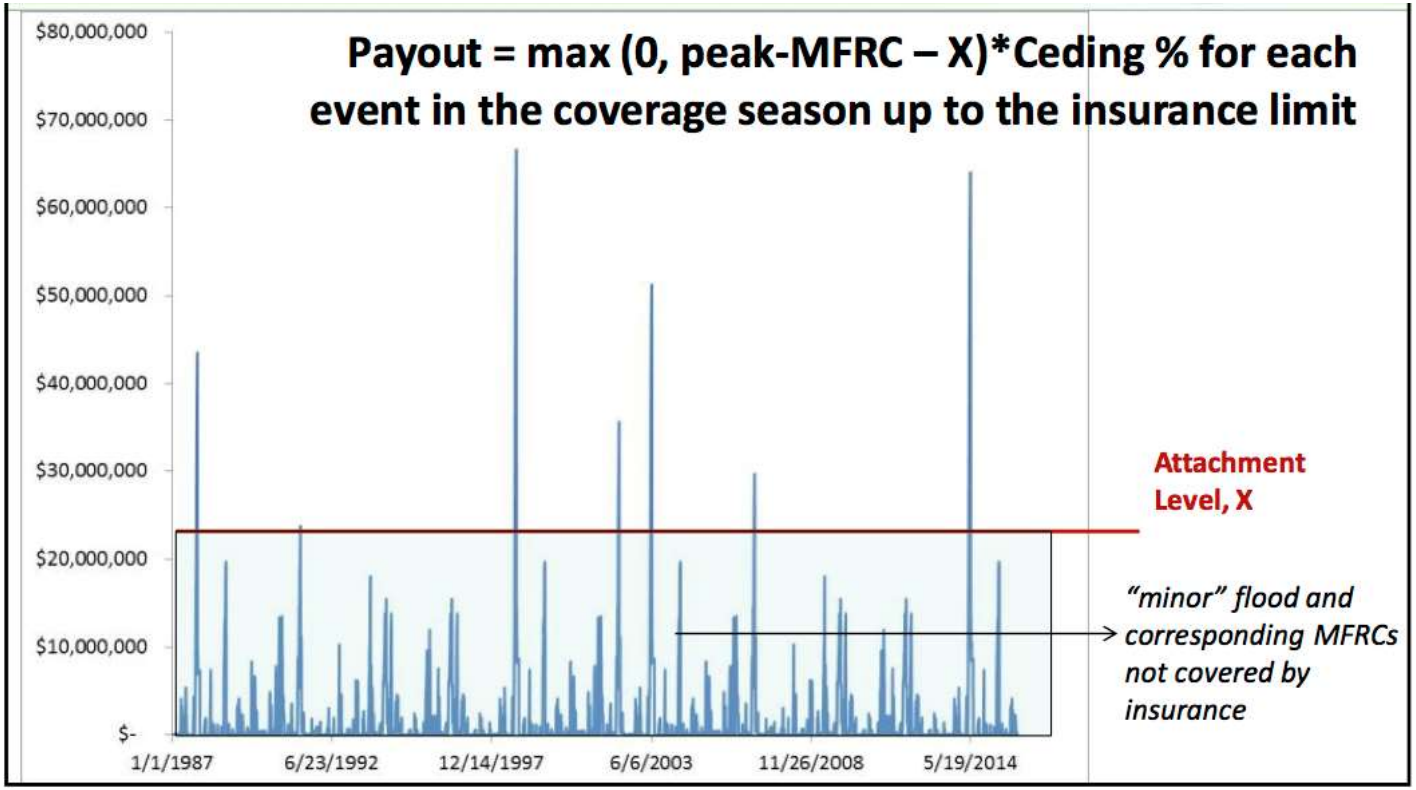


RESPONSE COSTS

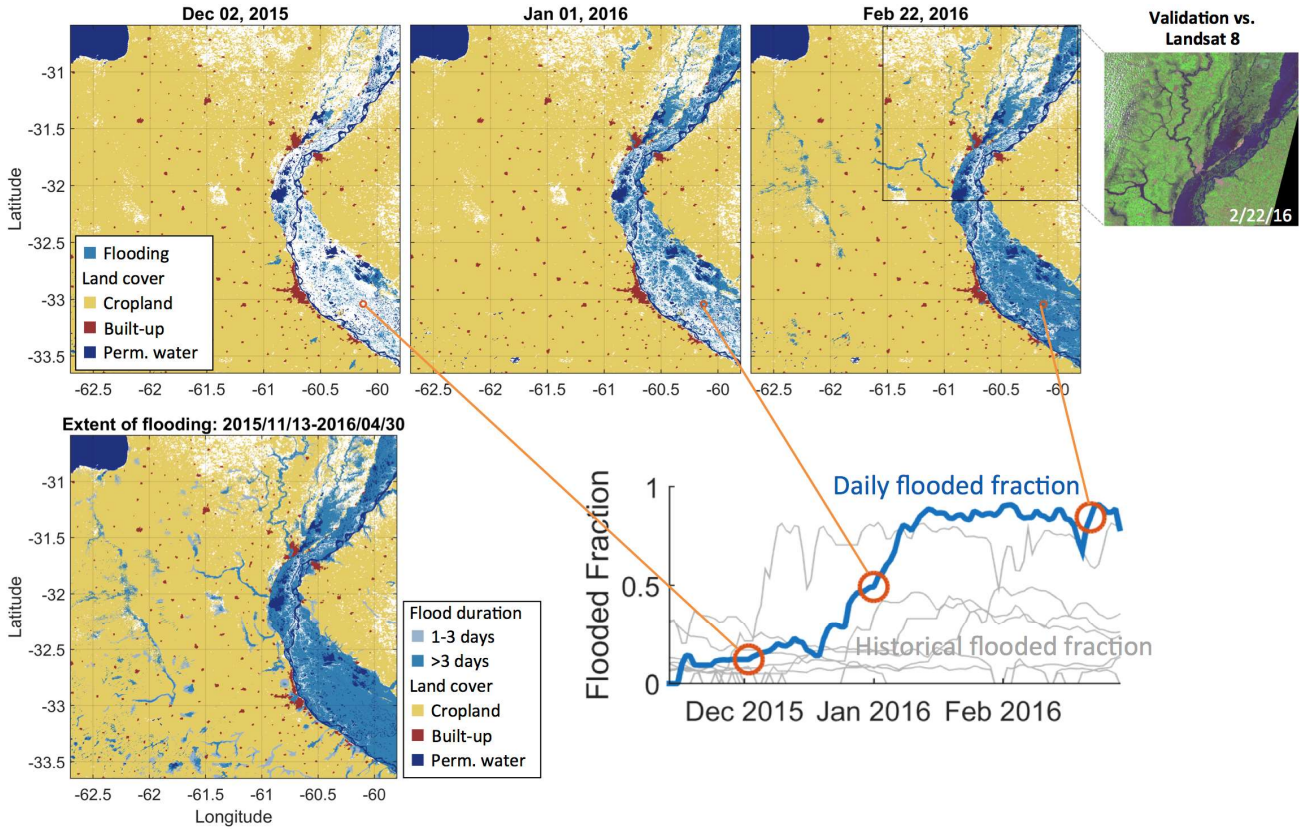


RISK TRANSFERRED TO ARC

Example of Modeled Flood Response Costs (MFRC) Time Series

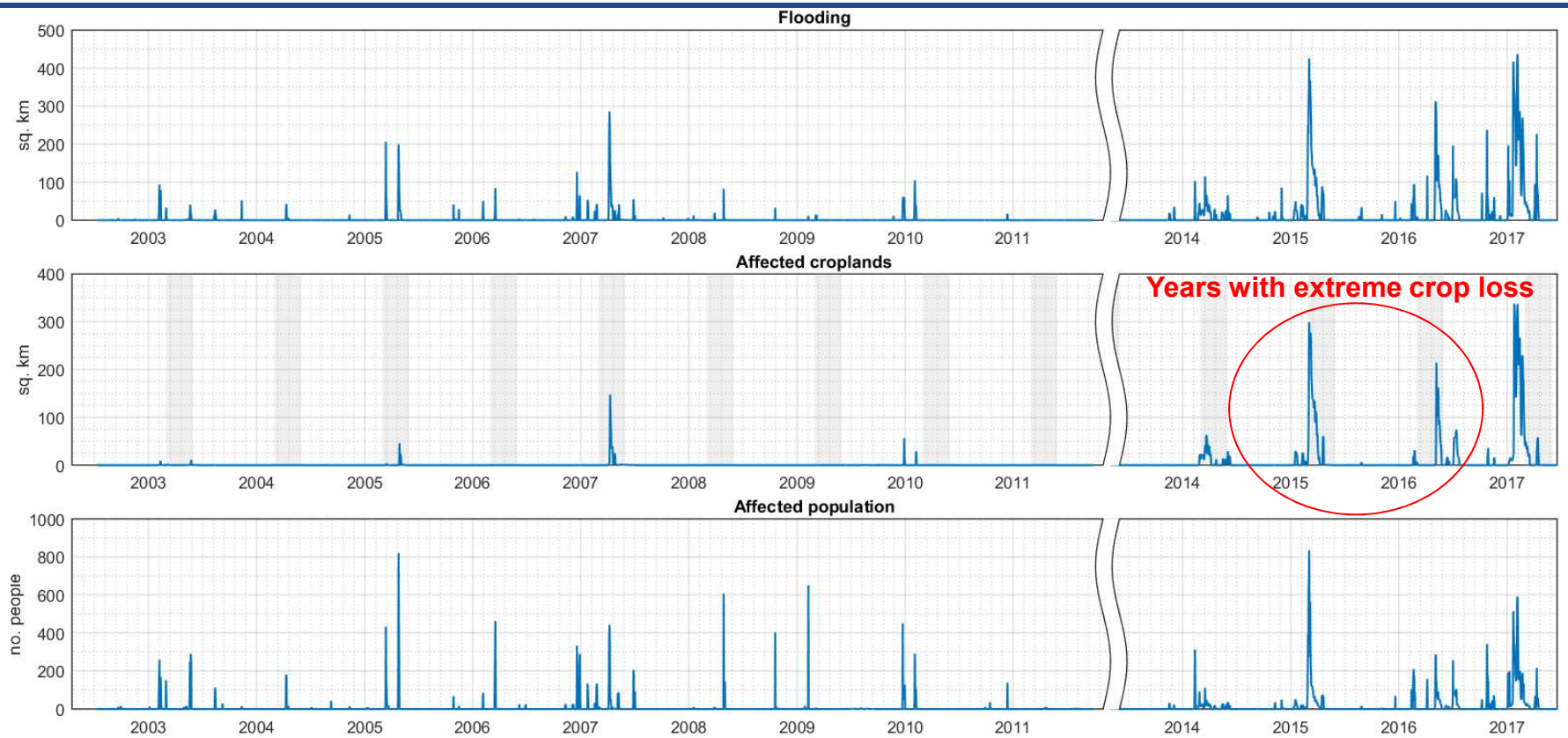


Argentina flooding, 12/2015-04/2016: Sustained flooding – high impact on crop yields

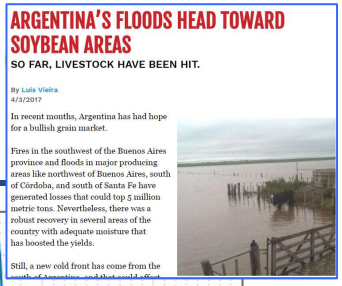


Flood impacts over time

Castellanos Department, Santa Fe Province, Argentina



Flood timing affects crop loss


ARGENTINA'S FLOODS HEAD TOWARD SOYBEAN AREAS

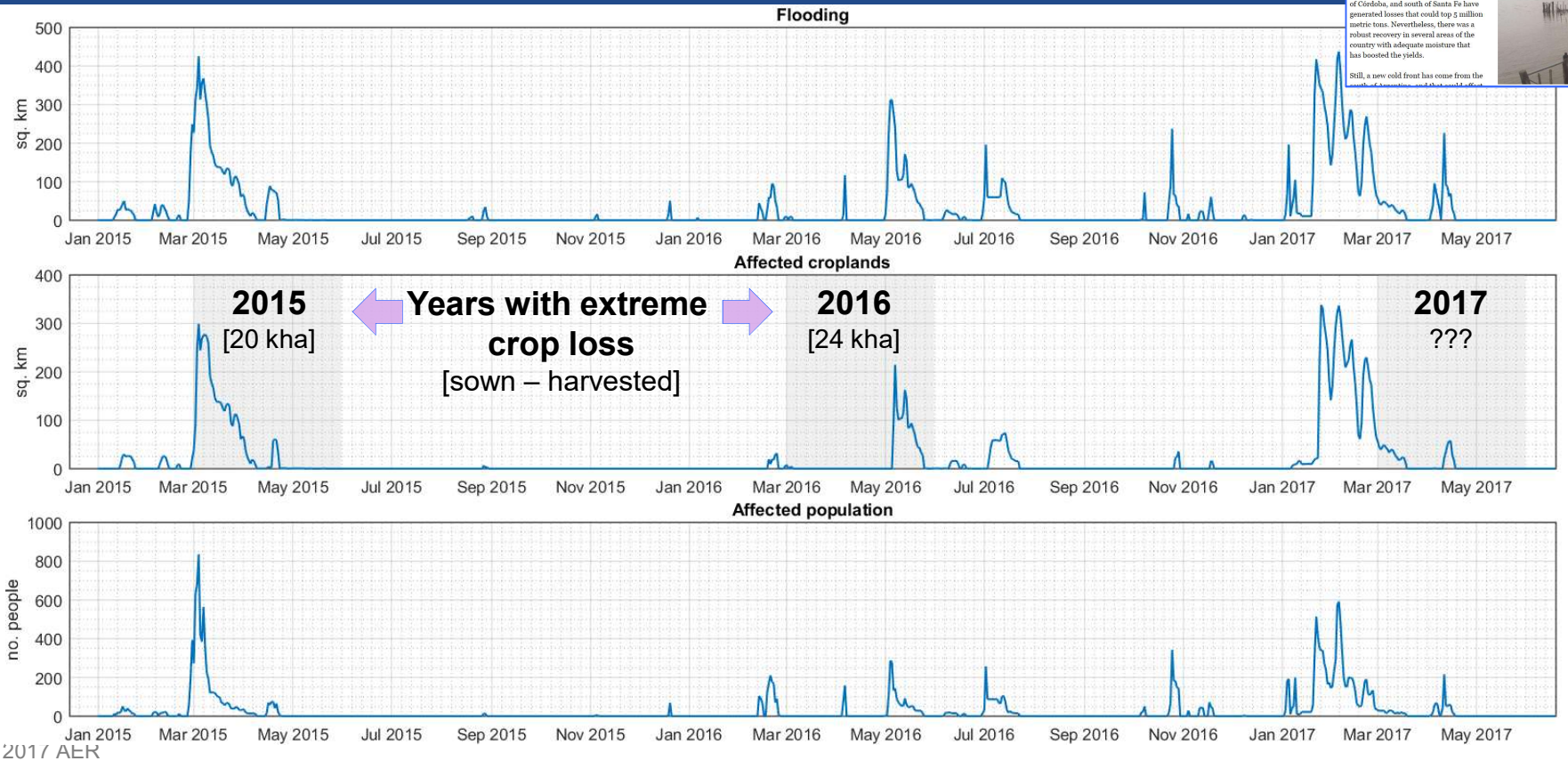
SO FAR, LIVESTOCK HAVE BEEN HIT.

By Luis Vieira
4/3/2017

In recent months, Argentina has had hope for a bullish grain market.

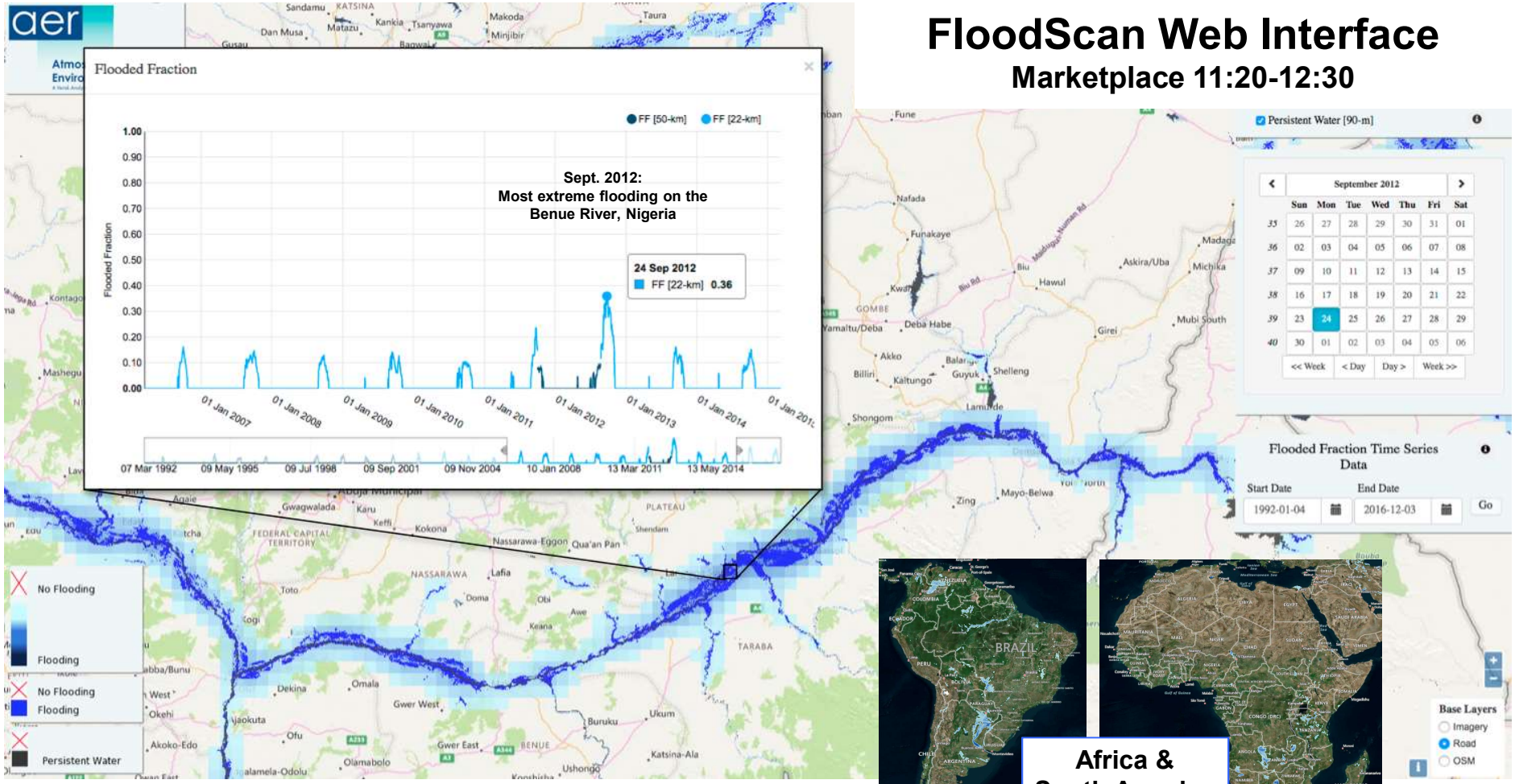
Fires in the southwest of the Buenos Aires province and floods in major producing areas like northwest of Buenos Aires, south of Córdoba, and south of Santa Fe have generated losses that could top 5 million metric tons. Nevertheless, there was a robust recovery in several areas of the country with adequate moisture that has boosted the yields.

Still, a new cold front has come from the



FloodScan Web Interface

Marketplace 11:20-12:30



Let's talk more about…

- **Insurance!**
- **DEM/DTM:**
  - Best available global DTM now and plans for the future
  - Derived: Flow direction, stream line, etc. data consistent with DTM
  - Plus: Global levee/dike/levee-protected-area databases
- **Persistent water masks:**
  - Tracking artificial changes over time (e.g., reservoirs)
- **Flood extent ground truth:**
  - Esp. for vegetation-obscured flooding
- **NRT flood mapping integrating multiple sources:**
  - Optical – radar – microwave remote sensing + hydrologic modeling