

Xubin's 5 Questions

National Security, Health, Agriculture, Weather, & **Science**

What are your EO data needs? - **real-time and historical time series of photosynthetic capacity.**

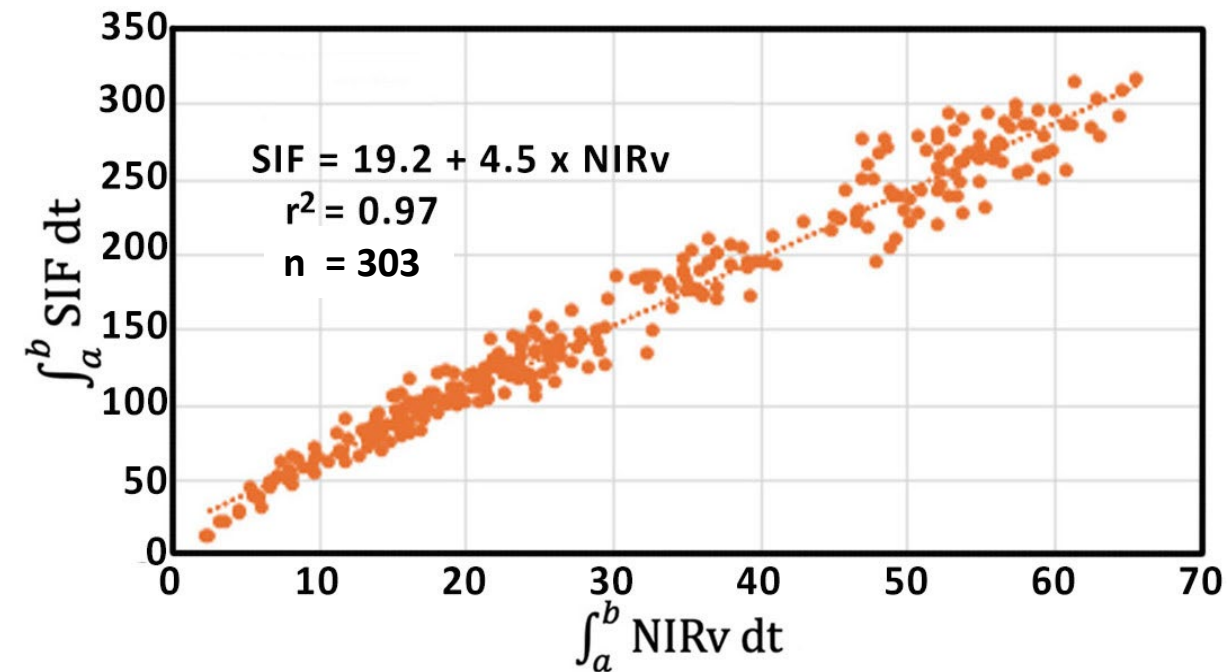
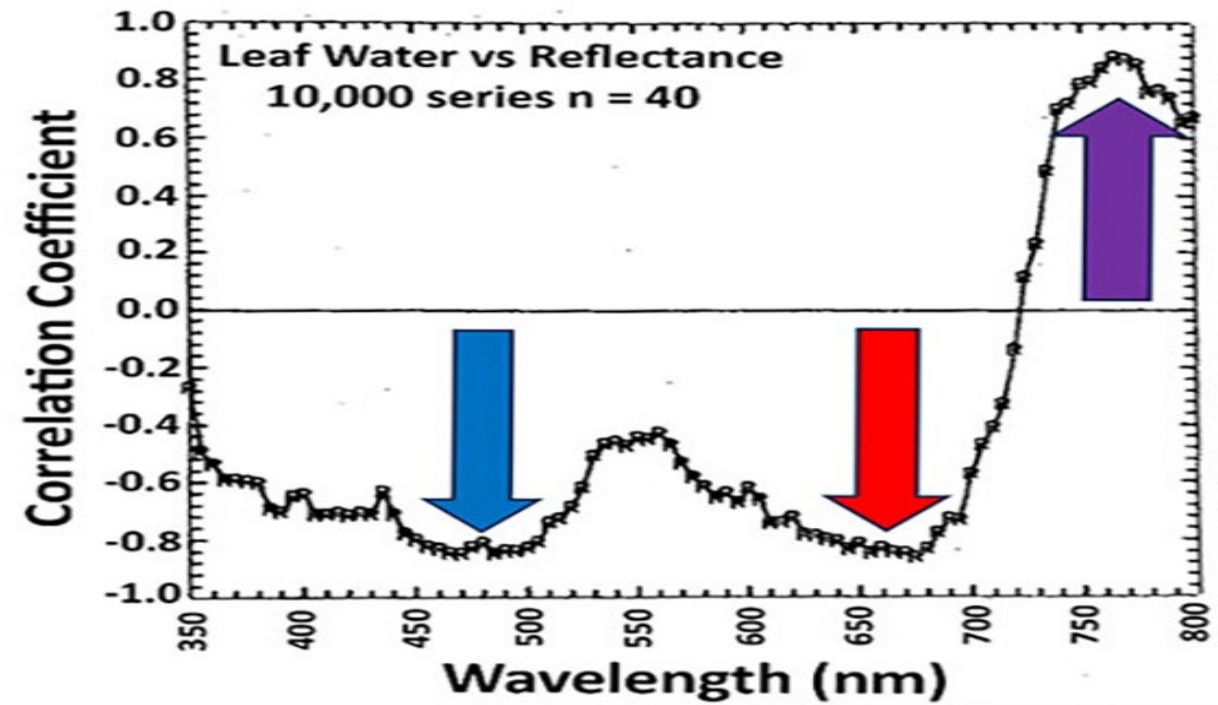
How important to you are near real-time data latency vs length of historical record? **One contributes to the other. We have gone from 8 km, to 250 m, & need to move to 10 m with photosynthetic capacity.**

To what extent do you emphasize scientific vs. informational vs. societal value, or all three? **Scientific value is the key. No scientific value no societal value.**

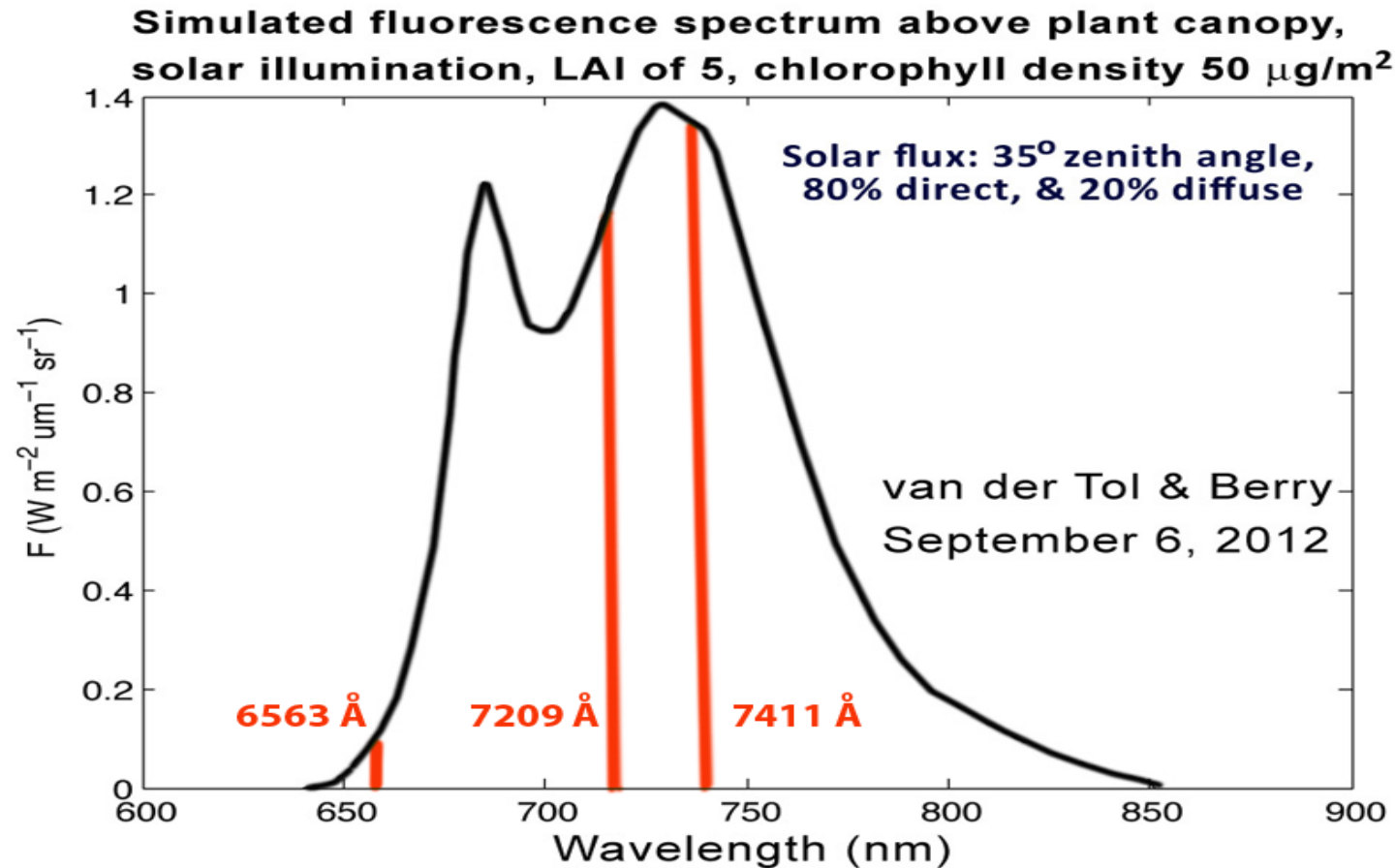
What are the major gaps that complicate your use of EO data? **NASA's failure to compliment ESA's Sentinel-2 global time series of Photosynthetic Capacity at 10 m.**

What do you feel are the most important considerations for the next Decadal Survey in facilitating broader use of EO data? **Compliment Sentinel-2s' 10 m red & NIR data in the time domain.**

Compton Tucker/CSU & NASA 1971-1975 & 1975- 2026 ...



Solar Induced Fluorescence (a flux)



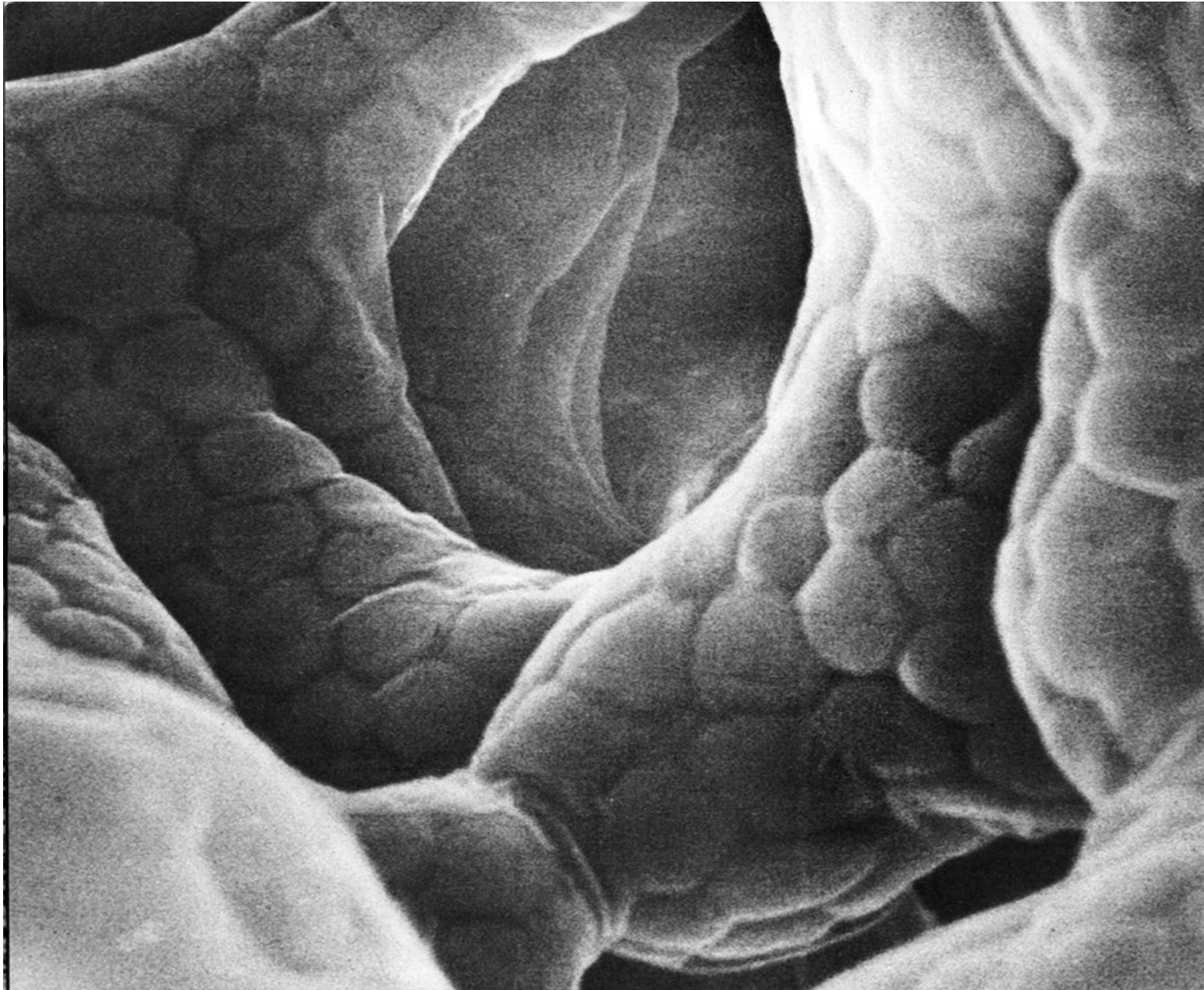
To accurately measure fluorescence, this has to be done within appropriate solar Fraunhofer line(s) which means a spectral interval of 0.5 Angstrom or 0.05 nm. This means low signal-to-noise that translates into larger areas of data collection to achieve desired measurement accuracies.



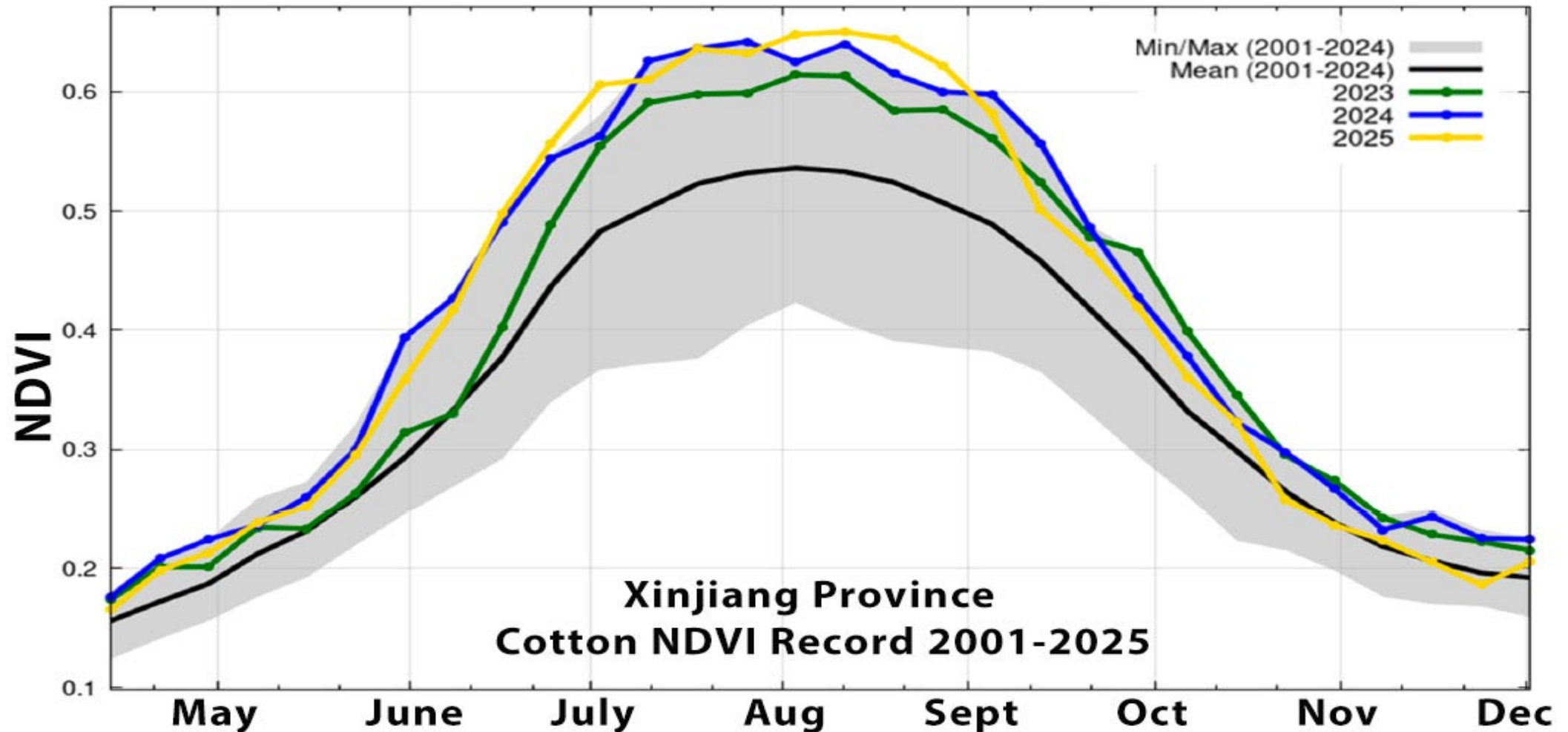
X420

Bean Leaf Spongy mesophyll

X4200

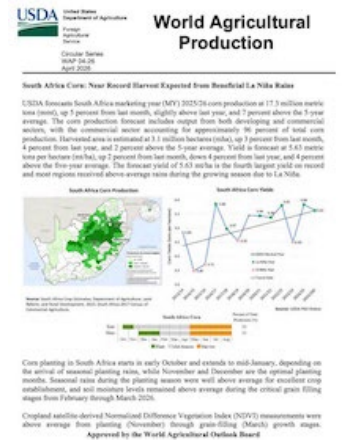
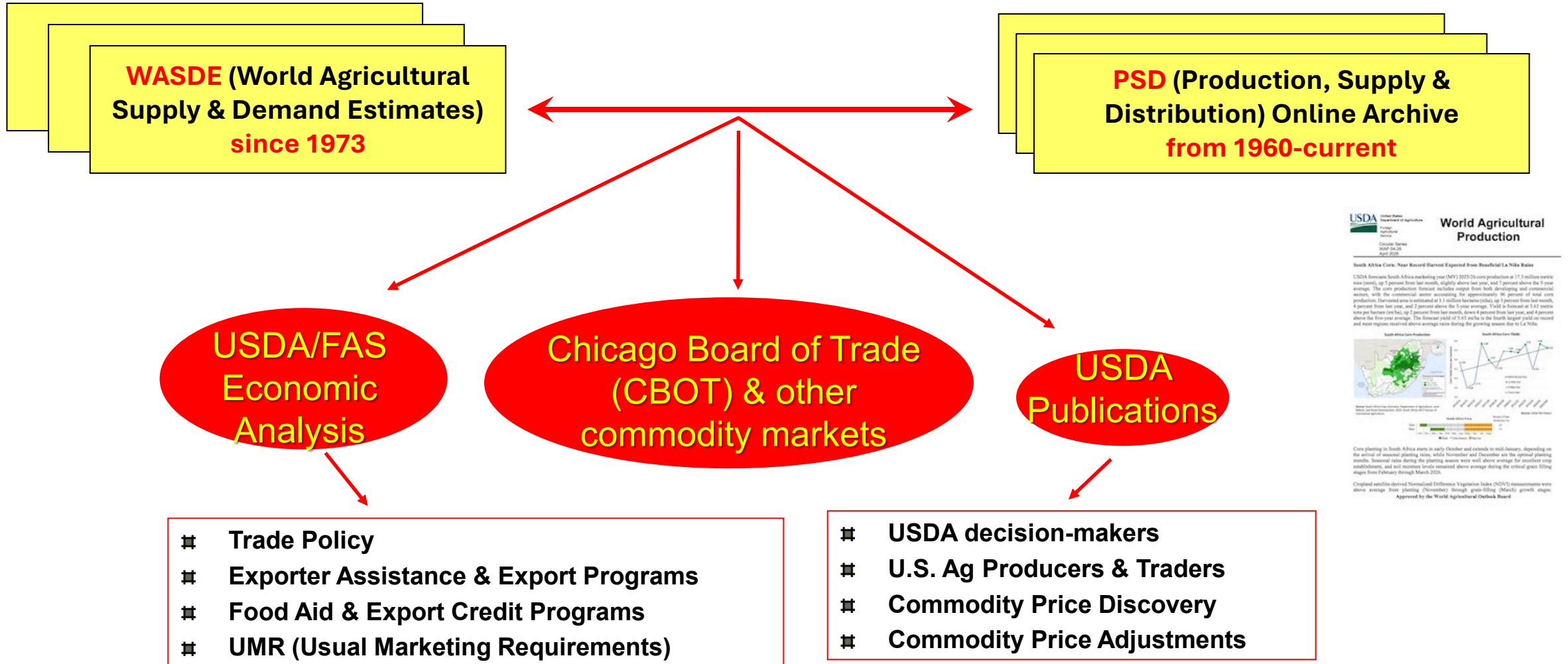


MODIS NDVI Cotton Record Xinjiang, China



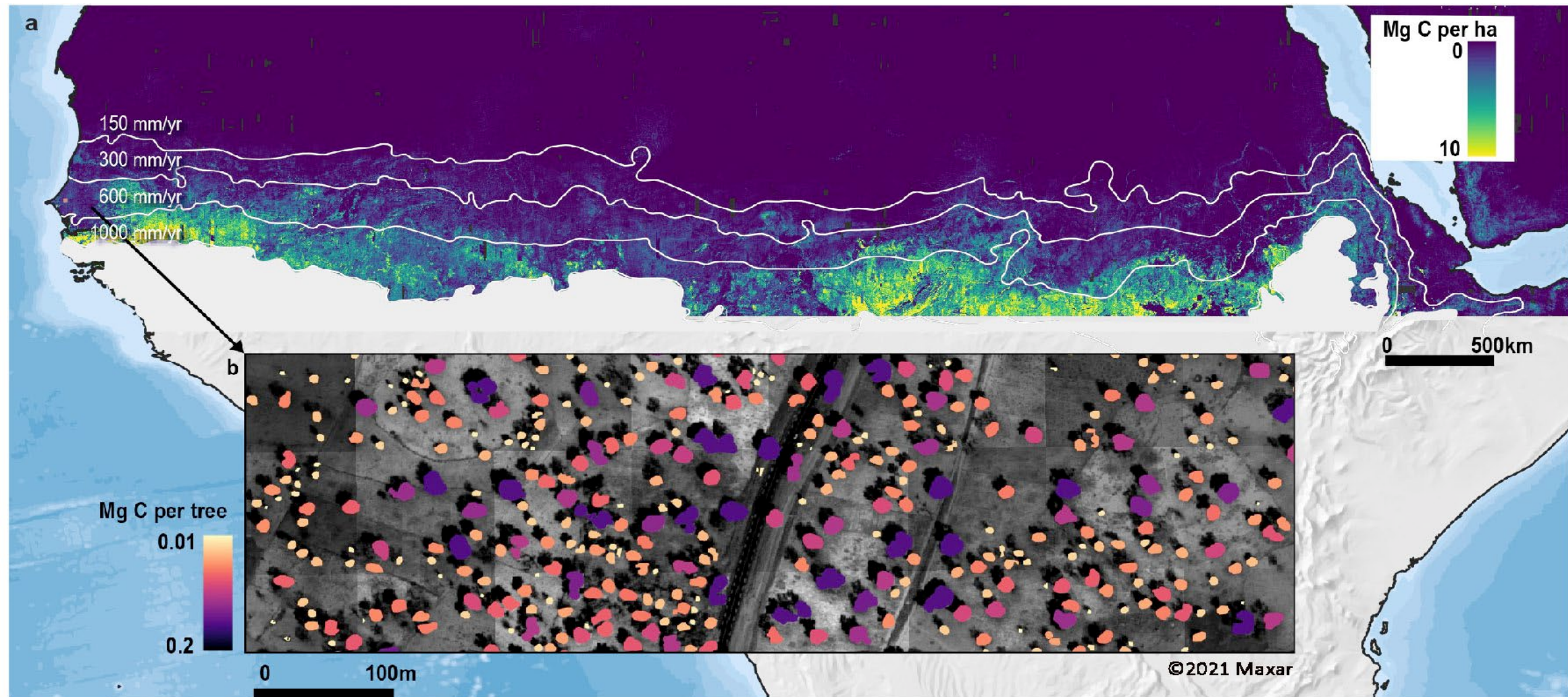
Source: USDA/NASA Global Agricultural Monitoring (GLAM) MODIS Terra 8-day NDVI

USDA's Economic Intelligence System

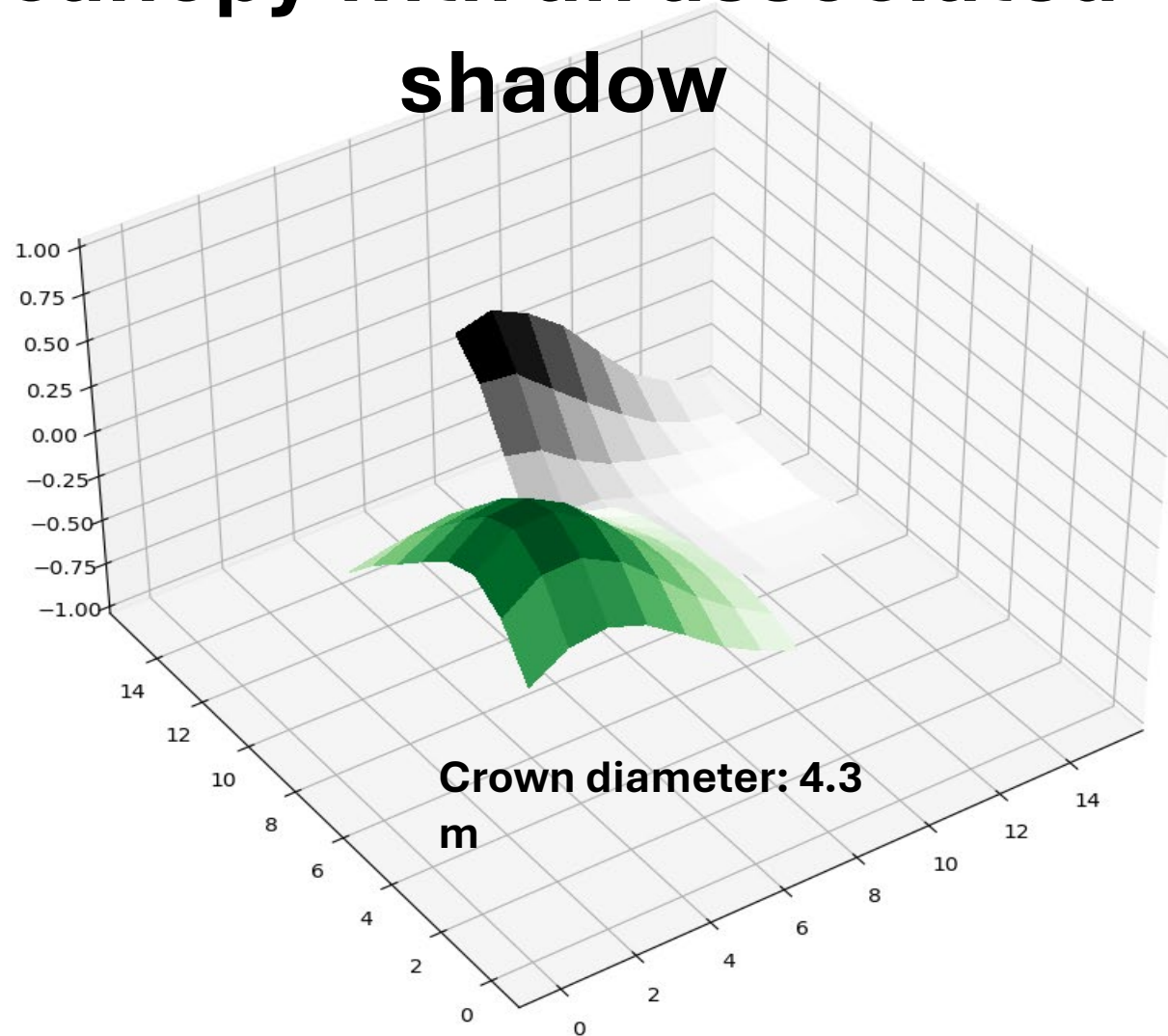


10 B trees converted to carbon using machine learning & High-Performance Computing with a 4×10^{13} Element Array

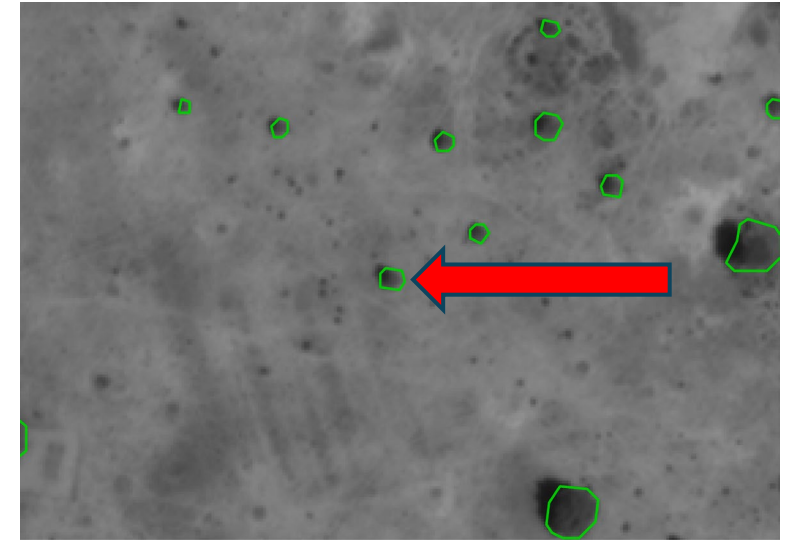
Tucker et al. NASA/GSFC



A tree must have a high NDVI green canopy with an associated shadow



PAN



NDV

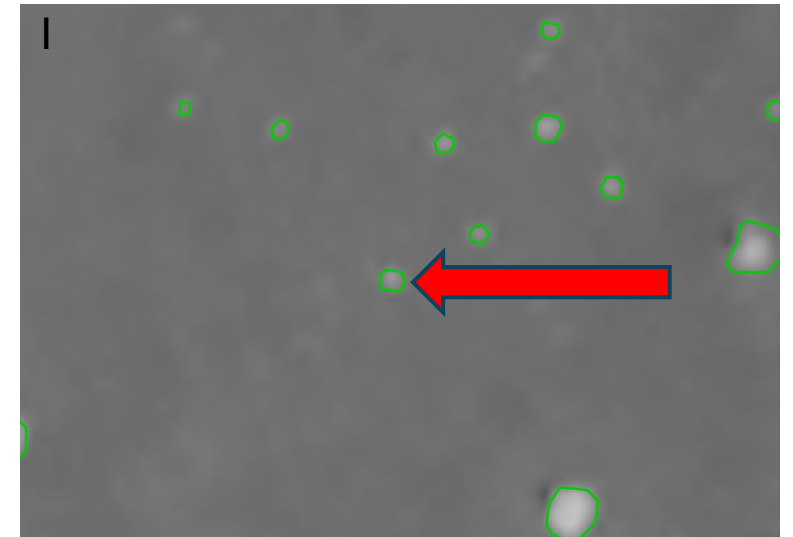
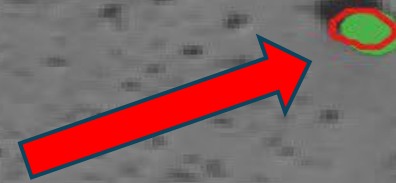


Image: SSAr2_32634_GE01-QB02-WV02-WV03_PV_012_037_mosaic
Crown Area: 14.75 m²; Feature FID: 242307; Lat/Lon: 1237201.5,



Only trees/shrubs with
a shadow have been
included, no grass
tussocks and bushes
are mapped





Polygons may be offset relative to basemap imagery due to differences in imagery and/or [orthorectification](#).

Dec 28, 2014

Source image date

137 kg

Root carbon

465 kg

Wood carbon

14.1 kg

Leaf carbon

616 kg

Total carbon

8.18395,
17.93455

0.47

NDVI

147.3 m²

Area

Preview source imagery

© Maxar 2014

Dec 8, 2016

Source image date

40 kg

Root carbon

147 kg

Wood carbon

5.3 kg

Leaf carbon

193 kg

Total carbon

8.19143,
17.93448

0.38

NDVI

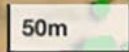
52.0 m²

Area

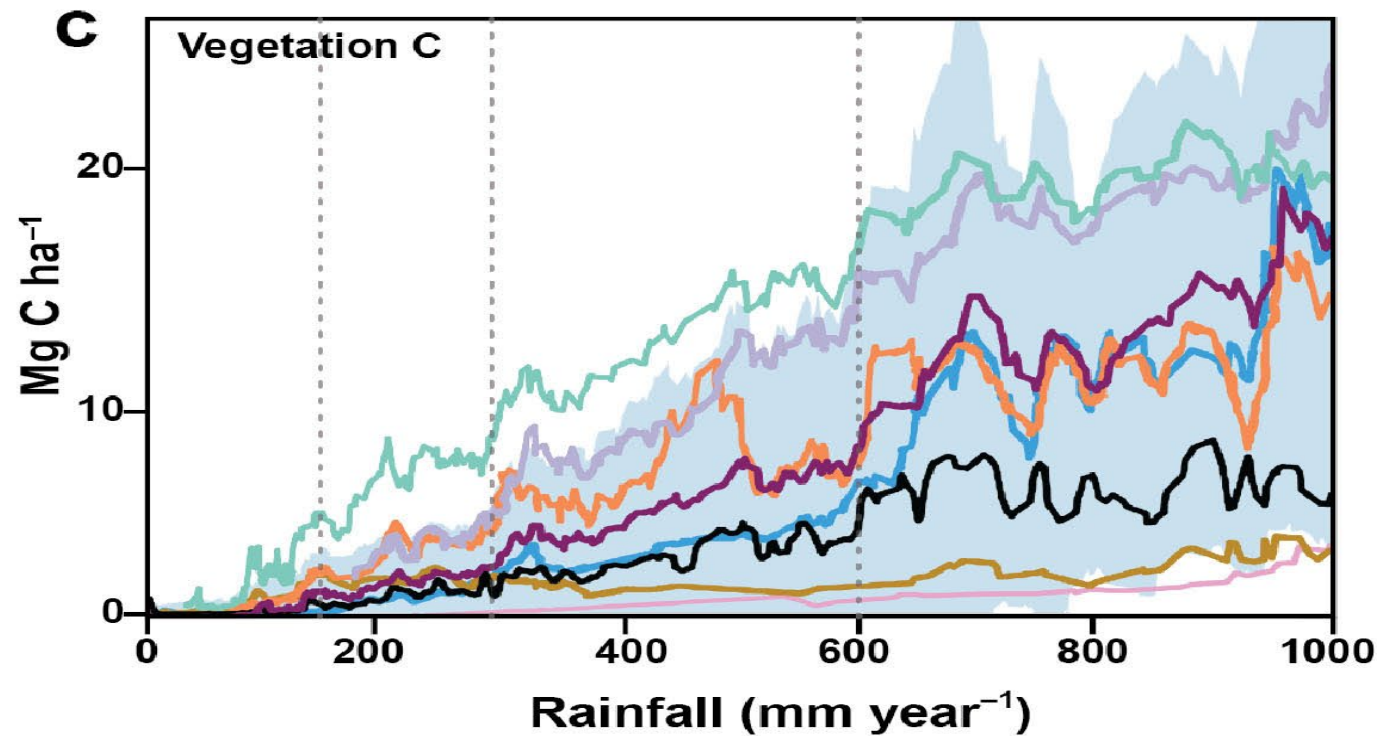
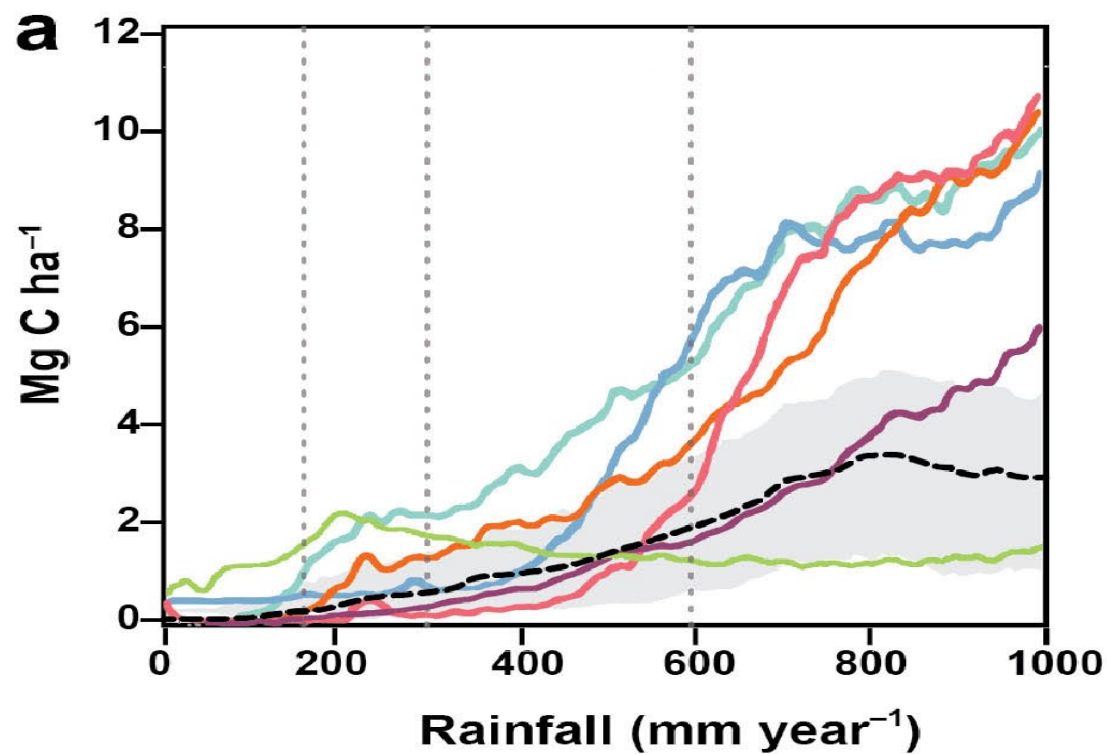
Preview source imagery

© Maxar 2016

zoom=14.31359&lng=8.18842&lat=17.93165



Carbon comparisons by rainfall for observations & models



Uncertainty analyses

neural net crown area error: 2.5 %

omission/commission error: 2.2%

total crown error: $\text{SQRT}(0.025^2 + 0.022^2) = \pm 3.3\%$

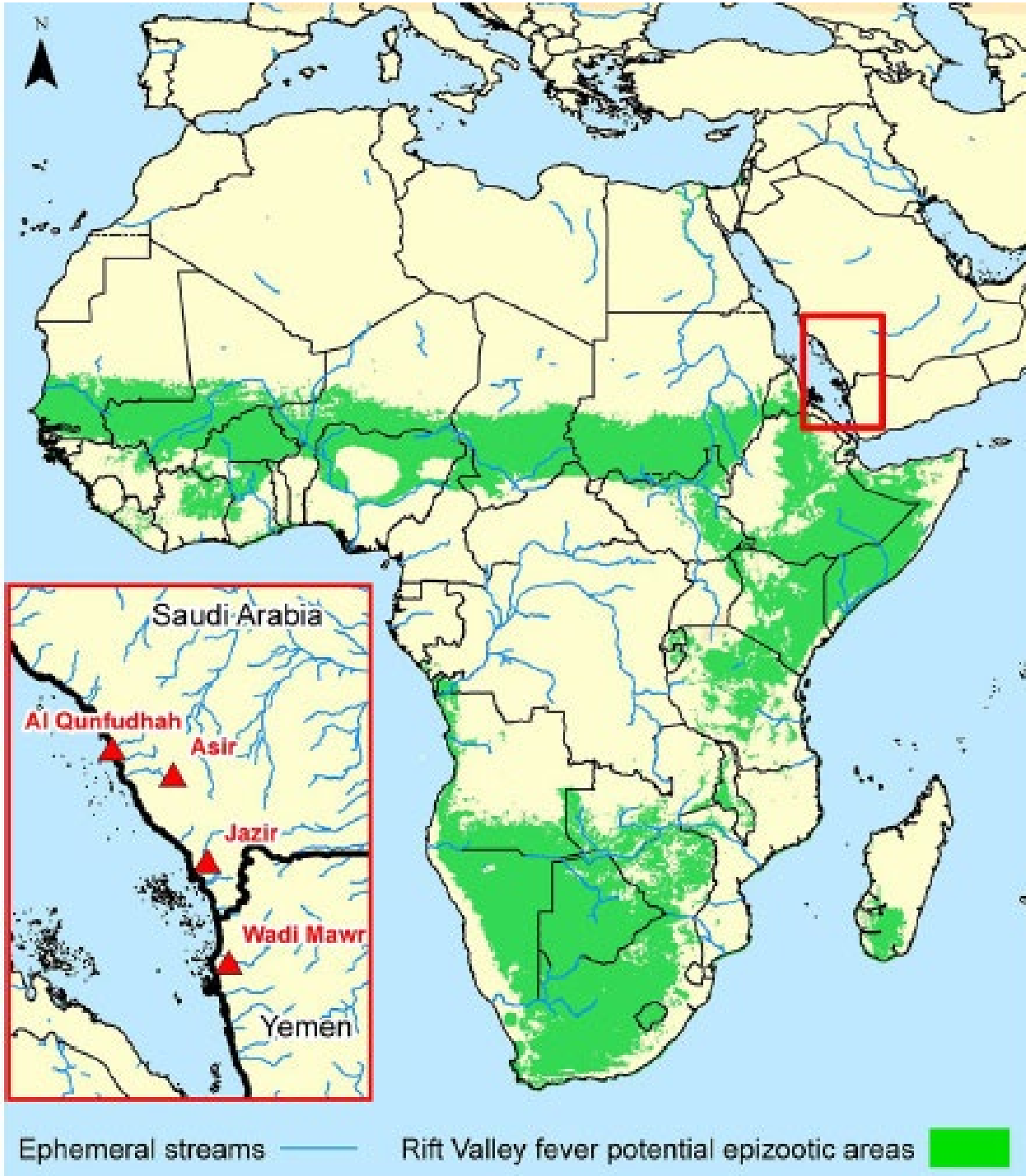
Allometry error: 19.5%

Total error: $\text{SQRT}(0.033^2 + 0.195^2) = \pm 20\%$

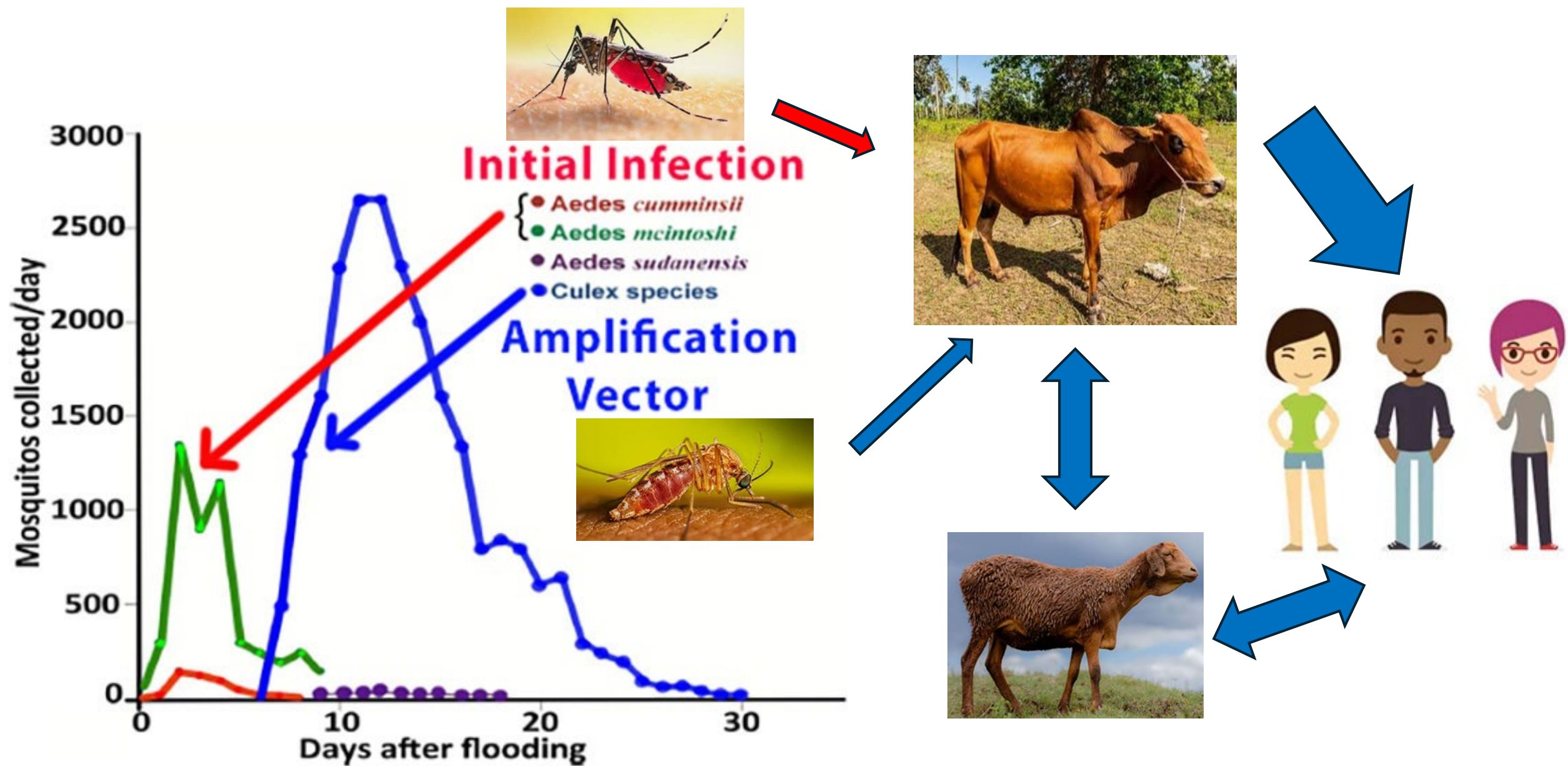
This assumes independence of allometry errors when allometry errors covary with crown area. Thus our uncertainty is conservative.

Rift Valley Fever: a RNA virus hemorrhagic fever

The First Rift Valley fever
outbreak in Arabia:
August 2000 to Sept. 2001
Natural Causes or
Bioterrorism?



Infected eggs hatch -> low transmission -> amplification -> Epidemic

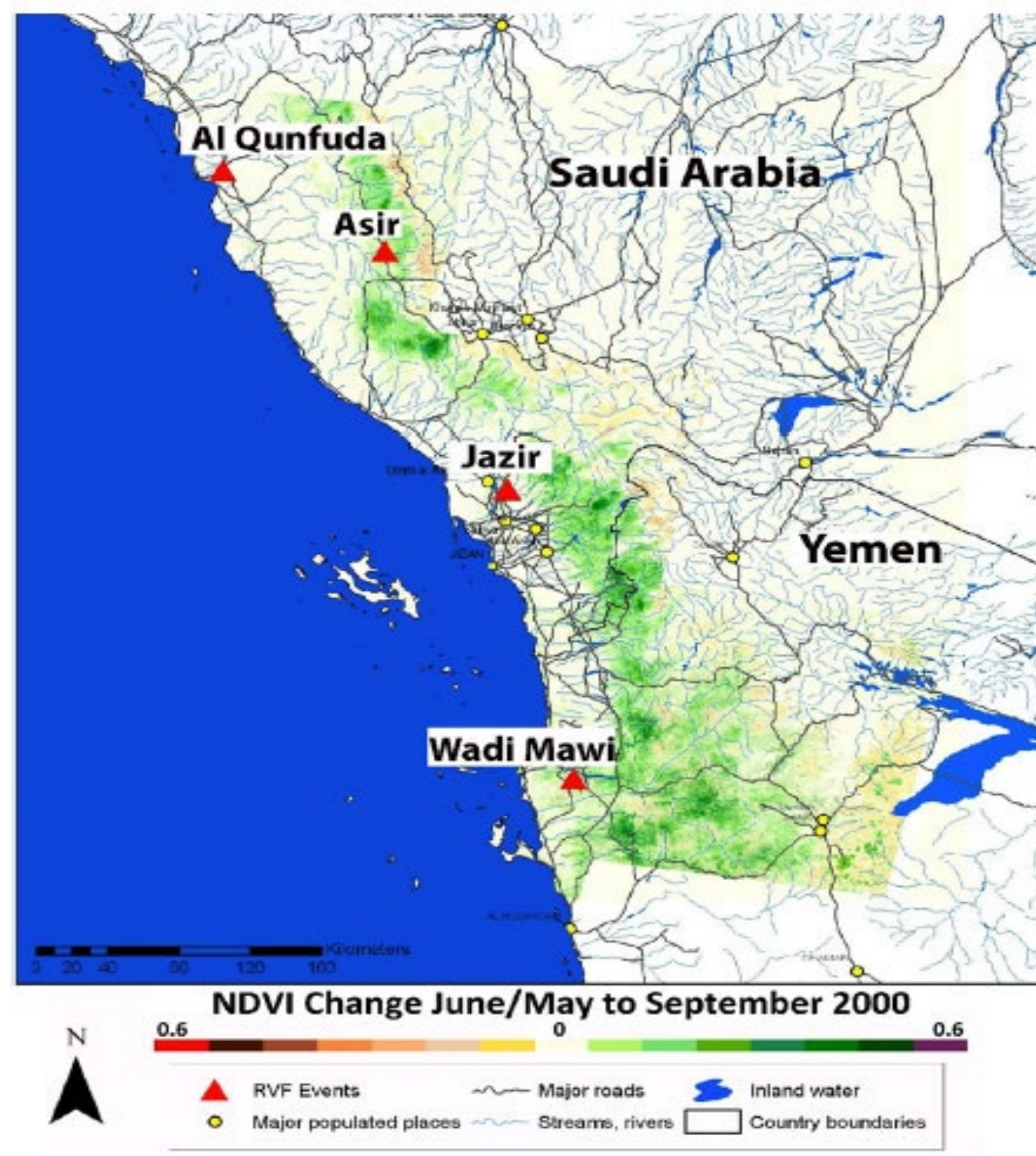


Saudi Arabia-Yemen

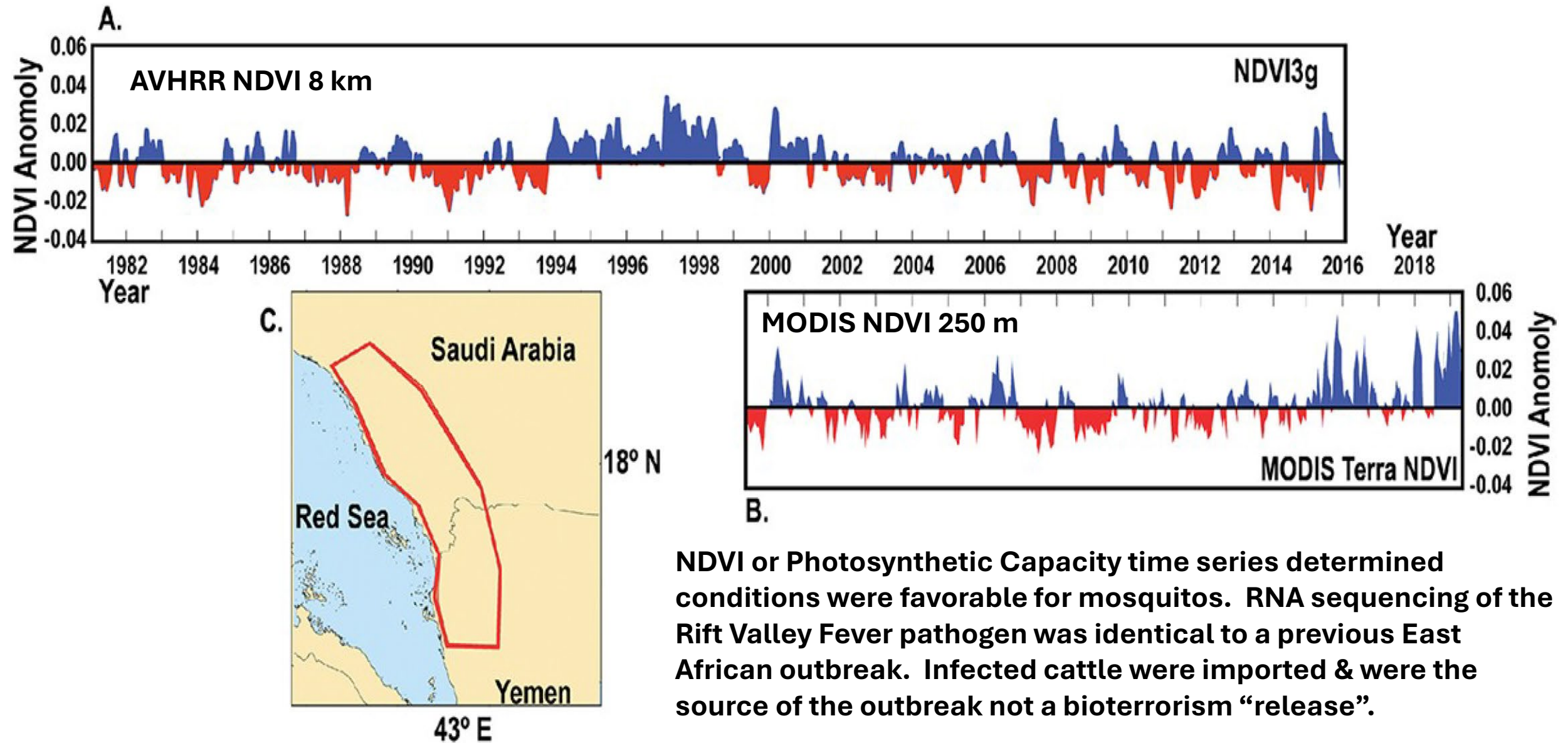
**Cities, Hospitals, & Areas
with more Rainfall**

**Epidemic started in
June/May 2000**

**Higher Rainfall higher
NDVI**



First Rift Valley Fever in Arabia 2000-2001



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The NDVI Club

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad (1)$$

$$EVI2 = 2.5 * \frac{NIR - RED}{1 + NIR + 2.4 * RED}$$

$$= NDVI * 2.5 * \frac{NIR + RED}{1 + NIR + 2.4 * RED} \quad (2)$$

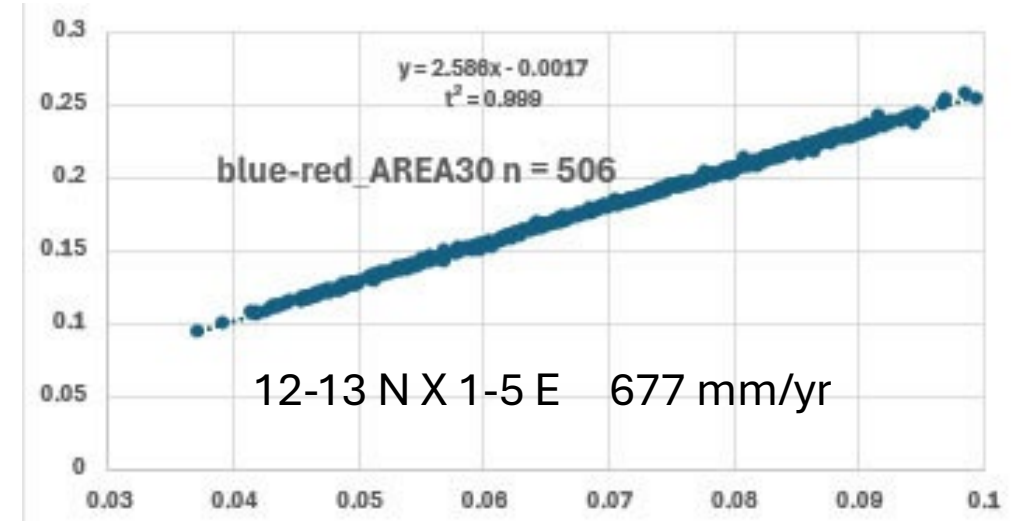
$$EVI3 = 2.5 * \frac{NIR - RED}{1 + NIR + 6 * RED - 7.5 * BLUE}$$

$$= NDVI * 2.5 * \frac{NIR + RED}{1 + NIR + 6 * RED - 7.5 * BLUE} \quad (3)$$

$$SAVI = 1.5 * \frac{NIR - RED}{0.5 + NIR + RED}$$

$$= NDVI * 1.5 * \frac{NIR + RED}{0.5 + NIR + RED} \quad (4)$$

$$NIR_v = (NDVI - 0.08) * NIR \quad (5)$$



$$kNDVI = \text{TanH}(NDVI^2) \quad (6)$$

