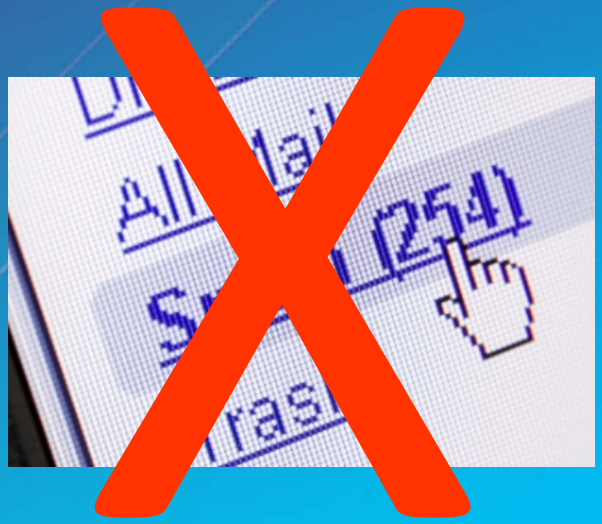
SPAM



Not your usual SPAM but the **S**patial **P**roduction **A**llocation **M**odel

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IFPRI, Washington DC

ESRI User Conference
San Diego, July 20-24, 2015

Spatial Production Allocation Model
- SPAM -

1. What is SPAM
2. Why SPAM
3. The SPAM process - visualization
4. Crop list and statistical data coverage
5. SPAM on the Web and sample results
6. Equations behind SPAM (dig deep)
7. Challenges, Issues & Validation
8. Users

1. What is SPAM

Drawing on a variety of inputs

- SPAM uses an entropy-based, data-fusion approach to
- “plausibly” assess cropping system distribution and performance at a
- “meso-gridded” scale: 5-minutes globally
- 30-seconds at country level (if data is available)
- with results centered around the year 2005

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1. What is SPAM

Major input layers for SPAM:

- National and subnational production statistics: area, yield (production) (average 2004-2006)
- Proportion of production systems (irrigated, rainfed H/L/S)
- Crop prices
- Rural population density
- Cropland extent
- Irrigation map
- Crop suitability
- Existing crop distribution maps/information

2. Why SPAM

- Account for *spatial heterogeneity* of agricultural production to better inform policies, interventions, sustainability issues, …
- Reveal *spatial patterns* of agricultural practices to maybe see untapped opportunities for intensification, diversification, infrastructure improvement, …
- Take advantage of increasingly available information and lower cost software and processing power to explore *spatial dimensions of agriculture*
- *Satellite imagery* generally available for cropland overall, roads, transport, but *not crop specific* (at least in most developing countries)

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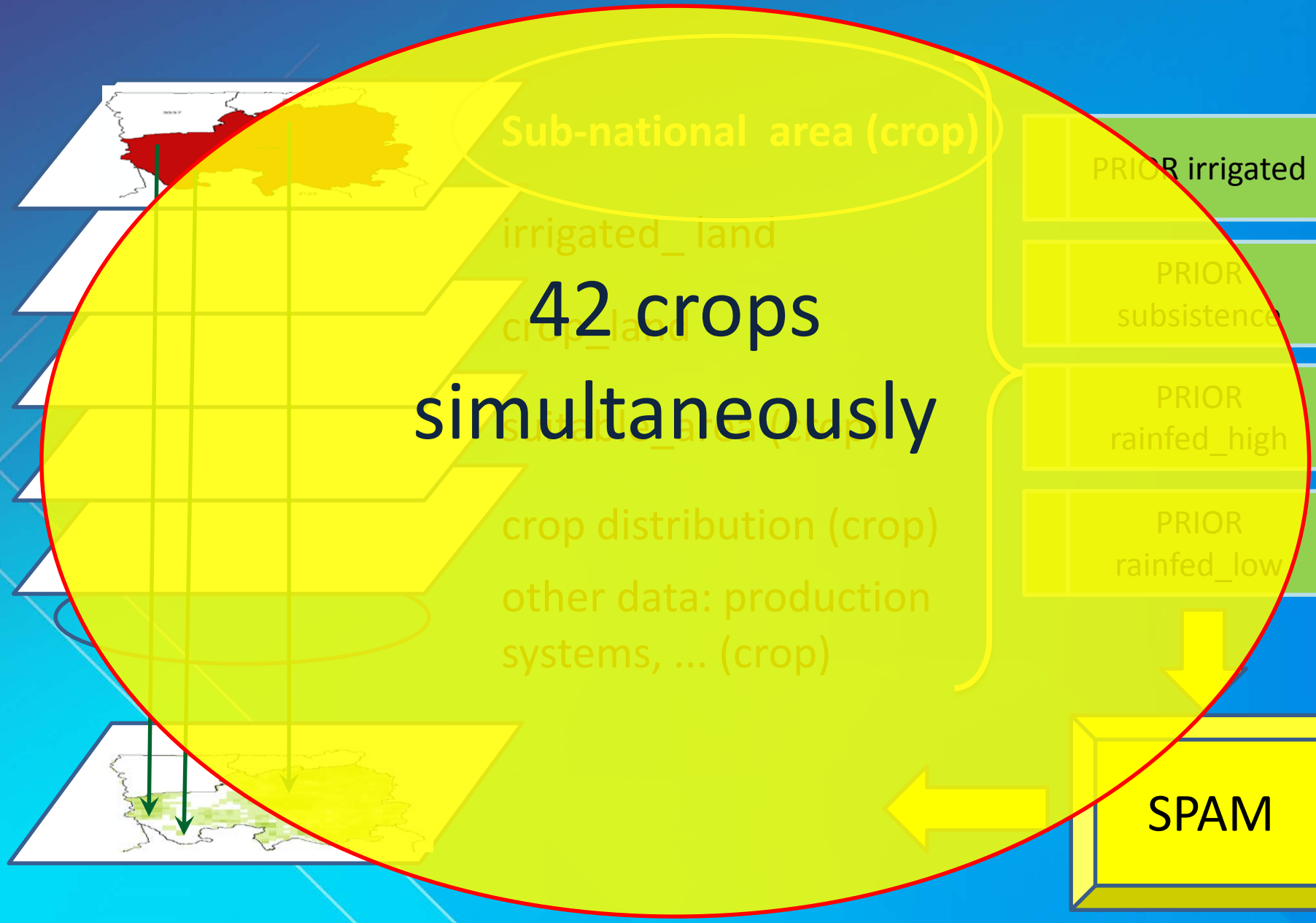
2. Why SPAM

- SPAM provides a *baseline* for
  - ✓ investment decisions in agriculture;
  - ✓ agricultural policies;
  - ✓ scenarios of new technologies and climate change;
- SPAM delivers parameters for *segmentation*;
- *Link* between macro and micro models;
- Food Security is of interest to donors, practitioners, policymakers – need knowledge of *where* to target interventions in sub-national/sub-regional areas;
- Agricultural Statistics are generally available, but resolution is mostly *too coarse* for detailed planning.

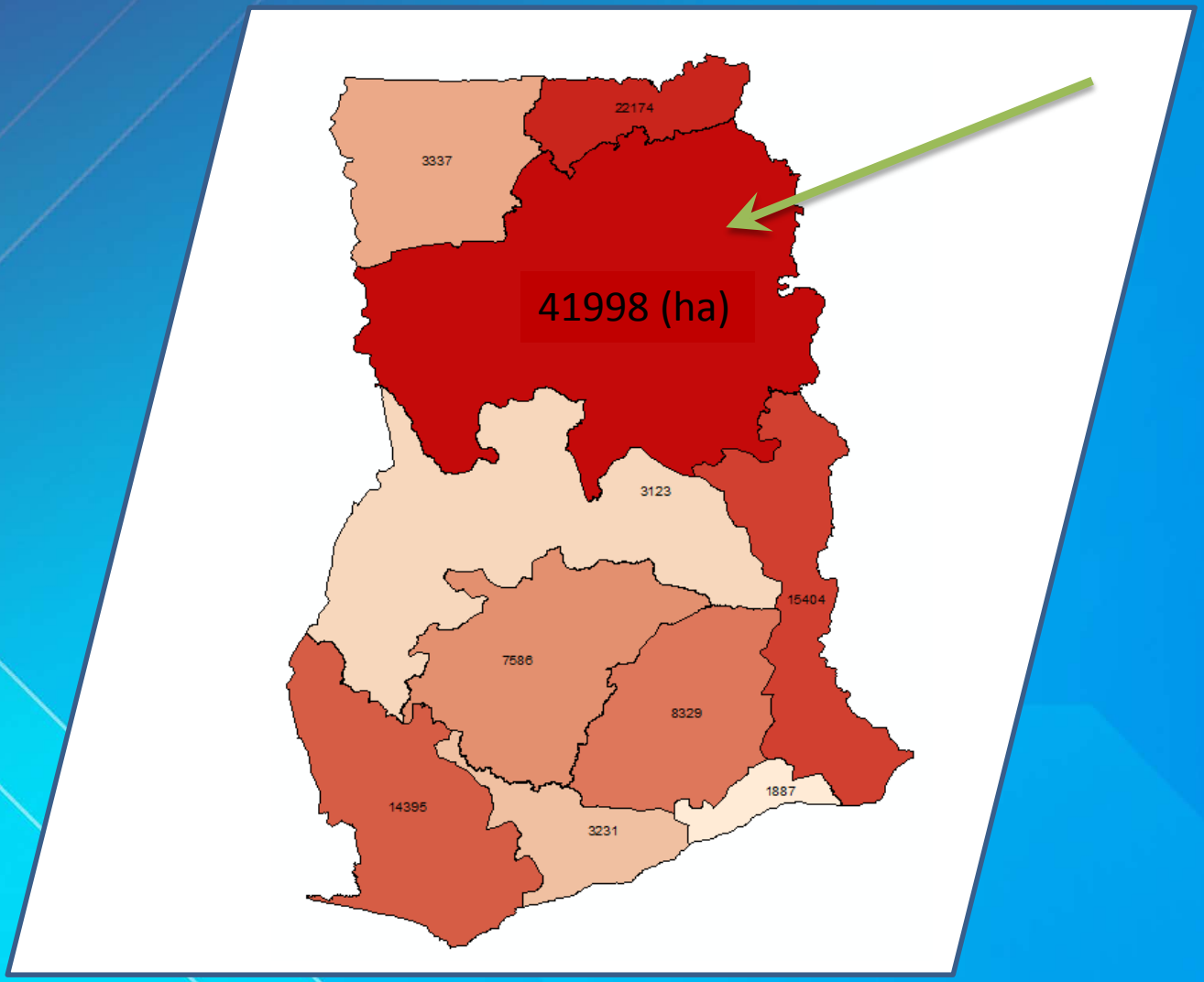
3. The SPAM process



42 crops simultaneously

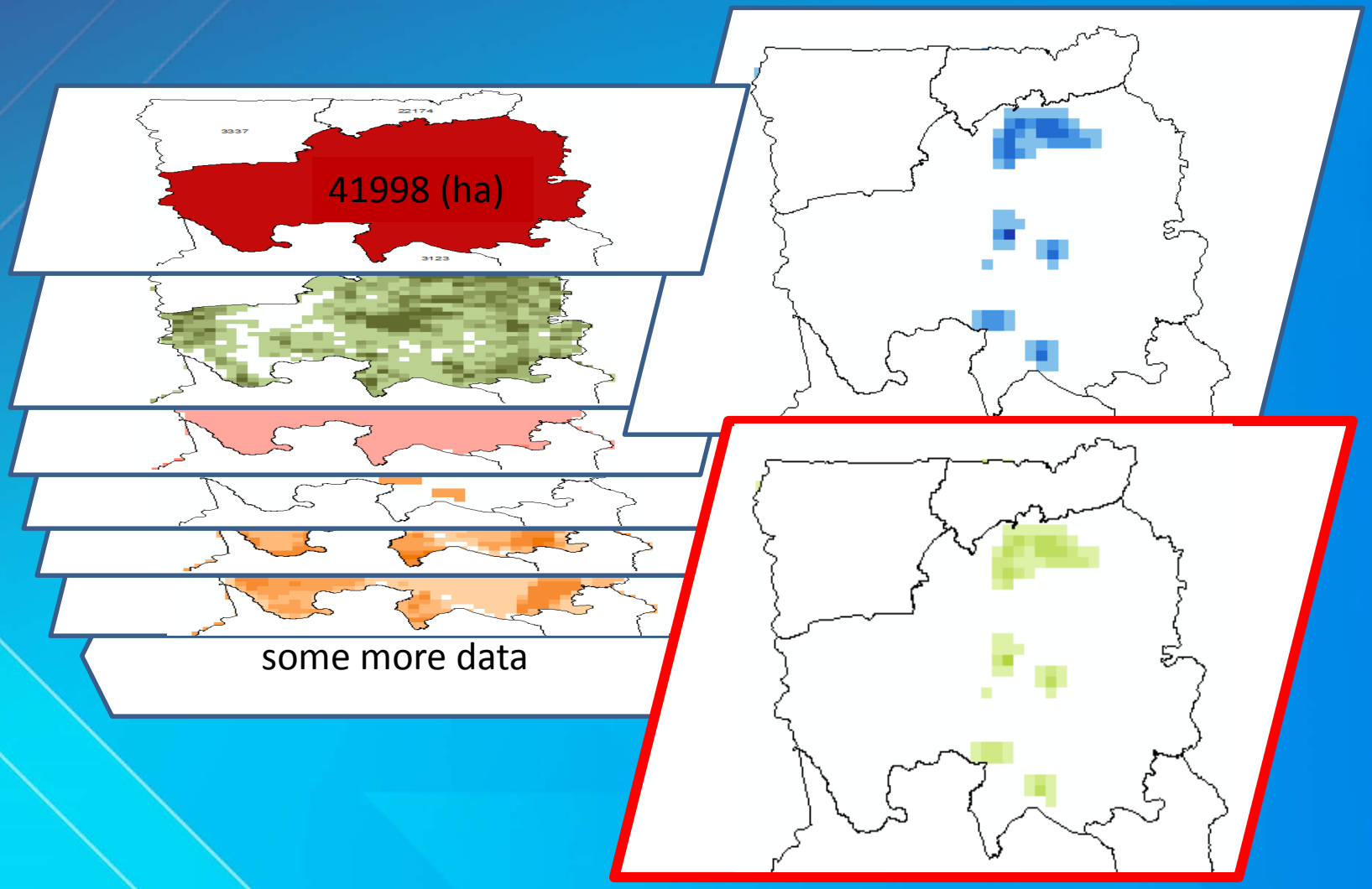
3. Visualization of Downscaling

example: Ghana harvested area rice per region



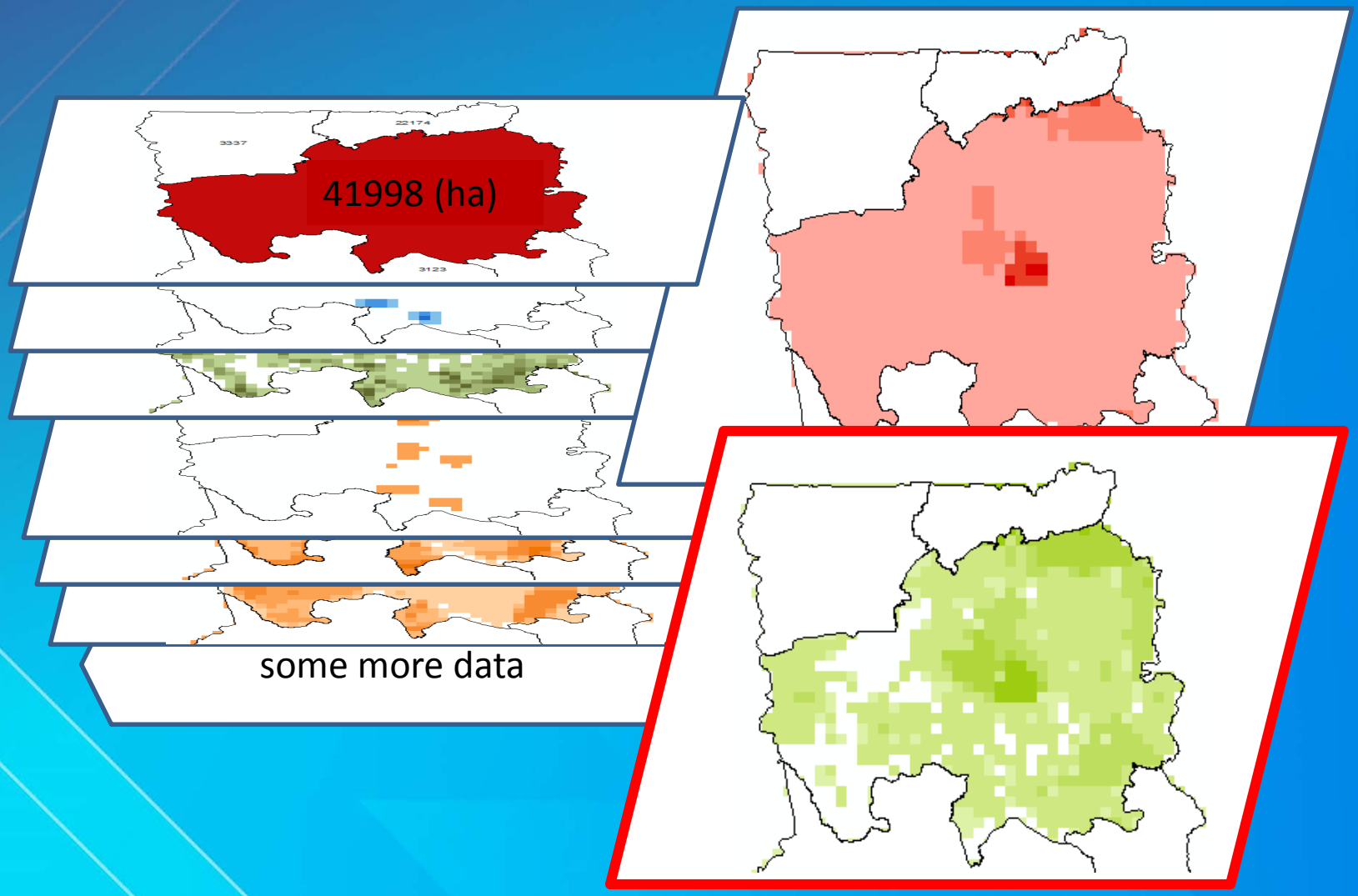
3. Visualization of Downscaling ... continued

result 1: Northern Region – allocated irrigated area rice



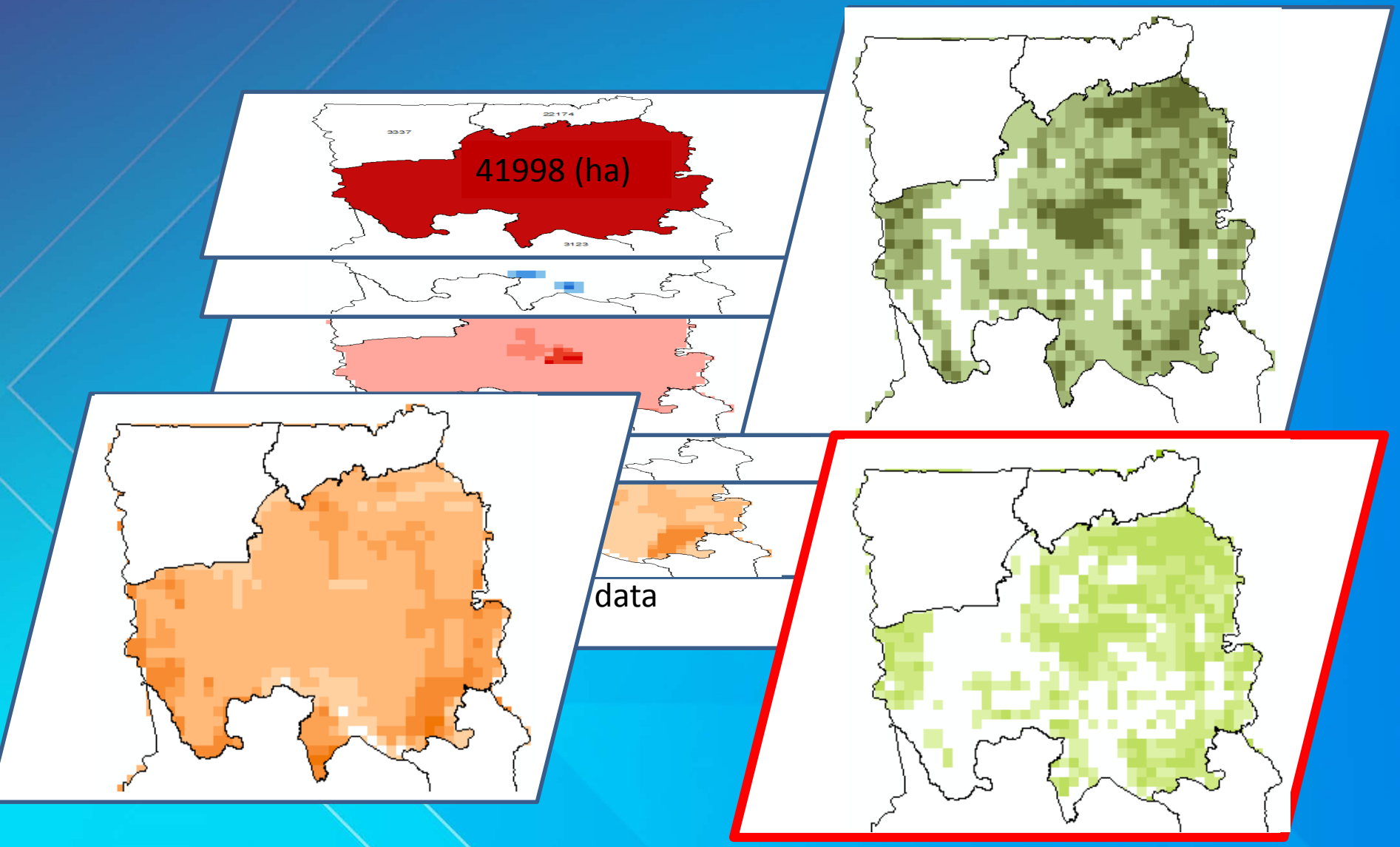
3. Visualization of Downscaling ... continued

result 4: Northern Region – allocated subsistence area rice



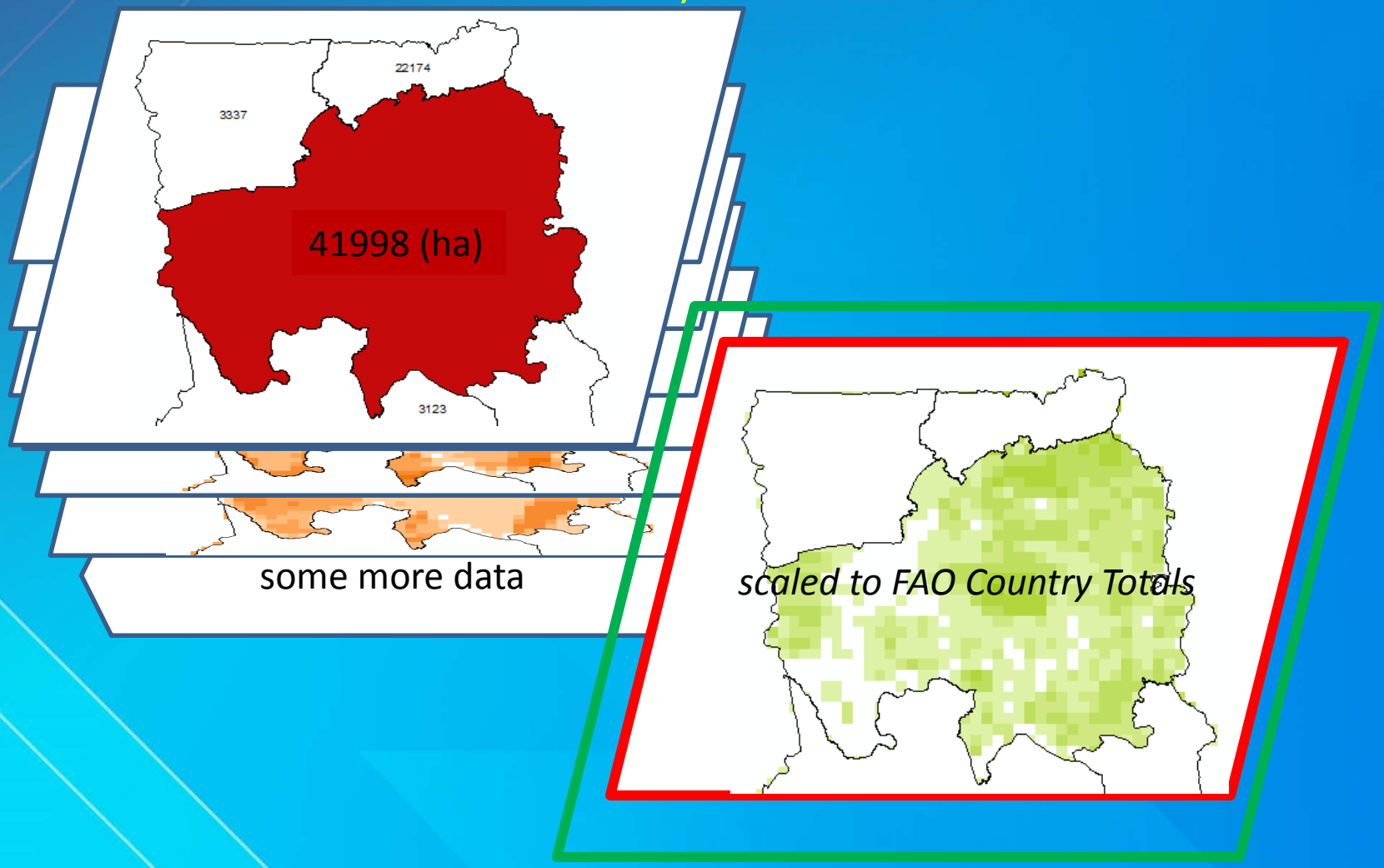
3. Visualization of Downscaling ... continued

result 2: Northern Region – allocated rainfed high area rice



3. Visualization of Downscaling

result 5: Northern Region – allocated rice area total (irrigated+ rainfed H + L+ subsistence)



4. SPAM2005 Crop List and ...

cereals

1 wheat
2 rice
3 maize
4 barley
5 pearl millet
6 finger/small millets
7 sorghum
8 other cereals

roots & tubers

9 potato
10 sweet potato
11 yam
12 cassava
13 other roots & tub.

pulses

14 dry beans
15 chickpea
16 cowpea
17 pigeon pea
18 lentils
19 other pulses

oil crops

20 soybeans
21 groundnuts
22 coconuts
23 oil palm
24 sunflower
25 rapeseed
26 sesame seed
27 other oil crops

sugar c.

28 sugarcane
29 sugar beet

fibres

30 cotton
31 other fibres

stimulants

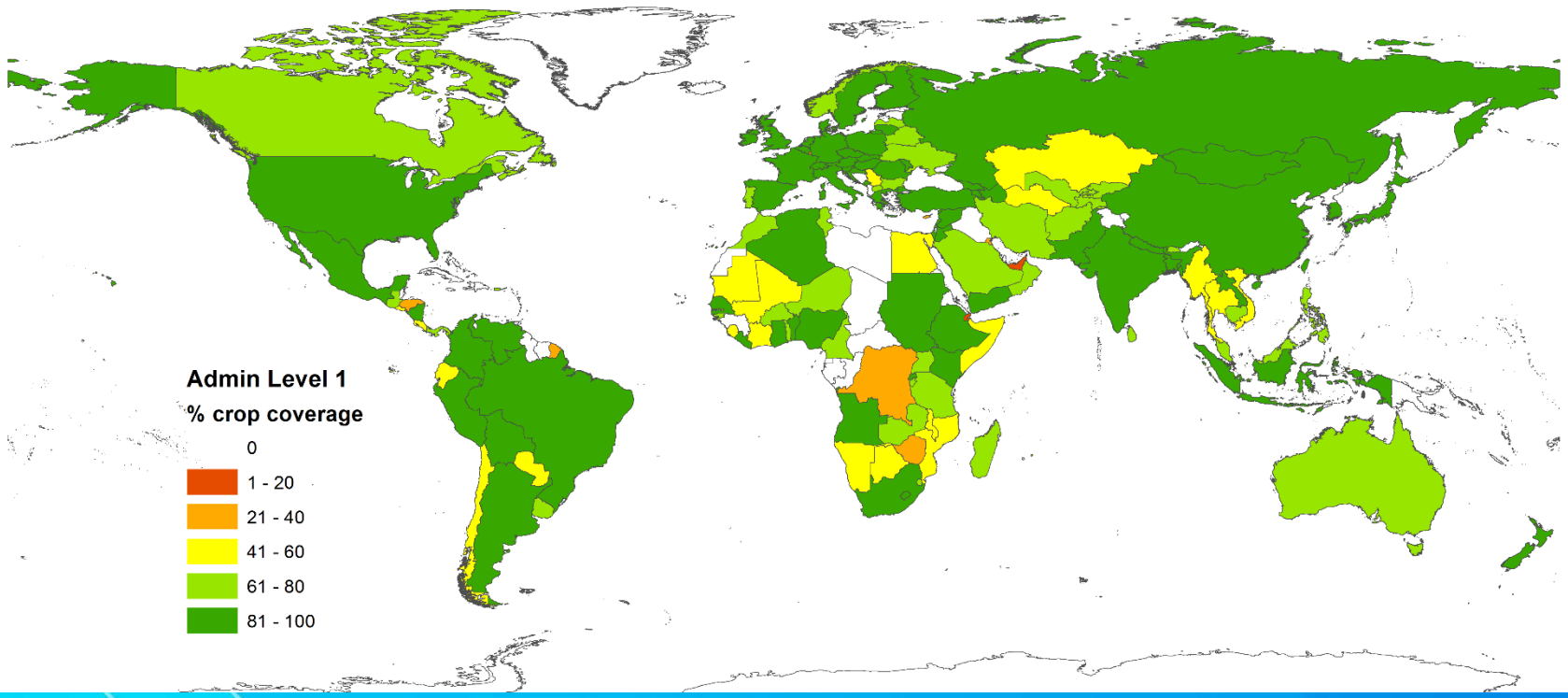
32 arabica coffee
33 robusta coffee
34 cocoa
35 tea
36 tobacco

fruits & veg

37 banana
38 plantains
39 tropical fruit
40 temperate fruit
41 vegetables
42 all the rest

…. continue

4. and … Statistical Area Coverage – subnational 1



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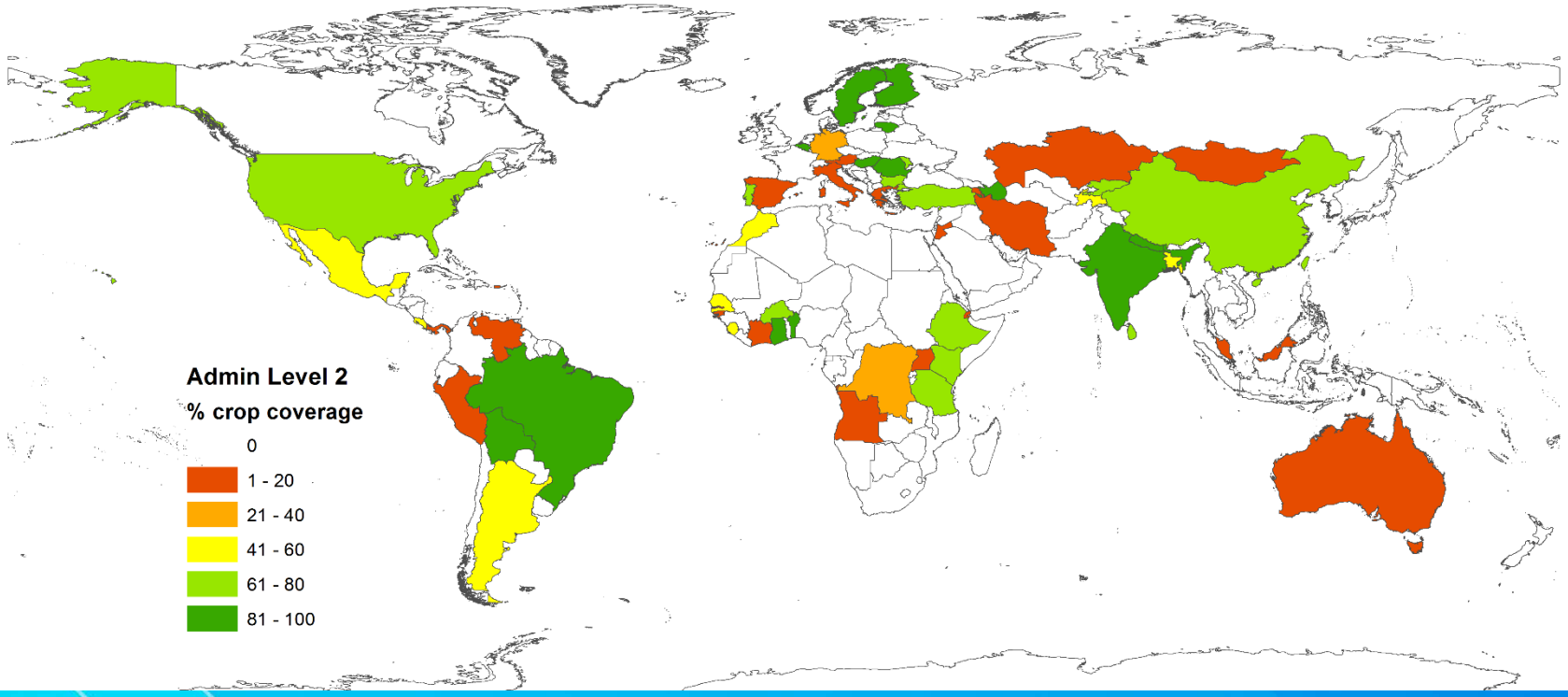
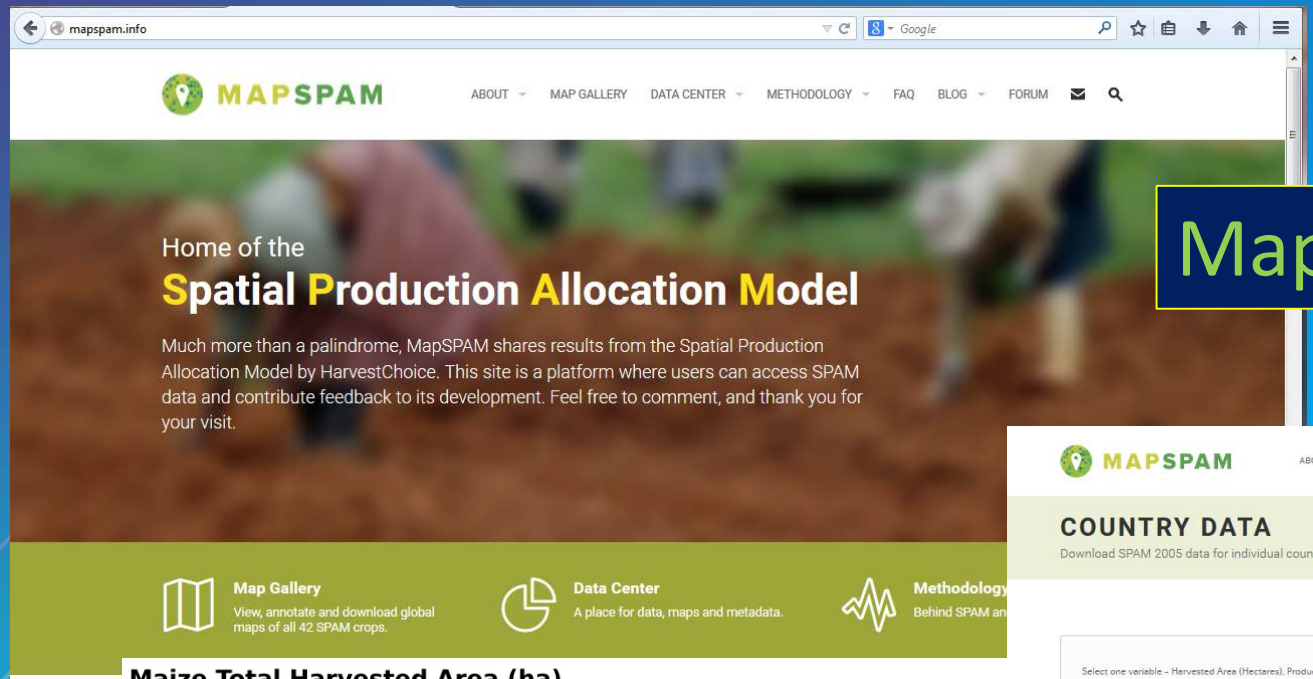
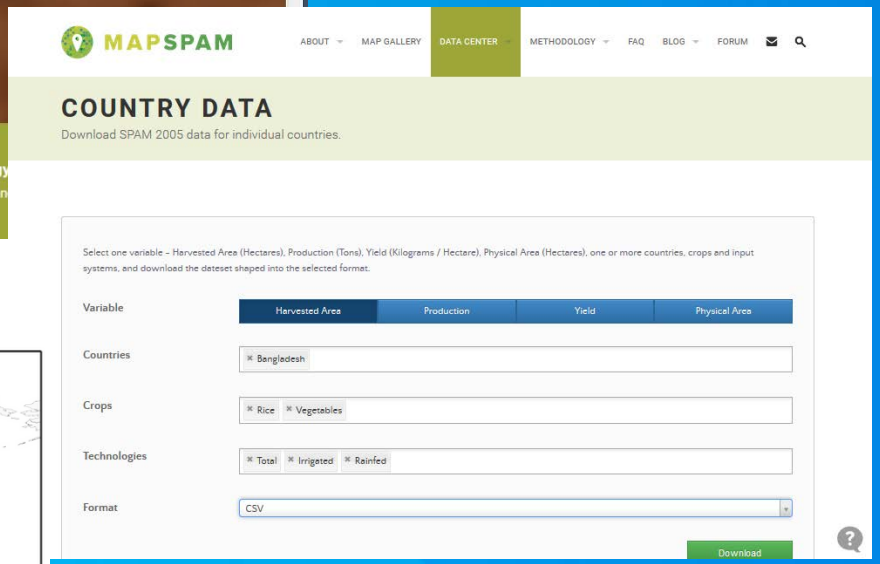
4. and … Statistical Area Coverage – subnational 2

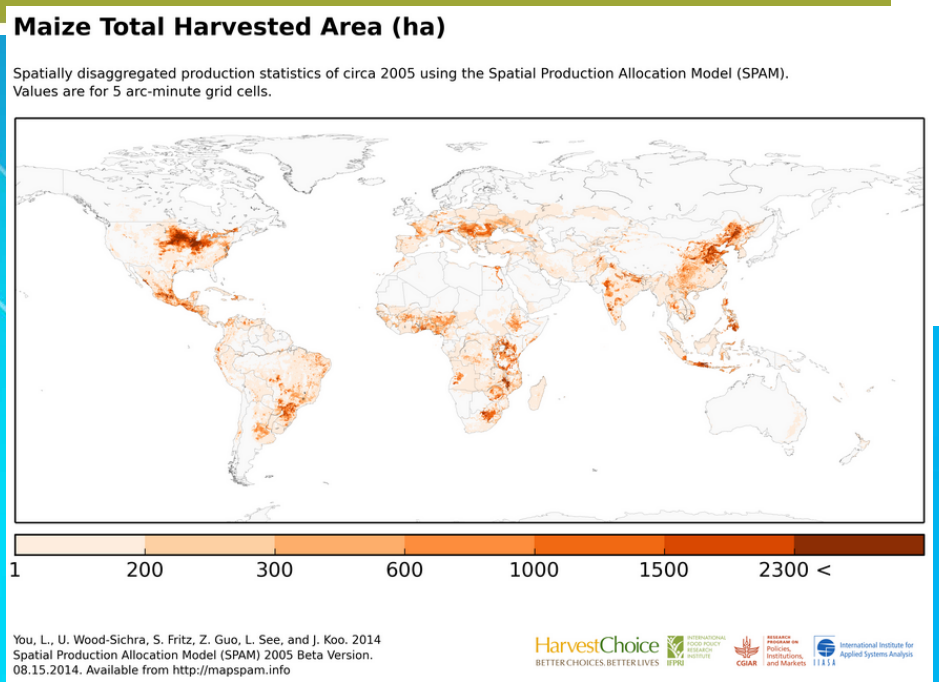


5. SPAM on the Web …



MapSpam.info





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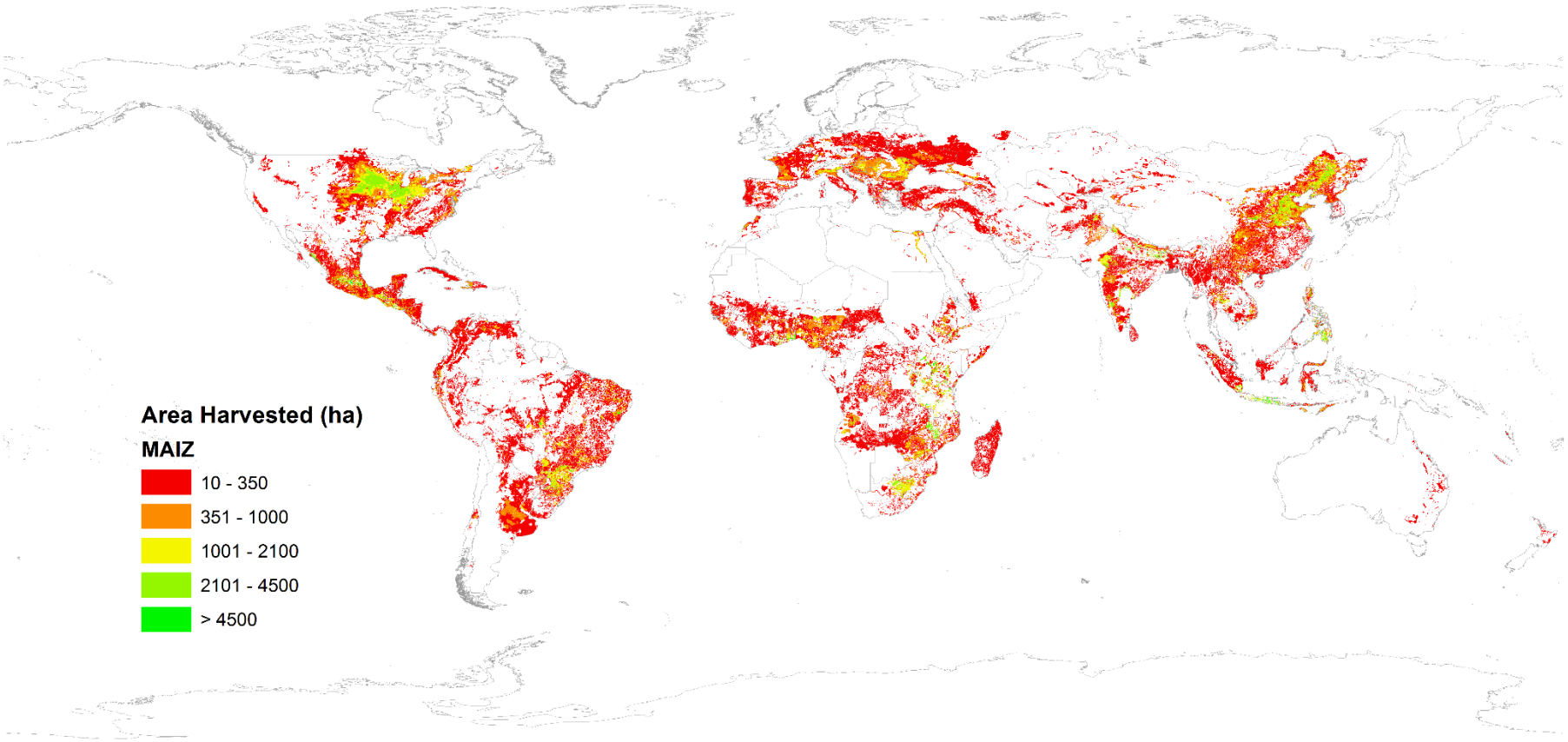
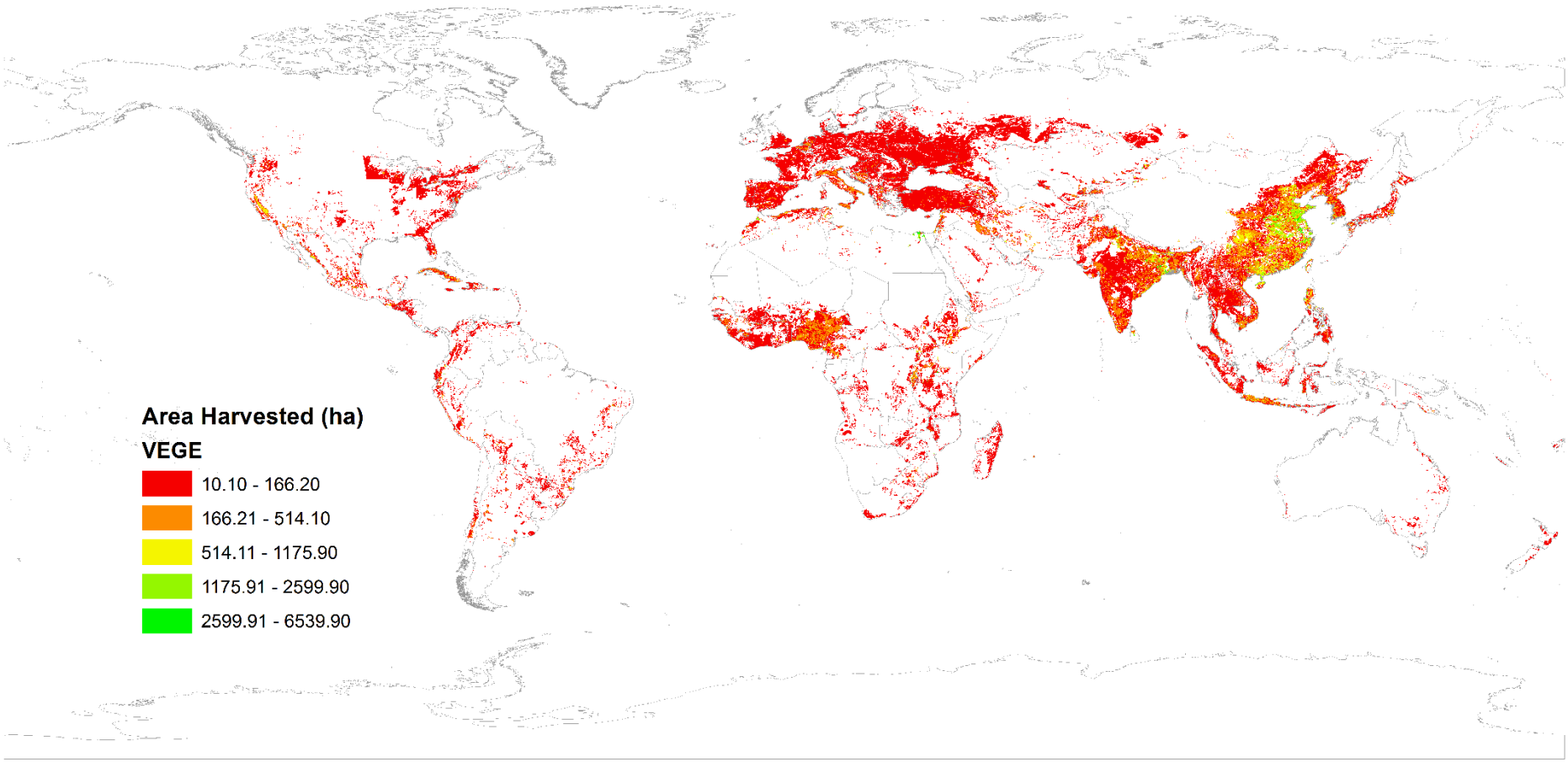
5. … Sample results … continued

Crop Distribution – Maize 2005



5. … Sample results

Crop Distribution – Vegetables 2005



6. Equations behind SPAM

Minimize difference between prior and allocated area share for all pixels, crops and production systems in a cross entropy equation

subject to constraints (limits) dictated by existing

- crop area statistics
- cropland area
- irrigated area
- suitable area

and solve in GAMS (General Algebraic Modeling System)

But first calculate the priors for each pixel, crop and production system as a function of potential revenue, irrigated area and agricultural land,

where potential revenue is a function of percentage of crop area, crop price, rural population density and potential yield.

7. Challenges & …

- Different sources -> ‘contradictory’ information
- Raster data not at same scale and similar time period
- Complete sub-national data, at least level1, better level2
- Conform national crops -> FAO/SPAM crops
- Consistencies between layers – constraints met

  cropland >= stats, irr >= crop_irr, suit_land >= cropland >= stats
- Cropping intensities & production systems shares not consistent with data and model
- Produce more recent results (SPAM2010 in the making, SPAM2014?)

…. continue

7. … Issues & …

- Unreliable, often carelessly processed/validated statistics
- Statistics do not match admin. area shape files
- Unreliable cropland extent/area intensity estimates
- Lack of data on cropping patterns and *systems* (e.g. cropping intensity – converting harvested to physical land footprint)
- Unsatisfactory data on location-specific biophysical conditions (e.g., soils) and economic behaviour (e.g., prices and risks)
- Lack of established validation data, methods, and protocols
- Unspecified reliability of results
- Consistency of approach has potential tradeoff with reliability (e.g. patchwork of best national data vs consistent regional data)

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7. … and Validation

Lack of established validation data, methods, and protocols …

- Validation process by other CGIAR centers (e.g. IRRI, CIAT, ILRI, CIP, CYMMT). Each focuses on their mandate crops;
- Crop map view ‘parties’ attended by local experts and agronomists;
- Crowd-sourcing on a dedicated website (MapSPAM.info).

8. Users and Applications

- CGIAR centers such as IRRI, CYMMT, CIP, CIAT, ILRI;
- FAO, World Bank, and universities;
- HarvestChoice, Agricultural Water Management, AgFutures; The Sustainability Consortium;
- Geoglam (USDA/U. Maryland), USAID FtF;
- Widely applied in country strategy work within IFPRI, regional priority settings such as ASARECA, CORAF, and in ReSAKSS, CAADP, AGRA.

11. Projects and Publications

- AGRODEP Library (http://www.agrodep.org/fr/node/1794)
- FutureAg: The information resource for the future of sustainable agriculture – (http://futureag.info/innovations/spam-the-spatial-production-allocation-model-mapping-crops-to-improve-food-security)
- In East African Agriculture and Climate Change (https://books.google.com/books?id=cWB0AgAAQBAJ)
- Trends and Spatial Patterns in Agricultural Productivity (http://www.resakss.org/sites/default/files/pdfs/trends-and-spatial-patterns-in-agricultural-produc-53115.pdf)
- Centre for Climate Change Economics and Policy (http://www.lse.ac.uk/CATS/Publications/Publications%20PDFs/Working-Paper-JoshE2013.pdf)
- Toward Climate-Resilient Development in Nigeria (https://books.google.com/books?id=8jpSSB7n1X4C)
- ESRI (http://www.arcgis.com/home/item.html?id=db028cfc90a342d7b2f16ac7a9ad779b)
- GEOGLAM (http://www.earthobservations.org/documents/geoglam/GEOGLAM_Implementation_Plan.pdf)
- GEOSHARE (http://www.ilsi.org/ResearchFoundation/CIMSANS/Pages/GEOSHARE-Workshop.aspx)
- Global Futures (http://www.pim.cgiar.org/2014/03/26/global-futures-and-strategic-foresight-program-second-2014-impact-training-in-cali)
- The Sustainability Consortium: Arizona State U, U of Arkansas, Wageningen, Nanjing U (http://www.sustainabilityconsortium.org/commodity-mapping)
- FARMD Forum for Agricultural Risk Management in Development (https://www.agriskmanagementforum.org/content/additional-resources-geospatial-data-agriculture-risk-management)
- Irrigation Potential of African Infrastructure (http://www.infrastructureafrica.org/sectors/irrigation)
- USAID Feed the Future Innovation Lab for Small-scale Irrigation (http://borlaug.tamu.edu/projects-by-region/sub-saharan-africa/feed-the-future-innovation-lab-for-small-scale-irrigation)
- USAID Feed the Future Innovation Lab for Sustainable Intensification (http://gfc.ucdavis.edu/profiles)

- You, L., S. Wood, U. Wood-Sichra, W. Wu. 2014. Generating global crop distribution maps: From census to grid. Agricultural Systems 127 (2014) 53–60
- Anderson, W, L.You, S. Wood, U. Wood-Sichra, W. Wu. 2015. An analysis of methodological and spatial differences in global cropping systems models and maps. Global Ecology and Biogeography Volume 24, Issue 2, Page 180-191

Thank you !