Measuring economic well-being from space

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* With thanks to SustainLab collaborators David Lobell, Stefano Ermon, Neal Jean, Tony Duan, and others

UN ITU AI for Good | Geneva, May 16 2018

Why use satellites for poverty prediction?

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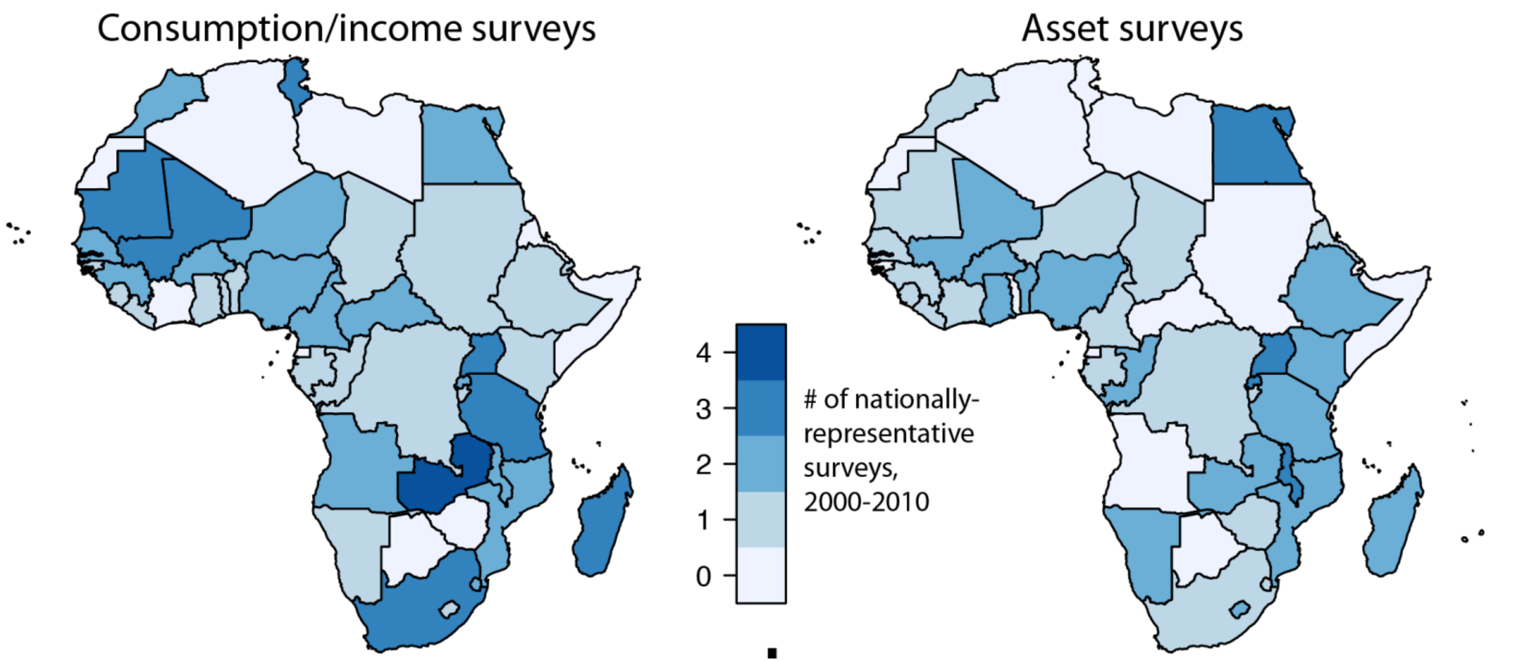

Jean, Burke et al 2016

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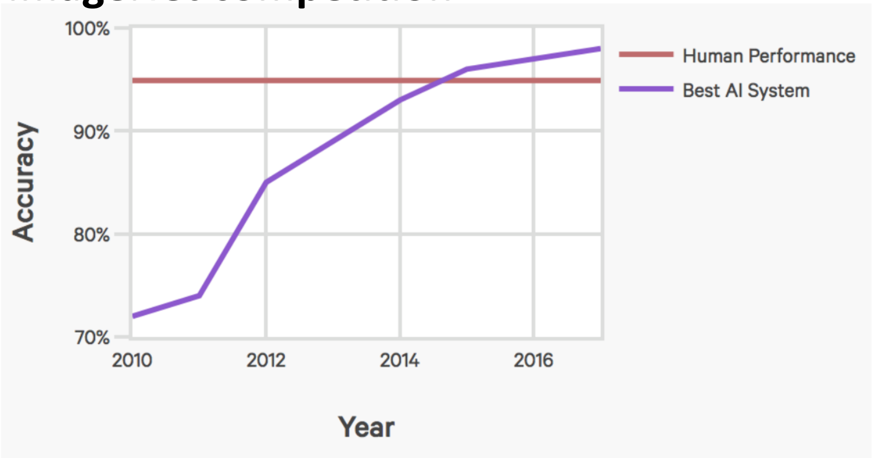
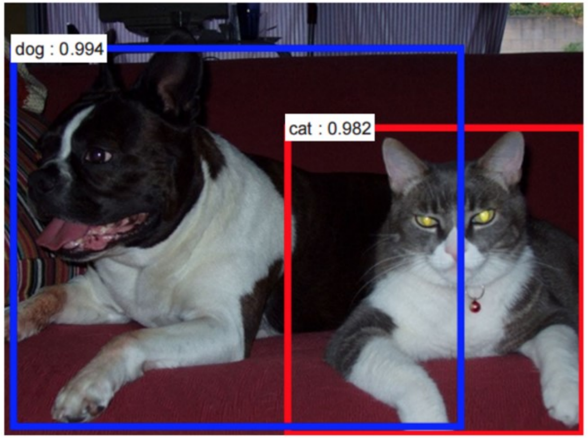
ImageNet competition





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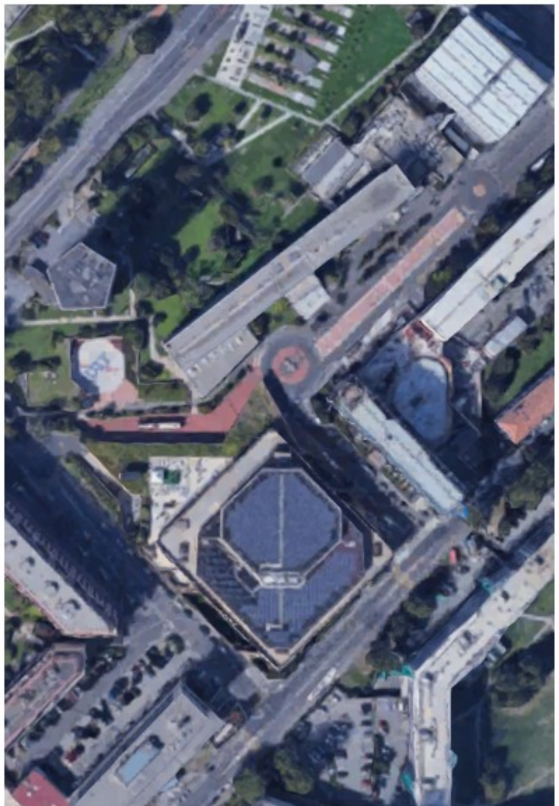
1. Ground data are very infrequent
2. Humans can distinguish well-being in imagery
3. Computers are getting really good at image recognition tasks
4. **There is a lot of new imagery to play with**

New sources of satellite data



Sensor	Wavelengths	Spatial Resolution	Revisit frequency	Launch year
Sentinel-1	C-band radar	20m	6 day	2014, 2016
Sentinel-2	Optical	10m	5 day	2015, 2017
Skysat	Optical	1m	~weekly	2013-present
Planet	Optical	3-5m	~daily	2014-present

Some results: **poverty in Africa**

Outcome: village-level consumption (LSMS) **Input**: ~3m RGB **Model**: CNN/ transfer learning

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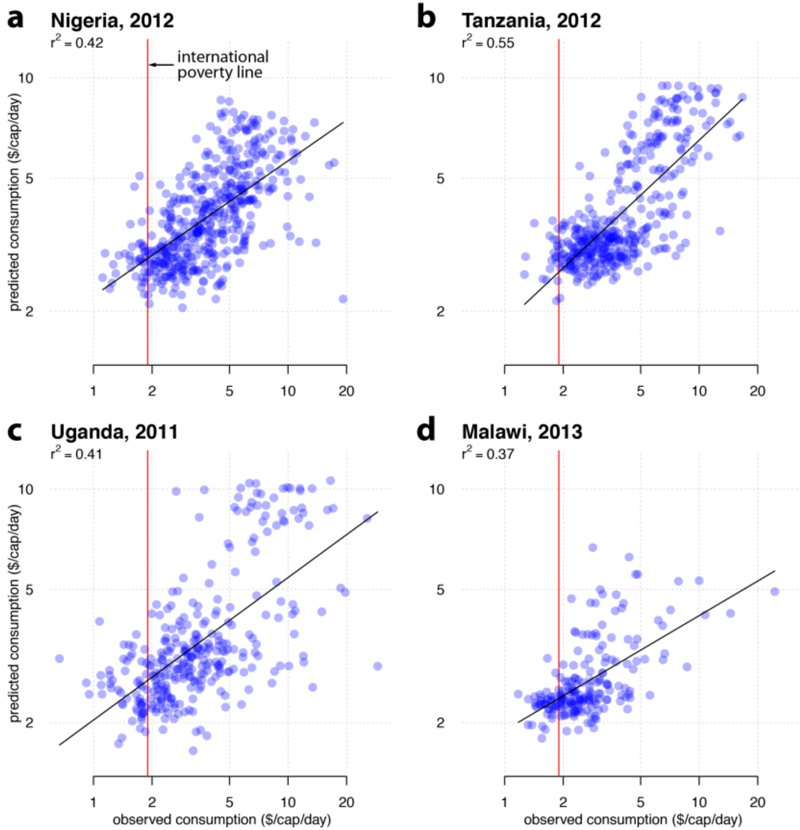
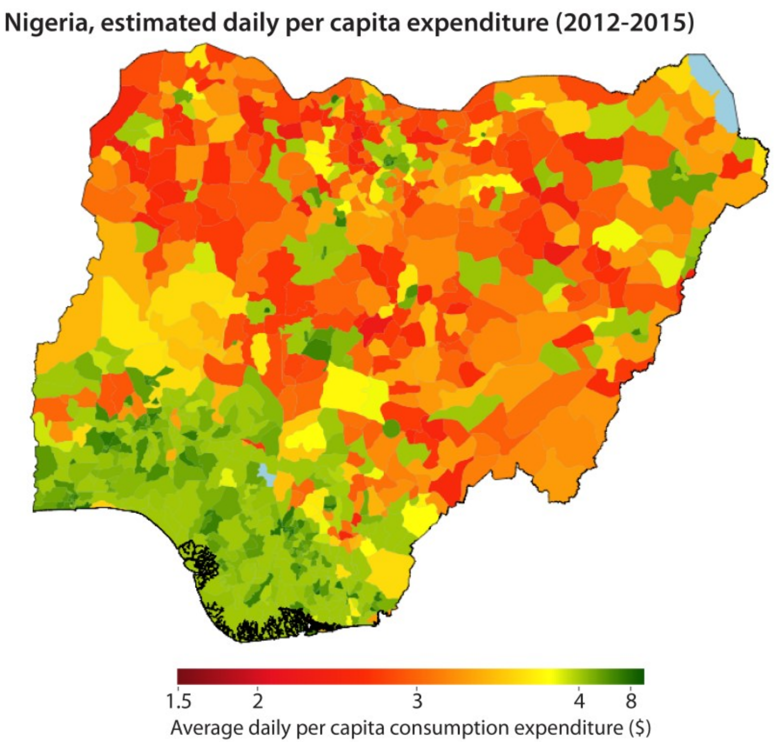


Jean, Burke et al *Science,* 2016



Data from: N. Jean, M. Burke, M. Xie, W.M. Davis, D. Lobell, S. Ermon., "Combining satellite imagery and machine learning to predict poverty". *Science*, 2016
For more info, visit **sustain.stanford.edu**

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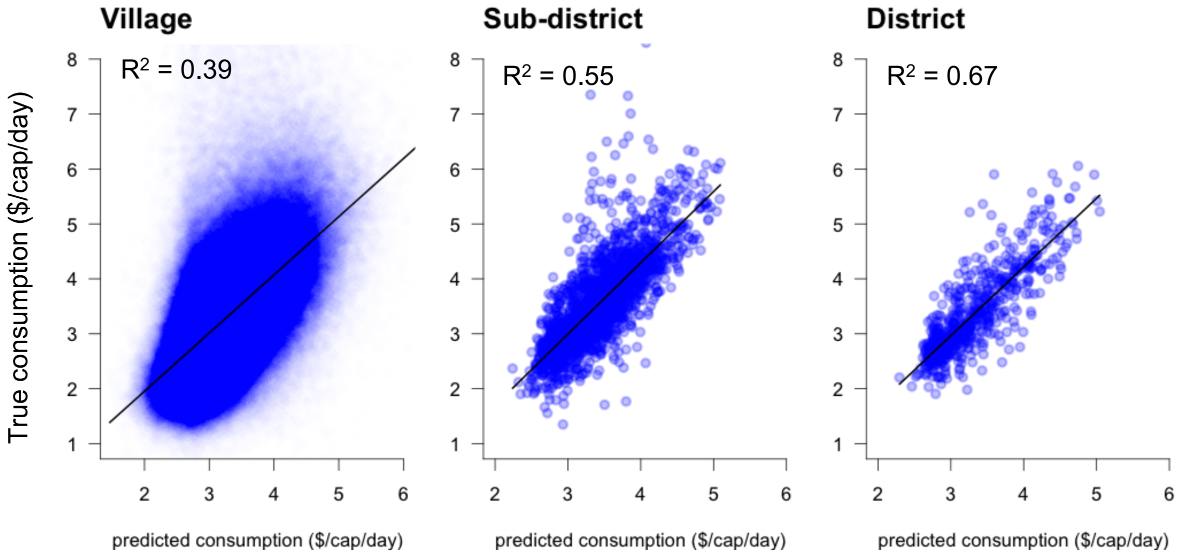

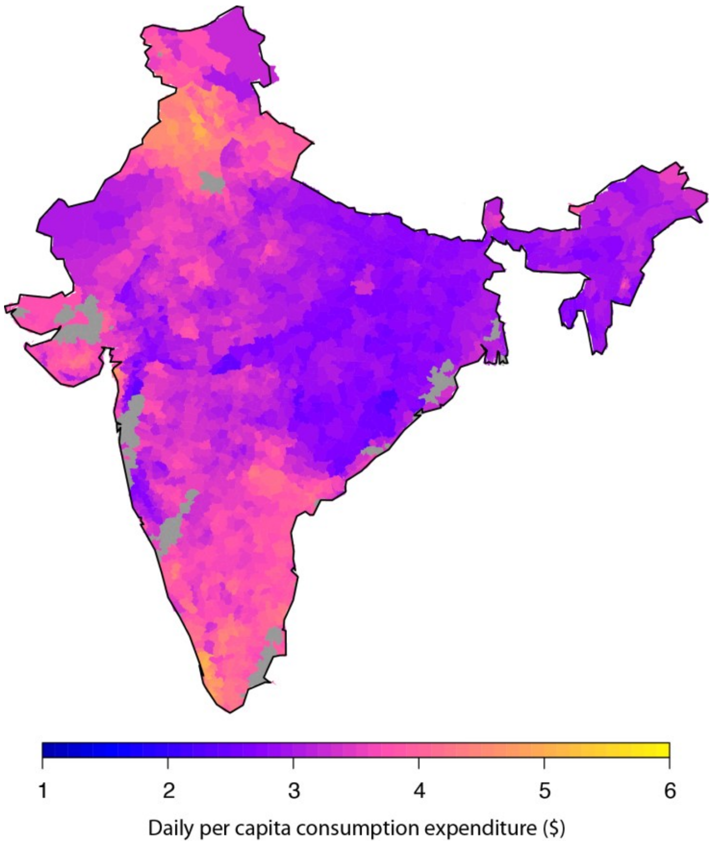

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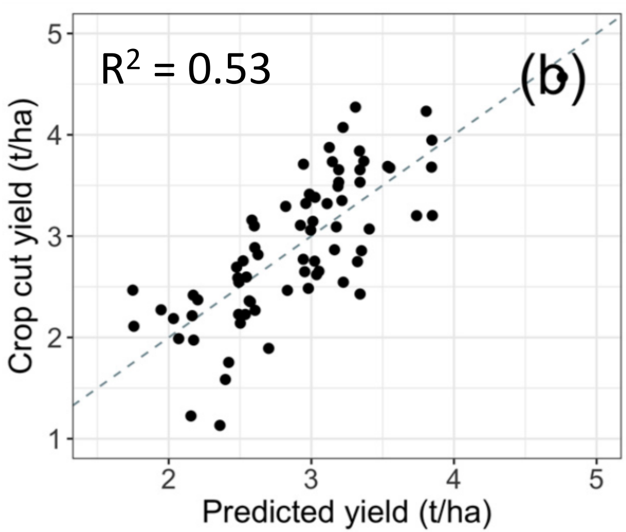

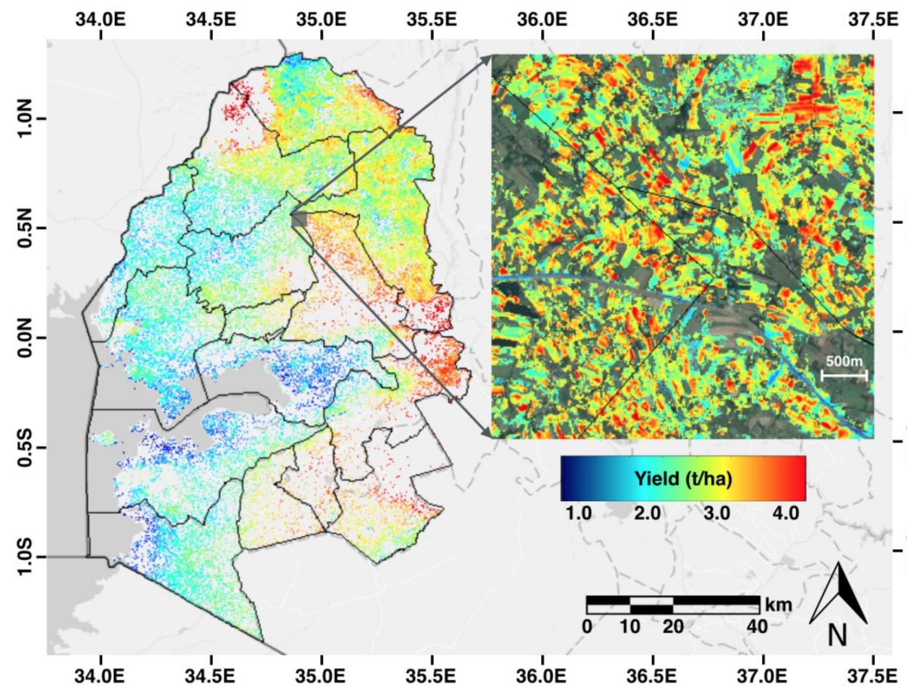

Jin et al. (2017), *Remote Sensing*

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Outcome: Village-level electricity (Afrobar.) **Input**: 30m Landsat **Model**: CNN

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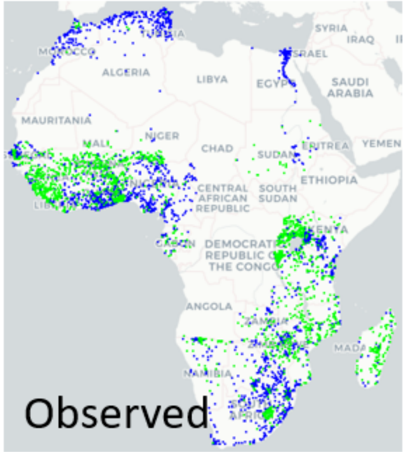

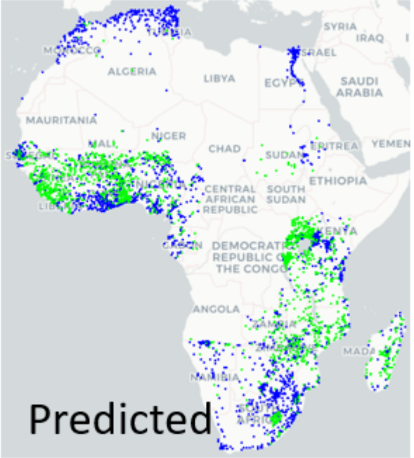

label	balance	nightlights	OSM	oracle	Landsat 8
Electricity	0.66	0.79	0.73	0.89	**0.85**
Pipedwater	0.60	0.73	0.73	0.89	**0.86**
Sewerage	0.35	0.75	**0.77**	0.89	0.74
Road	0.53	0.67	0.68	0.79	**0.76**
Postoffice	0.24	0.56	0.64	0.92	**0.70**
Marketstalls	0.65	0.50	0.62	0.84	**0.65**
Policestation	0.33	0.54	**0.63**	0.90	0.62
Bank	0.24	0.57	**0.70**	0.93	0.68

Oshri et al 2018

Economic well-being from space

We are getting better at measuring development outcomes with satellites.

The next few years will see huge advances, and we are working on scaling these estimates.

We want to work with policymakers and practitioners to operationalize satellite-based estimates.

Thank you!

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Extra slides

Are these useful measurements?

$R_2 < 1$

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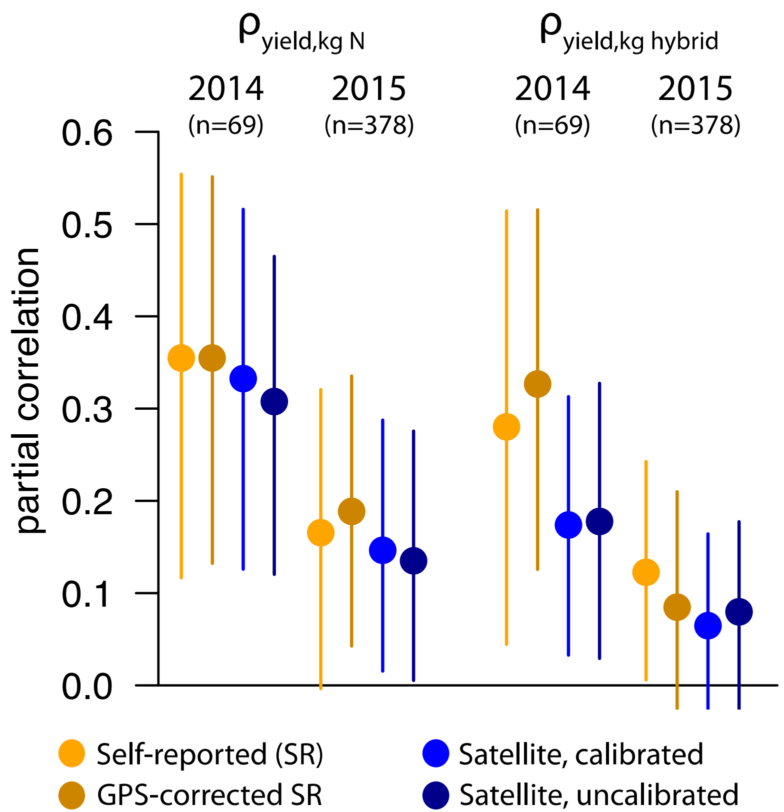
Attempt at diagnosing source of error:

- We have two measurements of the same outcome
- See how well they relate to known inputs
  - *Agriculture*: fertilizer/ hybrid seed
  - *Poverty*: roads, climate, independent wealth estimates
- "Better" outcome measurement is that which correlates more strongly with input

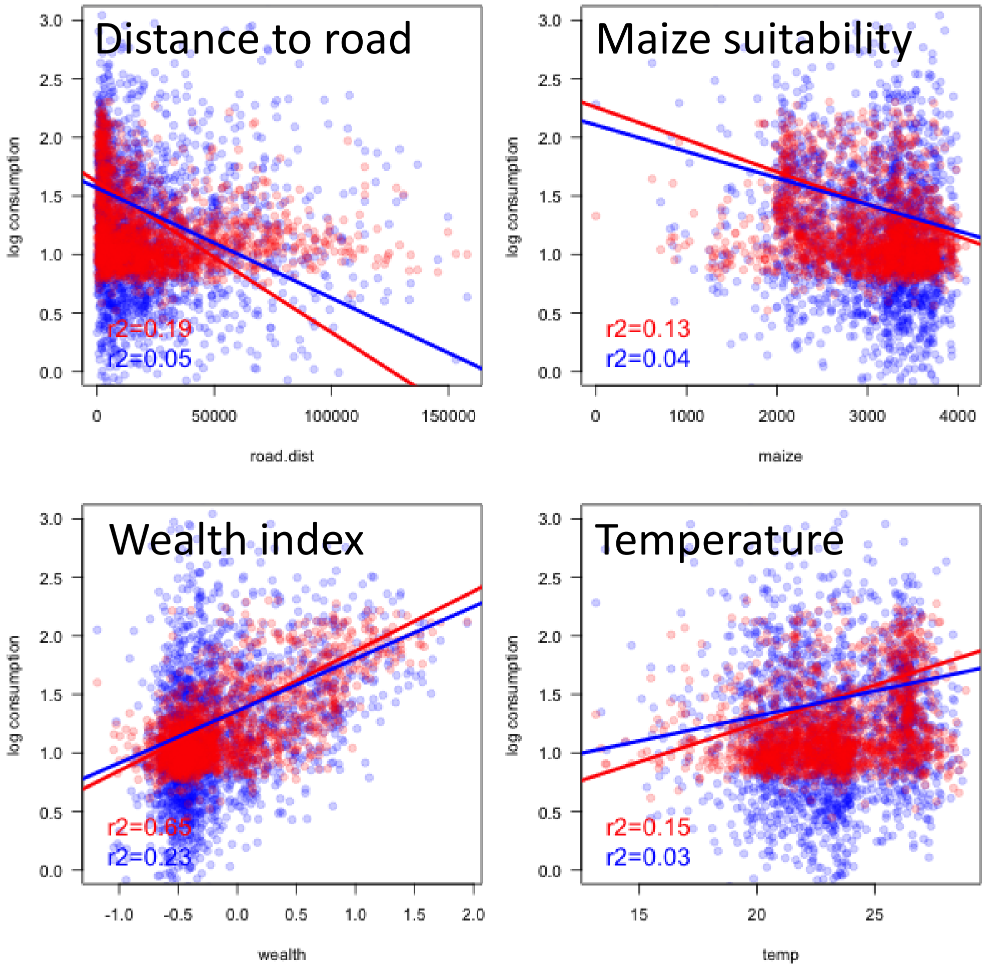
Results: **agriculture**

Relationship between inputs (fertilizer, hybrid seed) and outputs the same for the two outcome measures



Burke and Lobell, 2017, *PNAS*

Results: **poverty**



Satellite-based predictions

Survey-based measurements

Suggests that, at minimum, there is no more error in satellite-based measures than ground measures