

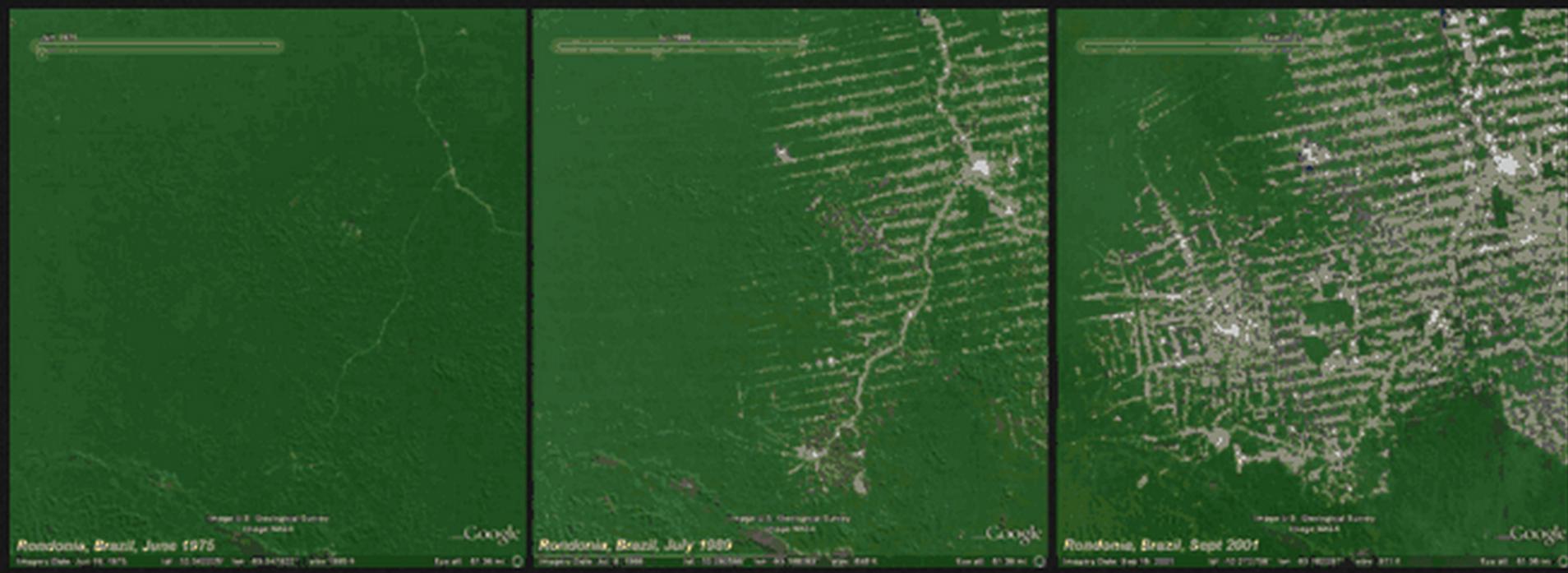
# Google Earth Engine

What is Google Earth  
Engine?

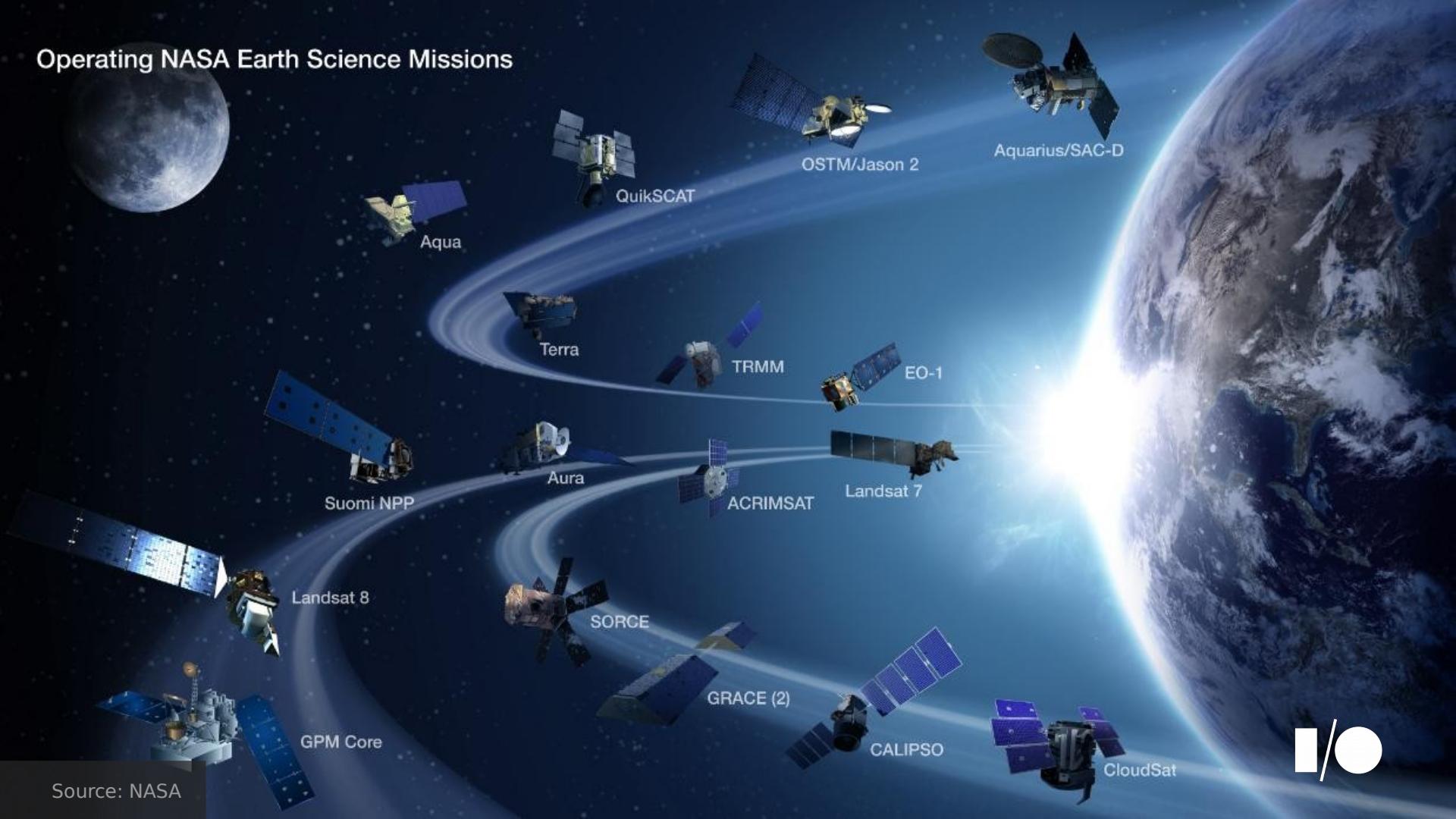


# Background

# Deriving Information from Earth Observation Data



## Operating NASA Earth Science Missions

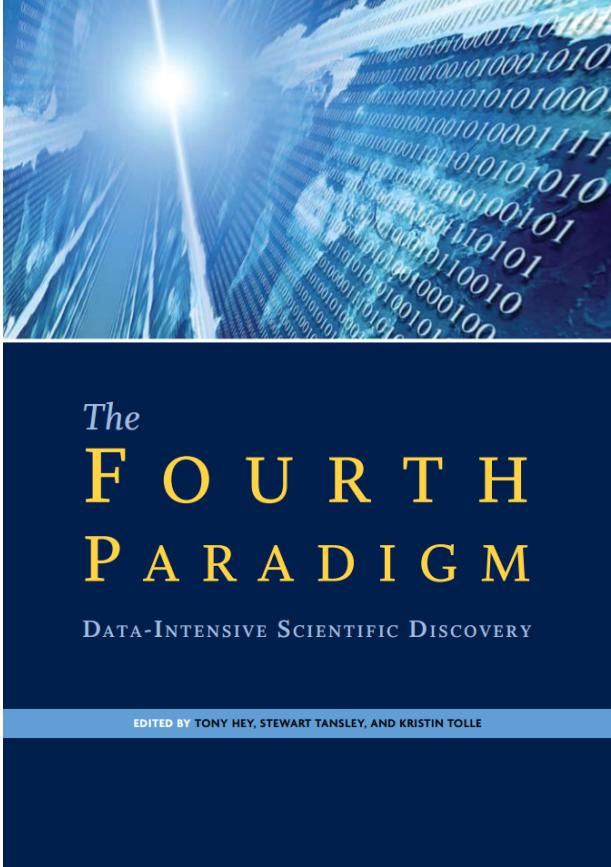


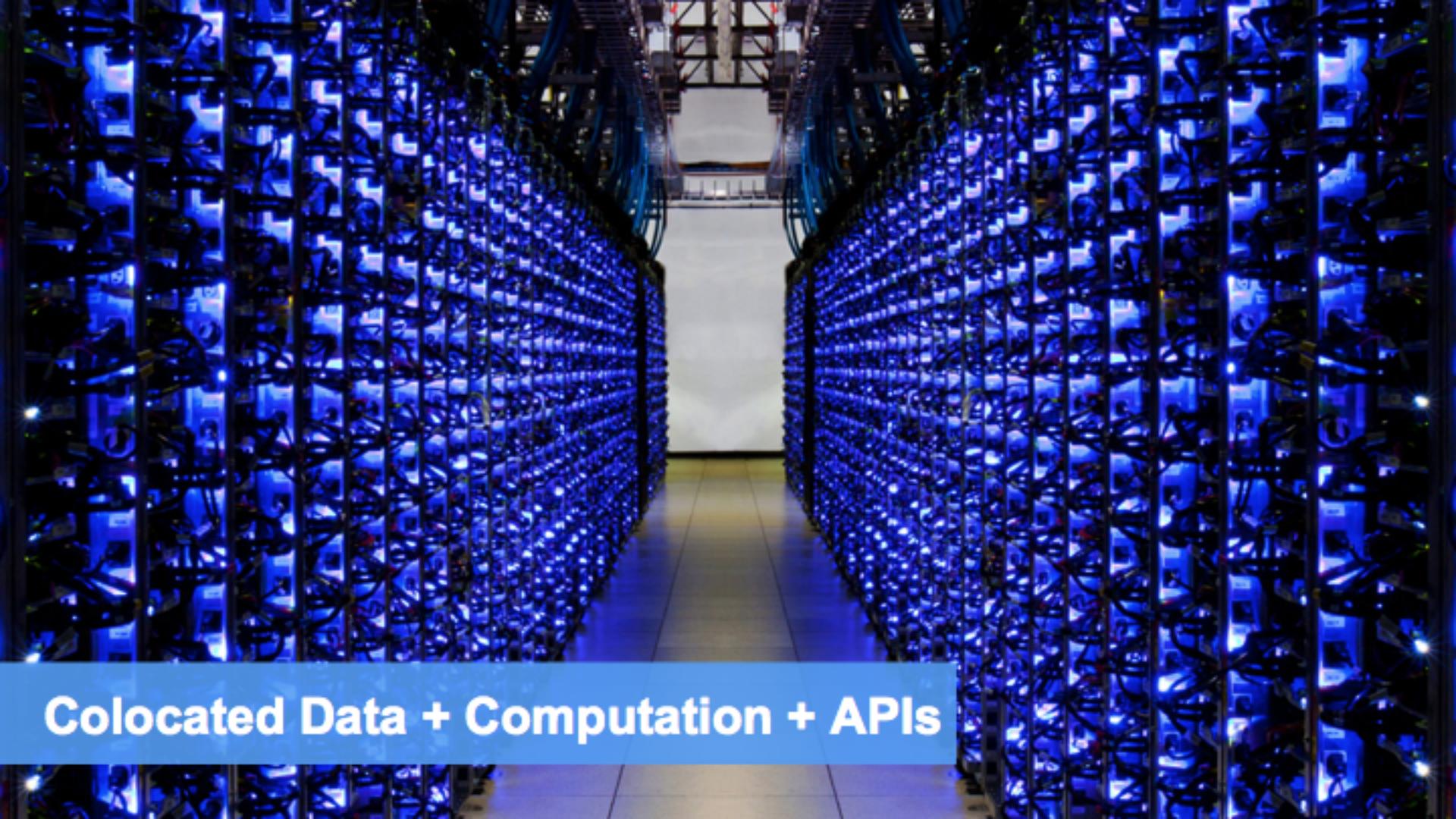
Source: NASA



*“Often it turns out to be more efficient to move the questions than to move the data.”*

-Jim Gray (1944-  
2007)





**Colocated Data + Computation + APIs**

## Results

Layers

Map | Satellite







1984





1984

1984

<https://earthengine.google.com/timelapse>

**29 years**  
of satellite data

 **2,068,467**  
landsat scenes analyzed

**909**  
terabytes of data

More than **2M** hours of computation over **66,000** computers

Elapsed time: **~1.5** days to build the mosaics

**TIMELAPSE**

the course of nearly three  
decades of satellite photography

Pictured: The megacity of Dubai grows in the desert, from 1984 to today

# Data Catalog



# The Earth Engine Public Data Catalog



**Landsat and  
Sentinel**  
Raw, TOA, SR, ...



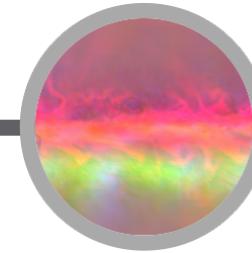
**MODIS**  
Daily, NBAR, LST, ...



**Terrain**  
SRTM, GTOPO,  
NED, ...



**Land Cover**  
GlobCover, NLCD, ...



**Atmospheric**  
NOAA NCEP, OMI, ...

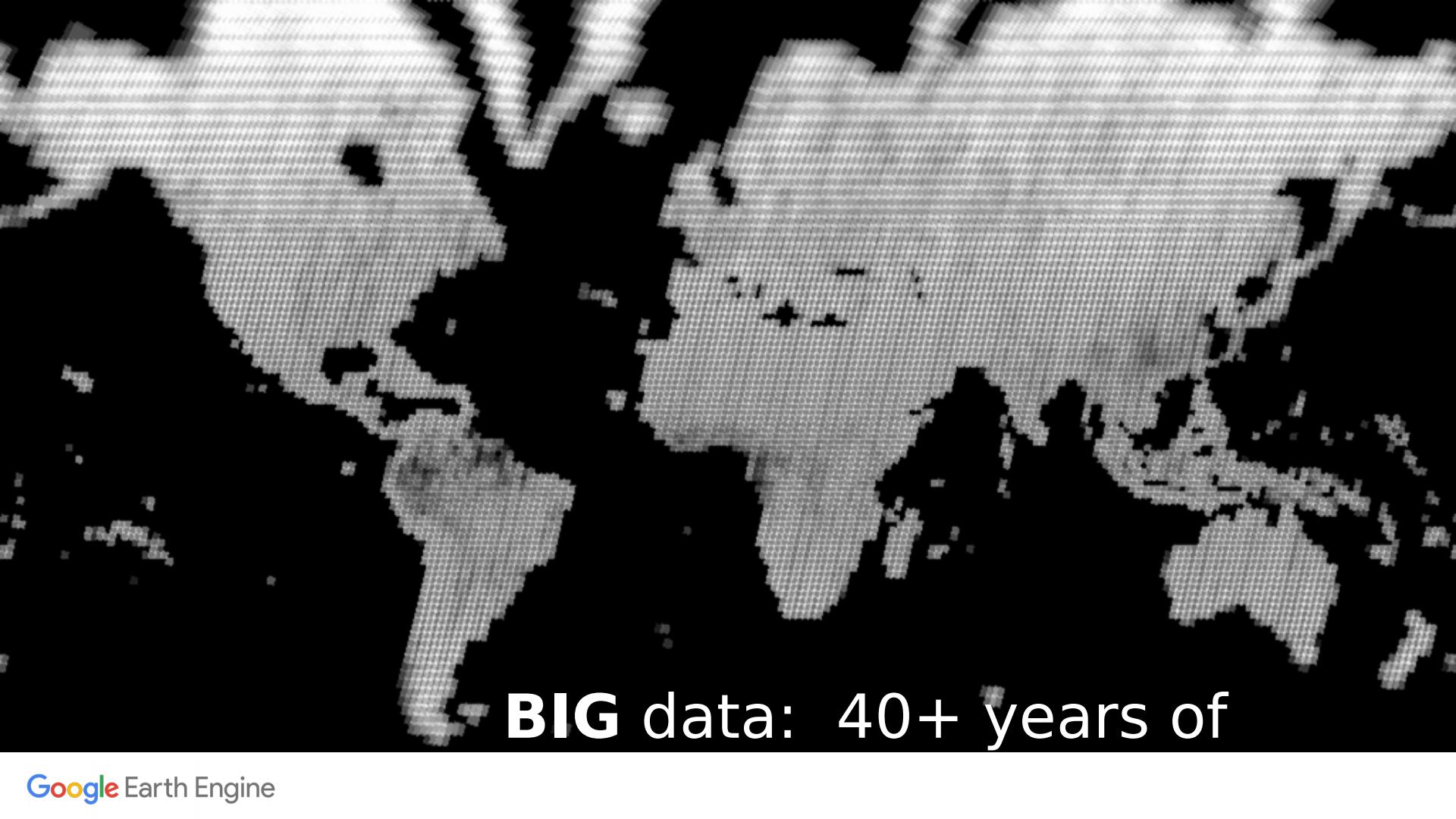
**... and many more, updating  
daily!**

**> 200 public datasets**

**> 5 million images**

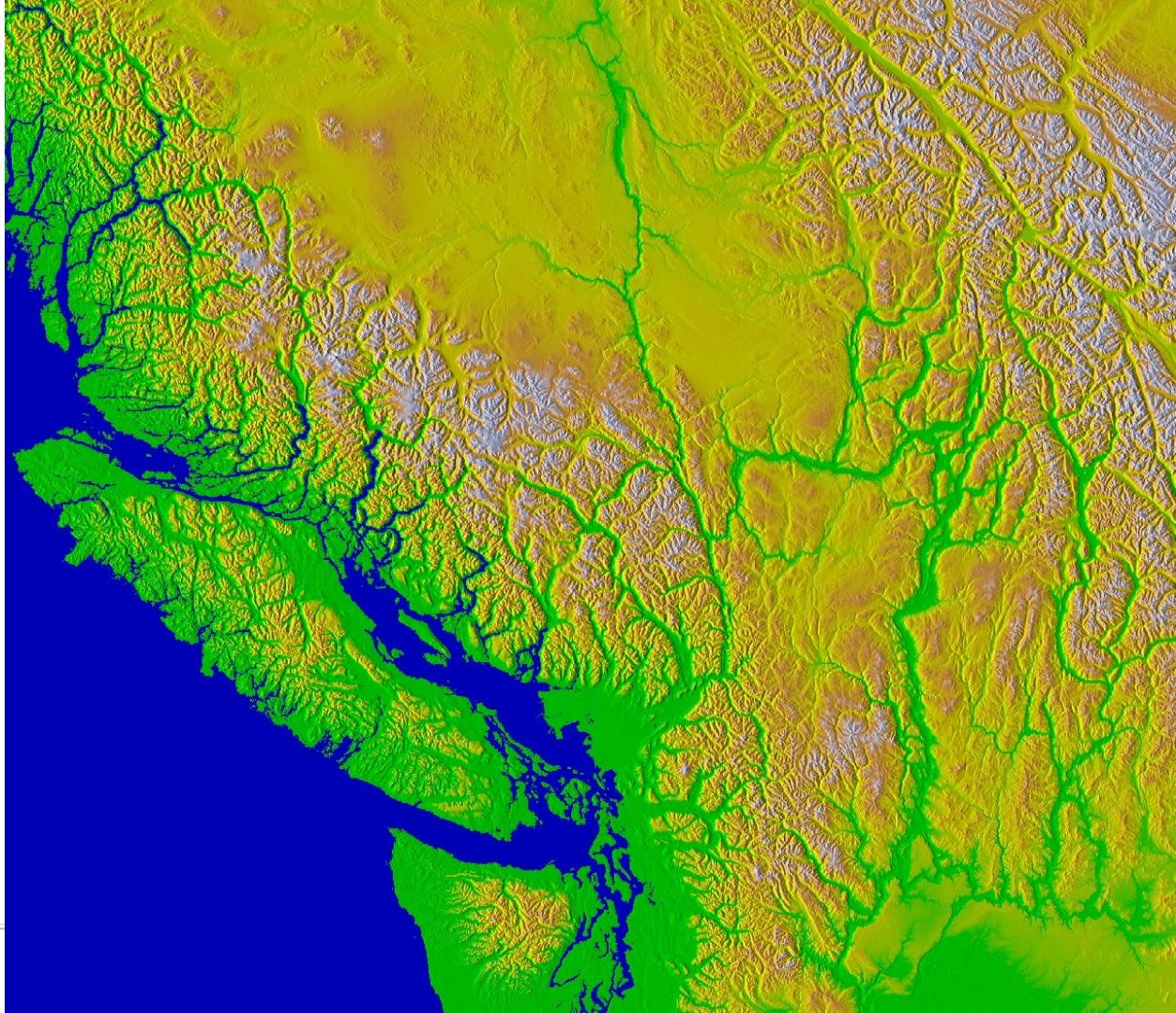
**> 4000 new images every**

**day**  
**> 5 petabytes of data**



**BIG** data: 40+ years of

# Terrain



API



# Data Types and Geospatial Processing Functions

- **Image** - band math, clip, convolution, neighborhood, selection ...
- **Image Collection** - map, aggregate, filter, mosaic, sort ...
- **Feature** - buffer, centroid, intersection, union, transform ...
- **Feature Collection** - aggregate, filter, flatten, merge, sort ...
- **Filter** - by bounds, within distance, date, day-of-year, metadata ...
- **Reducer** - mean, linearRegression, percentile, histogram ....
- **Join** - simple, inner, outer, inverted ...
- **Machine Learning** - CART, random forests, bayes, SVM, kmeans, cobweb ...
- **Projection** - transform, translate, scale ...

over 1000 data types and operators, and growing!



# What can you do with Earth Engine?

## Get an Image

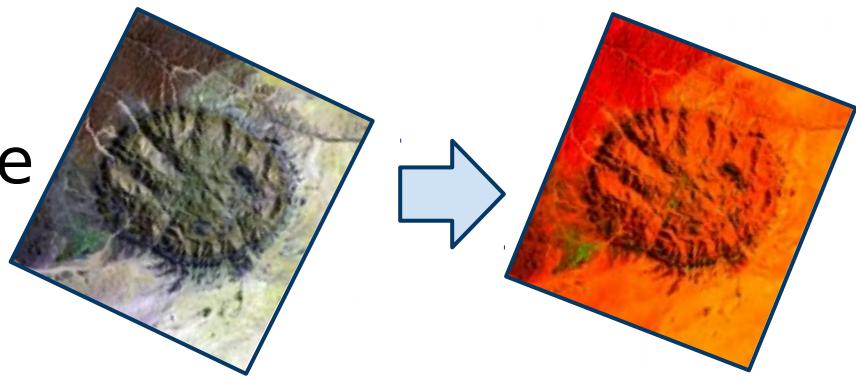


Pick your: Projection, resolution, bands, bounding-box, visualization

# What can you do with Earth Engine?

Get an Image

Apply an algorithm to an image



Library functions or script your own.

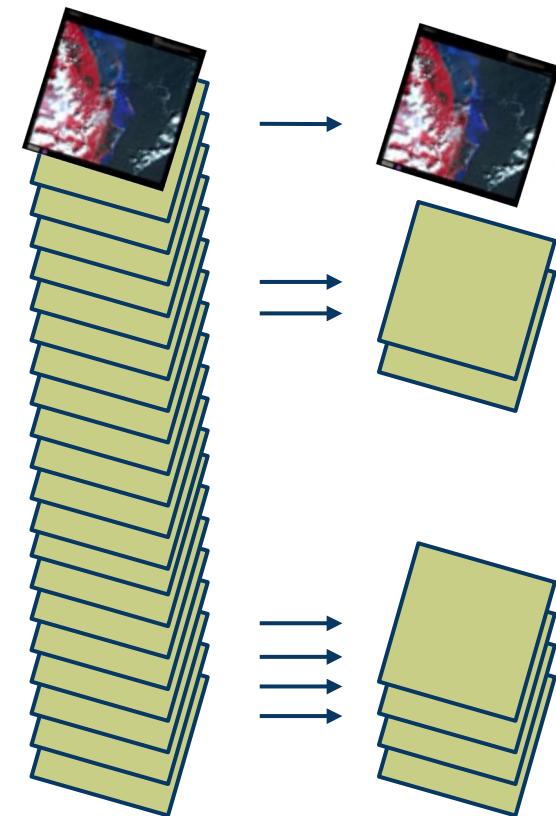
# What can you do with Earth Engine?

Get an Image

Apply an algorithm to an image

Filter a collection

Time, Space & Metadata search



# What can you do with Earth Engine?

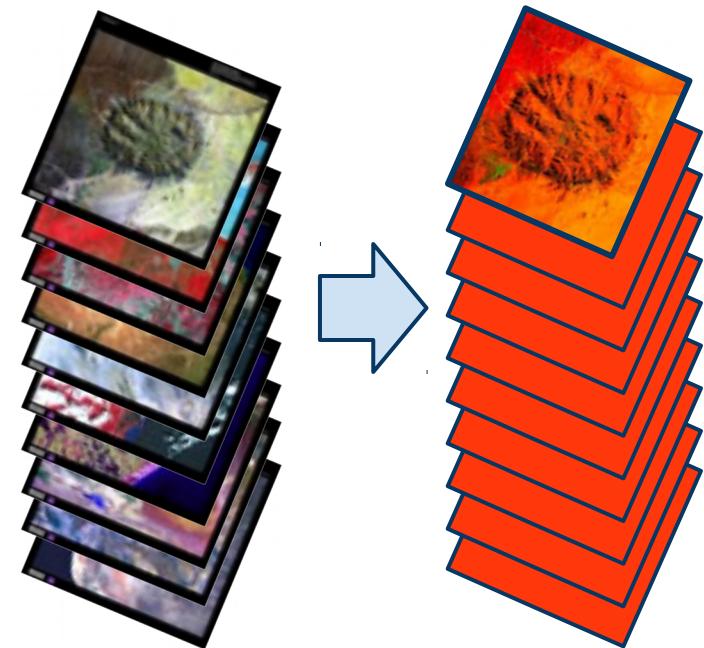
Get an Image

Apply an algorithm to an image

Filter a collection

Map an algorithm over a collection

$N \rightarrow N$



# What can you do with Earth Engine?

Get an Image

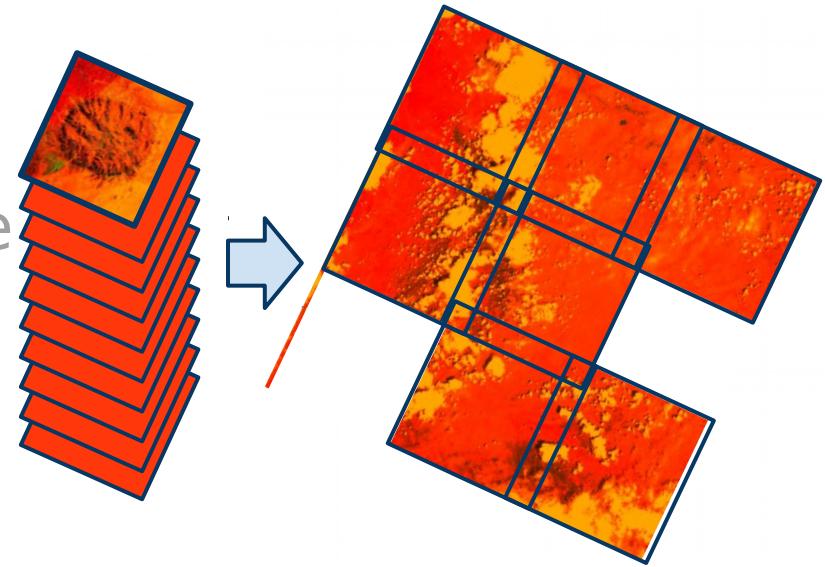
Apply an algorithm to an image

Filter a collection

Map an algorithm over a collection

Reduce a collection

$N \rightarrow 1$  or  $N \rightarrow M$



# What can you do with Earth Engine?

Get an Image

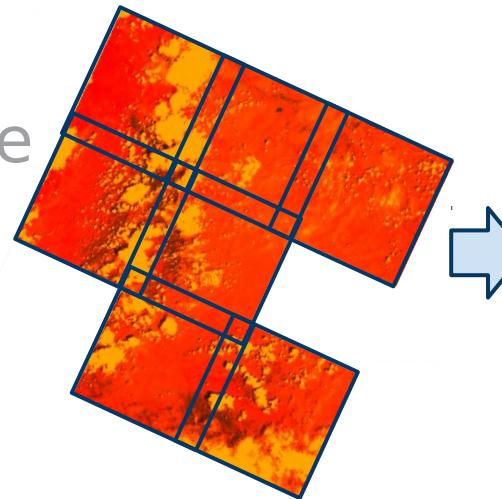
Apply an algorithm to an image

Filter a collection

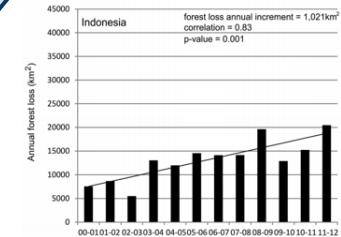
Map an algorithm over a collection

Reduce a collection

Compute aggregate statistics



|                | 1891 | 391  | 11898   |
|----------------|------|------|---------|
| Gabon          | 1891 | 391  | 11898   |
| Lithuania      | 1845 | 1226 | 40296   |
| Cuba           | 1725 | 2271 | 68008   |
| Mali           | 1694 | 0    | 1247103 |
| Costa Rica     | 1653 | 382  | 11327   |
| Czech Republic | 1646 | 1331 | 46934   |
| South Sudan    | 1635 | 38   | 460581  |
| North Korea    | 1605 | 137  | 67695   |
| Italy          | 1603 | 898  | 201331  |



## Scripts Docs Assets

- Modis Qa Bands
- Pixel Area
- Pixel Lon Lat
- Polynomial
- Zero Crossing
- ▼ Image Collection
  - Clipped Composite
  - Expression Map
  - Filtered Composite
  - Linear Fit
  - Modis Cloud Masking
  - Simple Cloud Score

## Linear Fit

Get Link

Save ▾

Run

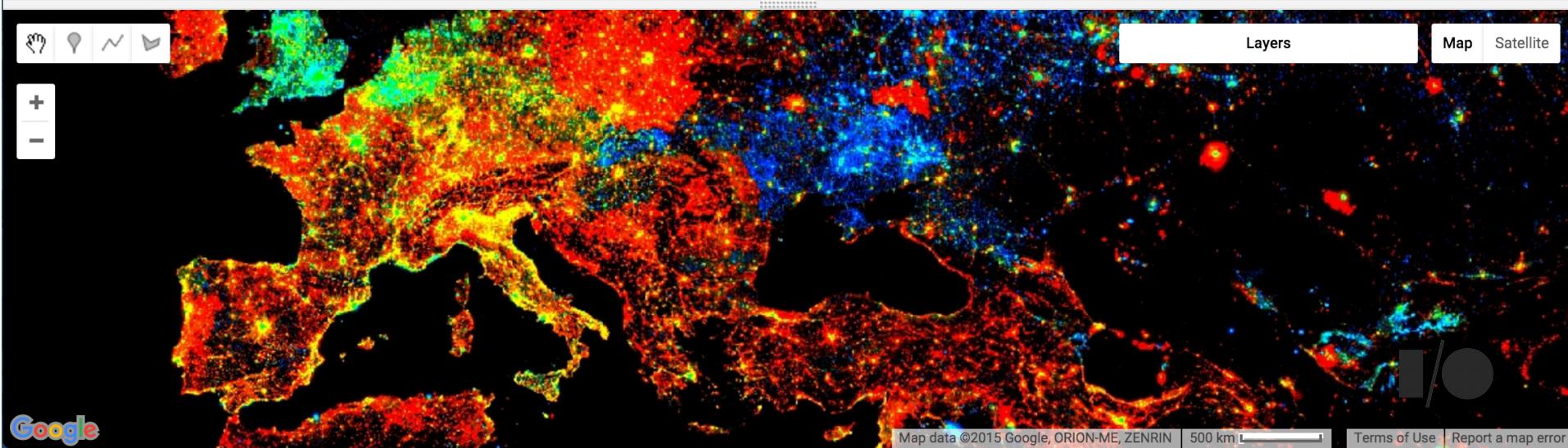
Reset ▾



```
1 // Compute the trend of nighttime lights from DMSP.  
2  
3 // Add a band containing image date as years since 1960.  
4 function createTimeBand(img) {  
5   var year = ee.Date(img.get('system:time_start')).year()  
6   return ee.Image(year).byte().addBands(img);  
7 }  
8  
9 // Fit a linear trend to the nighttime lights collected.  
10 var collection = ee.ImageCollection('NOAA/DMSP-OLS/1  
11   .select('stable_lights')  
12   .map(createTimeBand);  
13 var fit = collection.reduce(ee.Reducer.linearFit());  
14  
15 // Display a single image
```

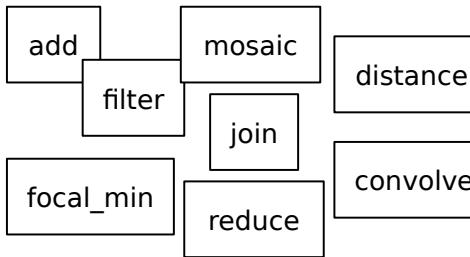
## Inspector Console Tasks

Use print(...) to write to this console.



Geospatial  
Datasets

Requests      Results



Algorithmic  
Primitives

Storage and Compute

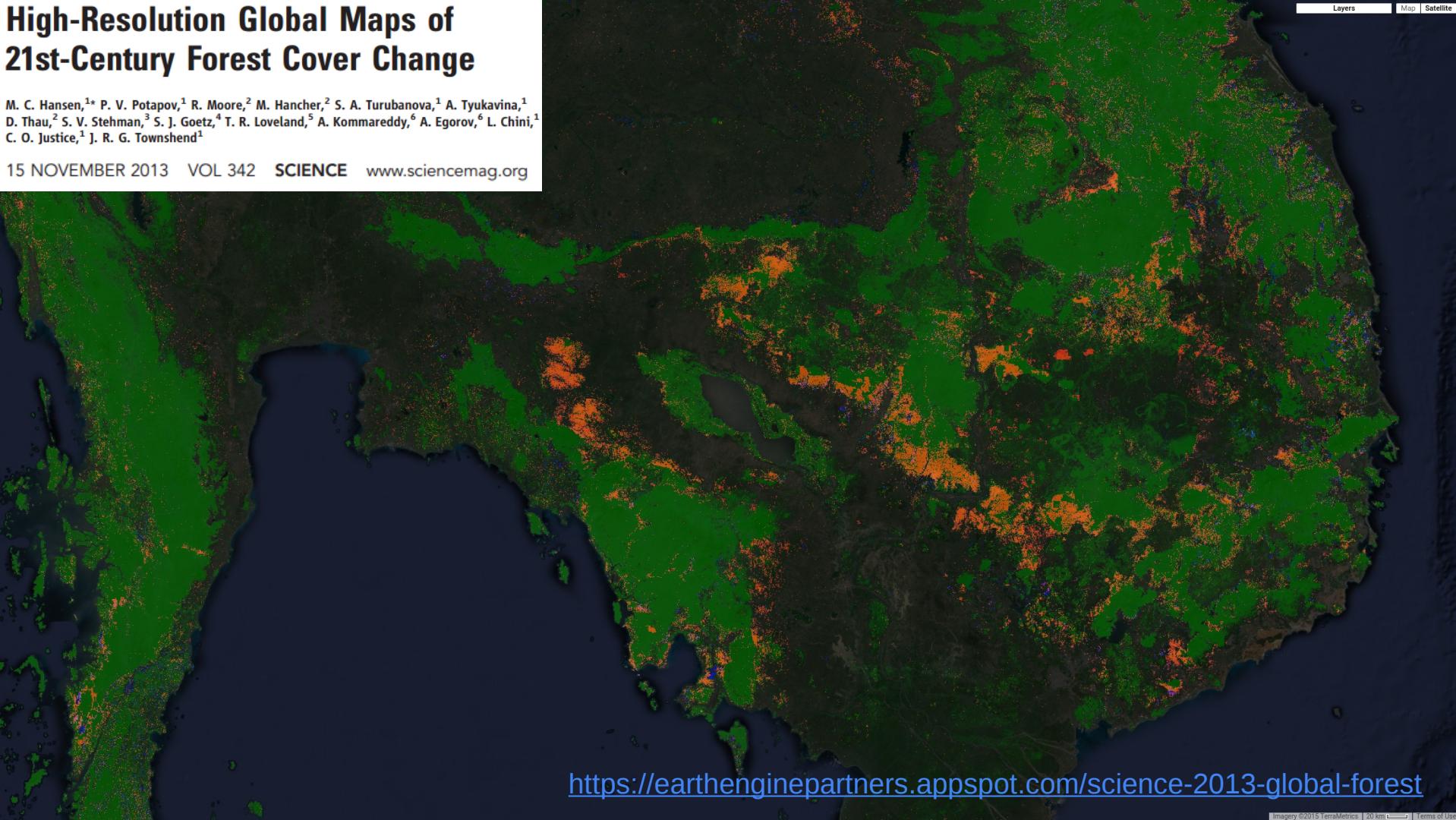
## Publications



# High-Resolution Global Maps of 21st-Century Forest Cover Change

M. C. Hansen,<sup>1\*</sup> P. V. Potapov,<sup>1</sup> R. Moore,<sup>2</sup> M. Hancher,<sup>2</sup> S. A. Turubanova,<sup>1</sup> A. Tyukavina,<sup>1</sup> D. Thau,<sup>2</sup> S. V. Stehman,<sup>3</sup> S. J. Goetz,<sup>4</sup> T. R. Loveland,<sup>5</sup> A. Kommareddy,<sup>6</sup> A. Egorov,<sup>6</sup> L. Chini,<sup>1</sup> C. O. Justice,<sup>1</sup> J. R. G. Townshend<sup>1</sup>

15 NOVEMBER 2013 VOL 342 SCIENCE www.sciencemag.org

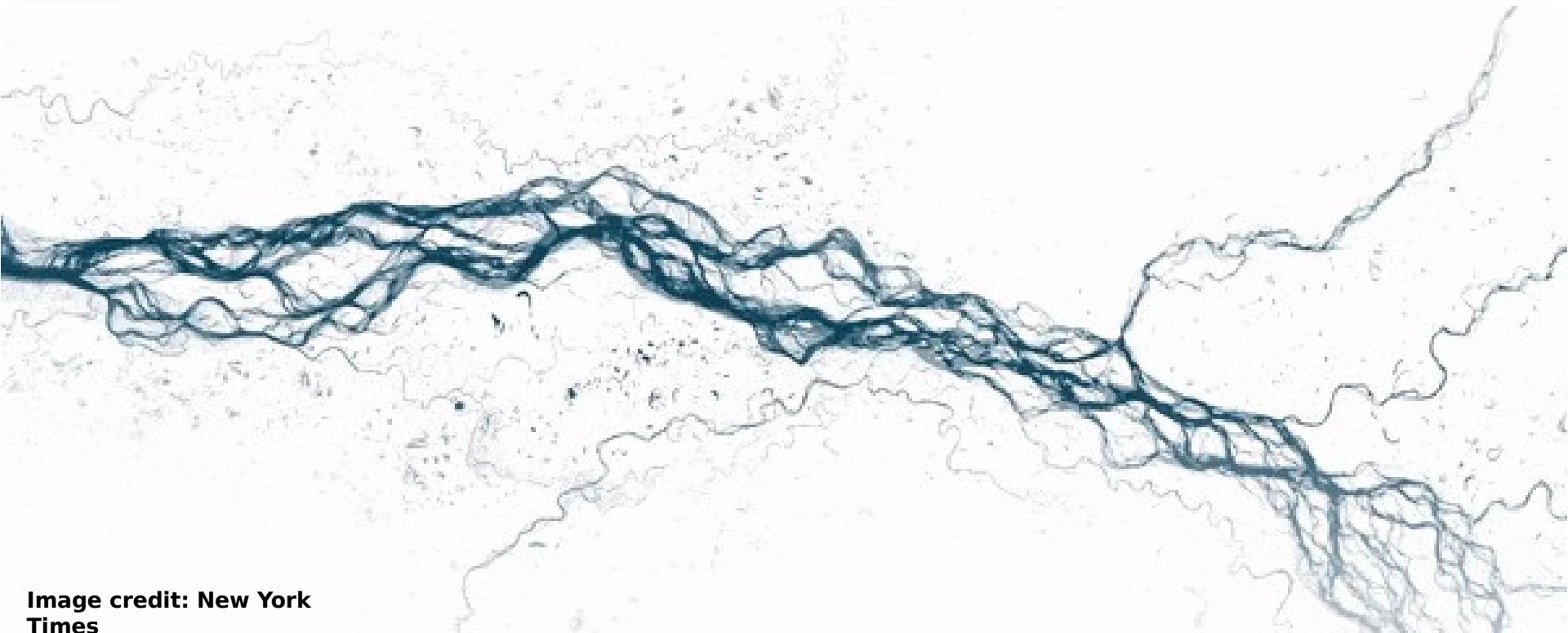


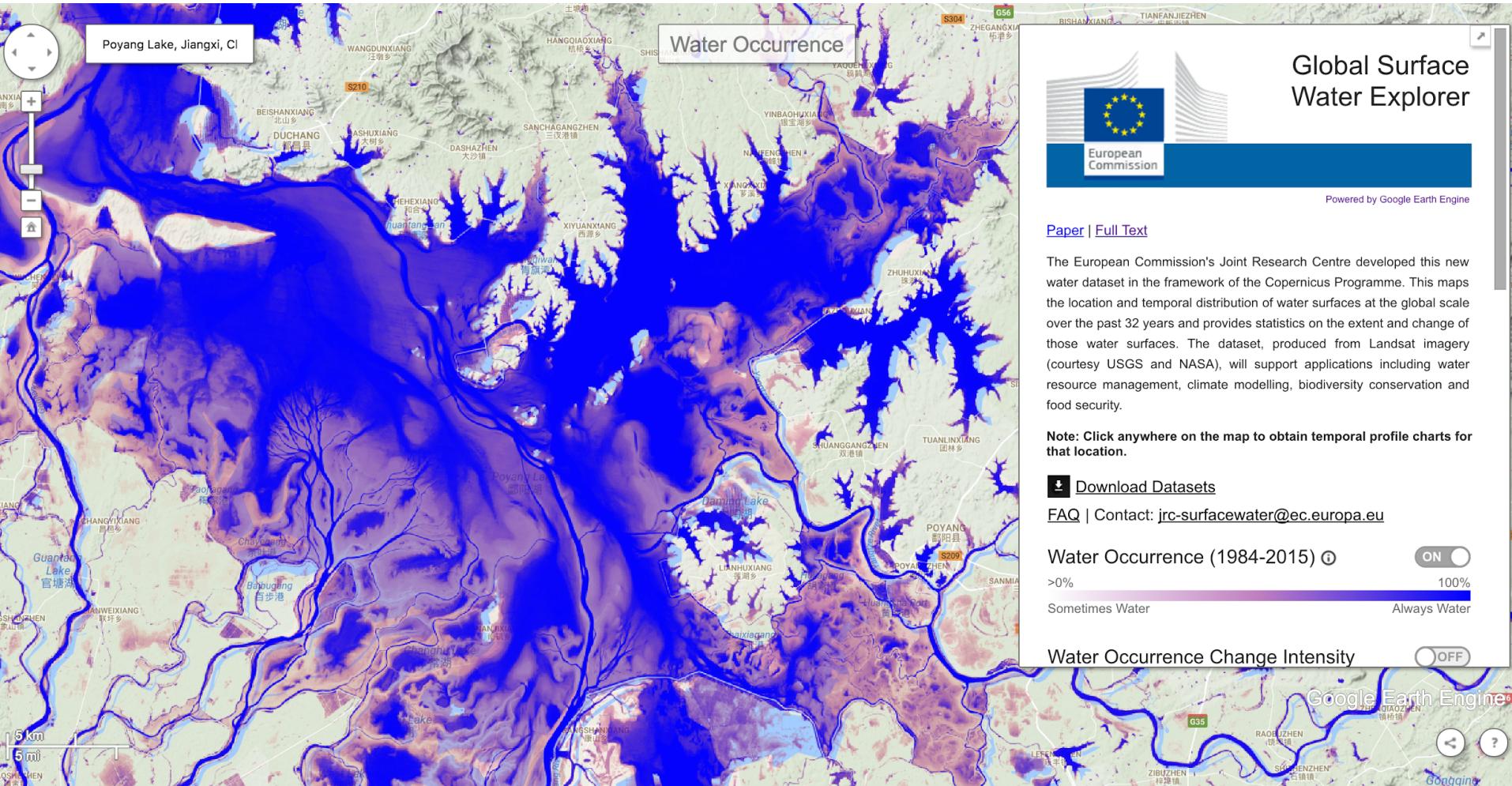
<https://earthenginepartners.appspot.com/science-2013-global-forest>

# High-resolution mapping of global surface water and its long-term changes

Jean-François Pekel<sup>1</sup>, Andrew Cottam<sup>1</sup>, Noel Gorelick<sup>2</sup> & Alan S. Belward<sup>1</sup>

doi:10.1038/nature20584





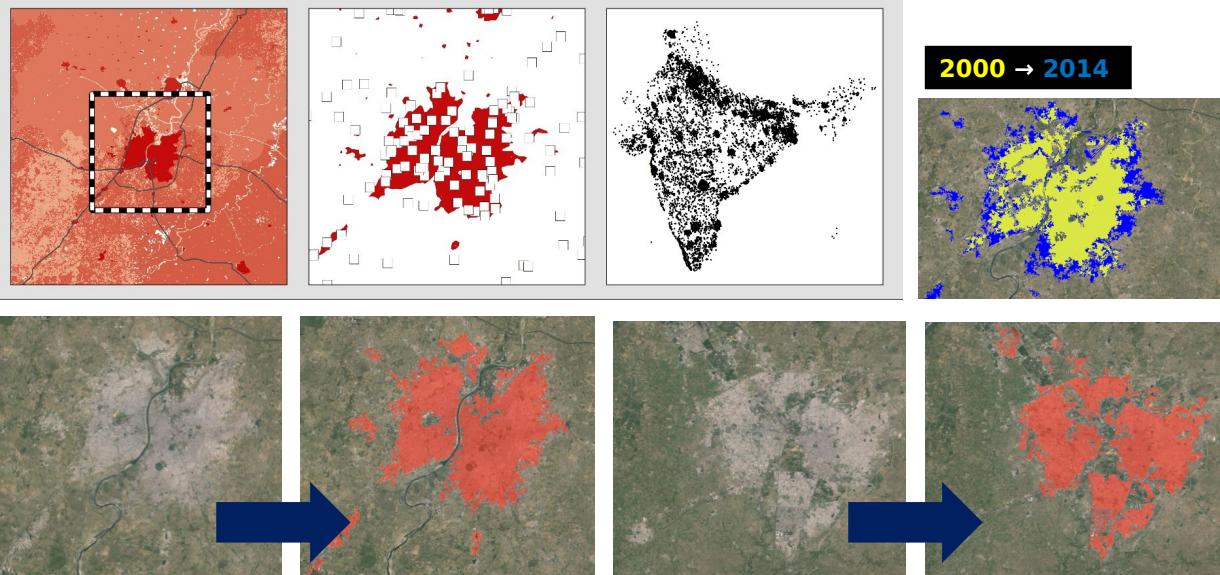
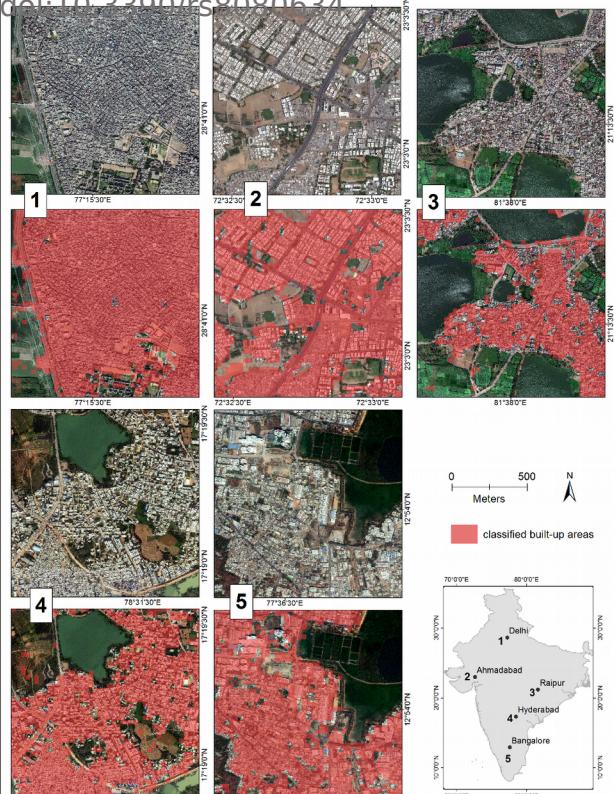
# Detecting the Boundaries of Urban Areas in India: A Dataset for Pixel-Based Image Classification in Google Earth Engine

Ran Goldblatt <sup>1,\*</sup>, Wei You <sup>2</sup>, Gordon Hanson <sup>1</sup> and Amit K. Khandelwal <sup>3</sup>



*remote sensing*

Remote Sens. 2016, 8, 634;  
doi:10.3390/rs8090634



The dataset can be accessed online as a Google Fusion Table at:

<https://www.google.com/fusiontables/DataSource?docid=1fWY4lyYiV-BA5HsAKi2V9LdoQgsbFtKK2BoQiHb0#rows:id=1>

# Building a Better Urban Picture: Combining Day and Night Remote Sensing Imagery

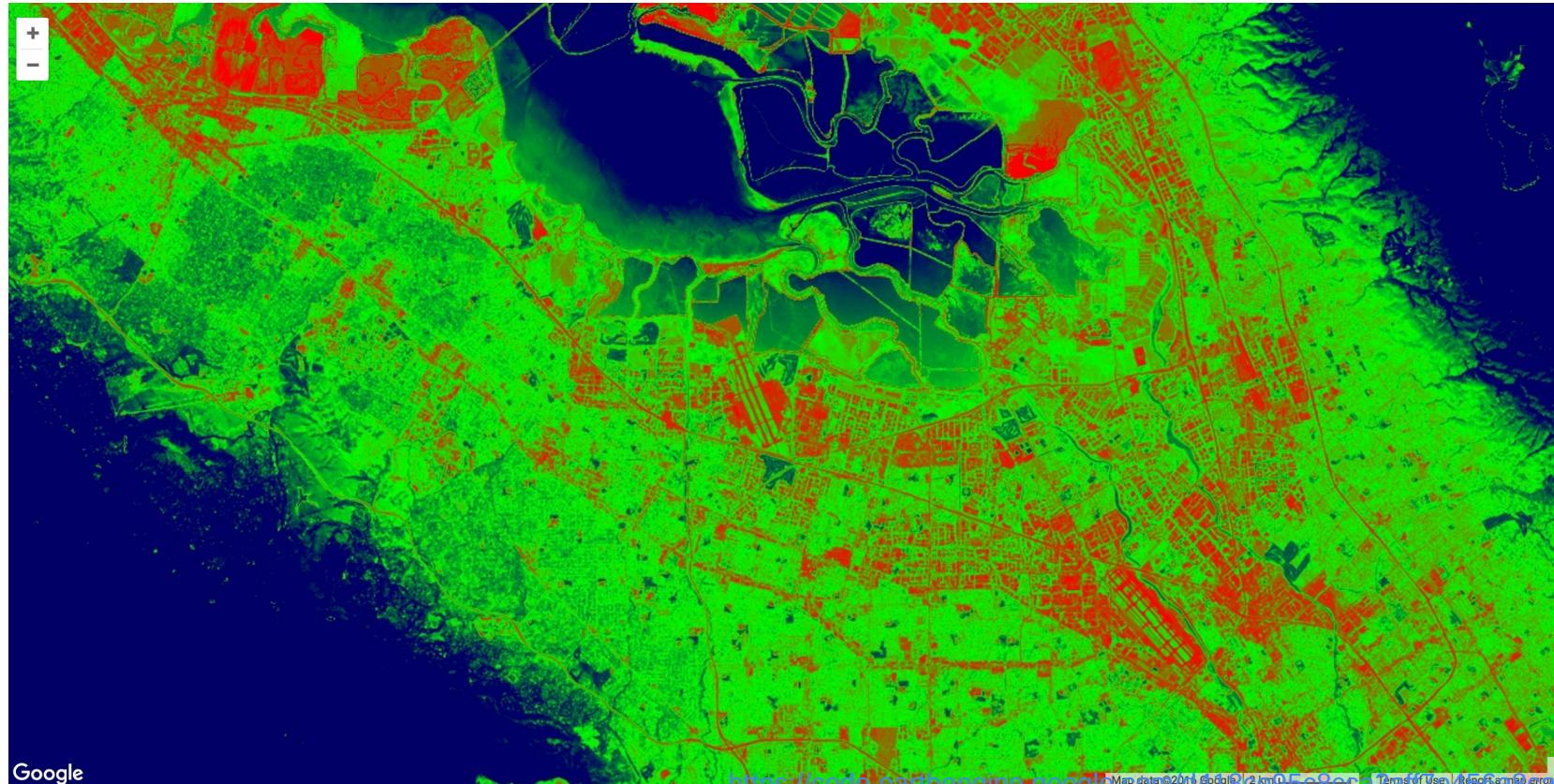
*remote sensing*

ISSN 2072-4292

[www.mdpi.com/journal/remotesensing](http://www.mdpi.com/journal/remotesensing)

Qingling Zhang <sup>1,2,\*</sup>, Bin Li <sup>1,3</sup>, David Thau <sup>4</sup> and Rebecca Moore <sup>4</sup>

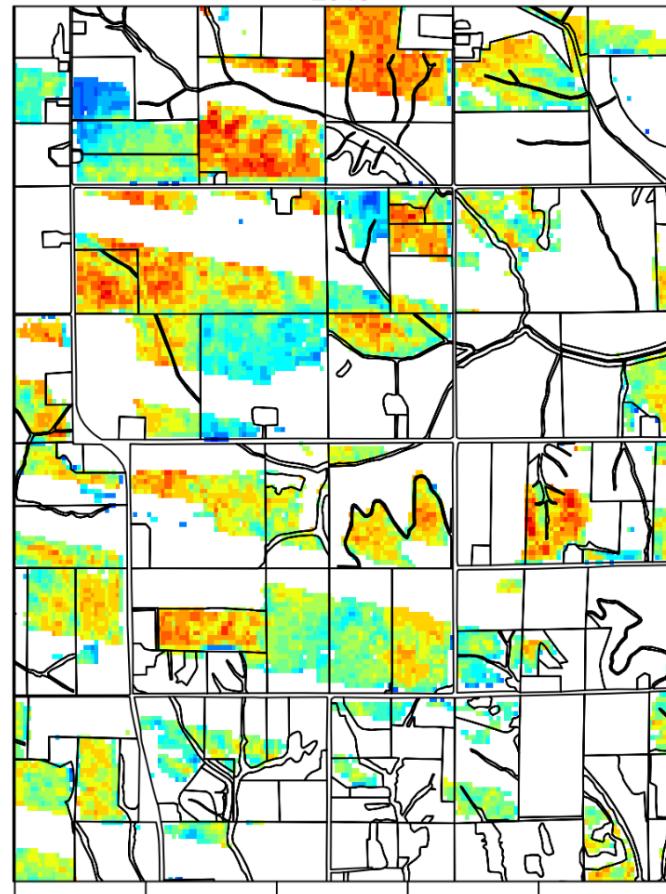
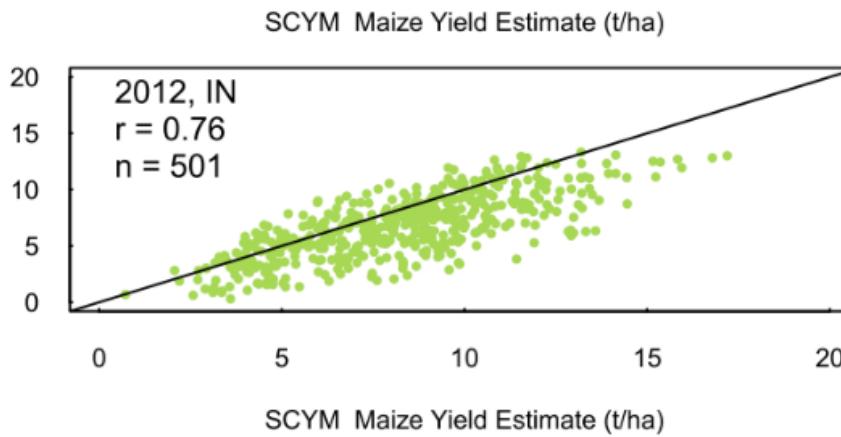
*Remote Sens.* **2015**, *7*, 11887–11913; doi:10.3390/rs70911887

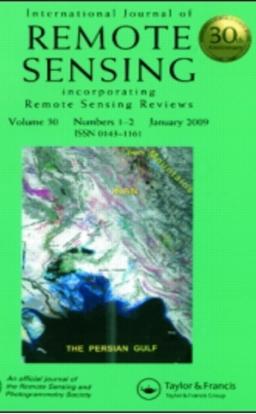


# A scalable satellite-based crop yield mapper

David B. Lobell <sup>a,\*</sup>, David Thau <sup>b</sup>, Christopher Seifert <sup>a</sup>, Eric Engle <sup>b</sup>, Bertis Little <sup>c</sup>

<http://www.sciencedirect.com/science/article/pii/S0034425715001637>





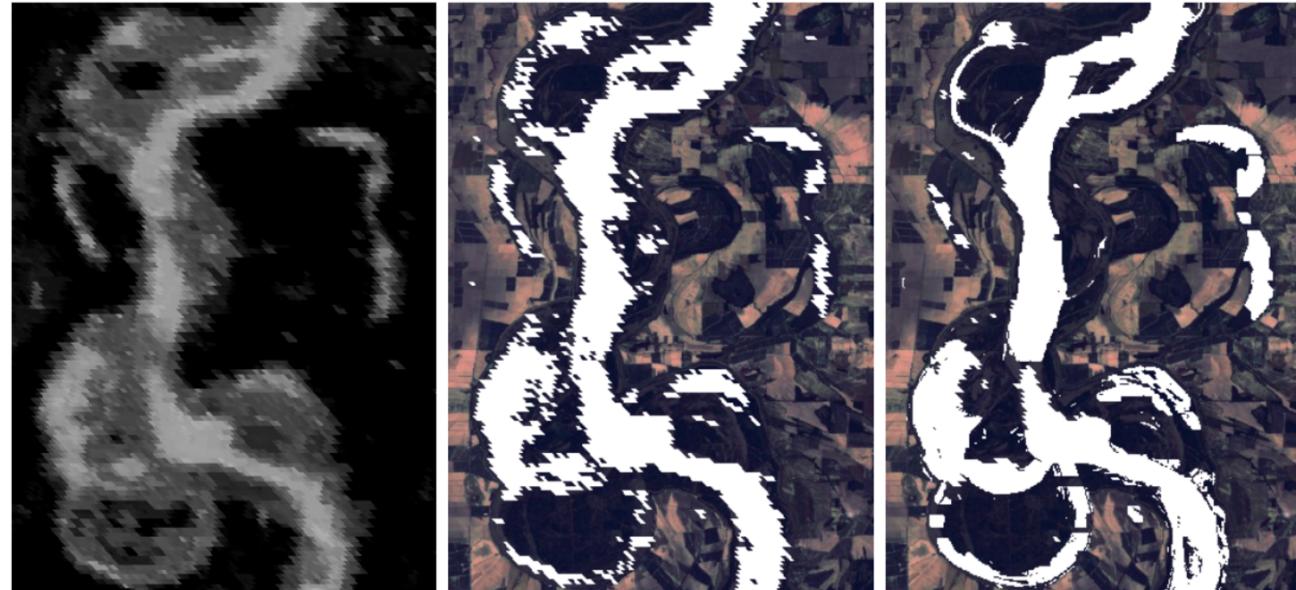
# Automatic Boosted Flood Mapping from Satellite Data

Brian Coltin\*, Scott McMichael, Trey Smith, and Terrence Fong

*Intelligent Robotics Group, NASA Ames, Moffett Field, CA*

<http://www.tandfonline.com/doi/abs/10.1080/01431161.2016.1145366>

<https://github.com/nasa/CrisisMappingToolkit>



# Mapping paddy rice planting area in northeastern Asia with Landsat 8 images, phenology-based algorithm and Google Earth Engine

Jinwei Dong <sup>a,b,\*</sup>, Xiangming Xiao <sup>a,b,c,\*</sup>, Michael A. Menarguez <sup>a,b</sup>, Geli Zhang <sup>a,b</sup>, Yuanwei Qin <sup>a,b</sup>, David Thau <sup>d</sup>, Chandrashekhar Biradar <sup>e</sup>, Berrien Moore III <sup>f</sup>

<http://www.sciencedirect.com/science/article/pii/S003442571630044X>

