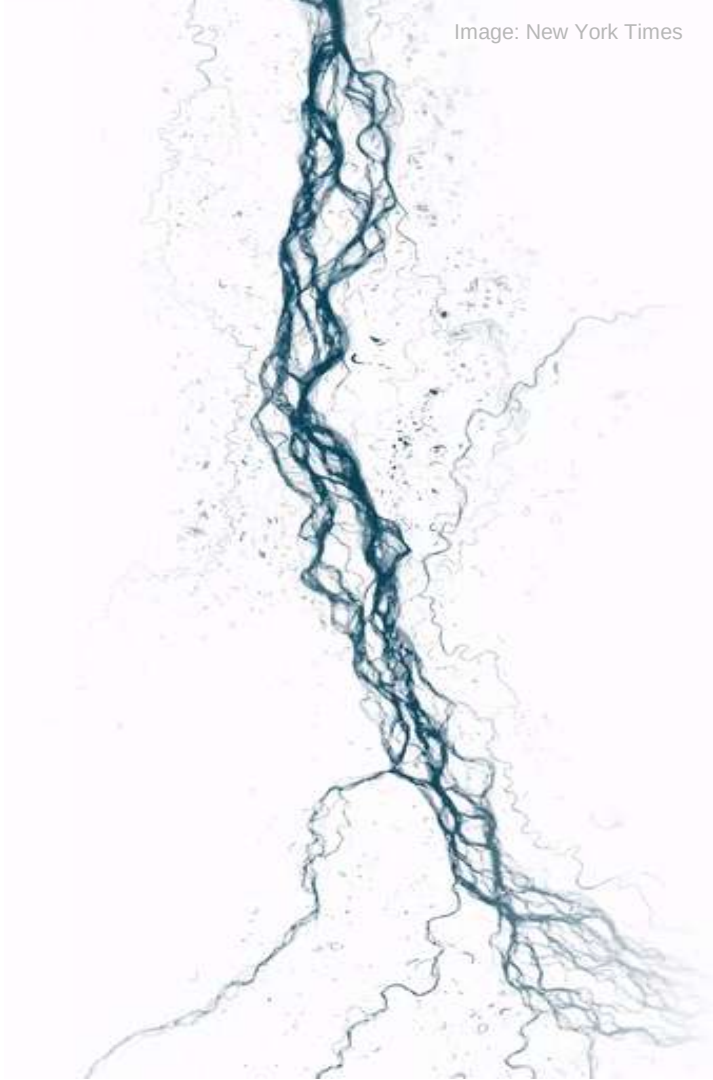

Google Earth Engine

Noel Gorelick
Google Switzerland

Google Earth Engine

"Big Data" analysis and visualization platform

- Inherently parallel system
- Designed for scientists, not software engineers
- Goals: make it easy, **enable non-traditional users**

Google Earth Engine

"Big Data" analysis and visualization platform

- Inherently parallel system
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Focused on society's biggest challenges

- Deforestation
- Drought
- Disaster
- Disease
- Climate Change
- Conflict
- Global Food Security
- Sustainability

9PB Public Data Catalog

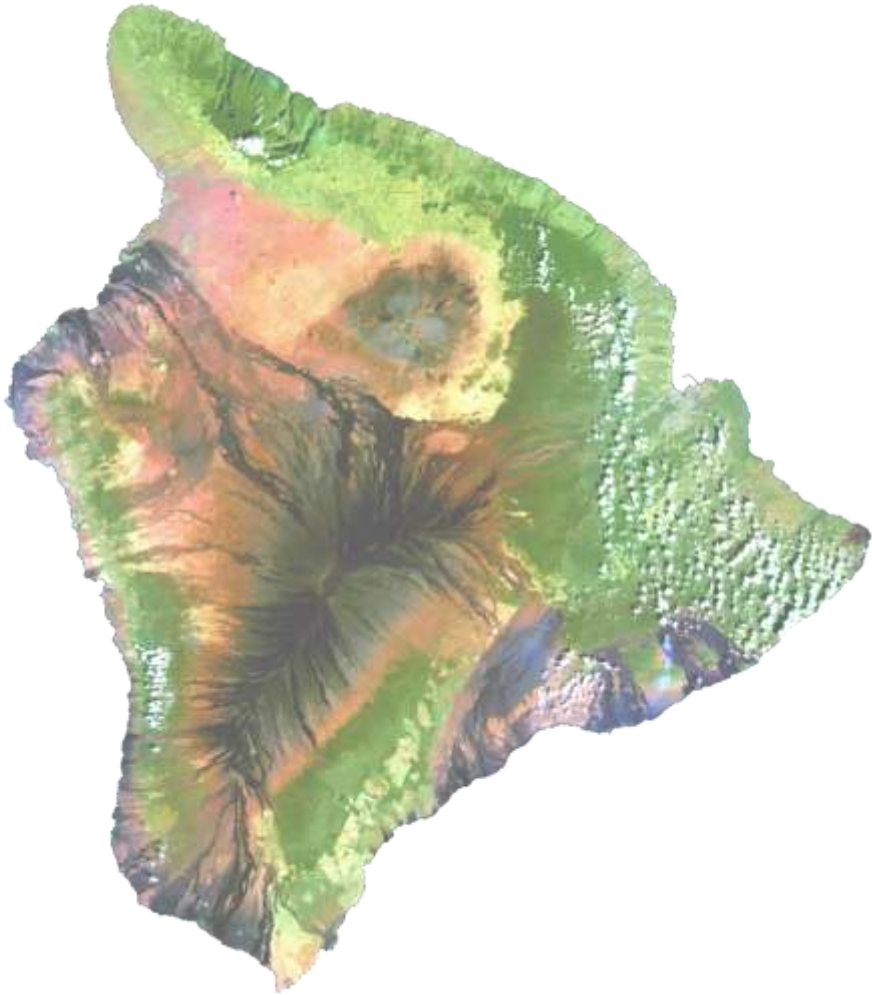
Imagery

Landsat 4-8	7 bands, 30m
MODIS	250m Daily Global
Sentinel-1	10m SAR
Sentinel-2	12 bands, 10/20/60m

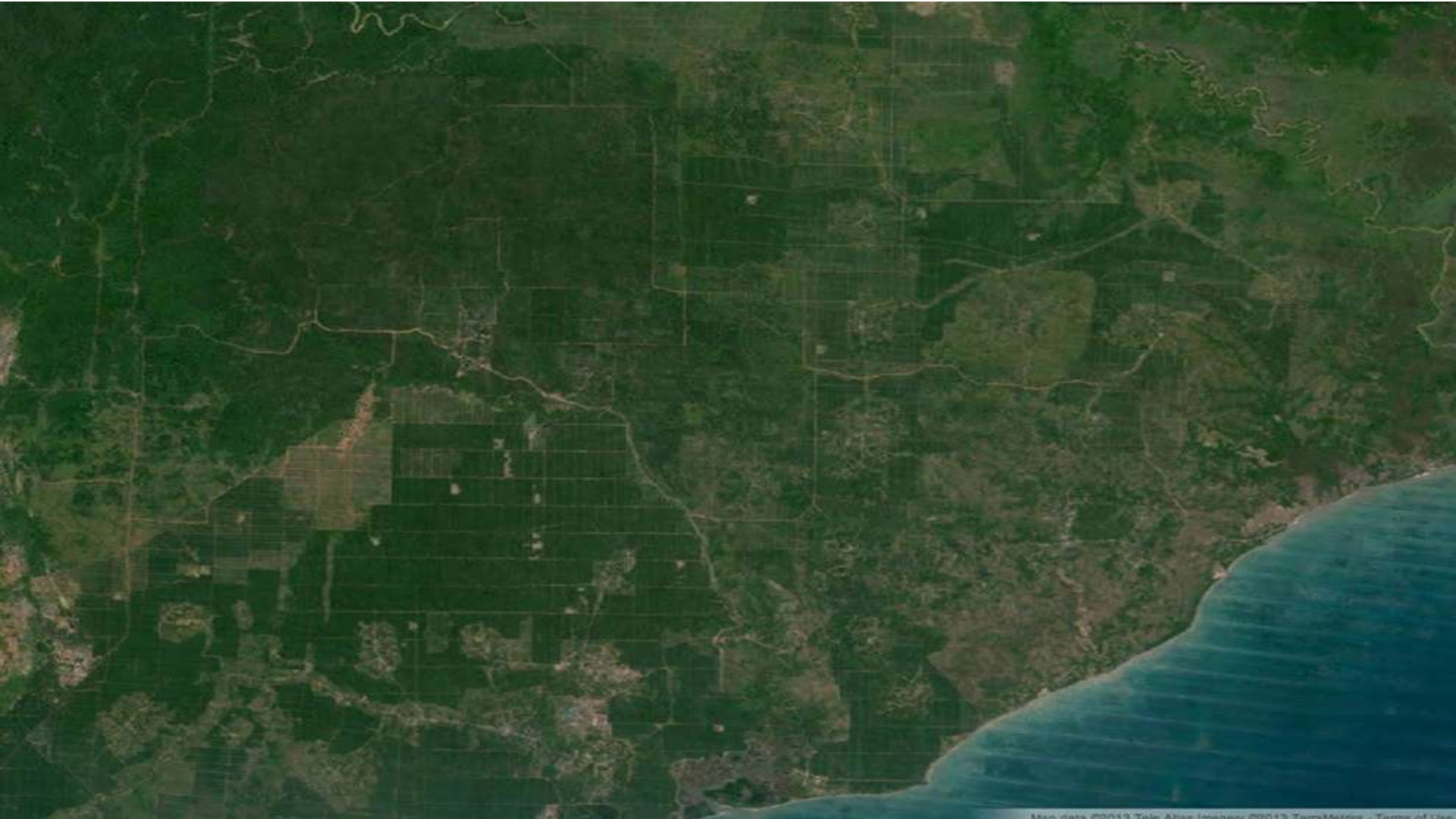
Geophysical

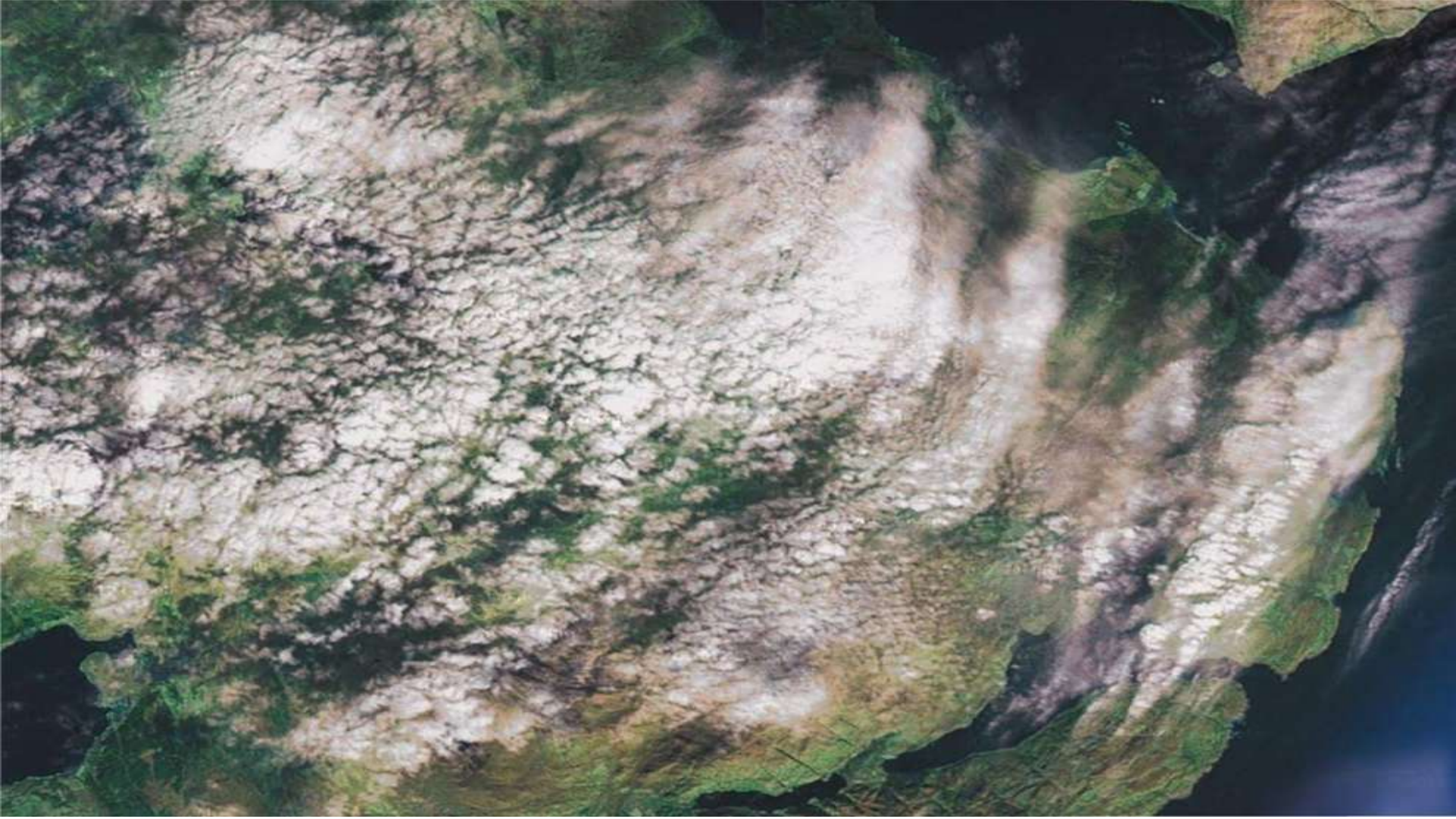
- Digital Elevation
- Land Cover
- Surface Temperature, etc.

Weather Forecasts, Climate Models
+300 more analysis ready datasets




Jalan Bekalan - Pelabuhan
Jalan Bekalan - Pelabuhan






Layers
Map
Satellite
Google


Layers
Map
Satellite
Google

24 Terapixels. 30 years / 30 meters global video.

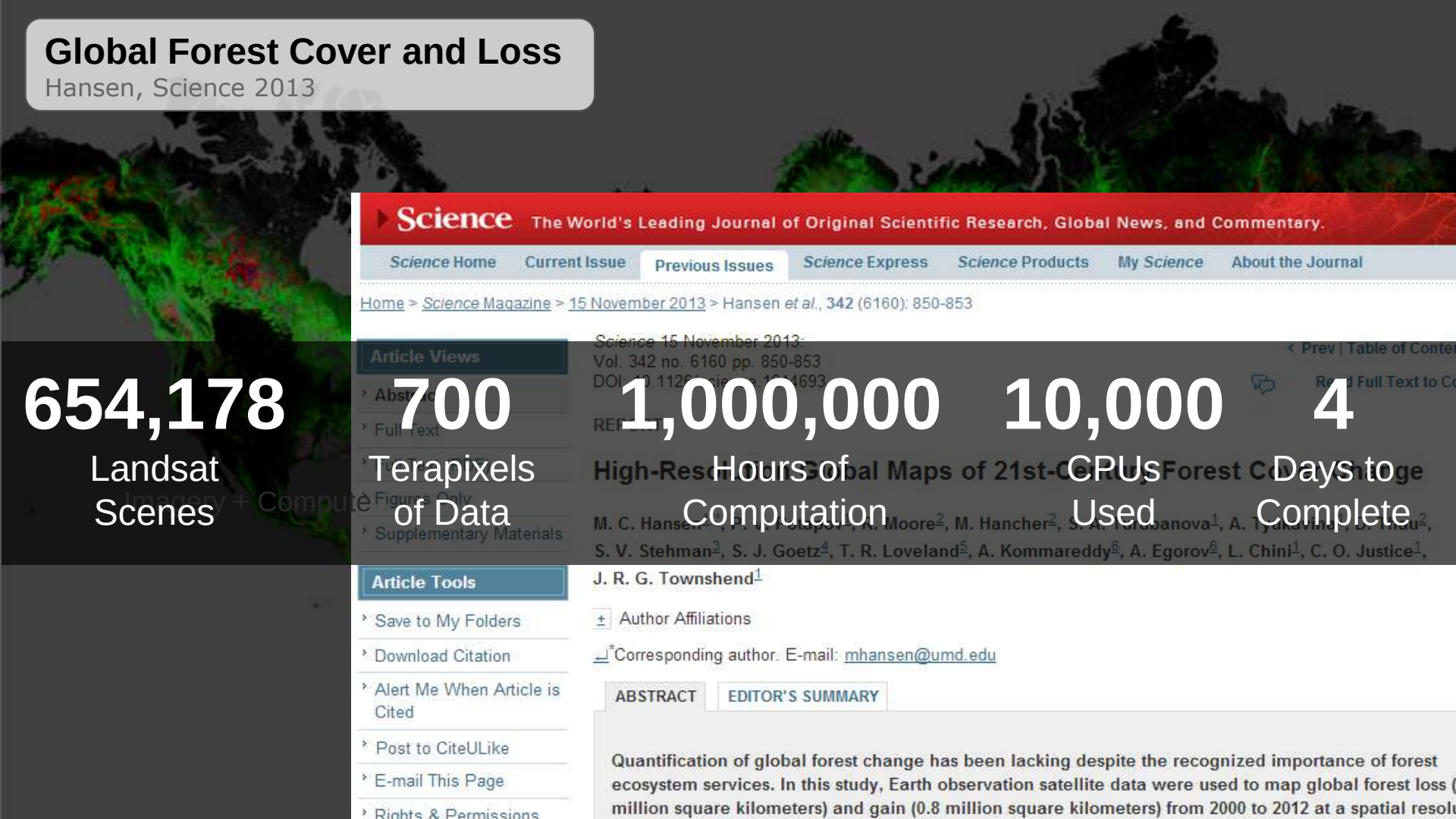
Las Vegas, Nevada

Ucayali River, Pucallpa, Peru

Cape Cod, Massachusetts

Global Forest Cover and Loss

Hansen, Science 2013



654,178
Landsat Scenes

700
Terapixels of Data

1,000,000
Hours of Computation

10,000
CPUs Used

4
Days to Complete

Imagery + Compute

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Home > Science Magazine > 15 November 2013 > Hansen et al., 342 (6160): 850-853

Science 15 November 2013:
Vol. 342 no. 6160 pp. 850-853

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

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

Author Affiliations

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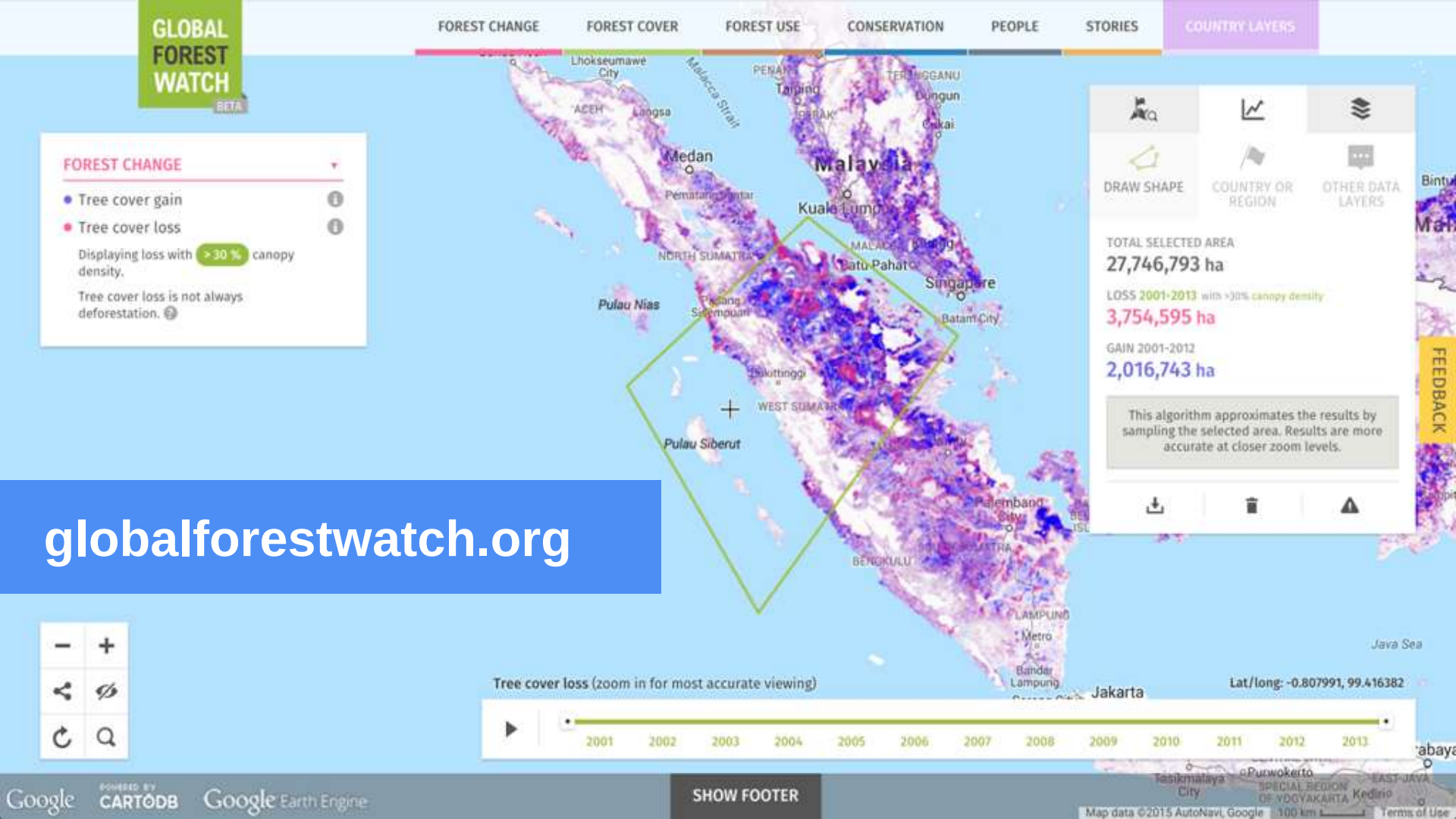
ABSTRACT | EDITOR'S SUMMARY

Quantification of global forest change has been lacking despite the recognized importance of forest ecosystem services. In this study, Earth observation satellite data were used to map global forest loss (million square kilometers) and gain (0.8 million square kilometers) from 2000 to 2012 at a spatial resolu


GLOBAL FOREST WATCH
BETA
FOREST CHANGE
FOREST COVER
FOREST USE
CONSERVATION
PEOPLE
STORIES
COUNTRY LAYERS
FOREST CHANGE
Tree cover gain
Tree cover loss
Displaying loss with > 30 % canopy density.
Tree cover loss is not always deforestation.
DRAW SHAPE
COUNTRY OR REGION
OTHER DATA LAYERS
TOTAL SELECTED AREA
27,746,793 ha
LOSS 2001-2013 with >30% canopy density
3,754,595 ha
GAIN 2001-2012
2,016,743 ha
This algorithm approximates the results by sampling the selected area. Results are more accurate at closer zoom levels.
FEEDBACK
globalforestwatch.org
Tree cover loss (zoom in for most accurate viewing)
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
Lat/long: -0.807991, 99.416382
Google
CARTODB
Google Earth Engine
SHOW FOOTER
Map data ©2015 AutoNavi, Google
Terms of Use

Global Surface Water Change

Pekel, Nature 2016

3,066,080
Landsat Scenes

1,800
Terapixels of Data

1,212
Years of Computation

12 x 32
Every month for 32 years

Imagery + Compute

nature International weekly journal of science

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LETTER

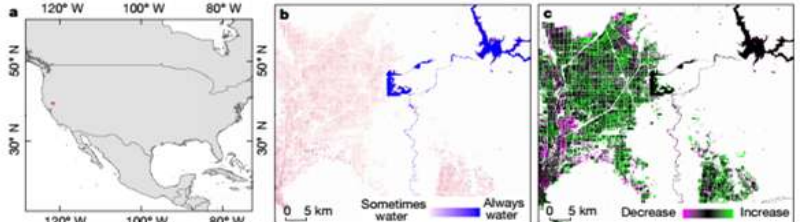
doi:10.1038/nature20584

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

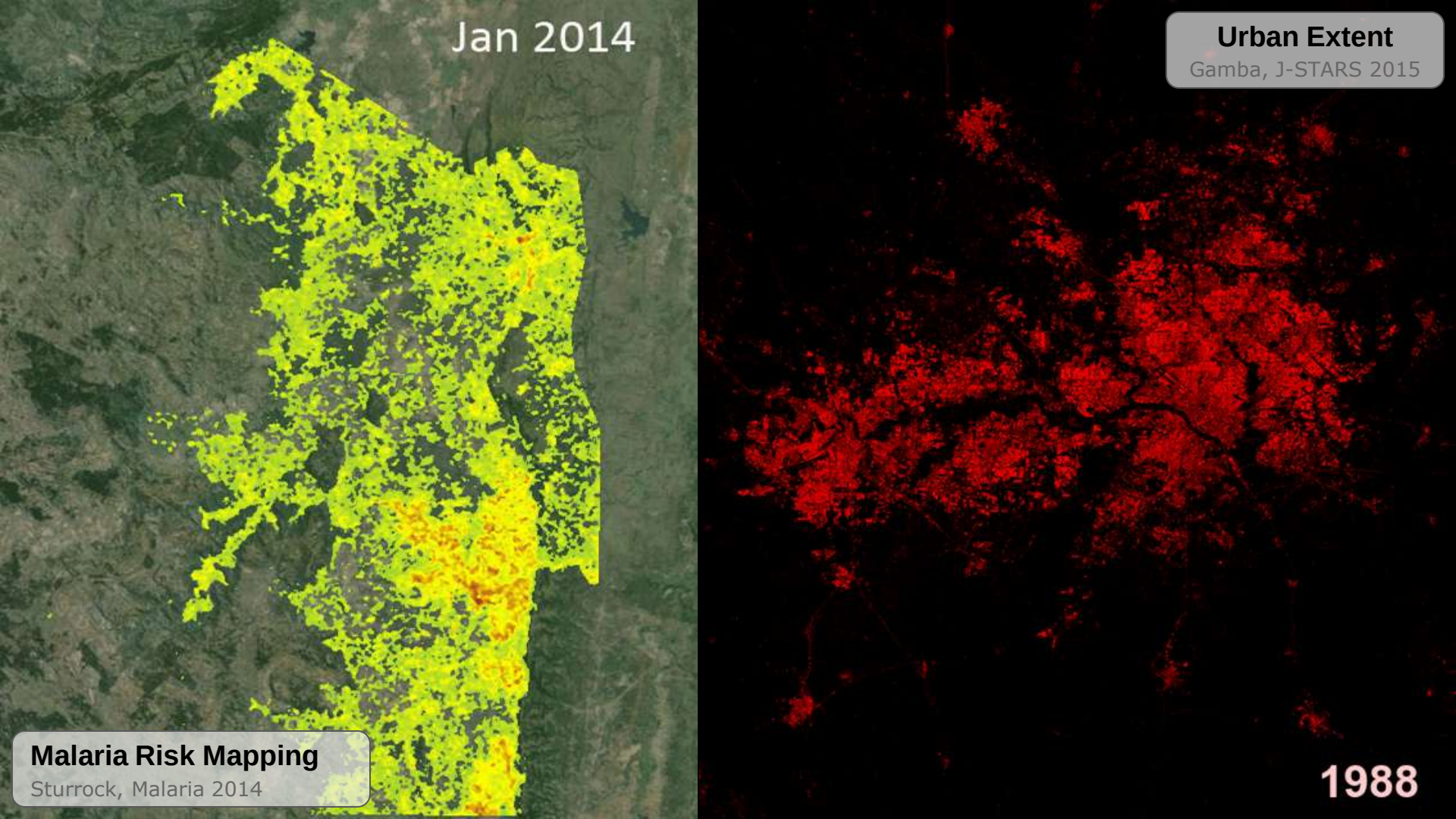
Jean-François Pekel[1], Andrew Cottam[1], Noel Gorelick[2] & Alan S. Belward[1]

The location and persistence of surface water (fluvial and coastal) is both affected by climate and human activity and affects climate[2,3], biological diversity[4] and human wellbeing[5,6]. Global data sets documenting [illegible] and seasonality have been produced from [illegible] descriptions[7], statistical extrapolation of regional data[8] and satellite imagery[9–12], but measuring long-[illegible] remains a challenge. Here, using [illegible] images[13], we quantify changes in global surface water over the past 32 years at 30-metre resolution. We record the months and years when water was present, where occurrence changed and what form changes took in terms of seasonality and persistence. Between 1984 and 2015 permanent surface water has disappeared from an area of almost 90,000 square kilometres, roughly equivalent to that of Lake Superior, though new permanent bodies of surface water covering 184,000 square kilometres have formed elsewhere. All continental regions show a net increase in permanent water, except Oceania, which has a fractional (one per cent) net loss. Much of the increase is from reservoir [illegible] although [illegible] implicated. Loss is more geographically concentrated than gain. Over 70 per cent of global net permanent water loss occurred in the Middle East and Central [illegible] including river div[illegible] Losses in Australia[17] and the USA[18] linked to long-term droughts are also evident. This [illegible] validated data set shows that impacts of clim[illegible] fluctuations on surface water occurrence can be measured and that evidence can be gathered to show how surface water is altered by human activities. We anticipate that this freely available data will improve the modelling of surface forcing, provide evidence of state and change in wetland ecotones (the transition areas between biomes), and inform water-management decision-making.

Between any two points in time, part of the Earth's surface is constantly underwater and part is never underwater, with the remainder fluctuating between these extremes. Coastlines and lake and river boundaries advance and retreat, rivers meander, new permanent lakes form and




River Morphology
A. Bryk, UC Berkeley
1984
2km
Global Surface Water


Jan 2014
Malaria Risk Mapping
Sturrock, Malaria 2014
Urban Extent
Gamba, J-STARS 2015
1988

Urban Mapping *

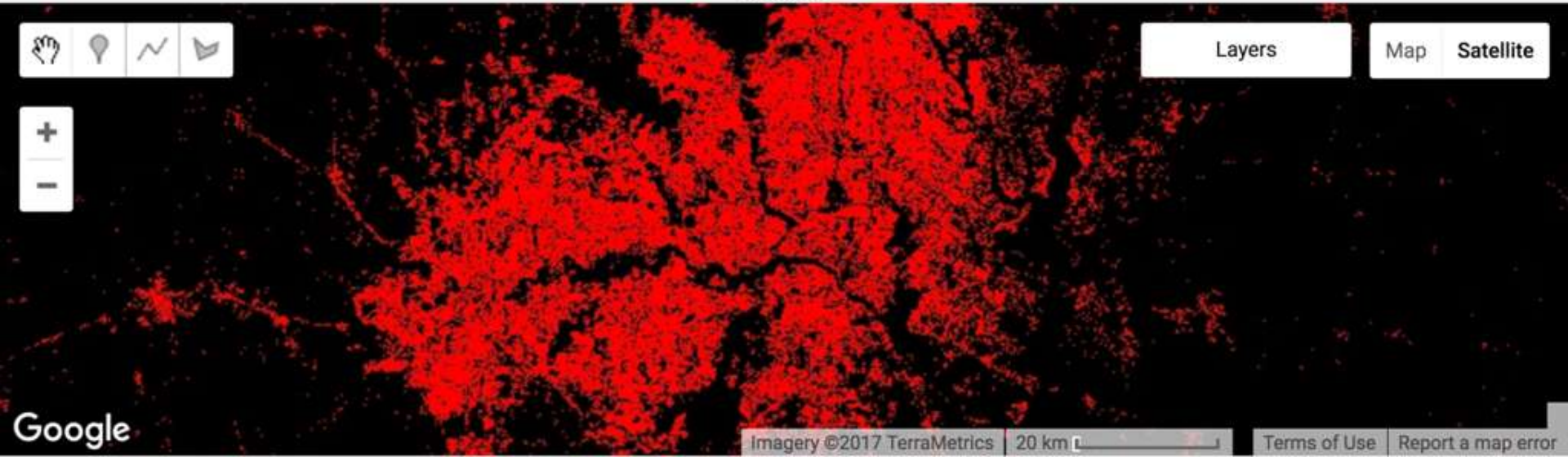
Get Link | Save | Run | Reset

```
1  var L8 = ee.ImageCollection("LANDSAT/LC8_L1T")
2      .filterDate("2015-01-01", "2016-01-01")
3      .select("B[0-9]*")
4
5  var image = ee.Algorithms.SimpleLandsatComposite(L8)
6  Map.addLayer(image, {min:0, max:60, bands: ["B4", "B3", "B2"]});
7
8
9
10
11
12
```

Urban Mapping *

Get Link | Save | Run | Reset

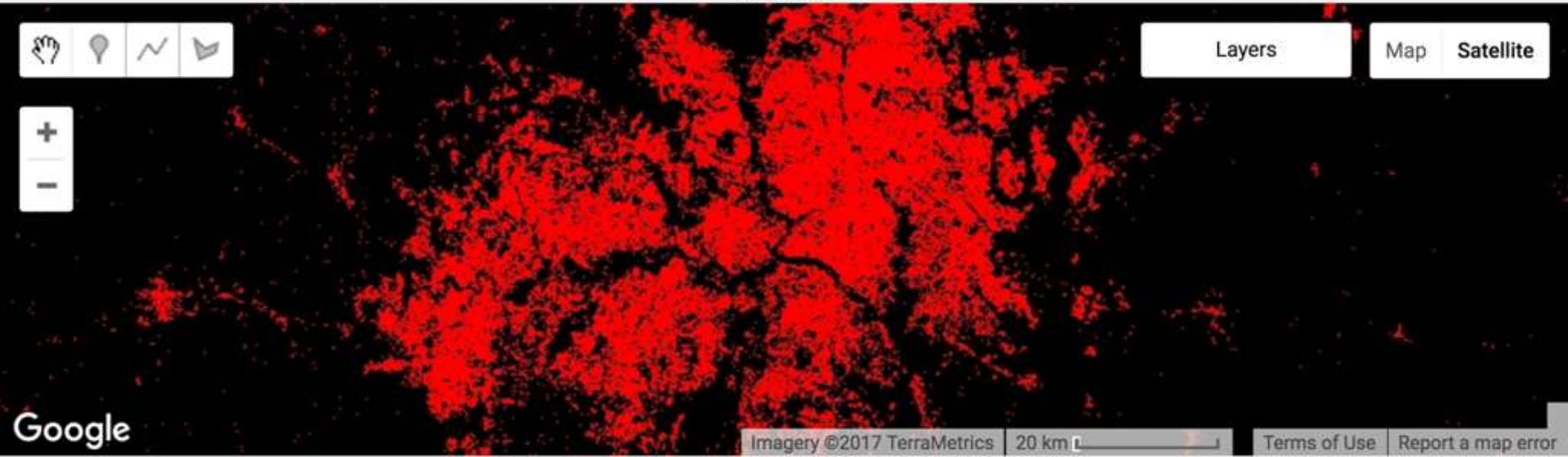
```
1  var L8 = ee.ImageCollection("LANDSAT/LC8_L1T")
2      .filterDate("2015-01-01", "2016-01-01")
3      .select("B[0-9]*")
4
5  var image = ee.Algorithms.SimpleLandsatComposite(L8)
6  var training = image.sampleRegions("users/gorelick/urban/dallas", null, 30);
7  var classifier = ee.Classifier.cart().train(training, "class")
8  var result = image.classify(classifier);
9
10 Map.addLayer(result, {min:0, max:1, palette: ["black", "red"]});
```



Urban Mapping *

Get Link | Save | Run | Reset

```
1  var L8 = ee.ImageCollection("LANDSAT/LC8_L1T")
2      .filterDate("2015-01-01", "2016-01-01")
3      .select("B[0-9]*")
4
5  var image = ee.Algorithms.SimpleLandsatComposite(L8)
6  var training = image.sampleRegions("users/gorelick/urban/dallas", null, 30);
7  var classifier = ee.Classifier.svm().train(training, "class")
8  var result = image.classify(classifier);
9
10 Map.addLayer(result, {min:0, max:1, palette: ["black", "red"]});
```

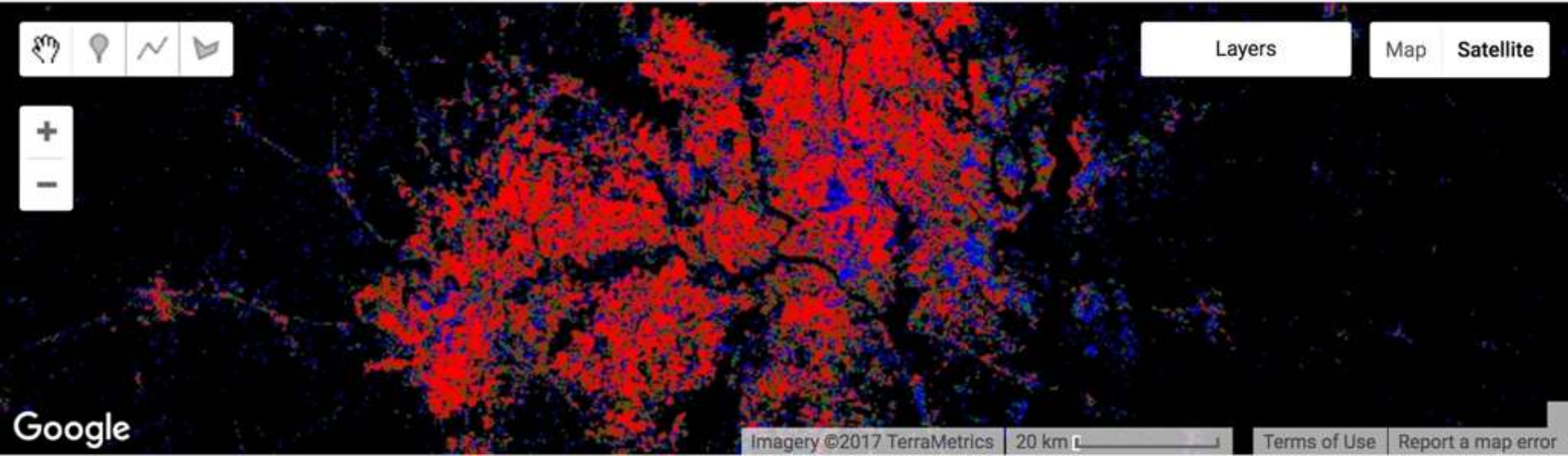


Urban Mapping *

Get Link | Save | Run | Reset

```
var L8 = ee.ImageCollection("LANDSAT/LC8_L1T")
    .filterDate("2015-01-01", "2016-01-01")
    .select("B[0-9]*")

var image = ee.Algorithms.SimpleLandsatComposite(L8)
var training = image.sampleRegions("users/gorelick/urban/dallas", null, 30);
var classifiers = [ee.Classifier.cart(), ee.Classifier.svm(), ee.Classifier.randomForest(10)]
var votes = ee.Image();
for (var i in classifiers) {
  votes = votes.addBands(image.classify(classifiers[i].train(training, "class")));
}
Map.addLayer(votes.reduce('sum'), {min:0, max:3, palette: ["black", "blue", "green", "red"]});
```



Sentinel-1 Explorer

This app allows you to filter and export images from the Sentinel-1 GRD collection.

1) Select filters

Start date: 2017-01-01

End date: 2017-04-01

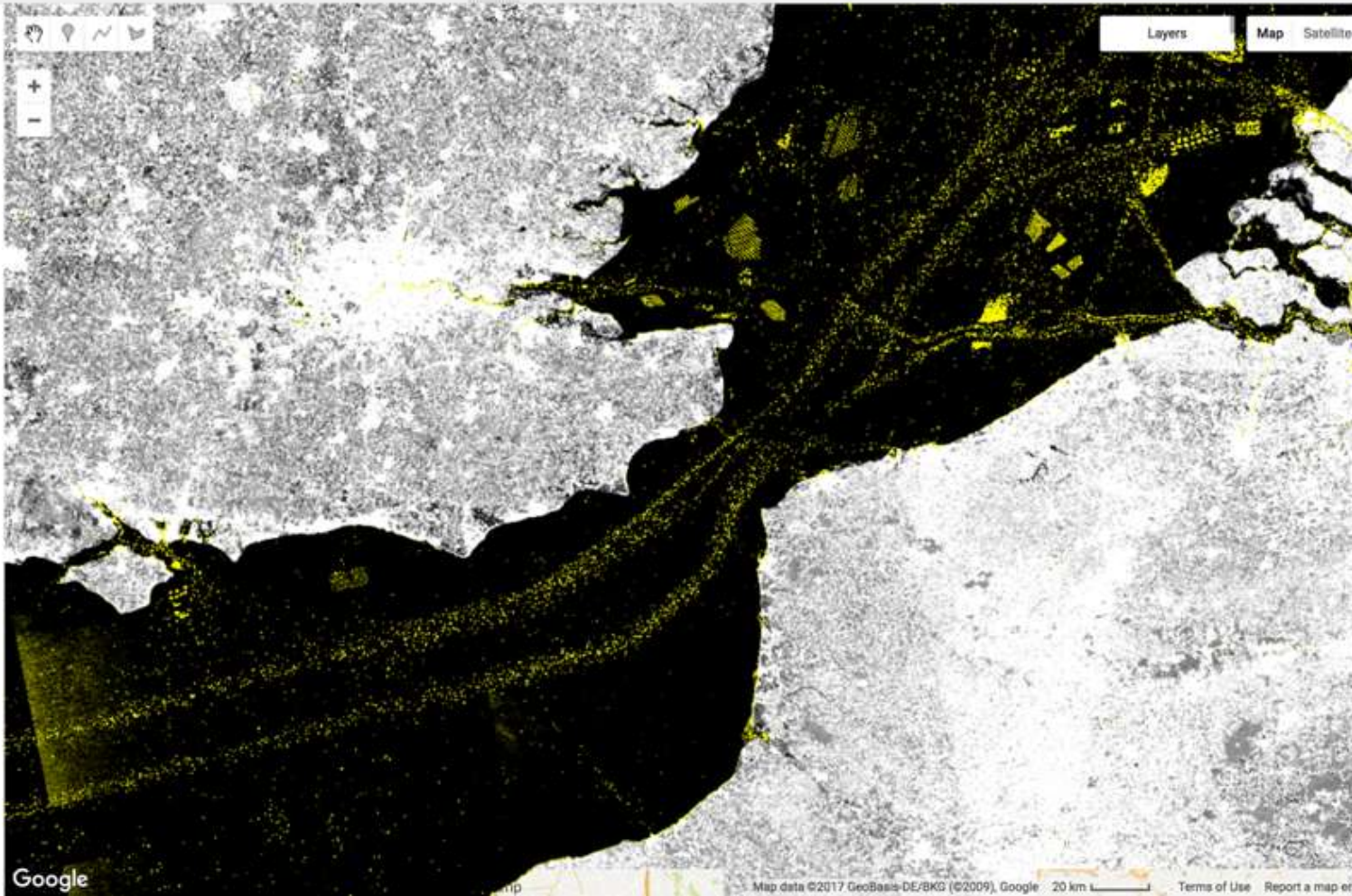
Polarization: VV

Image Stack reducer: max

Apply filters

4) Start an export

TODO: Have this export a video...



What's your business model?

We have to live on this planet too

- Societal benefit has a huge value

~400 Earth Engine based papers published in 2016

Google uses this technology internally

- Maps, Crisis Response, Network Operations, Access, Energy, etc.

Commercial Use

Status

Free for non-commercial use

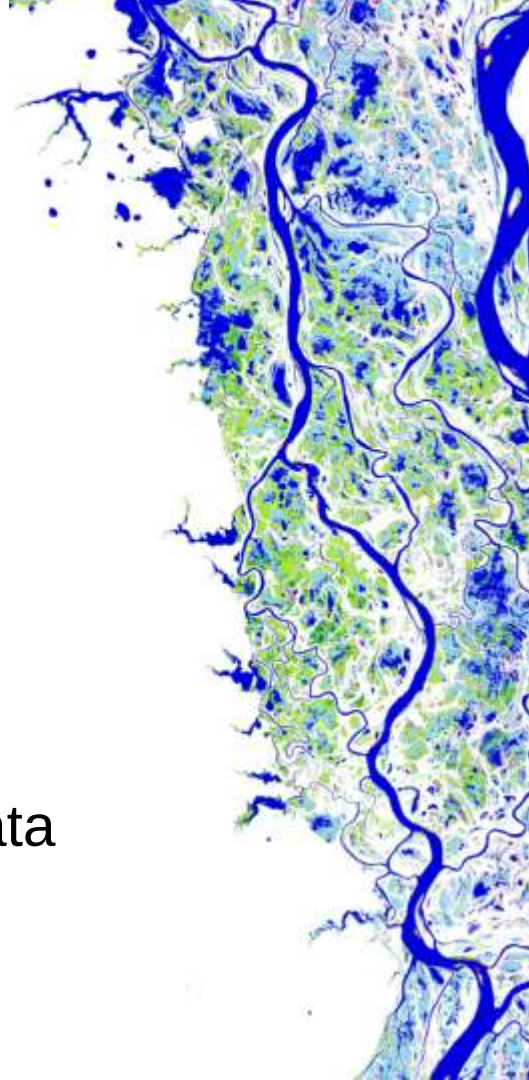
- More than 45,000 users in 170 countries
- ~400 Earth Engine based papers last year
- Large "freemium" quota

Open for commercial users, 2017

- Consumption based billing

No, we don't claim/take/own your Algorithms or Data

- But we do make it easy to share



Thank You

earthengine.google.com