The background image shows a complex network of water bodies and landforms, primarily the Ob River delta in Russia. The water is a deep blue, while the land is a mix of white (snow/ice) and brownish-green (wetland vegetation). The river network is dense and winding.

# The Global Surface Water Explorer

Jean-Francois Pekel, Andrew Cottam, \*Noel Gorelick  
and Alan Belward

European Commission, Joint Research Centre, 21027 Ispra (Va), Italy

\*Google Earth Engine team, Zurich, Switzerland

Goal 6: Ensure availability and sustainable management of water and sanitation for all

Target 6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, *aquifers* and lakes

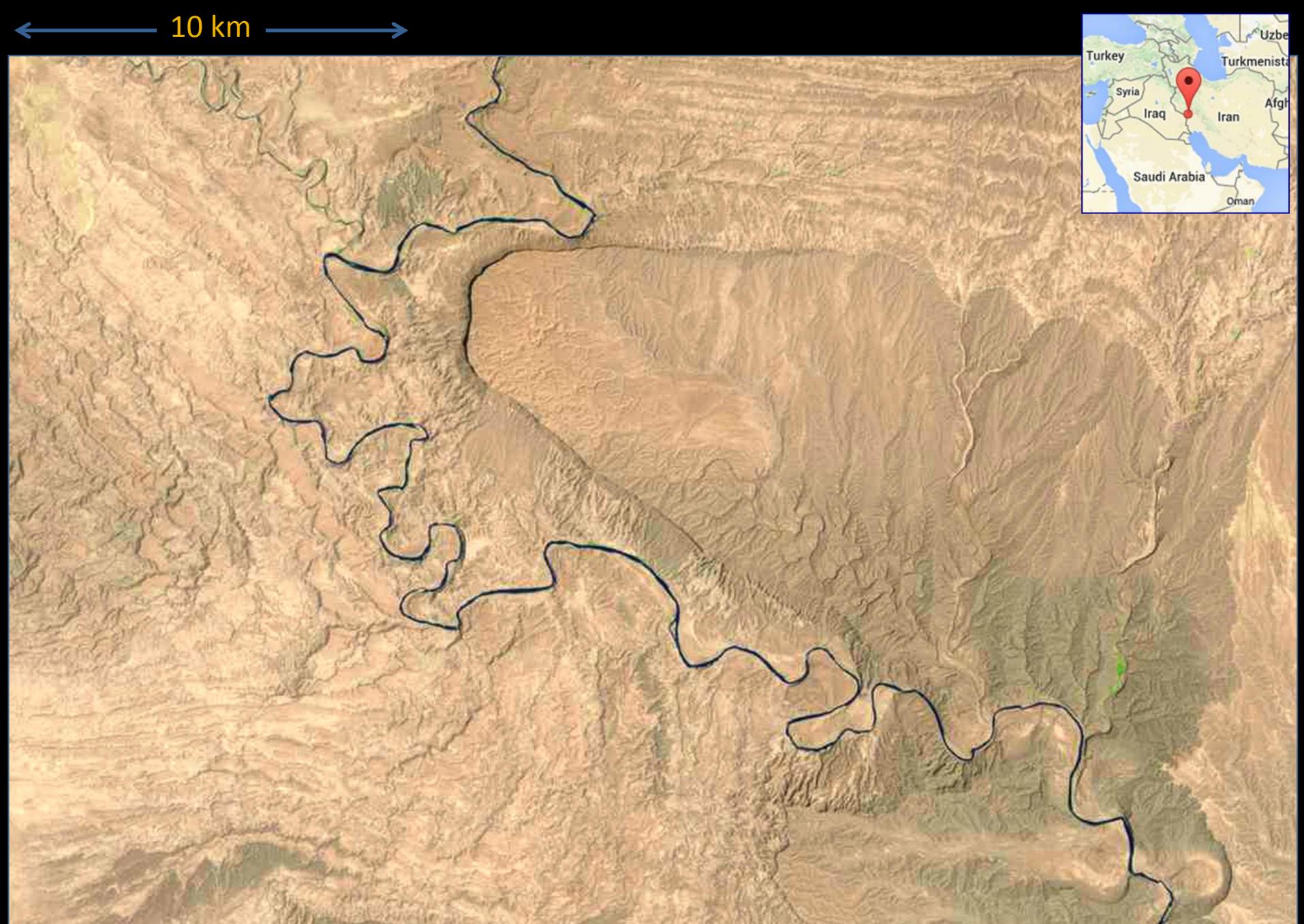
Indicator 6.6.1: Change in the extent of water-related ecosystems over time

Sub-Indicator 6.6.1.a: Spatial extent

## Inland open waters, rivers and estuaries



Humboldt Bay, Robert Campbell, Creative Commons Attribution-Share Alike 3.0; Wetlands in Cape May, U.S. Army Corps of Engineers, public domain; Katse Dam SkyPixels, Creative Commons Attribution-Share Alike 4.0 International; Dove Lake, Bjørn Christian Tørrissen, e Commons Attribution-Share Alike 3.0 Unported; Greenland meltpond, Michael Studinger, Creative Commons Attribution-Share Alike 2.0 Generic; Dourtenga pond, KKB, Creative Commons Attribution-Share Alike 4.0 International; Suez Canal, Panoramio user 2433337, Creative Commons Attribution-Share Alike 3.0 Unported; Rice fields, Supercarwaar, Creative Commons Attribution-Share Alike 3.0 Unported; Amazon, Neil Palmer, Creative Commons Attribution-Share Alike 2.0 Generic



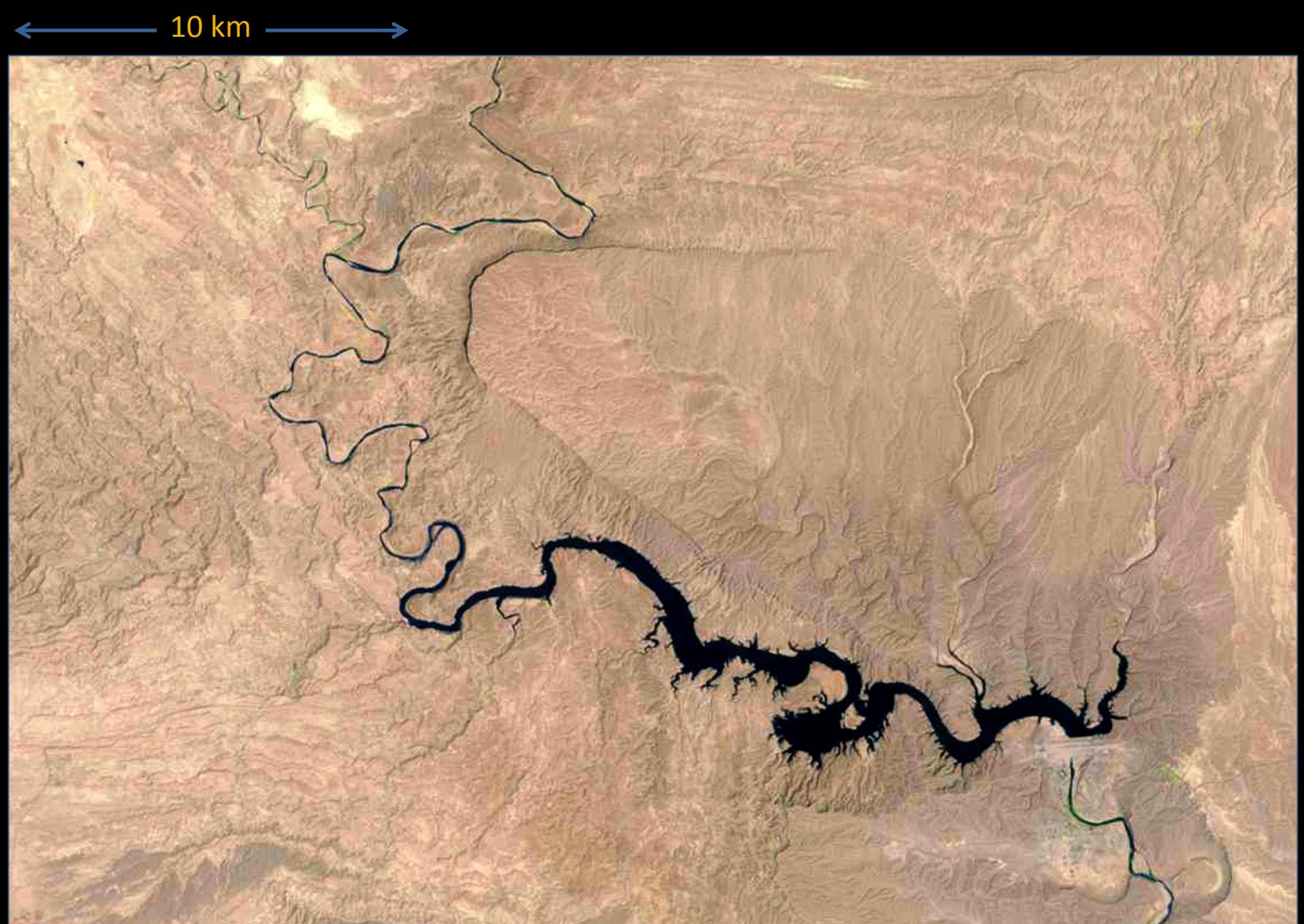
Landsat image of Karkheh River, Iran 13<sup>th</sup> August 1984, Source USGS / NASA

10 km



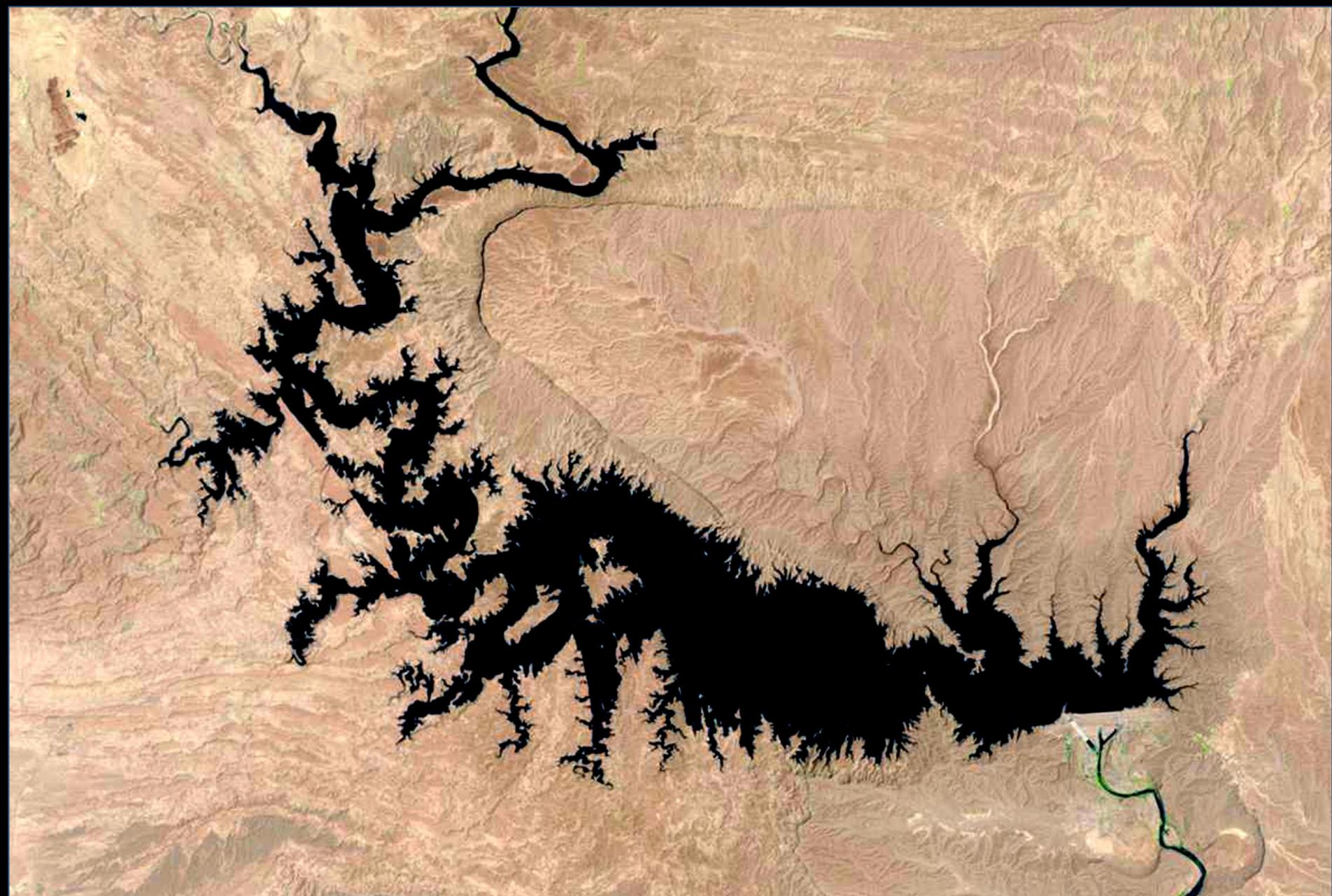
Karkheh Dam

Landsat image of Karkheh River, Iran 23<sup>rd</sup> August 1999, Source USGS / NASA



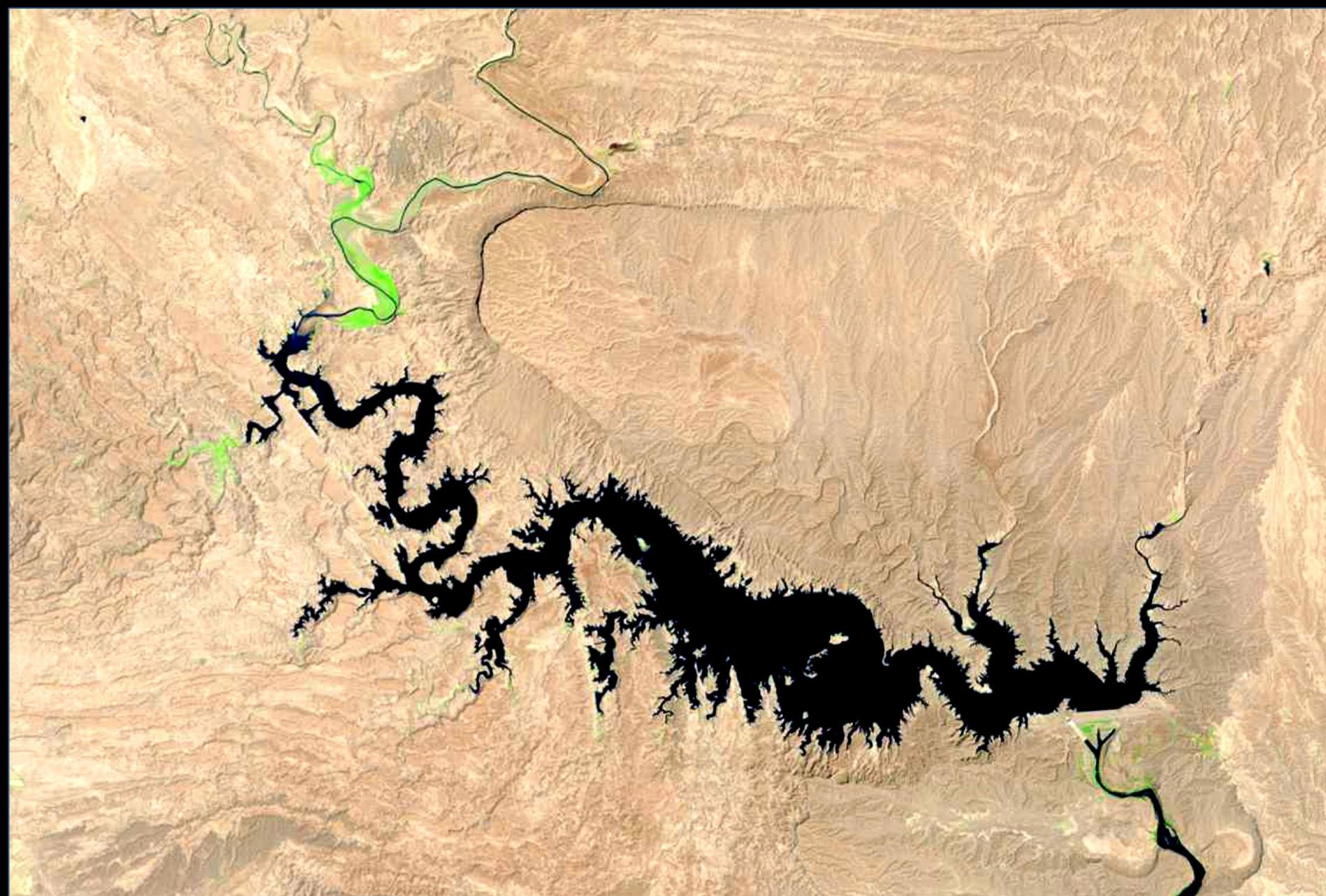
Landsat image of Karkheh River, Iran 17<sup>th</sup> August 2000, Source USGS / NASA

10 km

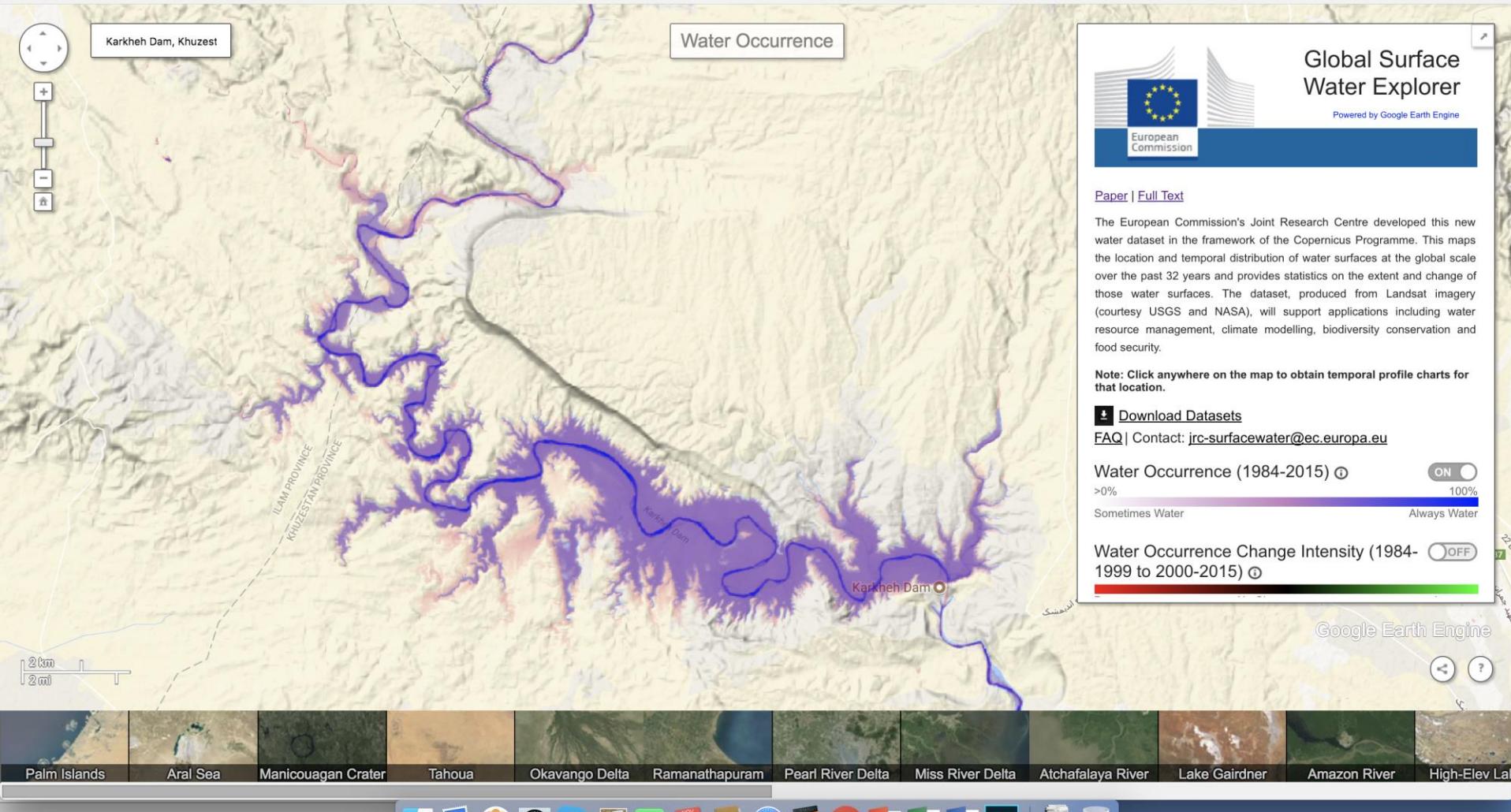


Landsat image of Karkheh River, Iran 7<sup>th</sup> August 2002, Source USGS / NASA

10 km



Landsat image of Karkheh River, Iran 19<sup>th</sup> August 2015, Source USGS / NASA



Chrome File Edit View History Bookmarks People Window Help

100% 15:59 Mon Alan Belward

Global Surface Water Explorer 

Secure | https://global-surface-water.appspot.com

Search for a location... 

Water Occurrence

 Global Surface Water Explorer  
Powered by Google Earth Engine

Paper | Full Text

The European Commission's Joint Research Centre developed this new water dataset in the framework of the Copernicus Programme. This maps the location and temporal distribution of water surfaces at the global scale over the past 32 years and provides statistics on the extent and change of those water surfaces. The dataset, produced from Landsat imagery (courtesy USGS and NASA), will support applications including water resource management, climate modelling, biodiversity conservation and food security.

Note: Click anywhere on the map to obtain temporal profile charts for that location.

 Download Datasets

FAQ | Contact: [jrc-surfacewater@ec.europa.eu](mailto:jrc-surfacewater@ec.europa.eu)

Water Occurrence (1984-2015)  ON

>0% 100%

Sometimes Water Always Water

Water Occurrence Change Intensity (1984-1999 to 2000-2015)  OFF

Google Earth Engine  ?

50 km 20 mi

50 km 20 mi

Palm Islands Aral Sea Manicouagan Crater Tahoua Okavango Delta Ramanathapuram Pearl River Delta Miss River Delta Atchafalaya River Lake Gairdner Amazon River High-Elev La



Search for a location...



### Water Occurrence Change Intensity



Global Surface Water Explorer

Powered by Google Earth Engine

[Paper](#) | [Full Text](#)

The European Commission's Joint Research Centre developed this new water dataset in the framework of the Copernicus Programme. This maps the location and temporal distribution of water surfaces at the global scale over the past 32 years and provides statistics on the extent and change of those water surfaces. The dataset, produced from Landsat imagery (courtesy USGS and NASA), will support applications including water resource management, climate modelling, biodiversity conservation and food security.

**Note:** Click anywhere on the map to obtain temporal profile charts for that location.

 Download Datasets

FAQ | Contact: [jrc-surfacewater@ec.europa.eu](mailto:jrc-surfacewater@ec.europa.eu)

Water Occurrence (1984-2015) ⑧

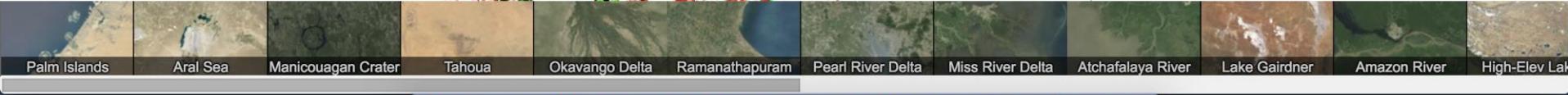
200

Sometimes Water

OFF

100%

## Water Occurrence Change Intensity (1984-1999 to 2000-2015) ⓘ



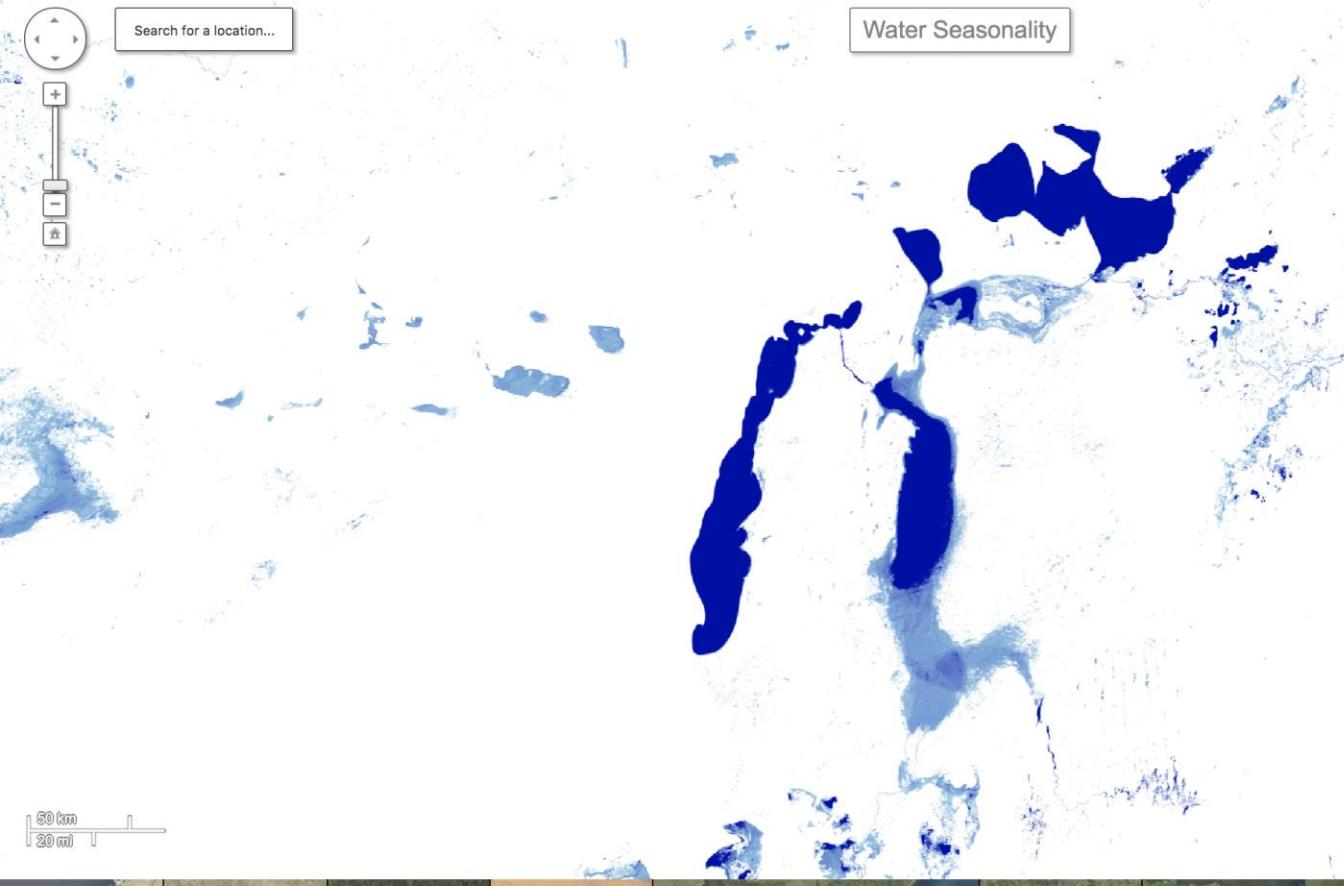
Chrome File Edit View History Bookmarks People Window Help

100% 15:59 Mon Alan Belward

Global Surface Water Explorer  

Secure | https://global-surface-water.appspot.com

Search for a location... 

Water Seasonality 

European Commission 

Global Surface Water Explorer  
Powered by Google Earth Engine

Water Occurrence Change Intensity (1984-1999 to 2000-2015)  OFF

Decrease No Change Increase

Water Seasonality (2014-2015)  ON

1 11 12  
Seasonal Permanent

Annual Water Recurrence (1984-2015)  OFF  
0% 100%

Water Transitions (First Year to Last Year)  OFF

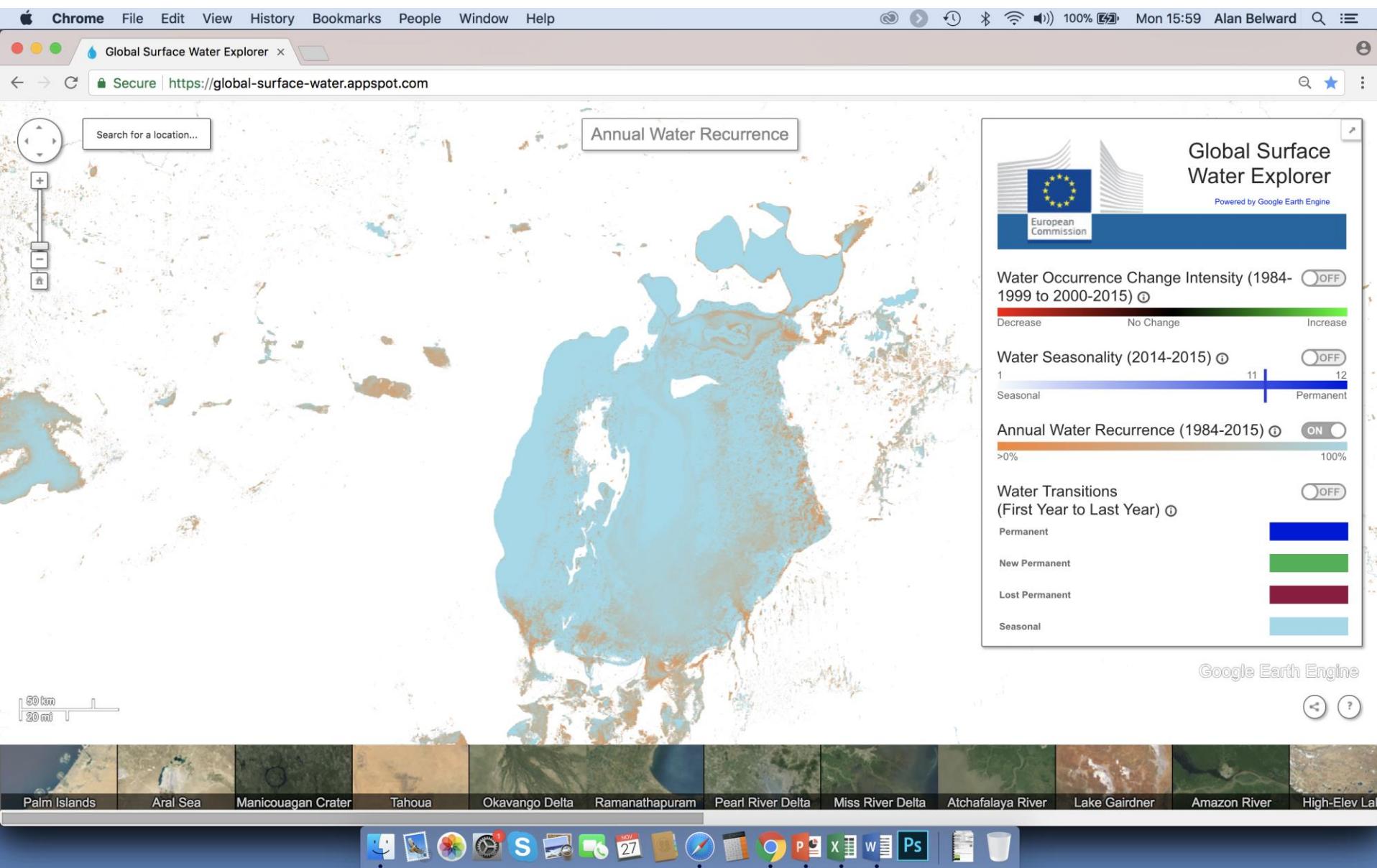
Permanent  
New Permanent  
Lost Permanent  
Seasonal

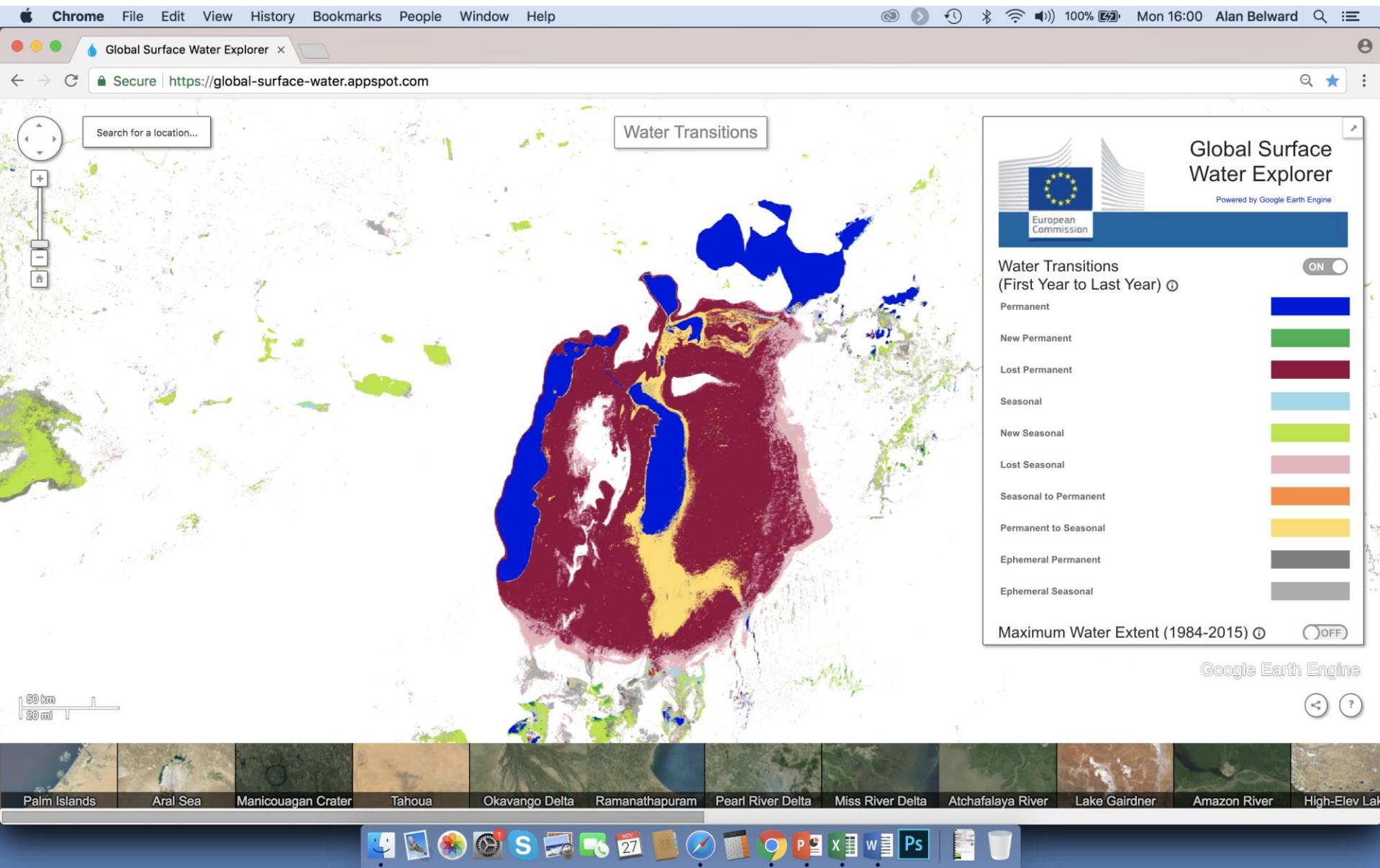
Google Earth Engine 

50 km 20 mi 

Palm Islands Aral Sea Manicouagan Crater Tahoua Okavango Delta Ramanathapuram Pearl River Delta Miss River Delta Atchafalaya River Lake Gairdner Amazon River High-Elev La 

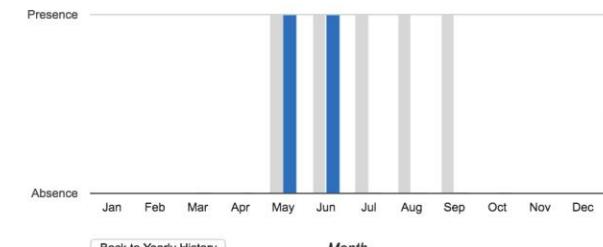
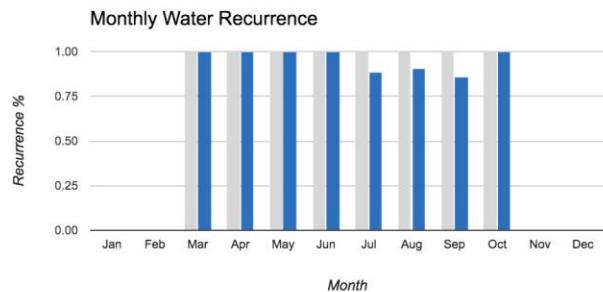
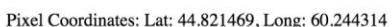
                











### **x ter Transitions**



Global Surface Water Explorer

Powered by Google Earth Engine

## Water Transitions (First Year to Last Year) ⓘ

## Permanent

### New Permanent

Lost Remanence

Sessions

### Name \_\_\_\_\_

140

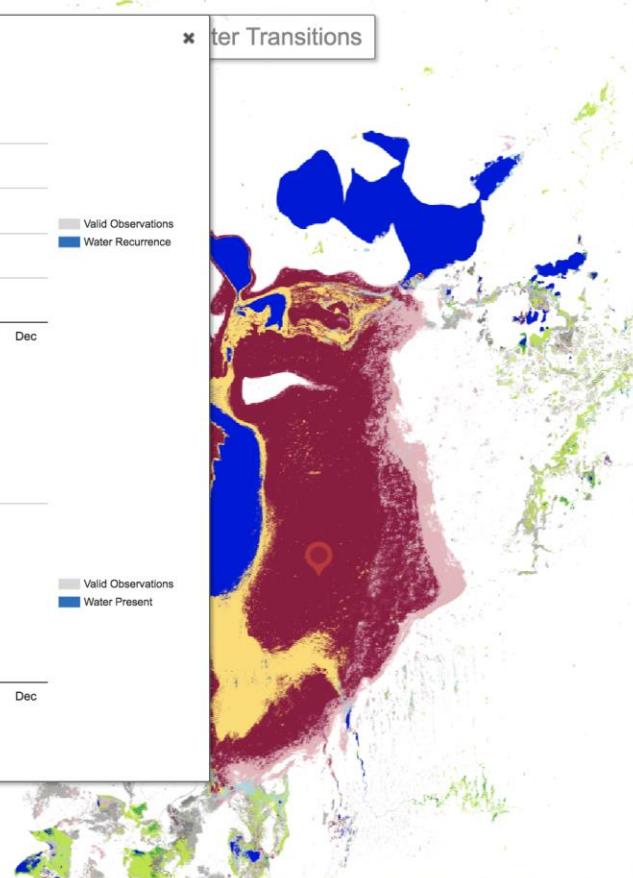
卷之三

Journal of Health Politics, Policy and Law, Vol. 30, No. 3, June 2005  
DOI 10.1215/03616878-30-3 © 2005 by The University of Chicago

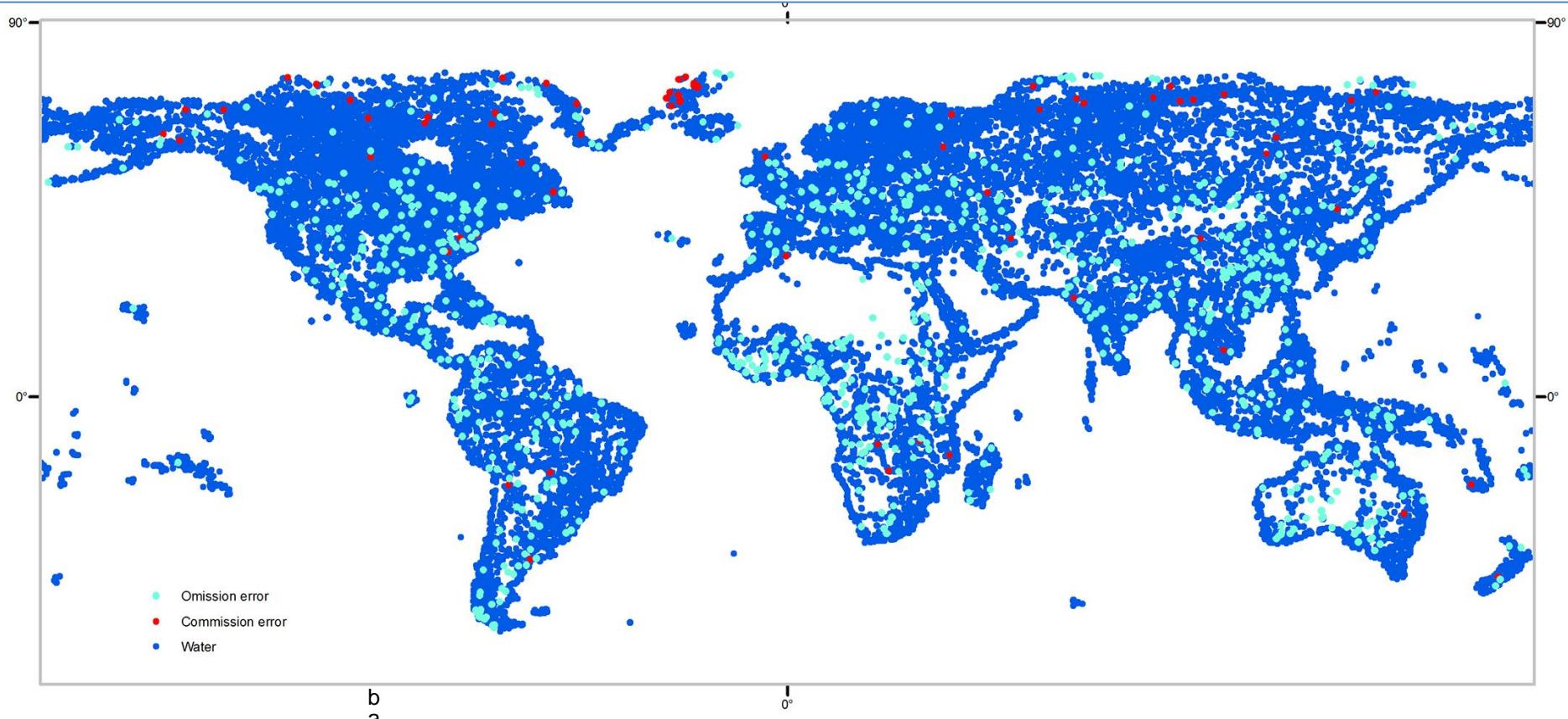
1000

10.000-15.000 m²

THE INFLUENCE OF CULTURE ON PARENTING



# Validation (errors of omission and commission)



b  
a

0°

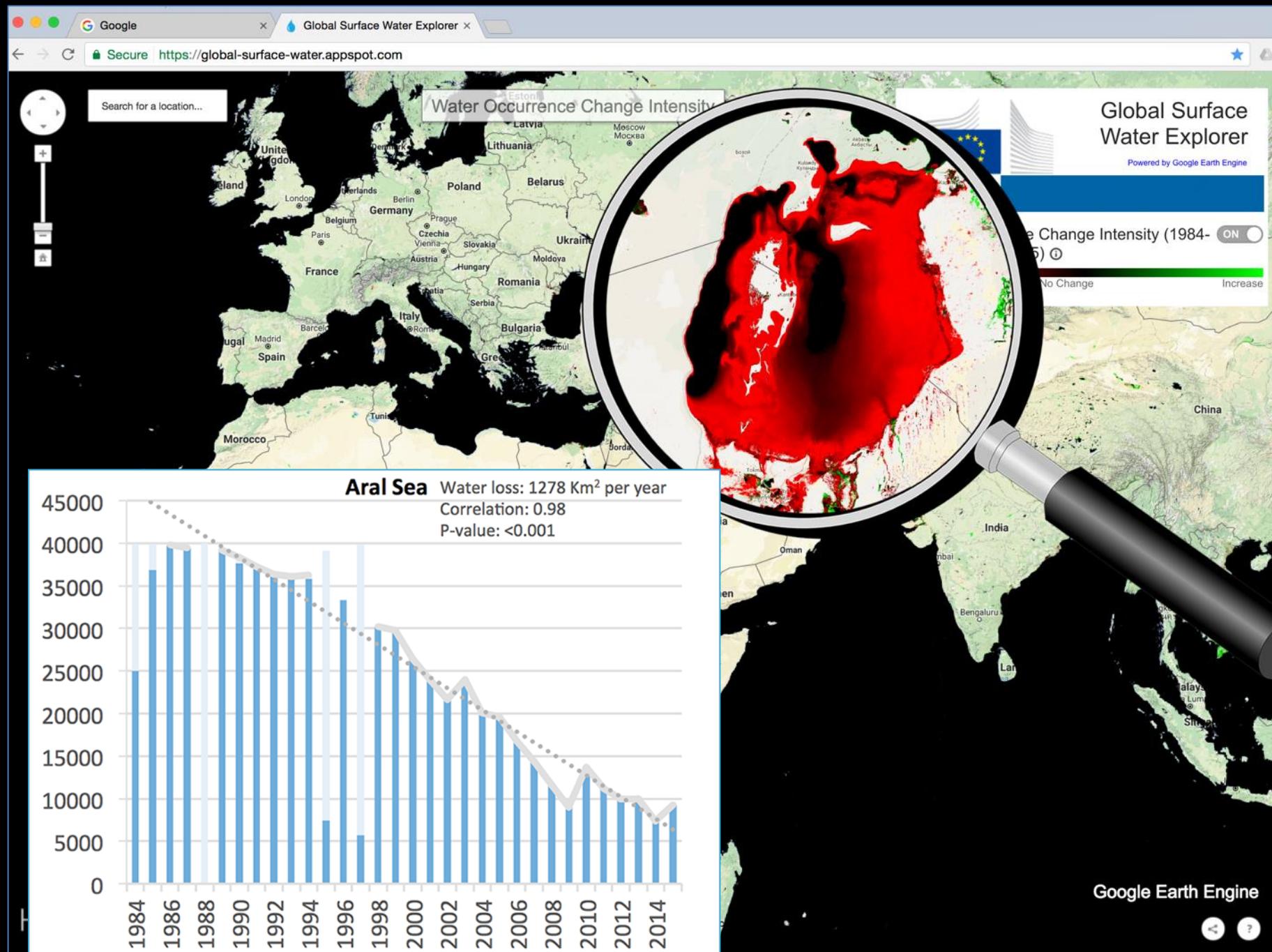
40,124  
pixels

a) Commission

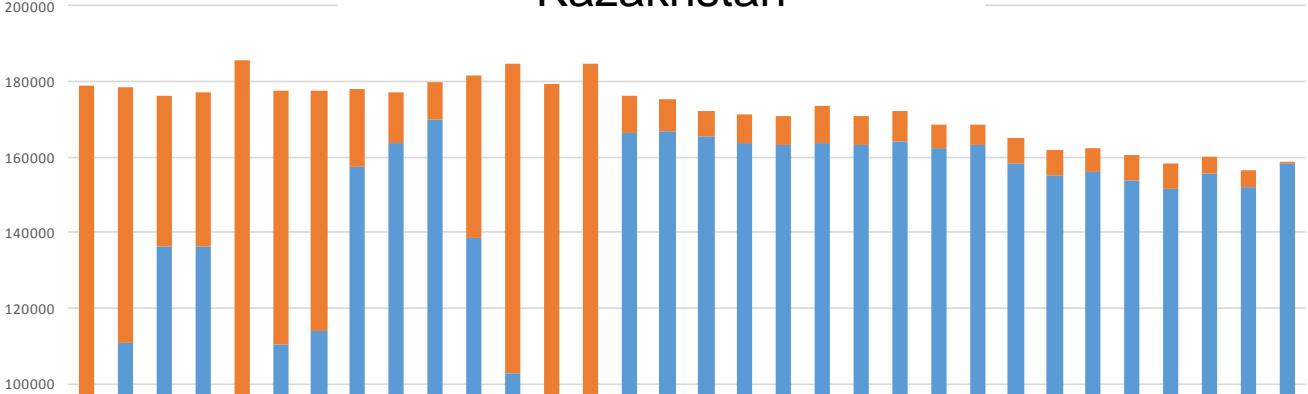
|                                 | Landsat 5 |          |           | Landsat 7 |          |           | Landsat 8 |          |           |
|---------------------------------|-----------|----------|-----------|-----------|----------|-----------|-----------|----------|-----------|
|                                 | Overall   | Seasonal | Permanent | Overall   | Seasonal | Permanent | Overall   | Seasonal | Permanent |
| Misclassified as land #         | 18        | 6        | 12        | 20        | 7        | 13        | 30        | 10       | 20        |
| Correctly classified as water # | 3226      | 493      | 2733      | 3037      | 424      | 2613      | 6525      | 671      | 5854      |
| Commission accuracy             | 99.45%    | 98.80%   | 99.56%    | 99.35%    | 98.38%   | 99.50%    | 99.54%    | 98.53%   | 99.66%    |

b) Omission

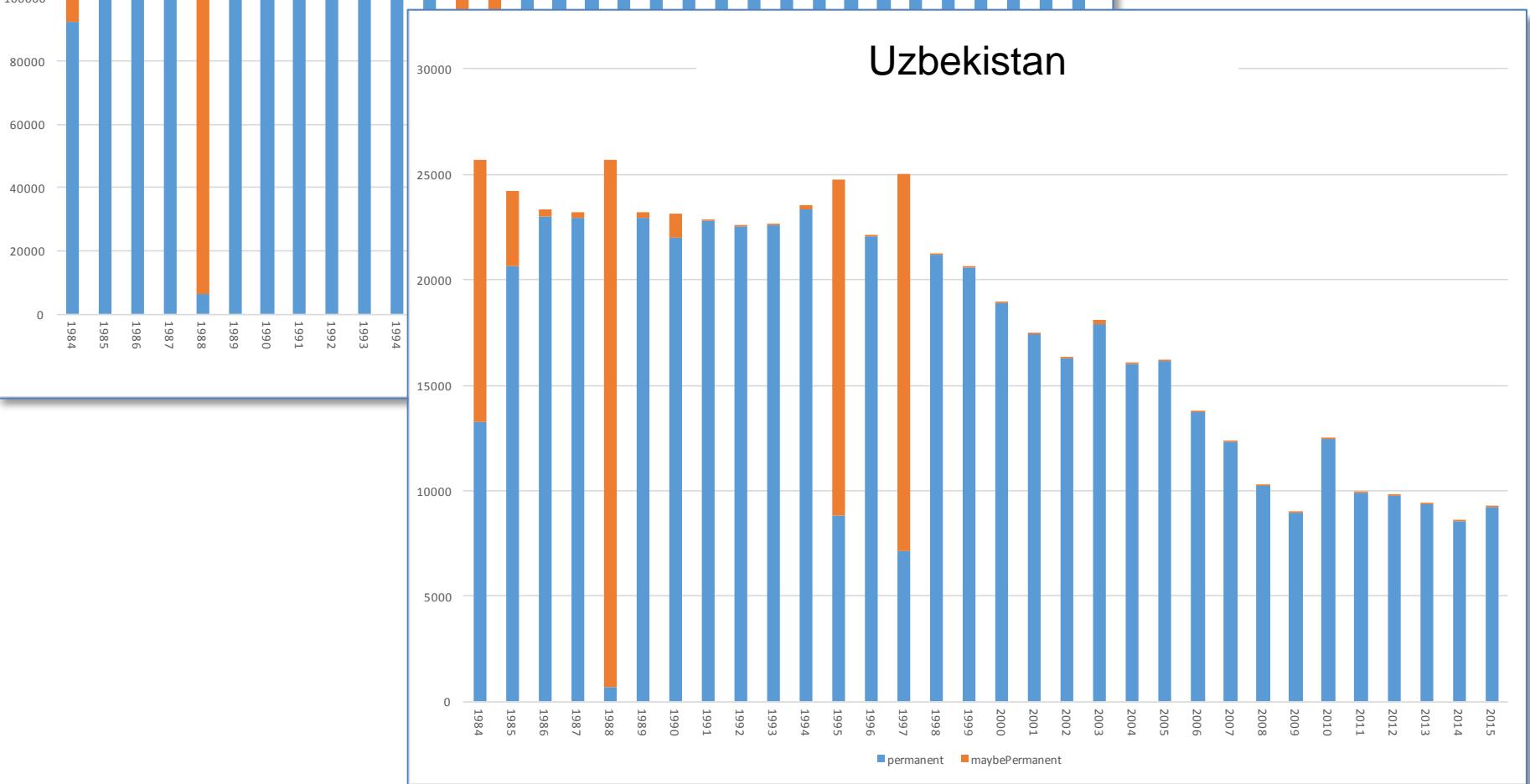
|                                 | Landsat 5 |          |           | Landsat 7 |          |           | Landsat 8 |          |           |
|---------------------------------|-----------|----------|-----------|-----------|----------|-----------|-----------|----------|-----------|
|                                 | Overall   | Seasonal | Permanent | Overall   | Seasonal | Permanent | Overall   | Seasonal | Permanent |
| Misclassified as land #         | 233       | 146      | 87        | 343       | 172      | 171       | 425       | 336      | 89        |
| Correctly classified as water # | 7561      | 436      | 7125      | 7808      | 485      | 7323      | 10898     | 1151     | 9747      |
| Omission accuracy               | 97.01%    | 74.91%   | 98.79%    | 95.79%    | 73.82%   | 97.72%    | 96.25%    | 77.40%   | 99.10%    |



# Kazakhstan

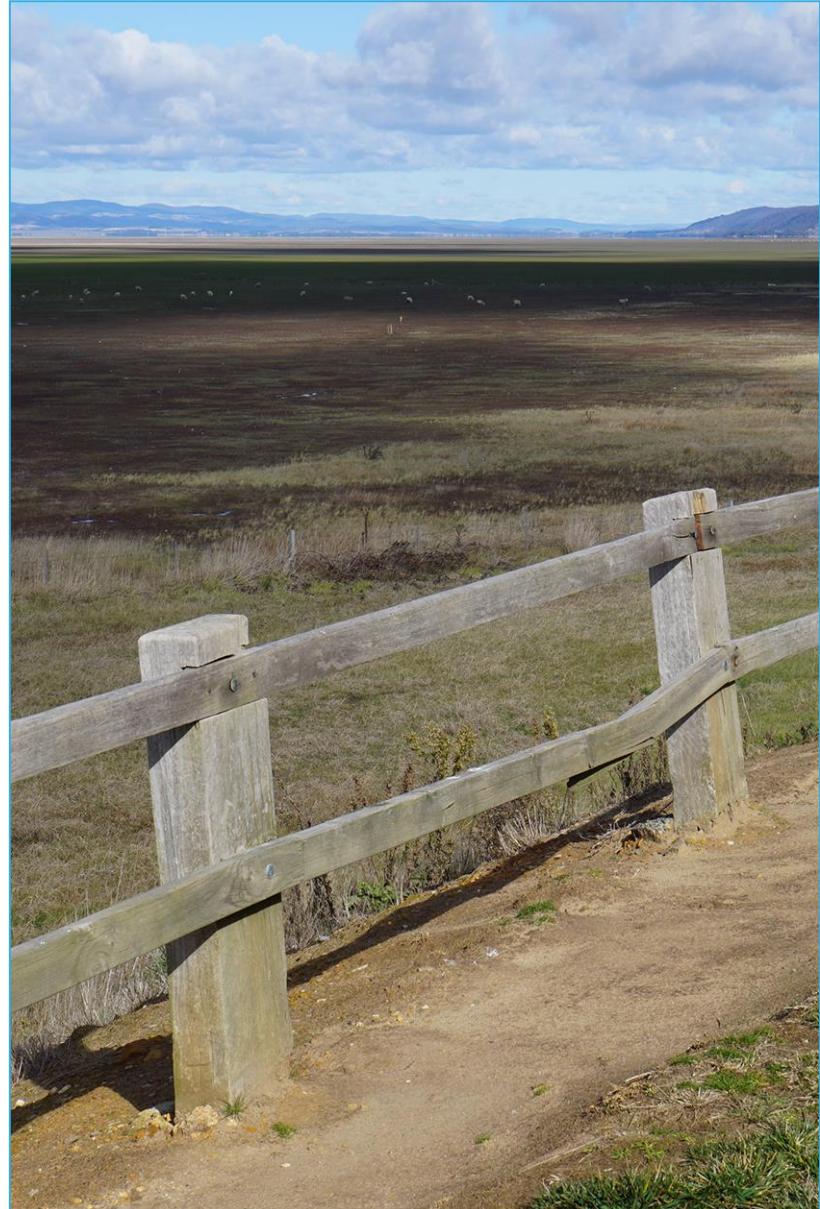
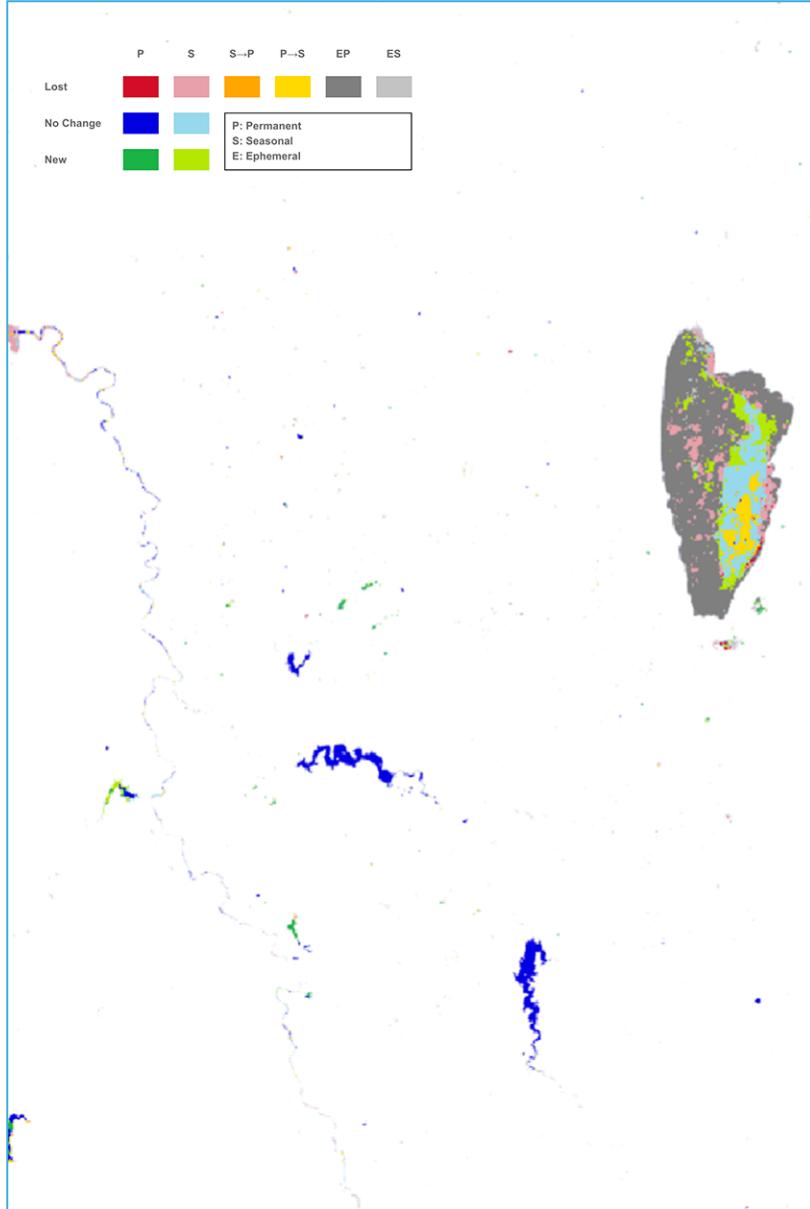


# Uzbekistan

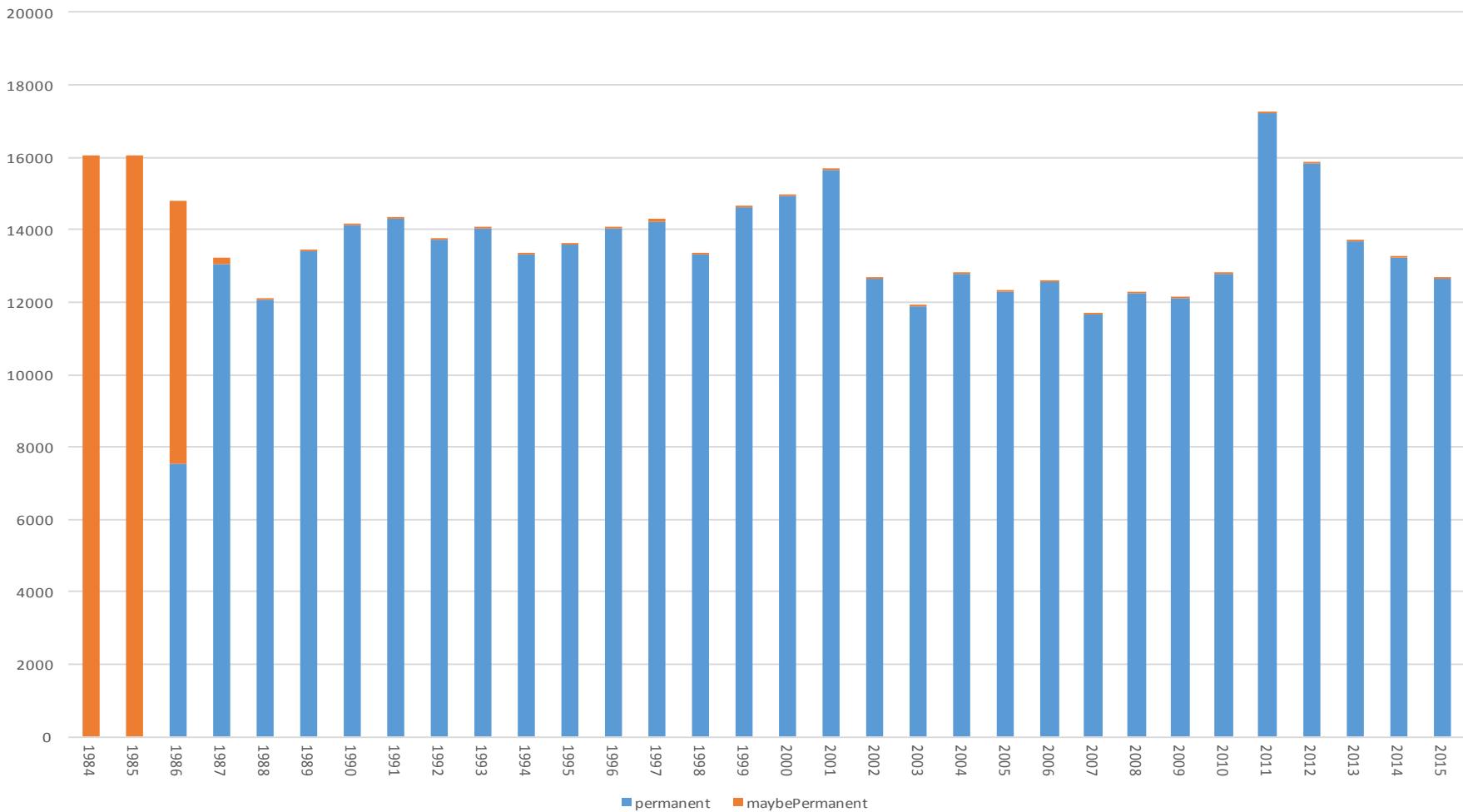


■ permanent ■ maybePermanent

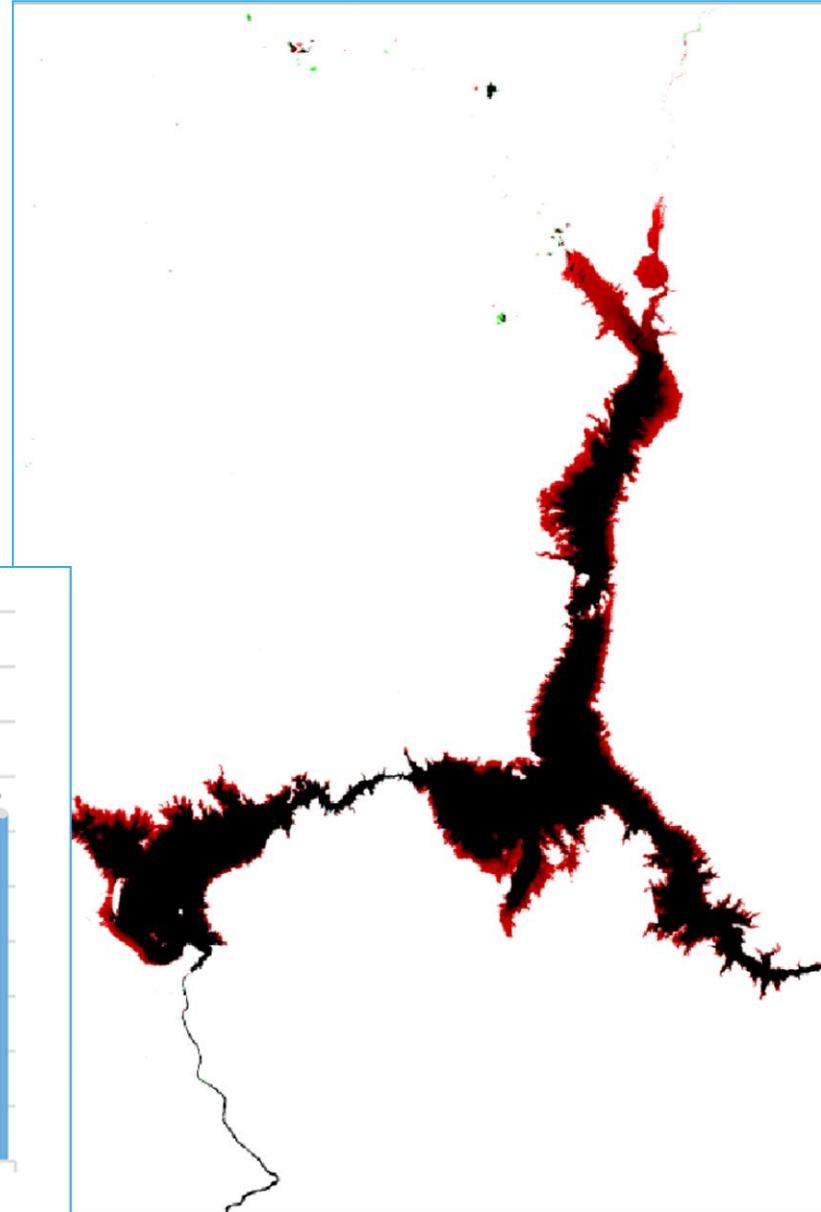
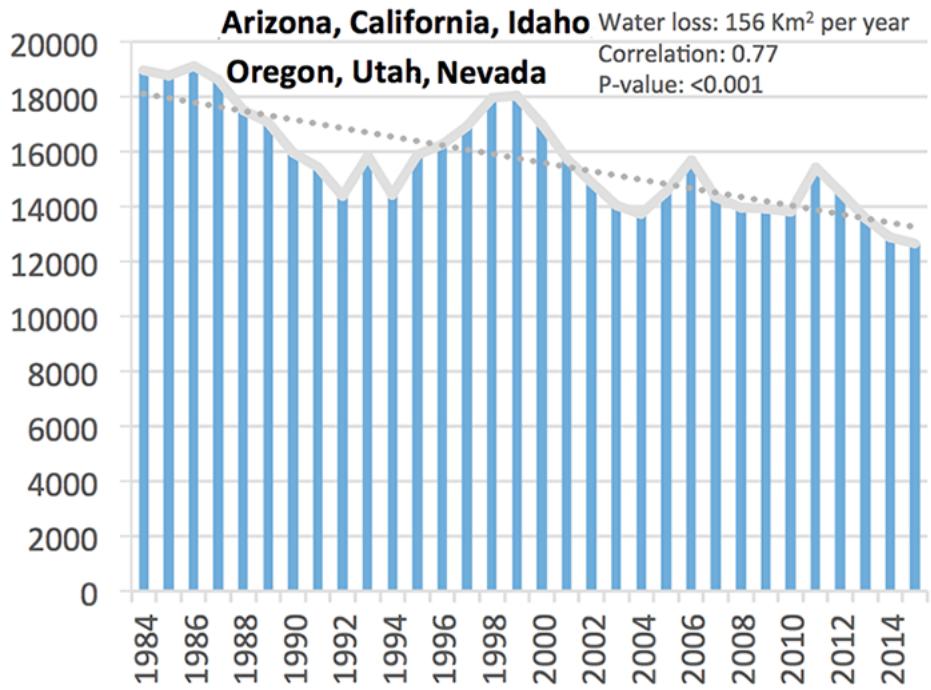
# Between 2001 and 2009, Australia's millennium drought impacts can be seen in the permanent surface water area trends

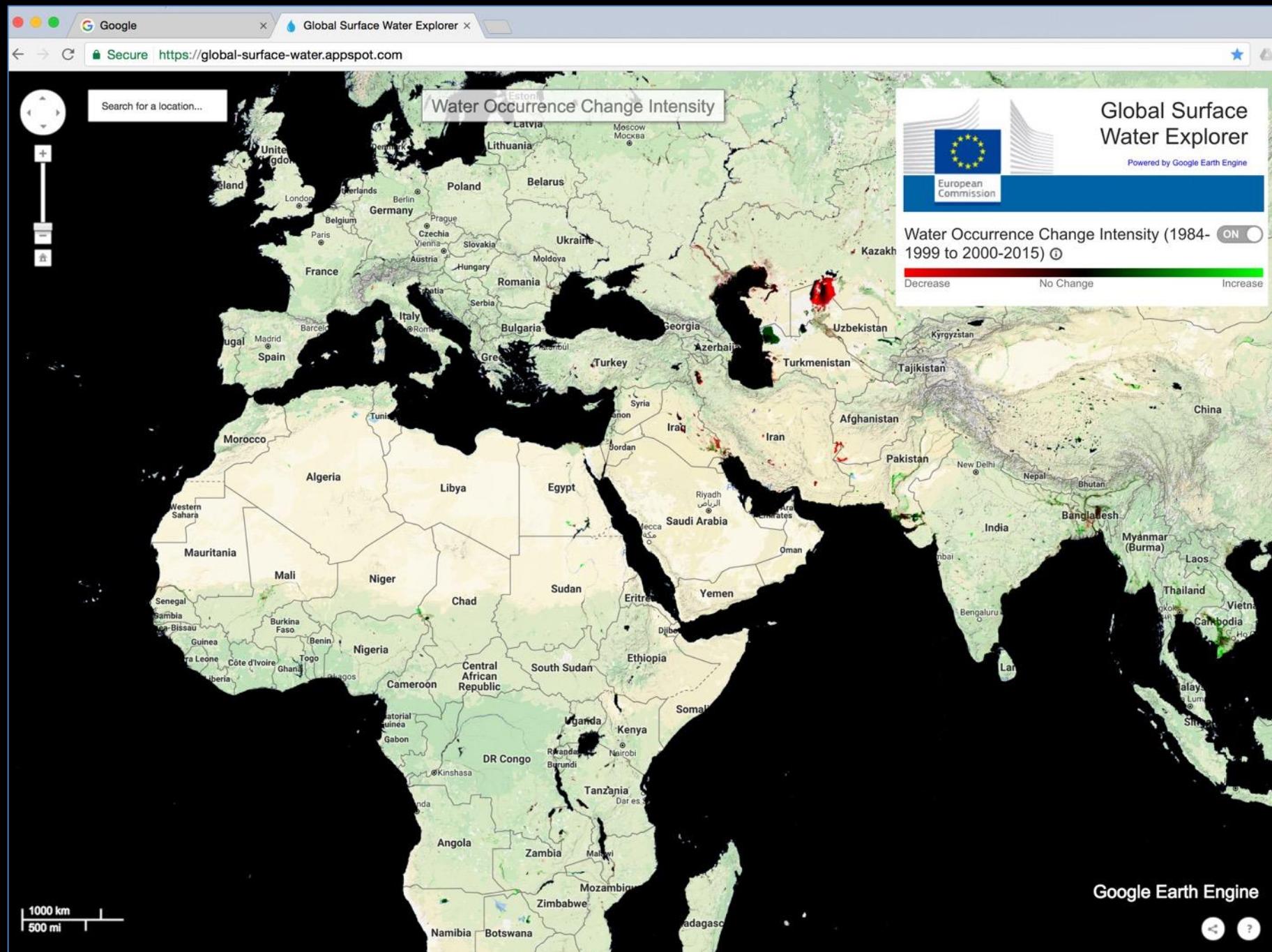


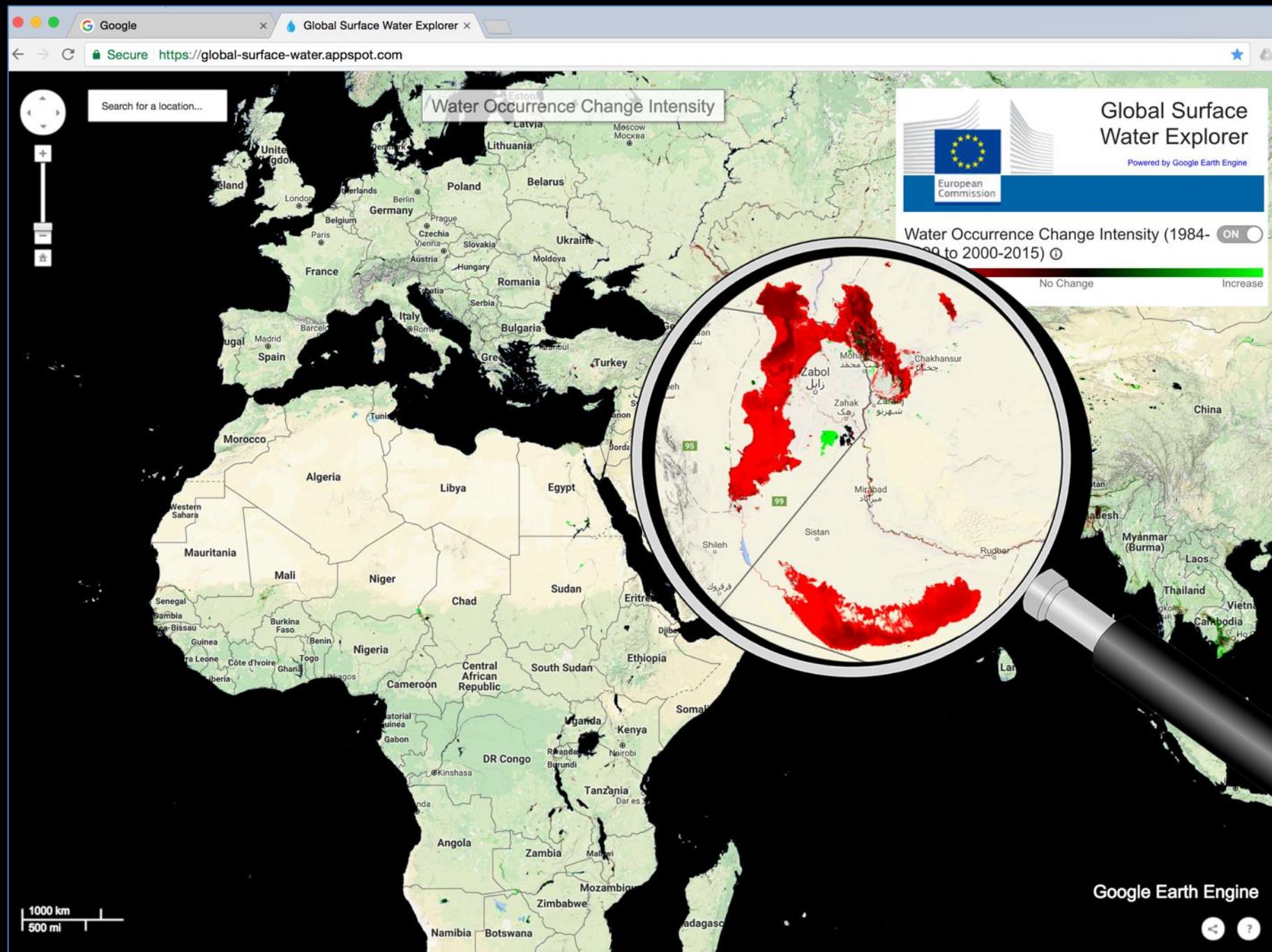
## Australia

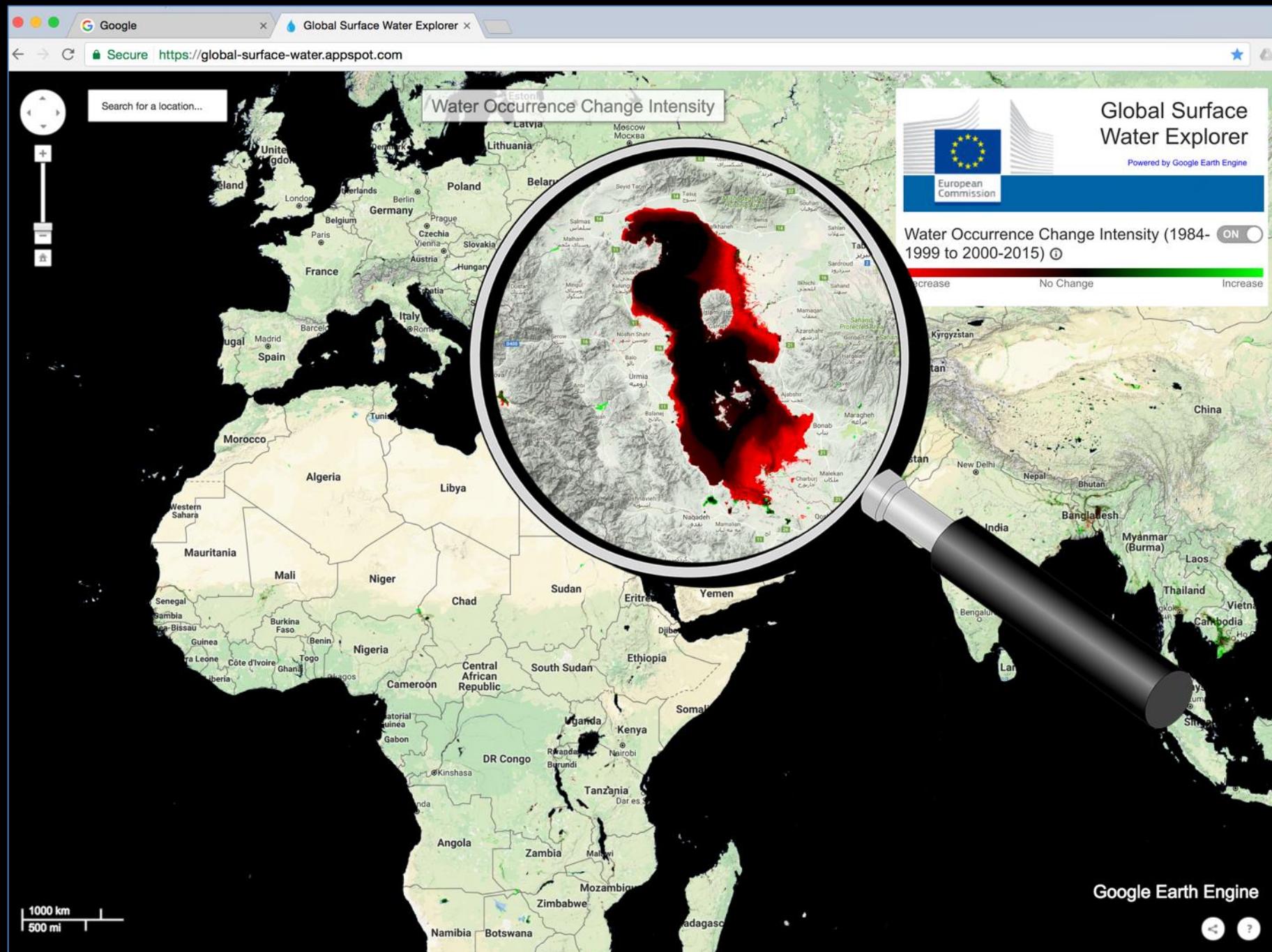


Drought and sustained demands for water have seen six western states lose more than 6,000 km<sup>2</sup> of their permanent surface water (33% )

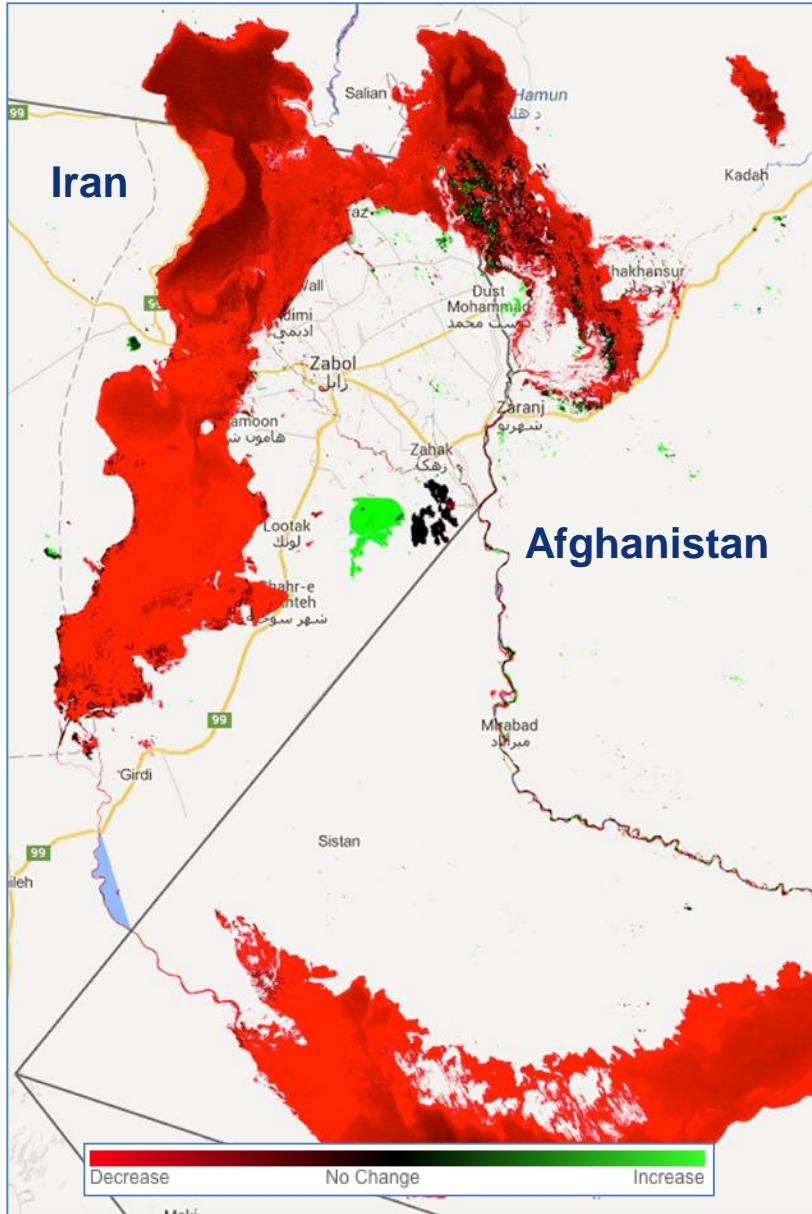








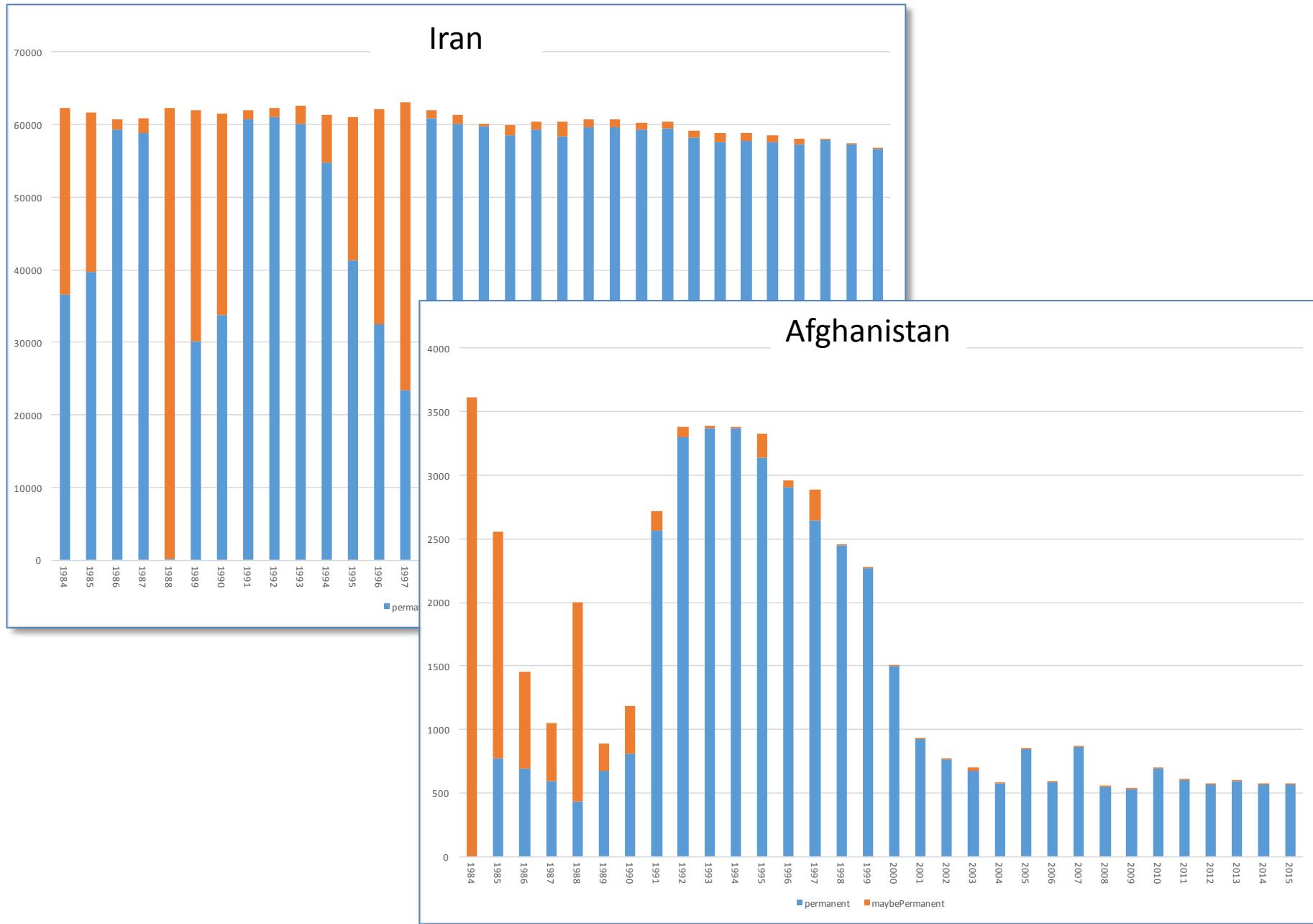
# Iran and Afghanistan have **less** permanent surface water area than they had in the 1980s

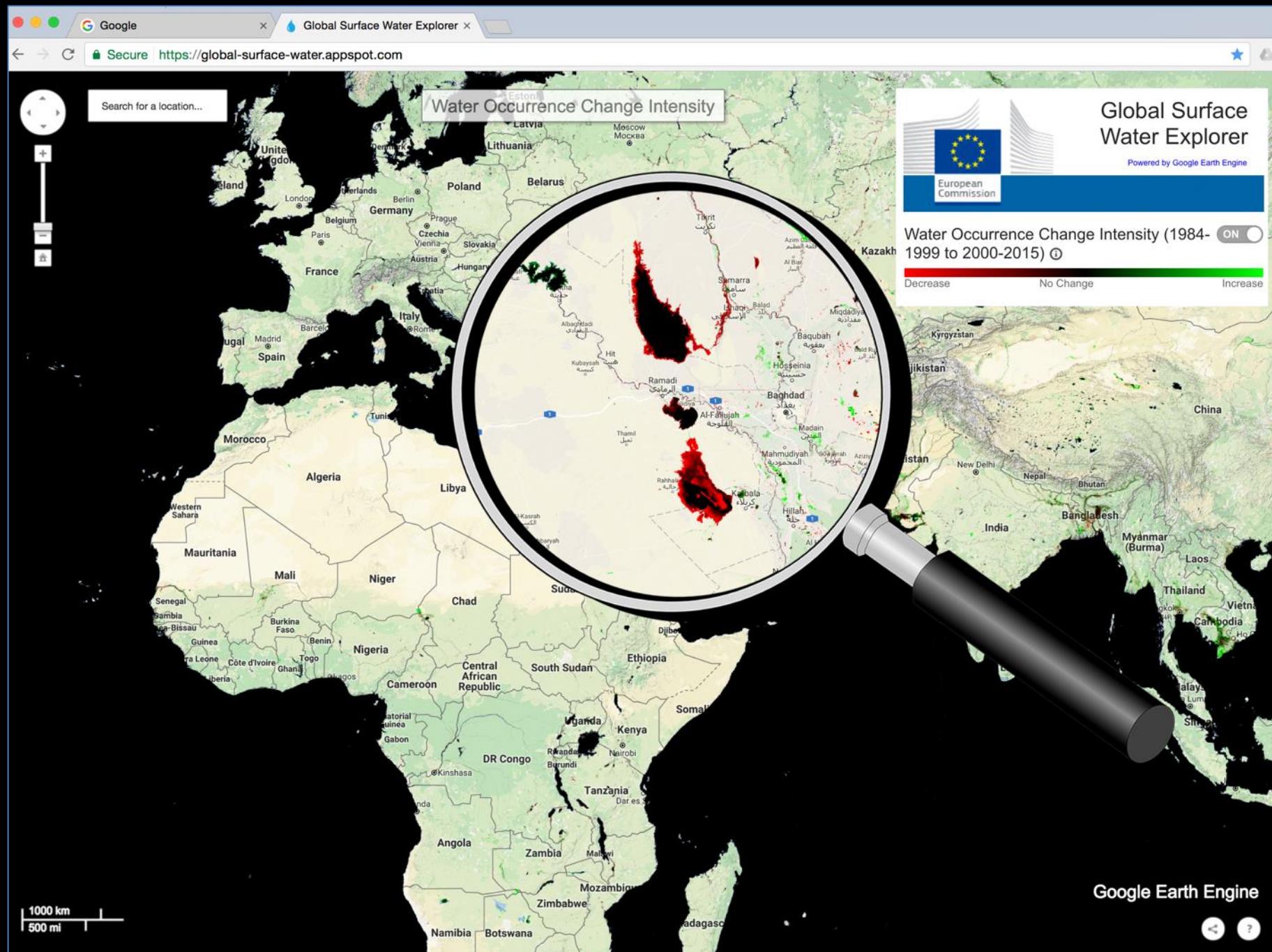


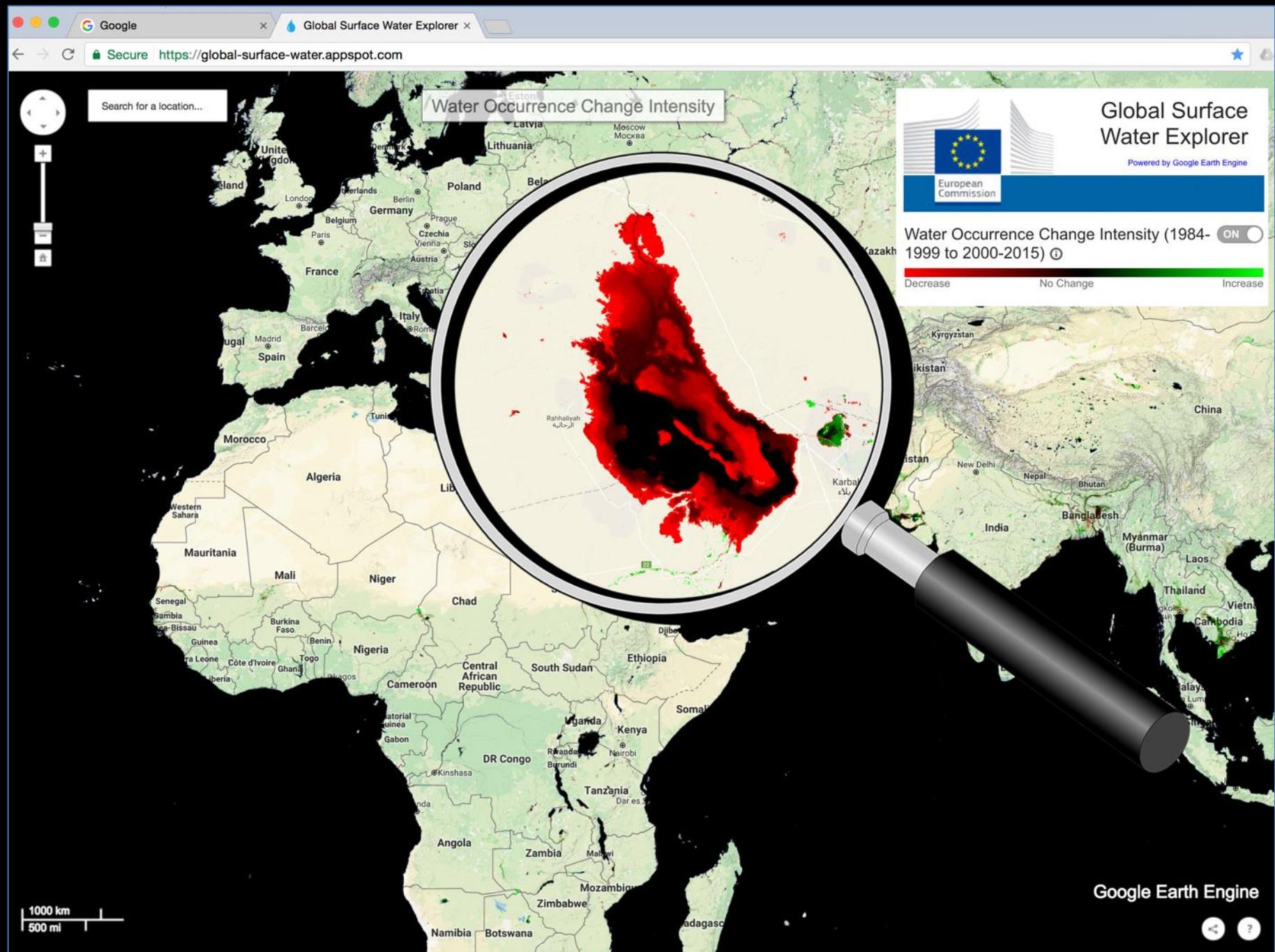
Hamoun wetlands Source Global Surface Water occurrence JRC/GEE

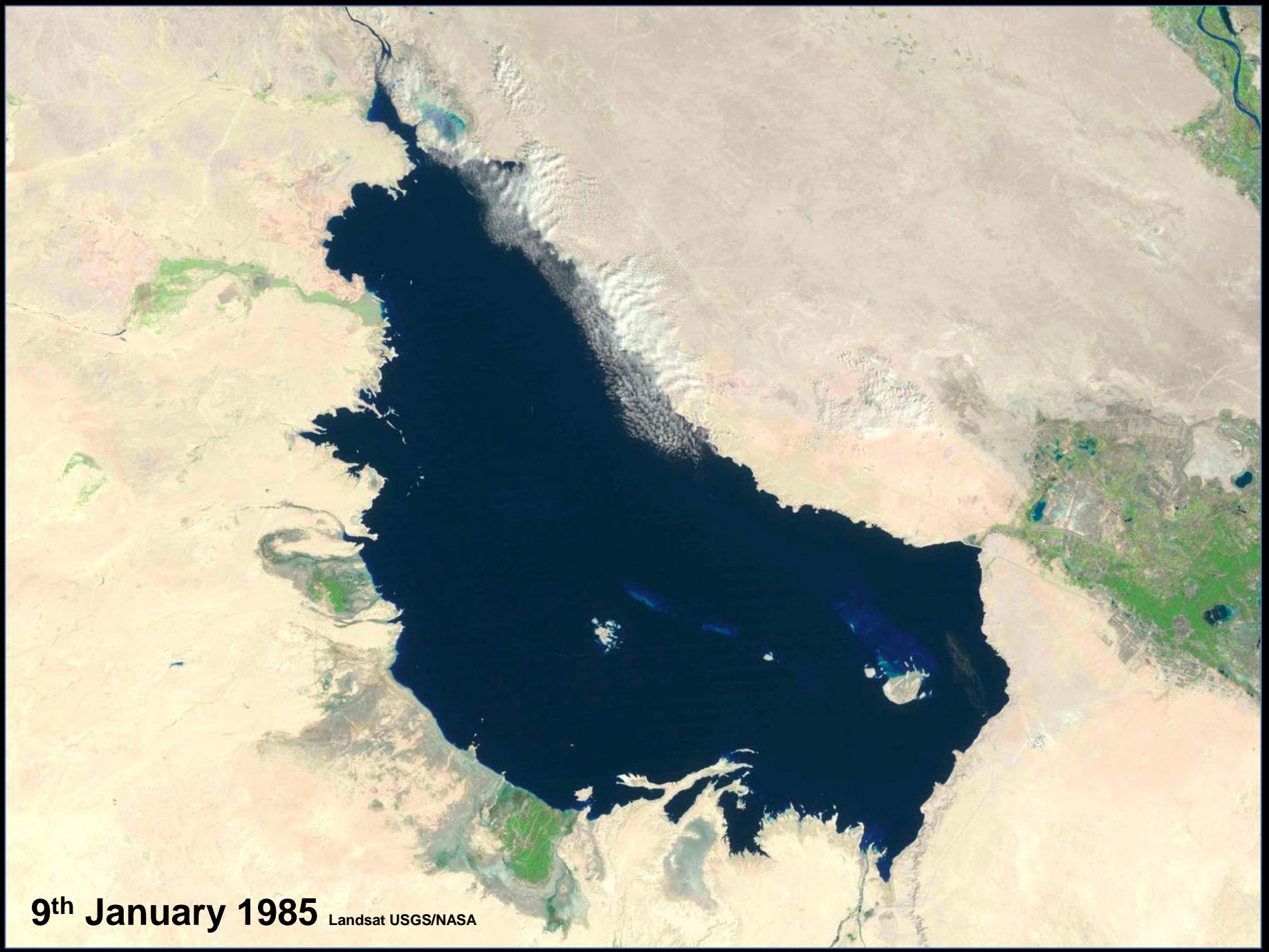
Source: United Nations information centre Tehran

# Iran and Afghanistan have less permanent surface water area than they had in the 1980s

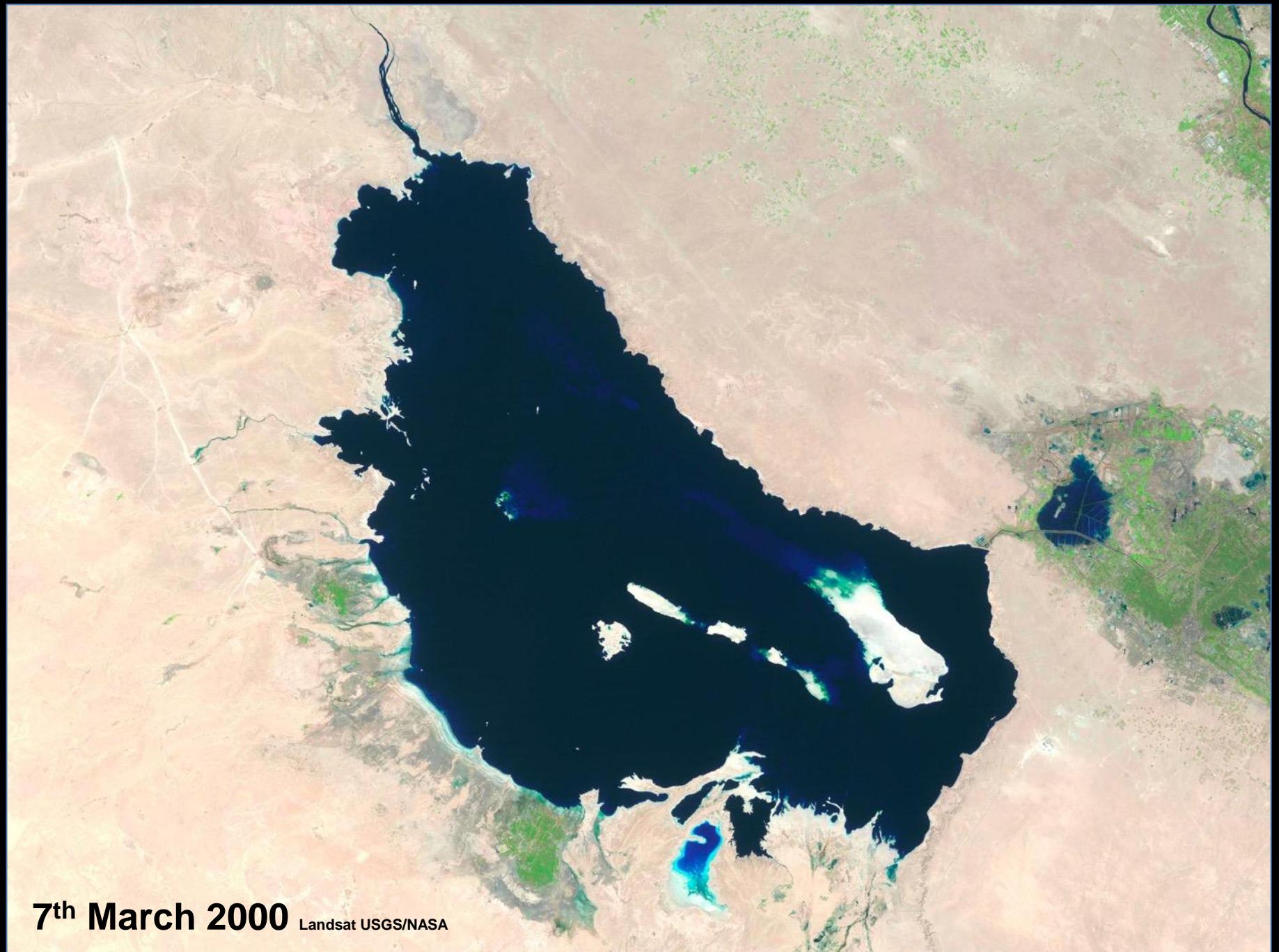




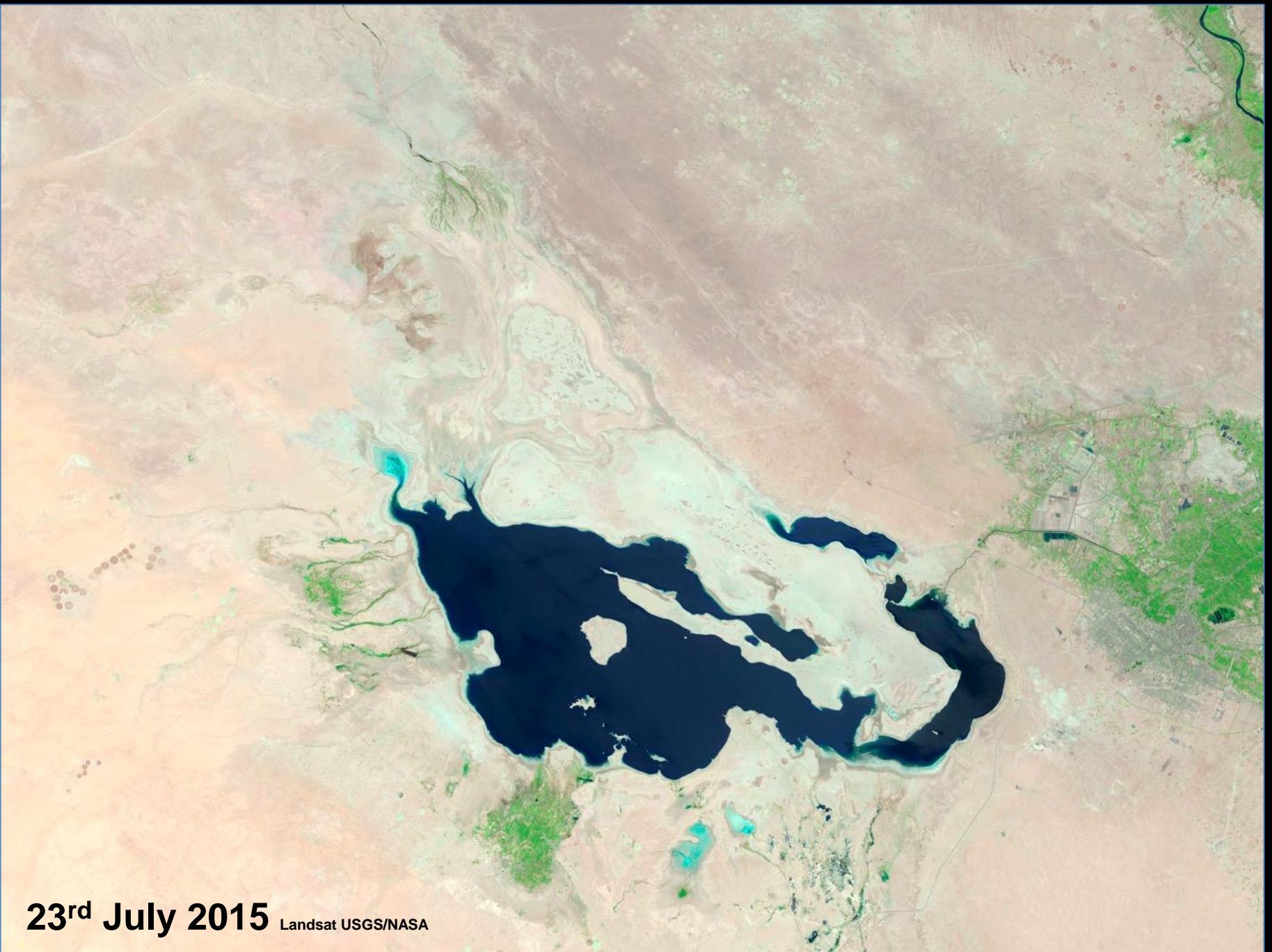




**9<sup>th</sup> January 1985** Landsat USGS/NASA

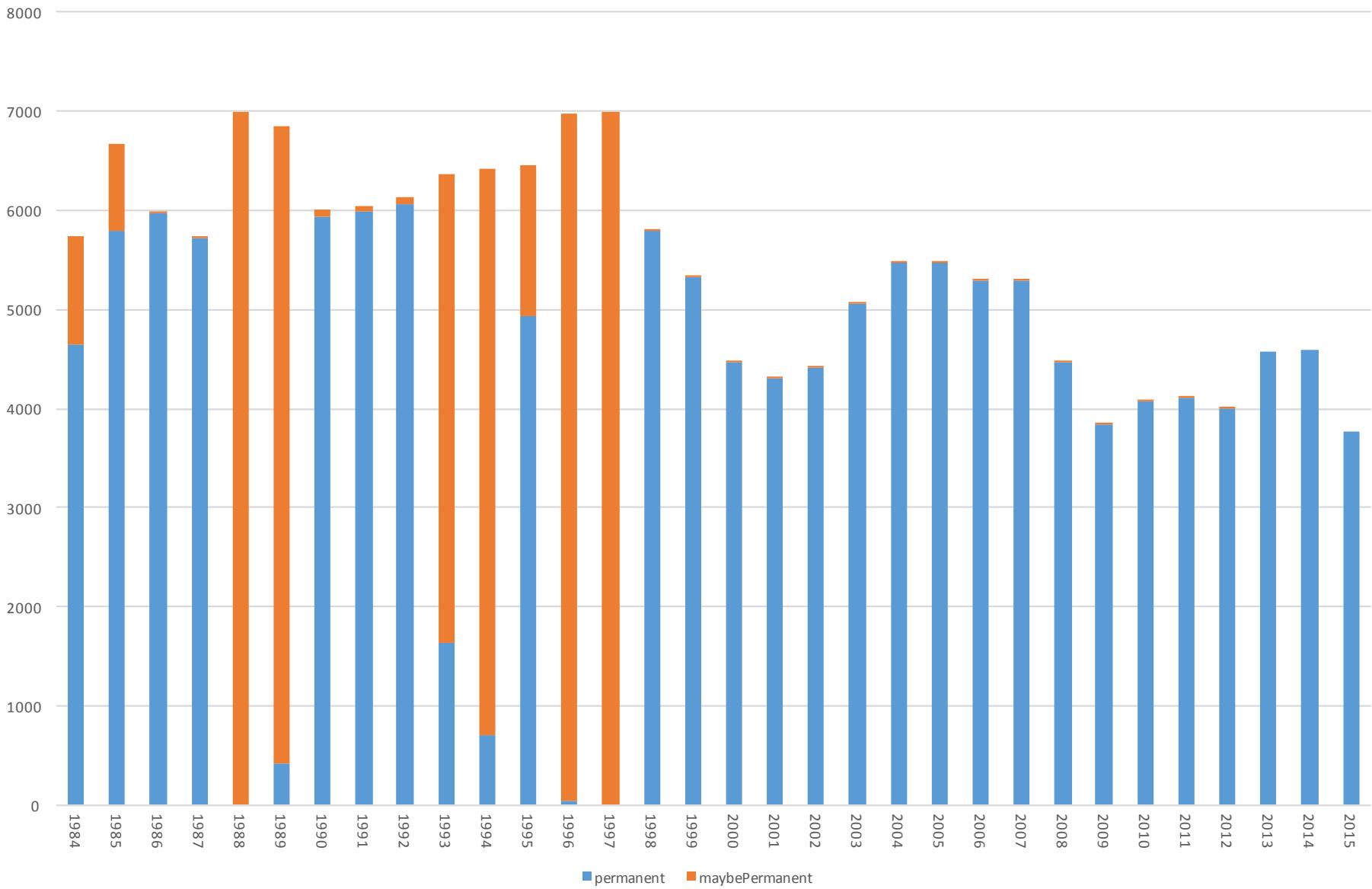


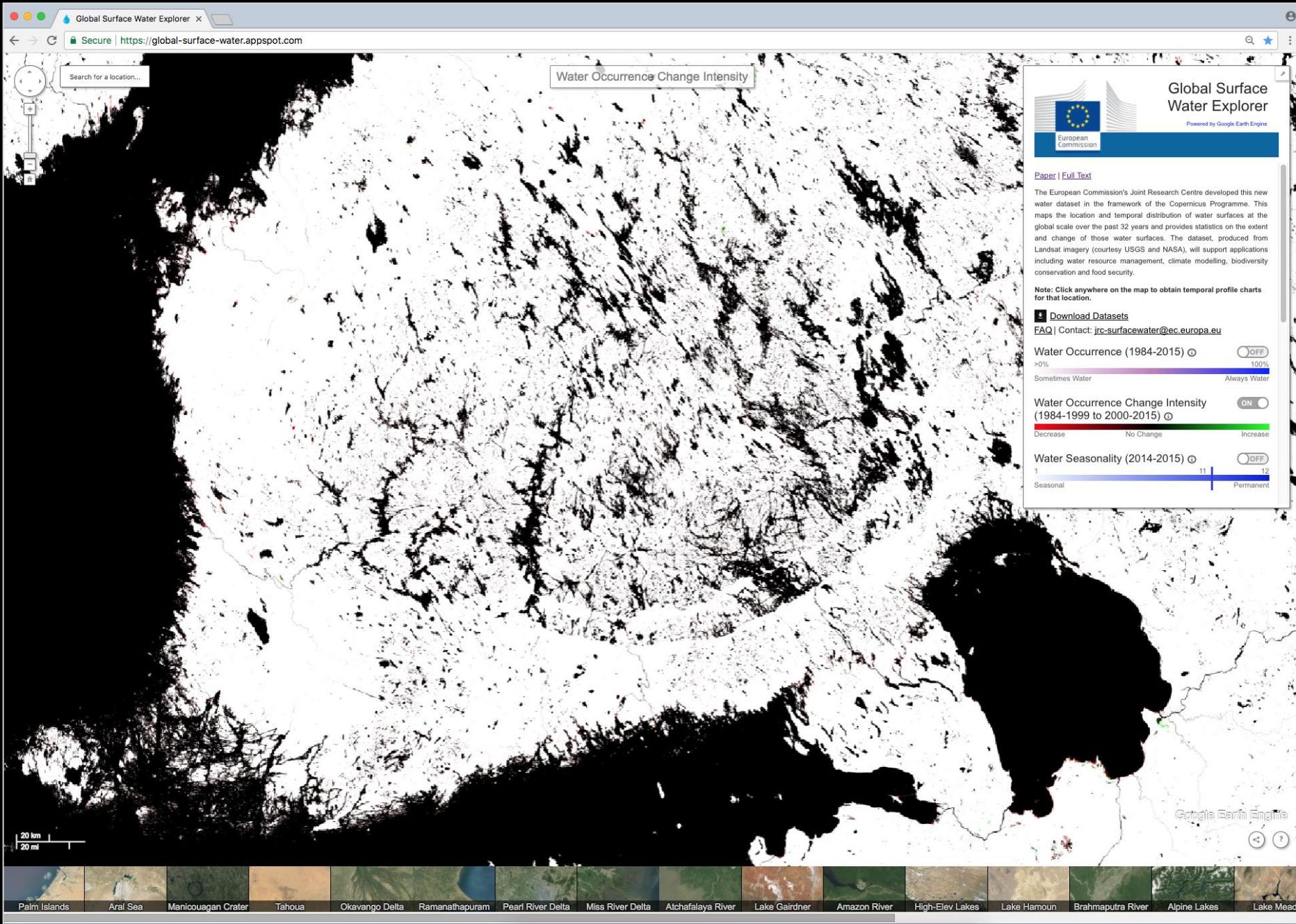
**7<sup>th</sup> March 2000** Landsat USGS/NASA



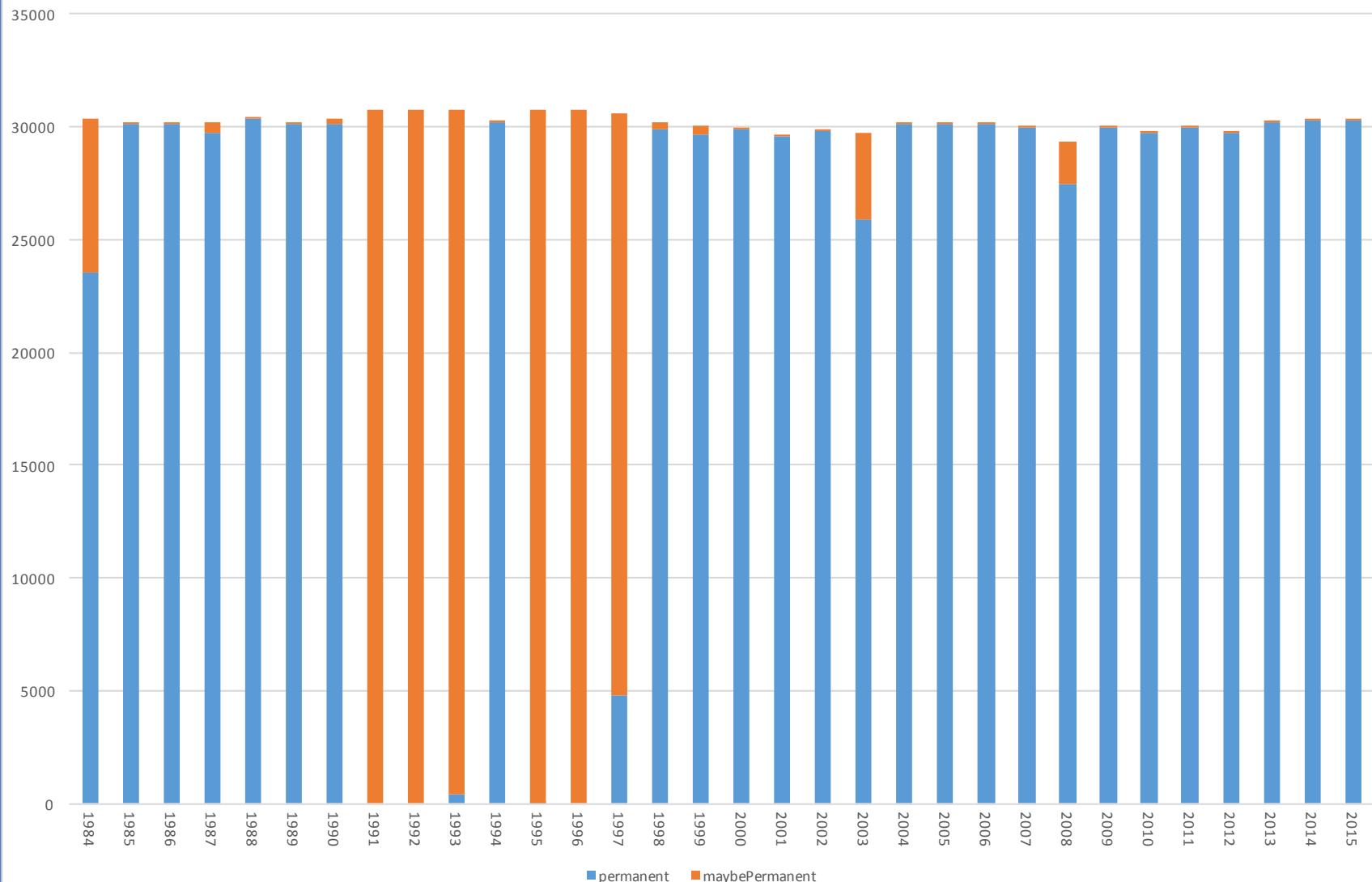
**23<sup>rd</sup> July 2015** Landsat USGS/NASA

# Iraq



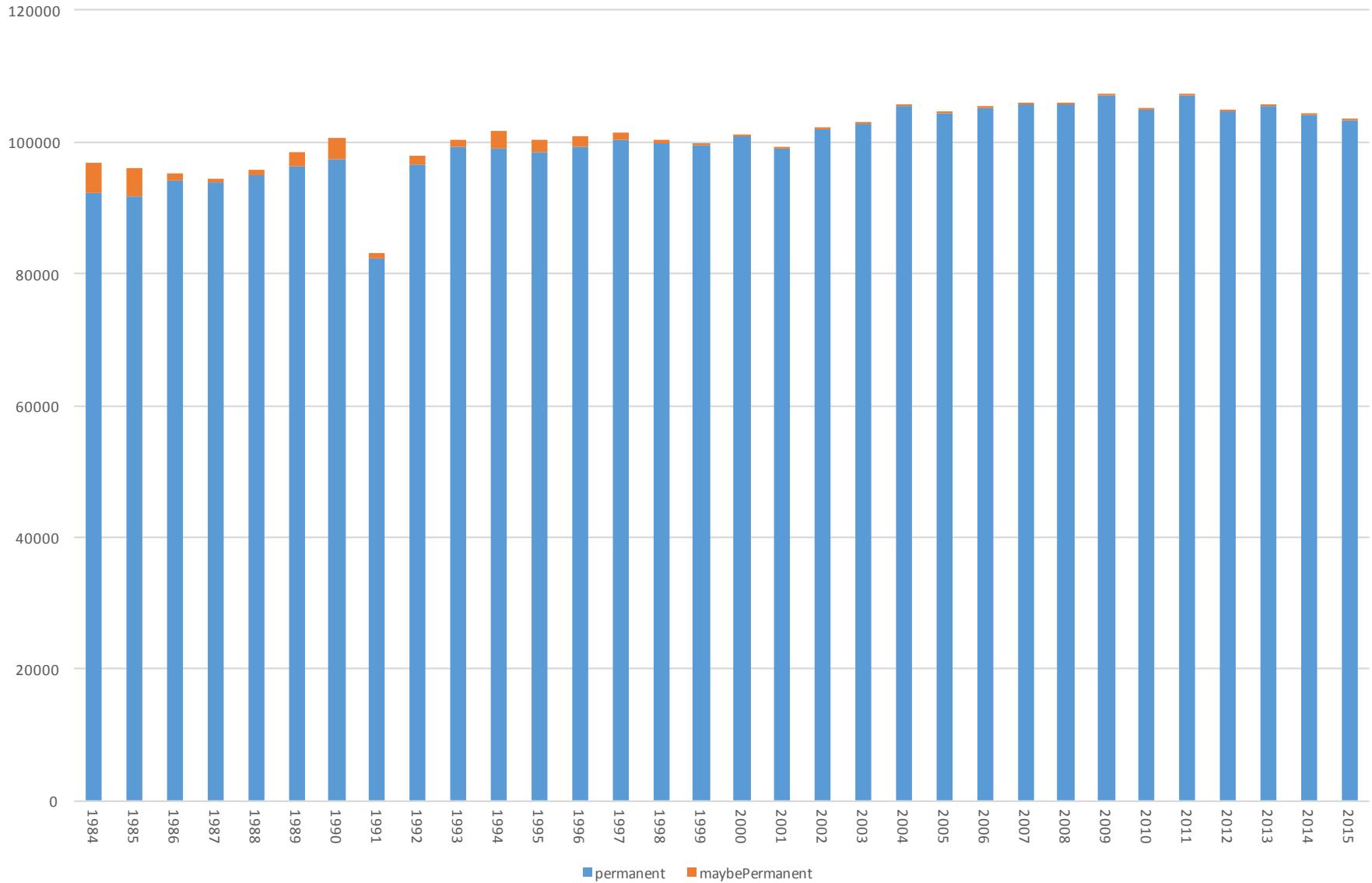


# Finland





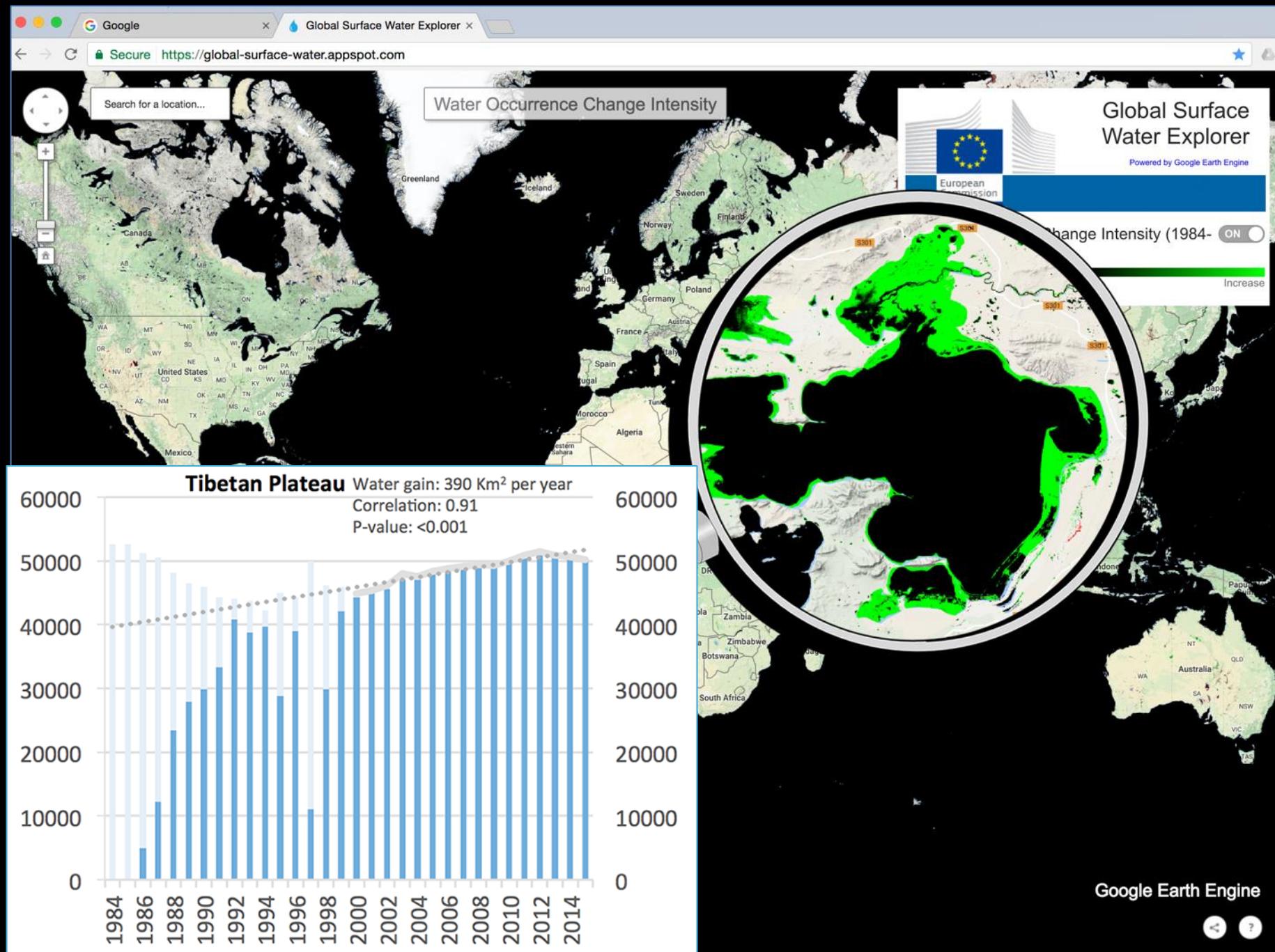
# Brazil





Tibet plateau, 29cm, Creative Commons Attribution-ShareAlike 2.0 Generic





# Roles for the Global Surface Water Explorer

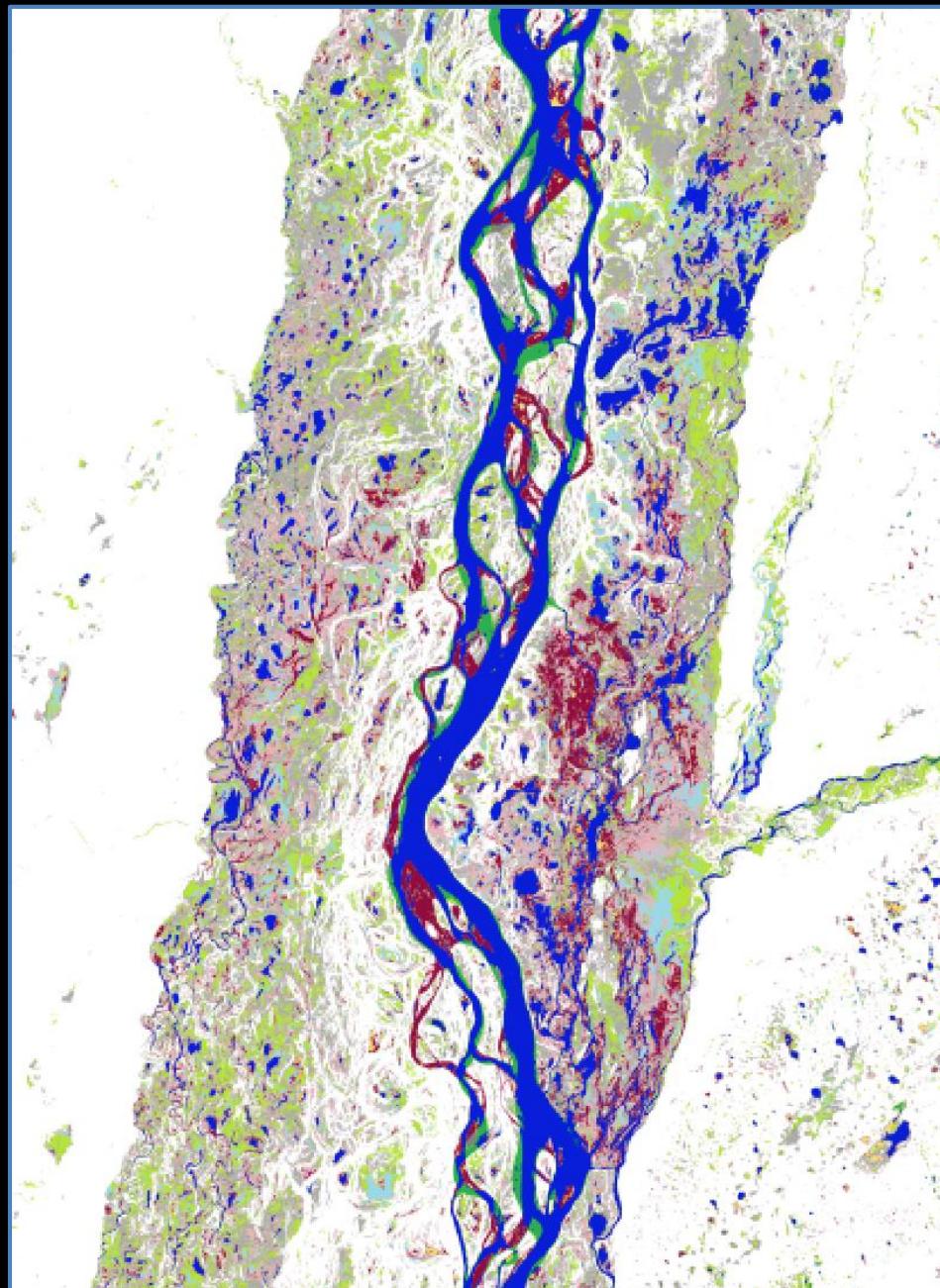
Annual summary by country (or any other geographic region of interest)

Maps of water occurrence and dynamics (inter and intra annual)

Indicator 6.6.1a Change in the spatial extent of water-related ecosystems over time

Indicator 15.3.1 Proportion of land that is degraded over total land area (indirect)

Target 15.5 Take urgent and significant action to reduce the degradation of natural habitats and loss of biodiversity



# Questions

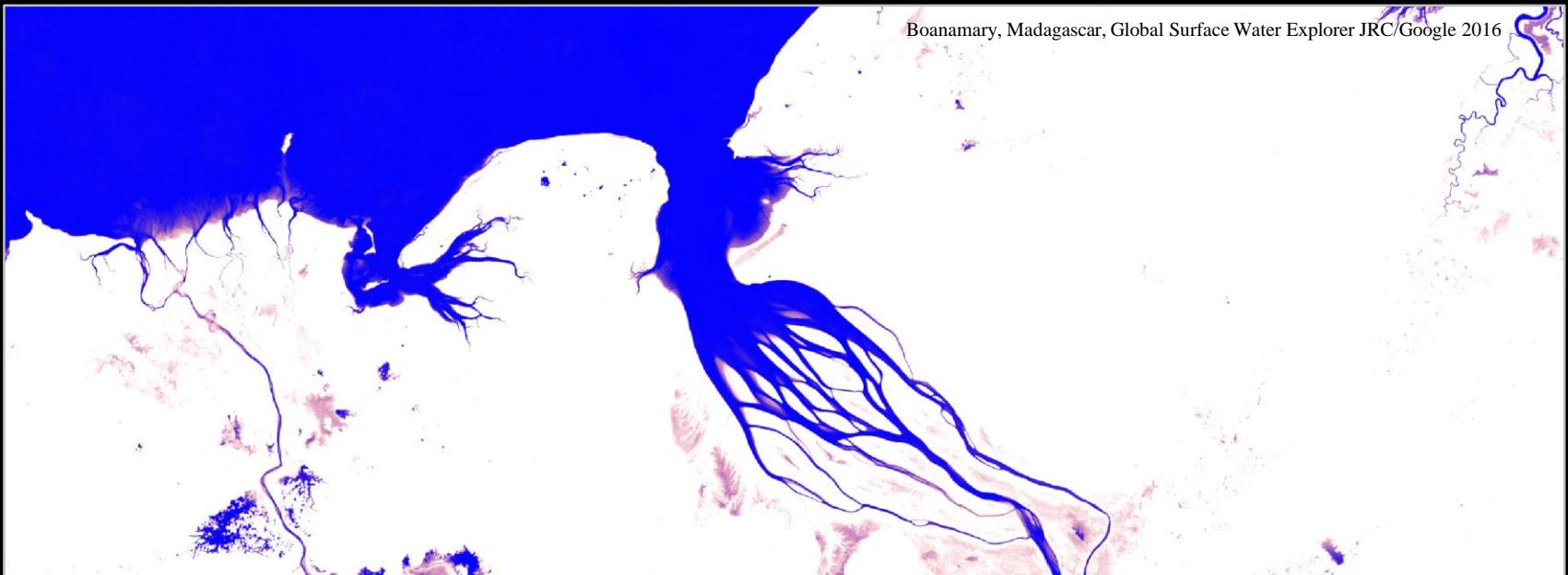
Options to report numbers on a country level for; unchanging permanent, 'lost' permanent, 'gained' permanent, and transitions to and from permanent/land and seasonal?

What is the time period over which the transitions are to be measured? No reference condition/year exists for SDG 6.

Concerning degree of anthropogenic intervention, is there a cut-off date for dams?

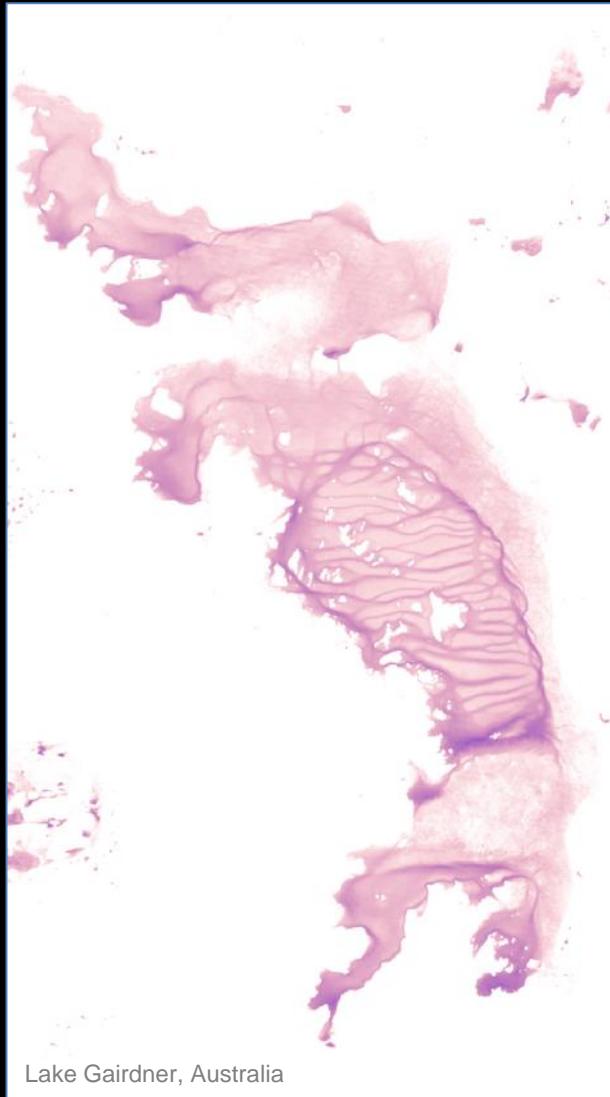
2000 to 2015/16/17 is good on the basis of the completeness of the Landsat archive. These numbers would perforce have to be computed from scratch.

Concerning coastline, is GAUL 'as is' OK? Should a buffer be used? If a buffer is used, then what value is set and on what basis? Should country-level map delivery be envisioned?

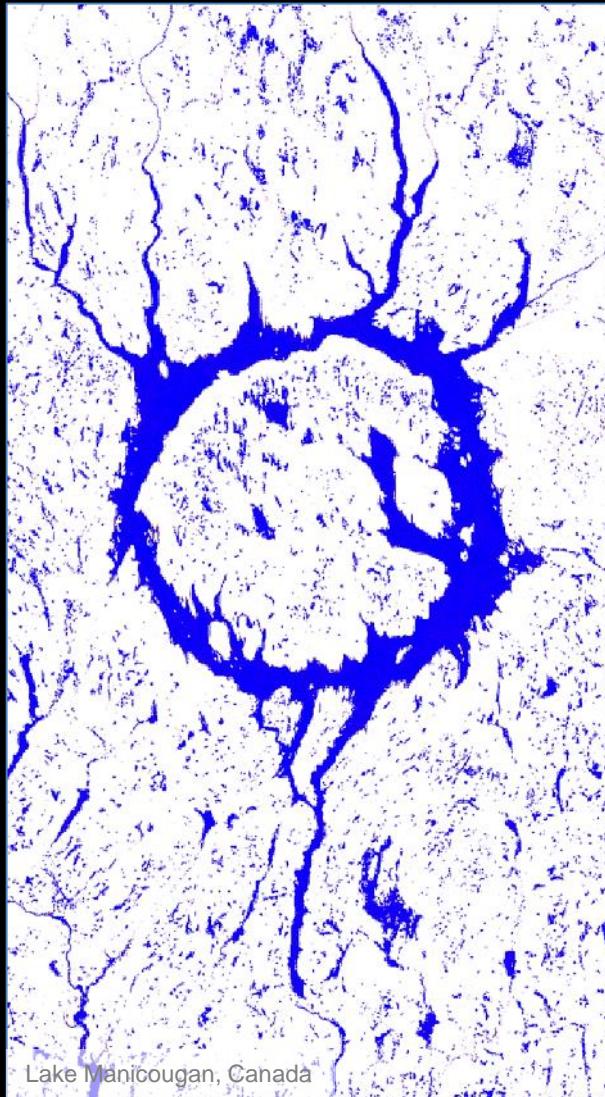




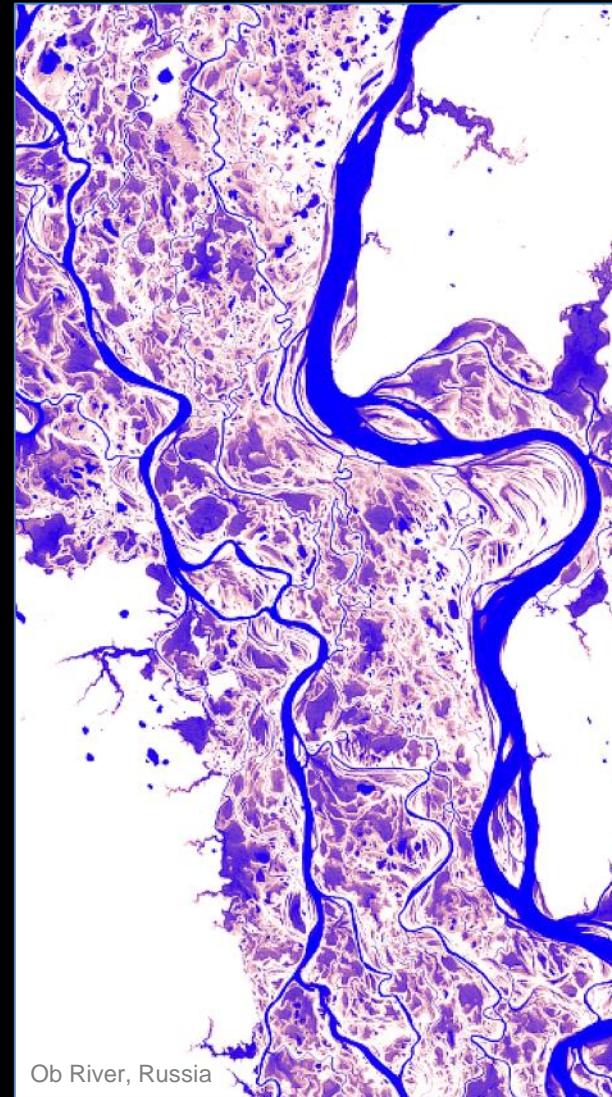
# the Global Surface Water Explorer



Lake Gairdner, Australia



Lake Manicougan, Canada



Ob River, Russia

<https://global-surface-water.appspot.com/>