OPENING KEYNOTE SPEAKER

# GOOGLE EARTH ENGINE

## INTERVIEW WITH TYLER ERICKSON

The Earth Engine platform, launched by Google in 2010, makes available online a very large volume of current and historic satellite imagery and data covering the entire planet, along with computer resources and analytical tools. Since its introduction several research groups and other organizations have partnered with Google to use it for the study of natural resources and environmental changes in different parts of the world. The Earth Engine platform has already been used to develop several applications supporting the study of the water environment. Hydrolink had the opportunity to interview Dr. Tyler Erickson, Senior Developer Advocate at Google and Water Cycle Analysis Lead for Earth Engine, who is also a featured keynote speaker at the 37$^{th}$ IAHR Congress in Kuala Lumpur. In this interview, Dr. Erickson answers several questions of special interest to the audience of this magazine.

***Can you give a brief overview of what Earth Engine is?***

Earth Engine is a cloud-based geospatial data analysis platform. Cloud-based means you have rapid access to petabytes of data co-located with large amounts of computer resources. Geospatial means that the system is optimized for working with spatial data that is referenced to the Earth's surface, and that allows you to easily combine data from multiple sources: satellite data, gridded model predictions, surface observations, natural or political boundaries. Analysis platform means that it is designed so that developers can customize it for their own specific use cases, by accessing Earth Engine's data storage and analysis functionality via application programming interfaces (APIs). The Earth Engine team maintains a few general purpose web applications using the APIs, but many organizations build and maintain their own domain specific applications.

***What projects related to water resources are under way by Earth Engine partners?***

Earth Engine partners are working on many projects throughout the water cycle, but a few areas stand out with a particularly large amount of activity. One focus area is mapping the occurrence of surface water resources and how they are changing over time. For example, scientists at the European Commission Joint Research Centre (JRC) have used Earth Engine to map the occurrence of surface water globally over 32 years at a monthly time scale and a 30-meter spatial resolution, based on imagery collected by the Landsat satellites. The JRC released the resulting dataset via an application that allows users to interactively visualize the dataset in space and time, as well as download the dataset under an open license for further analysis. The resulting dataset is also made available in Earth Engine so other developers can build analyses and applications on top of it. A small example of one of the layers in the dataset is shown in Figure 1.

Another exciting focus area is mapping variations in evapotranspiration (ET) for monitoring water consumption by agriculture. Several different ET algorithms, using a diverse set of remote sensing data sources, are currently being implemented in Earth Engine. Once available, these algorithms will improve the monitoring of water use at a global scale at high resolution.

Other analyses of the water cycle that partners are conducting with Earth Engine include monitoring land cover changes in watersheds, characterizing drought, building historical climatologies of flooding, and monitoring water quality of inland surface waters.

***Do you have plans to compile/organize in the Earth Engine database any other water-related data from different sources around the world?***

It largely depends on the interests of our partners, which we take into consideration when prioritizing new additions to the Earth Engine Public Data Catalog. Partners are encouraged to nominate new datasets and vote on existing nominations. Providing details on what could result if the dataset were made available in Earth Engine can help boost the prioritization. Of course, partner interest is not the only criteria that is taken into account. We prioritize datasets that have liberal licenses that do not restrict how others can utilize of the data. We believe in open science and open development and work to provide tools that make it easy to share source datasets, analyses, and results.

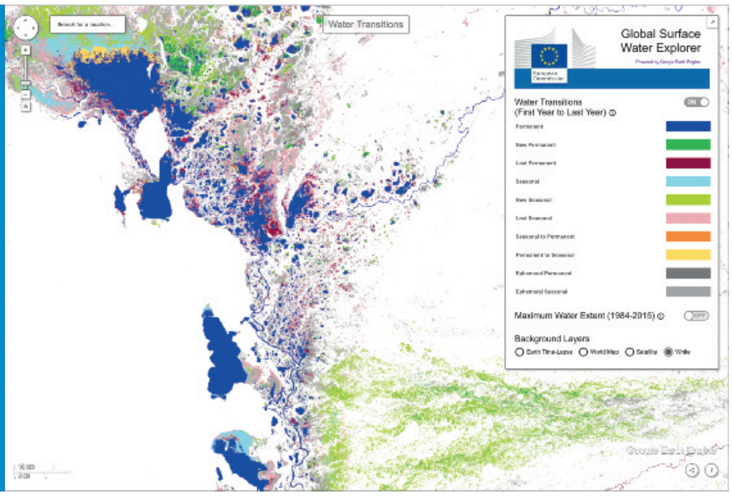


Figure 1. Surface water transitions layer of the Global Surface Water dataset for the Paraguay River floodplain on the border between Bolivia and Brazil. Source: EC JRC/ Google (https://global-surface-water.appspot.com)

In terms of datasets that may be useful for water-related analyses, recent additions to the Public Data Catalog include the Global Land Ice Measurements from Space (GLIMS) dataset of 200,000 glacier boundaries, the USGS Watershed Boundary Dataset, and the United States Department of State's Large Scale International Boundary (LSIB) Lines dataset.

***Are there any Earth Engine projects under way that address issues related to climate change, especially its impact on water resources?***

One interesting project is this area is Climate Engine (ClimateEngine.org), a web application for analyzing changes in gridded climate, weather, and satellite remote sensing datasets. The Climate Engine is being used to characterize climate changes over the last few decades in the western United States, monitor life-threatening drought conditions in Africa, and improve water management for mining operations and reclamation.

At present I feel that the potential for climate analysis in Earth Engine is still largely untapped and will grow as more climate-specific datasets are added to the catalog. One recent addition in this area is the NASA NEX Global Daily Downscaled Climate Projections (NEX-GDDP) which provide downscaled 0.25 degree daily projections of temperature and precipitation from 21 climate models and two emissions scenarios.

***How do you see Earth Engine contributing to achieving the Sustainable Development Goals (SDGs) set by the United Nations in Agenda 2030?***

One of the goals of the Earth Engine project is to make substantive progress on global challenges, and the UN SDGs are about the best list of global challenges compiled by international experts that I can think of. The main way I see Earth Engine contributing to achieving the SDGs is by supporting partners that are already working to address specific targets associated with the goals, by helping scale up their work to cover larger areas and handle larger and larger datasets. Water factors into many of the SDGs, not only as directly called out in Goal #6 Clean Water and Sanitation, but it also is critical for the goals of ending hunger through sustainable consumption, combating infectious diseases, preventing degradation of land cover, and building resilient infrastructure for sustainable cities. We are already adding relevant datasets that our partners have requested to address SDGs, such as global population and socio-economic datasets.

***Are you planning to make all the data in Earth Engine available for visualization in Google Earth?***

Earth Engine data can already be viewed in Google Earth by using KML files, an Open Geospatial Consortium (OGC) standard for geospatial visualization and annotation that is used by Google Earth and other earth browsers. Vector datasets can be exported directly from Earth Engine as KML files. Raster data can be exported as image files and draped on Google Earth using KML GroundOverlay elements. In the future we (or some Earth Engine developer) might create tools to make it easier to produce KML files for complex visualization, if it becomes apparent that this is a barrier that our user community cares about.

On a related note, the 700 trillion pixel cloud-free basemap image that you see in Google Earth when zoomed out to regional or continental scales was produced with Earth Engine, using the same tools that we make accessible to scientists and developers.

***Dr. Tyler A. Erickson* is a Senior Developer Advocate at Google. In this role, he fosters collaborations with researchers from academia, NGO's, and governmental organizations seeking to capitalize on Earth Engine's capabilities for geospatial analyses that involve immense satellite and model-based datasets. Dr. Erickson leads the development of Earth Engine's core efforts in water and climate, and guides the evolution of Earth Engine to support these scientific domains. A snow hydrologist by training, he has degrees civil and environmental engineering and geography degrees from Colorado State University, CalTech, Stanford, and the University of Colorado at Boulder.**

***What's exciting for the future?***

One thing that has been exciting for me is seeing developers rapidly deploy applications soon after we add features to Earth Engine. For example, in August 2015 we announced that Copernicus Sentinel–1 radar data had been added to the Earth Engine Public Data Archive. Less than a month later, Pakistan's SUPARCO's Space Application Center for Response in Emergencies and Disasters was blogging about how they were using Earth Engine and Sentinel-1 for rapid inundation analysis of the 2015 flooding events. As we continue to improve our tools for working with large geospatial datasets I look forward to this rapid development becoming more common.

I continue to be excited to see that more and more data providers and developers are adopting open data and open source development practices. They are seeing that that real value is not in collecting data or creating algorithms, but value is realized when the data or algorithms get used for a beneficial purpose. By utilizing cloud technologies such as Earth Engine, it becomes very easy to share datasets and code, and this has facilitated collaborations between scientists and developers working all over the world. And when it becomes easier to collaborate and share work, scientific progress and real world results happen at a much faster rate. ■

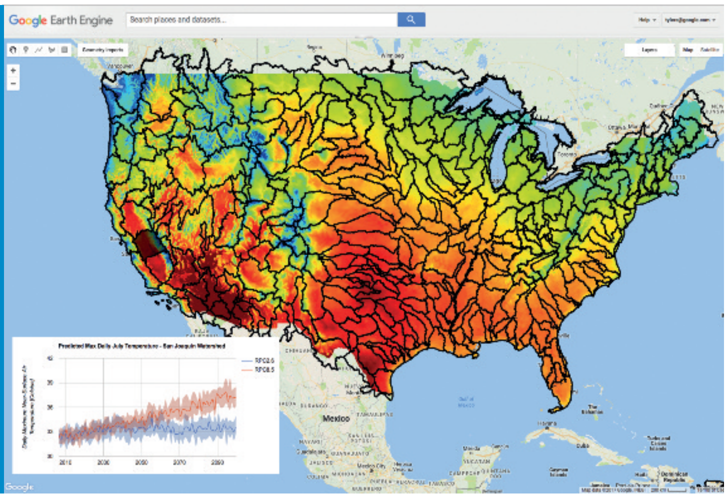


Figure 2. Map showing predicted maximum daily surface temperature for July for an emission scenario (RCP 2.6). The chart in the insert compares predicted maximum surface temperatures for two emission scenarios (RCP 2.6 & RCP 8.5) for the San Joaquin watershed. Dataset sources: NASA NEX-DCP30, USGS Watershed Boundaries