Gybe + TNC WaterFunds

Four locations across the Global TNC Water Funds:

- Jaguari-Jacarei Reservoir, São Paolo Water Fund
- Ribeirão das Lajes Reservoir, Río de Janeiro Water Fund
- Rio Grande Reservoir, Colombia Water Fund
- Thika Reservoir, Upper Tana-Nairobi Water Fund.

Dr. Fernando Miralles-Wilhelm, Lead Scientist for Global Water

Our goal is to compare reservoirs and uncover trends and patterns across a portfolio of water bodies.

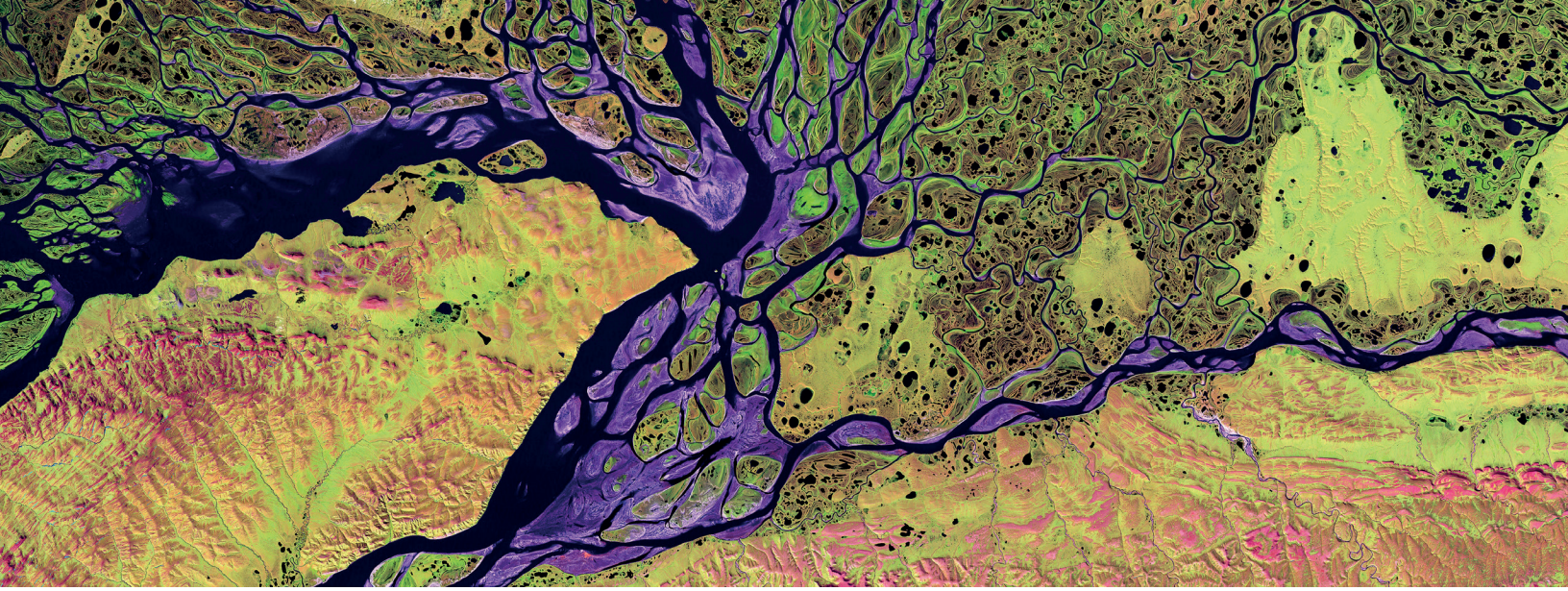
TNC Goal

TNC Water Funds are organizations that work to improve water availability and quality by implementing nature-based conservation projects in source waters. Downstream users (often cities) pay for upstream protection to achieve cleaner, safer water.

"Water Funds are organizations that design and enhance financial and governance mechanisms which unite public, private and civil society stakeholders around the common goal to contribute to water security through nature-based solutions and sustainable watershed management."

There are currently 43 TNC Water Funds, in 13 countries, on four continents, with 35 more in development. They have a need in common: to track ecological impact through outcome based metrics (= water quality), to help understand whether upstream conservation efforts are having the desired downstream effects:

- Understanding cause and effect between land based conservation projects and downstream water quality changes, to learn and increase the effectiveness of conservation efforts.
- Impact Reporting to help demonstrate results to stakeholders, including the donors, to help secure the long term funding needed to make an impact.



A set of analytics tools that can be applied to a portfolio of waterbodies →

The Challenge

The overarching goal: to provide conservation scientists, organizational decision-makers and other stakeholders in the Water Funds community with a comprehensive measurement basis to complement future monitoring efforts and inform investment planning to improve water quality in the Water Funds. Understanding water quality across a portfolio of water bodies around the world is currently very difficult.

> **"Water Funds do land based interventions, with the goal of having a positive impact on water quality. To be able to make those claims, we need to be able to measure the impact that our interventions are having."**

Each water fund has its own monitoring program, with vast differences in resources, leading to a disparity in data availability, coverage, and consistency over the years.

Additionally, most water data is collected through grab samples and sondes, which have very limited spatial range, and require a lot of manual work to collect the data. This makes water quality monitoring difficult and expensive.

As a result, the knowledge of the dynamics of each waterbody is very different. Without knowing what normal seasonal and multi-year variation looks like, it is difficult to discern what is normal variation, and how water quality is shifting over time in a reservoir or lake.

The Solution

Pilot project
In our pilot project, four important water bodies were chosen from the Water Funds portfolio.

Gybe processed all available historical data available from the Sentinel 2 and Landsat 8 satellites, which dates back to January 2015 for three of the sites, and March 2016 for the fourth site. New images are continuously added to the database, at a rate of 1 image every 3-5 days, depending on the site and on cloud cover.

The project focus was to demonstrate what can be learnt about water quality from satellite data alone, without any additional data sources. This is interesting for TNC Water Funds, since satellite data is consistently available at any location globally, and therefore an interesting technological solution to help understand what is happening at a wide range of sites.

Gybe processed and analyzed the data, to find trends and long term shifts, both across the entire reservoirs, as well as at specific locations of interest at each reservoir.

Results

Gybe worked together with the on the ground teams in each of the chosen Water Funds sites, and created a detailed report with scalable analytics results, comparing reservoirs and seeing trends. These analyses included seasonal trends (both spatial and temporal), long term baseline shifts (Mann-Kendall trend test), trend maps, and variation maps. Gybe also delivered the data for download to the local teams, to be used in further analysis, especially to compare with data on land use change and conservation efforts.

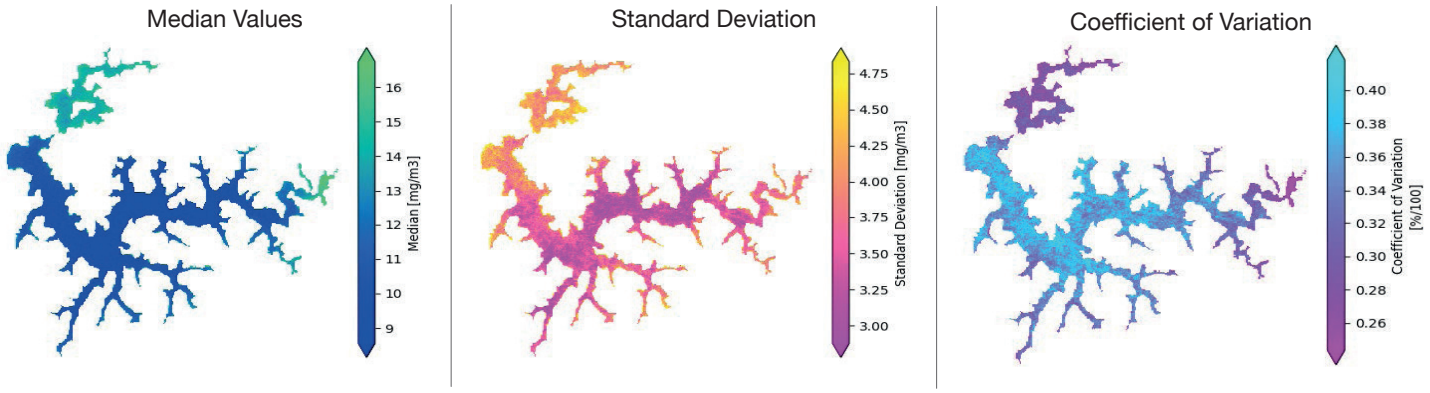
Interesting results were found in all of the chosen reservoirs, and it was shown that Gybe's remote sensing product opens up whole new possibilities of monitoring to help the Water Funds teams test a range of hypotheses. Seeing long term trends and seasonal variation, not just in time but also in space (through datamaps) gave the Water Funds teams a new understanding of their reservoirs.

Gybe also found reverse eutrophication trends in a reservoir, which is a very exciting finding. It was shown to be a significant benefit to be able to look back in time for 5-6 years, not just to the date when a new monitoring system was deployed. Additionally, all these results were achieved fully remotely, with very limited cost, and without any field work for grab sampling or sonde maintenance.

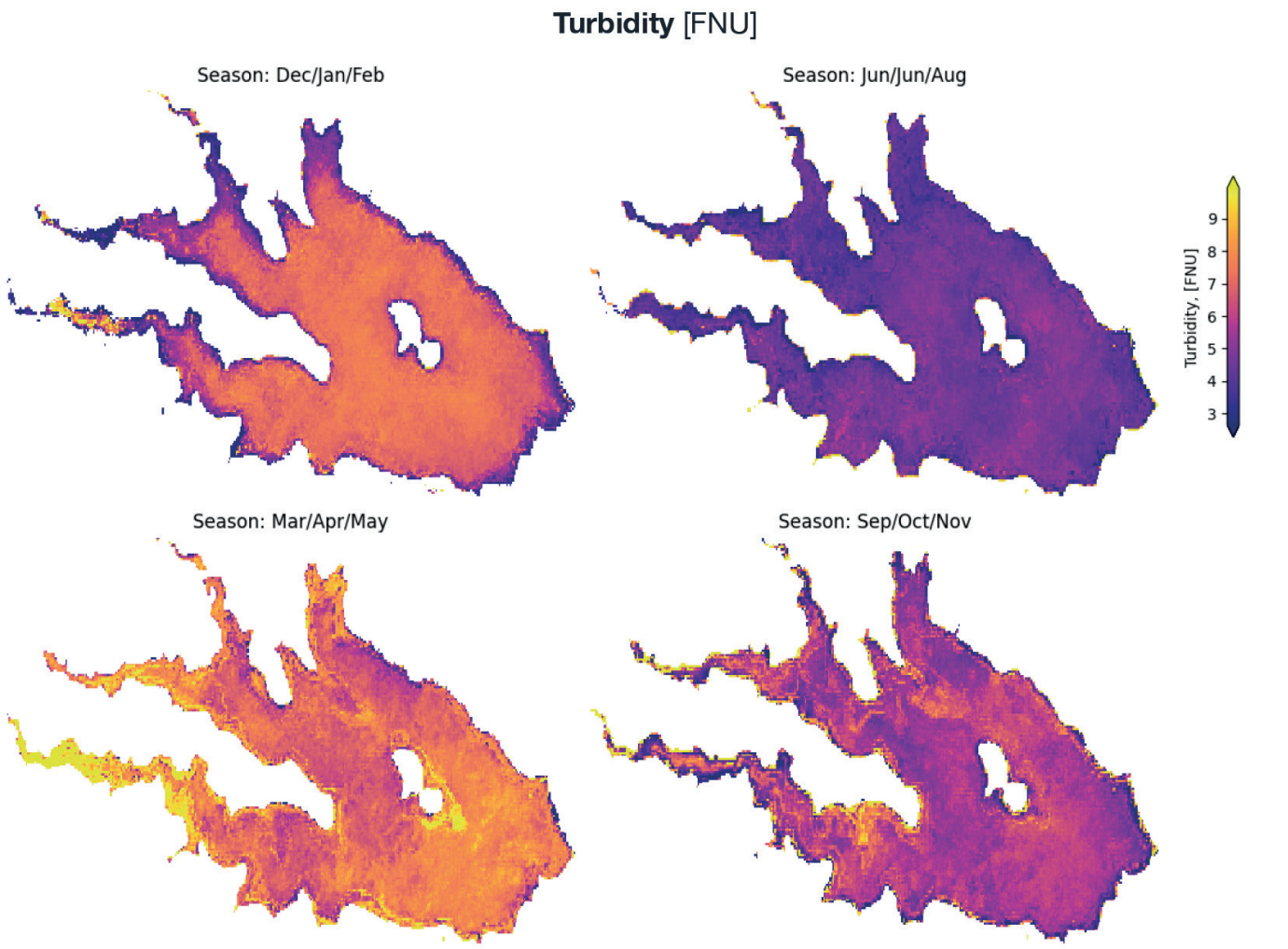
"This approach allows for asynchronous and systematic monitoring that can aid Water Fund teams with impact monitoring of conservation and restoration actions, and increasing efficiency in tactical and strategic decision making. We can leverage remote sensing data archives to provide a baseline assessment of how these water quality metrics behave over time and in space."

Dr. Fernando Miralles-Wilhelm,
Lead Scientist for Global Water
The Nature Conservancy

Chlorophyll-*a* Concentrations [mg/m^3]



Composite image showing the median, standard deviation, and coefficient of variation values for each pixel through the entire time series. Areas of high median values tend to also be more variable in absolute terms (standard deviation). This effect is accounted for in the coefficient of variation.



Seasonally partitioned mean turbidity concentrations across the entire Thika Reservoir site. Each surface depicts the mean pixel value across the entire site throughout a three-month period. While there is some localized spatial variation, the small size of this site produces consistent values across the entire area.

The TNC Water Funds teams use the data, analytics and report to provide insight in three key areas:

1. **Inputs to sampling plans.**
   Remote sensing results pinpoint locations of high activity and variability throughout the year, helping to optimize the effectiveness of on the ground sampling by ensuring sampling is happening in the most interesting places.

2. **Where to plan and develop future conservation efforts.**
   These data can also be used to set conservation goals and identify locations where specific conservation actions should be applied. In addition to location, the scale of the needed intervention can be determined based on modeled or predicted impacts, and then verified during project implementation.

3. **Inputs to help understand the ecological impact of projects.** This remote sensing dataset on water quality gives us insight on what seasonal fluctuations are to be expected, and how levels of different water quality parameters are shifting over the long term. By combining this dataset with the timing and location of projects, or interventions, as well as land use change information more generally, we can reach a more complete understanding of the effectiveness of different conservation and restoration efforts. Understanding ecological impact can help speed up learning for better results, and help with project fundraising.

How?

Data at the landscape scale

By proividing an order of magnitude more information, Gybe enables TNC to automatically track what is happening across the surface of the entire water body.

New Insights + Data Visualisation

Gybe visualises and analyses TNC data, enabling the discovery of new insights, and easier internal and external communication about the meaning of the data.

A fraction of the cost

Gybe's fully automatic system continuously updates the data, helping TNC spend more time on conservation work, and less time gathering data and maintaining sondes.

Performance

Satellite Data

Spatial resolution:10-20m
Data frequency: New map images every 5 days on average
Historical data: Back to 2016

1329
DataMaps Generated

Analytics

Five core types of analytics were run on each of the four sites, for the entire historical data archive (2015 - 2021):

- Spatial and temporal seasonal trends, for locations of interest
- Long term trends (Mann-Kendall Trend, showing baseline deviation)
- Variation Maps
- Trend Maps

What's next?

Improving the product: understanding cause and effect, or how land use changes, conservation efforts, and other drivers affect water quality. It is the hope that data pipeline, water quality products, and analyses will assist in more targeted monitoring, risk mitigation and eventual prevention of sediment and nutrient pollution and subsequent eutrophication.

Continued work with two of the local teams: "the Brazilian Water Funds team has been developing a very detailed land use change dataset (1985 to present, 30m res). Combining this dataset with Gybe's data will provide us with a powerful way to link one to the other. There are often different things happening in the same reservoir at once (eg. turbidity and effects on eutrophication) that we can now, for the first time, quantify". There is also an important potential for expansion into additional Water Funds.

Find out how our solutions can work for you.

Get in touch at info@gybe.eco