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eoapp AQUA

SATELLITE-BASED WATER QUALITY MONITORING

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eoapp AQUA and YSI Instruments: A Winning Pair for Modernizing Your Water Monitoring Needs

eoapp AQUA is a cloud-based data visualization platform that uses satellite data to provide key water quality information. Developed with the world class expertise of our partner, **EOMAP**, this innovative solution empowers you to easily generate, visualize, and analyze comprehensive water quality data. Using proprietary physics-based algorithms, eoapp AQUA transforms historical and near-real-time data from satellite-based optical sensors into actionable insights, setting a new standard in water quality monitoring.

Key parameters such as colored dissolved organic matter (CDOM), chlorophyll, Secchi disk depth, turbidity, and temperature enable proactive monitoring for issues like harmful algal blooms (HABs) and facilitate detailed analysis of aquatic environments before and after extreme events such as flooding, drought, or wildfires. With temporal resolutions as frequent as daily revisits and spatial resolutions as precise as 3 meters, you can delve into data dating back to the 1980s, offering unprecedented insights into water quality dynamics.

In addition, uploading field data from Xylem's extensive range of water quality instruments, including the EXO Sondes, Pro Series Handhelds, AUVs, and Integrated Systems, into the eoapp AQUA platform allows for simultaneous data analysis and enhances the capabilities of YSI's entire product portfolio. This synergy provides you with the opportunity to integrate satellite data into a sophisticated water monitoring program that augments your field data.

Benefits

See the "Big Picture"

Together with YSI's in-water instruments, satellite-based sensors provide increased spatiotemporal data to help detect seasonality, trends, spatial patterns, and extreme events in a long-term context.

Data at Your Fingertips

Near-real-time processing of latest satellite overflights allows for a fast overview of all areas of interest (AOIs). User-friendly dashboards support a rapid uptake.

Stay Informed

Create custom alarms to stay informed of changes to parameters and areas that matter to you. Receive early warning email notifications based on site-specific thresholds.

Assess Impacts

eoapp AQUA provides access to historical data as far back as the early 1980's, which can be used to assess the impacts of extreme events or climate change risks.

Applications

eoapp AQUA can be used to provide additional insights into a variety of applications.

Key Information on the Status of Water Reservoirs, Recreational Water, or Rivers

Satellite-based monitoring of key water quality parameters is delivered in the form of online accessible maps and time series and can be used to identify ideal in-water monitoring stations for YSI's instruments.

Near-Real-Time Conditions of Coastal and Inland Waters

Receive up to daily updates on parameters like turbidity and chlorophyll or email alerts on potentially harmful algal blooms for hands-on decision support.

Climate Change and Trend Analysis

Historical data going back 40 years facilitate environmental monitoring and reporting, as well as data-based infrastructure planning.

Detection of Rapid Changes in Condition

Daily, weekly, or monthly statistics enable thorough mapping of construction works and simplify assessments of environmental impacts of human activities or natural hazards.

Drinking Water Safety

Habitat Assessment

Coastal Engineering

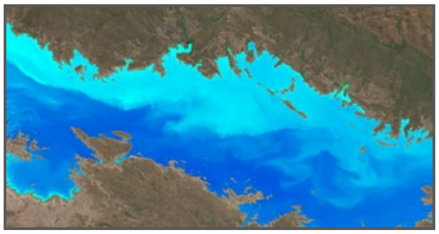
Monitoring Ecological Status

Hydrodynamic Modeling

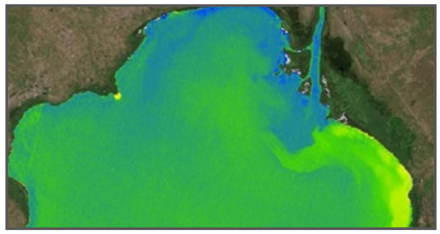
Hydropower Projects

Parameters Overview

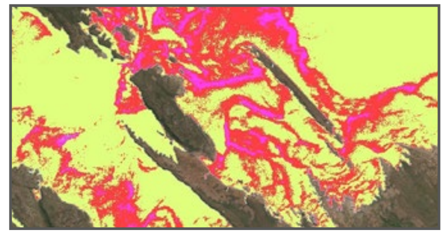
eoapp AQUA focuses on water quality for the following parameters:



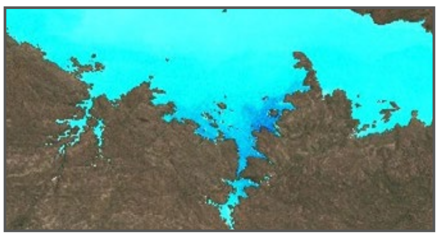
CDM - CDOM, Yellow Substance (1/m)
CDOM (Yellow Substance) includes all colored dissolved organic matter affecting water color, mainly humic or fulvic acids from river or groundwater transport, phytoplankton and vegetation decay, or surface runoff. It is measured by absorption at 440 nm.



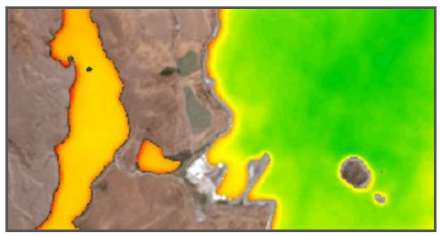
CHL - Chlorophyll (µg/l)
Chlorophyll, a pigment in phytoplankton cells, serves as a proxy for algae in natural waters. Its concentration is derived from in-water organic absorption, turbidity, and spectral characteristics.



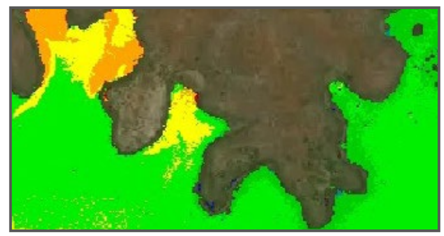
HAB - Harmful Algal Bloom Indicator
Harmful Algae Bloom Indicator (HAB) detects cyanobacteria by sensing the presence of Phycocyanin and Phycoerythrin. The algorithm analyzes spectral trends in the green-red bands (550–650 nm) as a proxy to identify areas likely affected by harmful algal blooms.



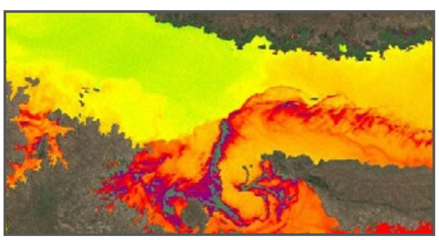
SDD - Secchi Disk Depth (m)
Secchi Disk Depth (SDD) measures light penetration or clarity and is related to the euphotic zone. It is traditionally determined by lowering a Secchi Disk into the water.



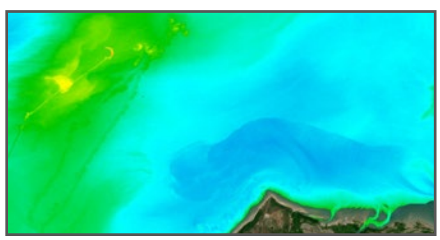
SST - Sea Surface Temperature (°C)
Water Surface Temperature, or lake skin surface temperature, affects water quality by promoting the growth of algae and cyanobacteria. It is calculated from thermal infrared channels.



TSI - Trophic State Index
The Trophic State Index is based on chlorophyll *a* in eoapp AQUA. It ranges from 0 to 100, with values below 40 indicating an oligotrophic state, and values above 70 representing a hypereutrophic state.

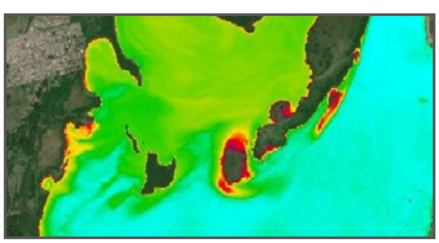


TSM - Total Suspended Matter (mg/l)
Total Suspended Matter (TSM), or mass concentrations of particles, are linearly related to turbidity at low to moderate levels. TSM is determined by measuring total particle and backward light scattering in the visible region.

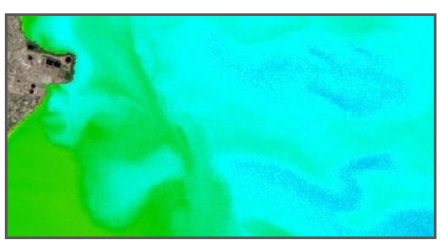


TUR - Turbidity (NTU)
Turbidity, a key water quality parameter for reservoirs and rivers, is caused by organic and inorganic particles that affect light penetration and primary productivity. These particles can carry pollutants like metals and bacteria and increase sedimentation, harming aquatic habitats. Turbidity is calculated by measuring backscatter between 450 and 800 nm.

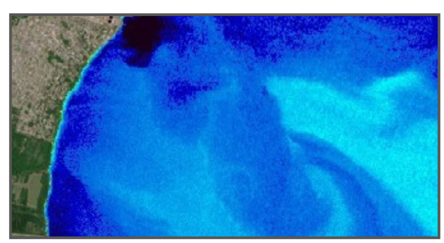
WEX - Water Body Extent
Water Extent differentiates land from water pixels based on reflectance in visible and near/shortwave infrared regions. It is useful for studying tidal areas, mapping floods, quantifying reservoir capacity, calculating river discharge, and observing shoreline changes.



ABS - Total Absorption (1/m)



SIA - Sum of Inorganic Absorbers (1/m)



SOA - Sum of Organic Absorbers (1/m)

The absorption parameters of ABS, SIA, and SOA provide a better understanding of a water body's spectral properties. Comparing SIA and SOA gives insights into whether the absorption patterns observed in the water body are more sediment-driven (high SIA) or driven by organic material (high SOA) and how this may change over time.

eoapp AQUA Features

Baseline

Detect trends and natural patterns using historical data from the 1980s to the present day.

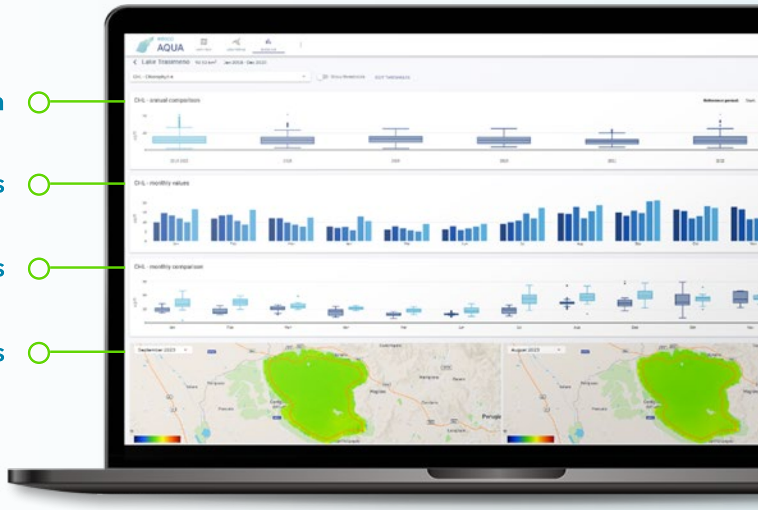
Access annual and monthly information, compare current and long-term data, detect trends and seasonality of water bodies, and directly compare two water bodies.

Annual Comparison

Monthly Values

Monthly Statistics

Monthly Maps



Monitoring

Observe changes through near-real-time statistics and visualizations in dashboards.

Enable quick overviews of current situations and emerging developments, efficiently supervising large amounts of water bodies to support management decisions and fieldwork planning.

Each Point is One Satellite Measurement

Visibility Depth

Chlorophyll Concentration

Algal Bloom Indicator

Alert

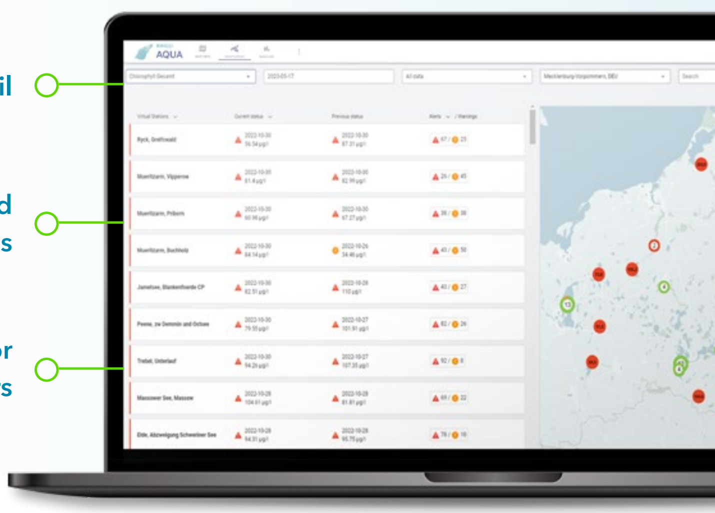
Receive early warning emails and notifications based on user-defined thresholds for each water body.

The system will send a notification email to the user when these thresholds are exceeded.

Notification via Email

User-Defined and Site-Specific Thresholds

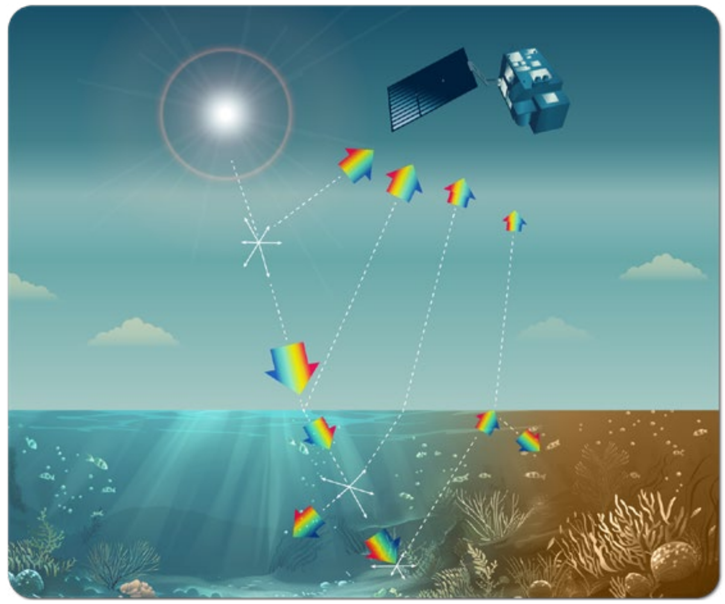
Combination of Data for Early Warning Indicators



Satellite-Based Water Quality Monitoring Methodology

Multispectral satellite sensors measure optically active water constituents by detecting sunlight as it penetrates the atmosphere and the water. As this light interacts with particles and dissolved materials in the water, it is absorbed and scattered. **The reflected light spectrum**, captured by satellite sensors, corresponds directly to various water quality parameters, such as turbidity, suspended matter, phytoplankton (and its primary pigment, chlorophyll), detritus, and colored dissolved organic matter.

By analyzing the optical properties of these constituents, it is possible to calculate their concentrations using only the reflectance of light measured by the sensors. The **color of the water** (and, therefore, the reflected light) is influenced by water quality and can be interpreted using physics-based algorithms to generate accurate and reliable data.



However, several external factors often disrupt the satellite signal, including atmospheric aerosols, water surface reflections, scattered light from nearby land, and observation geometry. Correcting for these interferences is essential to ensure accurate satellite data analysis.

eoapp AQUA's **physics-based algorithm**, developed by **EOMAP**, produces consistent and comparable water quality data across different locations and times. This contrasts with competitors that rely on AI-generated data, which may require ground-truth validation for specific water bodies and satellite sensors.

Spatial and Temporal Resolution

The spatial and temporal resolutions vary by satellite. The area of each pixel in one satellite tile is called the spatial resolution. For water quality, this typically varies from as fine as 3 m (very high resolution) to as large as 300 m (coarse resolution). How often a satellite revisits a location is called temporal resolution. This can range from daily to weekly or more.

Parameter Specifications

Parameter	Accuracy	Units of Measure	Range	Comments
CDM CDOM	~5–10% deviation, e.g. tested in Estonian waters	1/m	CDOM occurs in all natural waters, especially in forested watersheds with wetlands. Anthropogenic sources are wastewater and urban/agricultural runoff.	Can be used for flood monitoring, reservoir capacity, river discharge, tidal impacts, and shoreline changes. Some other satellite sensors (e.g. radar) are immune to cloud cover interference, and can be used to supplement the standard optical measurements.
CHL Chlorophyll	+/- 30% possible in comparisons with high concentration variability over small spatial areas and/or rapidly changing conditions.	µg/L or g/m³	Marine waters or clear lakes: 0.01–10 µg/L mesotrophic lakes: ~ 6–20 µg/L eutrophic lakes: ~ 20–150 µg/L hypereutrophic lakes: > 150 µg/L In warm, nutrient-rich environments, cyanobacteria can multiply quickly, creating blooms that spread across the water surface.	Chlorophyll serves as proxy for phytoplankton and is calculated based on the spectral characteristics of various pigments, including chlorophyll *a*. The chlorophyll measurement can also be used in the assessment for the probability of the presence of HABs.
HAB HABs Indicator	Calculation of likelihood HAB presence sensitive to the appearance of Phycocyanin and Phycoerythrin pigments.	No HAB, Unlikely, Likely, Very Likely	In warm, nutrient-rich environments, cyanobacteria can multiply quickly, creating blooms that spread across the water surface.	Calculated from the attenuation coefficient based on in-water scattering and absorption.
SSD Visibility (Secchi Disk Depth)	Very good correlation with *in situ* measurements (R = 0.93)	Meters	Ranging from few centimeters in very turbid waters to over 20 m in very clear ocean conditions	Measures the skin of the water; doesn't average the visible water column. Only certain satellites have the thermal sensors which is what limits the resolution. New satellites may improve in the years after 2024
SST Water Surface Temperature	+/- 0.5 to 2 degrees C or 5–10%. Temporal resolution, 1-week or greater. Spatial resolution appears 30 m; however, actual measurement is 100 m. For larger water bodies, daily measurements are possible with 1 km spatial resolution.	Celsius	Typically between 0–35°C	Very high CDOM absorption levels can make it difficult to calculate CDOM. It can also affect estimations for chlorophyll.
TSM Total Suspended Matter	Typically < 5% deviation between 0–30 mg/l	mg/l	Typically in the range of turbidity, during exceptional cases (e.g., flushing events of hydropower reservoirs) up to multiple grams per liter.	Mass concentrations of particles measured as Total Suspended Matter (TSM) are linearly related to turbidity at low to moderate values.
TUR Turbidity	Typically < 5% deviation between 0–30 NTU	NTU	EPA drinking water: < 1NTU Short-term stress to aquatic life: >10 NTU Unsafe level for most aquatic life: >100 NTU	The properties and wavelengths measured by *in situ* instruments differ from those measured by satellite sensors.
WEX Water Extent	Land and water have very different spectral properties (water: low reflectance, land: high reflectance), therefore it can be differentiated successfully in almost any case.	Water yes/no	> 0.1 for clear lake waters > 1 for humic lakes > 5 for very humic and turbid rivers	

Colored Dissolved Organic Matter

Colored Dissolved Organic Matter (CDOM, CDM) or Yellow Substance comprises all dissolved organic matter which influences the water color, mainly consisting of humic or fulvic acids, originating often from fluvial or ground water transport, degradation of phytoplankton and aquatic vegetation, or surface run-off. In high CDOM areas, the absorption leads to reduced euphotic depth and affects the growth of macrophytes.

Saidenbach drinking water reservoir, Germany

Typical Applications and Use Cases

- Recreational Water Monitoring
- Water Framework Directive
- Global Carbon Budgets

Technical Characteristics:

CDOM absorbs light especially in the blue wavelengths and can thus affect the transparency of the water column.

CDOM is measured in terms of absorption and the measurement unit is 1/m.

Additional Information:

CDOM has significant impacts on surface water quality through its ability to affect pH, mobilize metals and hydrophobic organic chemicals, and serve as a source of reactive intermediates in aquatic photochemistry.

CDOM also regulates heat transfer to water, controlling lake temperatures, mixing, and stratification.

Literature & Useful Links:

Kutser, Tiit & Pierson, Donald & Tranvik, Lars & Noorma, Anu & Sobek, Sebastian & Kallio, Kari. (2005). Using Satellite Remote Sensing to Estimate the Colored Dissolved Organic Matter Absorption Coefficient in Lakes. Ecosystems. 8. 709–720.

Aurin D, Mannino A, Lary DJ. (2018): Remote Sensing of CDOM, CDOM Spectral Slope, and Dissolved Organic Carbon in the Global Ocean. Appl Sci (Basel). 8(12):2687.

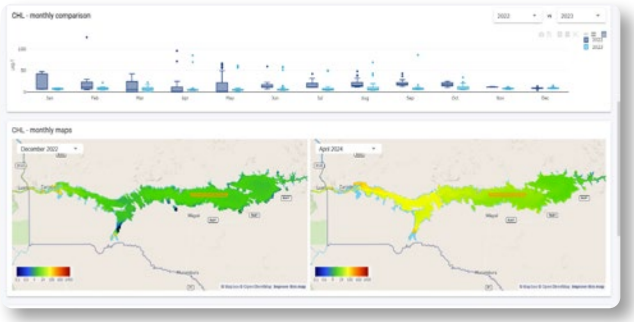
Saxony Drinking Water Reservoirs

Range – Validation – Accuracy:

CDOM values can range from very clear oceanic waters with 0.02 1/m, greater than 0.1 for clear lake waters, up to more than 1 for humic lakes or more than 5 for very humic and turbid rivers.

Errors in the calculated CDOM absorption may appear in shallow water areas, where the seafloor or bed contributes to the signal measured by the satellite or when the CDOM absorption cannot be sufficiently discriminated from the phytoplankton pigment or detrital absorption.

Chlorophyll



Monthly statistics and spatial distribution of chlorophyll concentrations over the course of a year

Typical Applications and Use Cases

- Ecological Assessments
- Environmental and Recreational Water Monitoring
- Storage Capacity Calculations

Technical Characteristics:

eoapp AQUA's chlorophyll retrieval is based on derived pigment-specific in-water absorption and the spectral characteristics of various pigments. The unit is µg/L or mg/m³.

The pigments contributing to this quantifiable absorption, which is measured by the spectral satellite sensors, not only include various chlorophyll pigments, but also other pigments such as Phaeophytin.

Additional Information:

The reliability of the data is sensitive to the specifications of the underlying satellite sensors and their specific characteristics, such as radiometric or spectral sensitivity. Still, with physics-based analysis methods, the data are comparable when accounting for absorption and scattering spectra. The applicability range for chlorophyll data can be limited in waters with exceptional optical properties, e.g., in humic, calcareous, or ferruginous waters.

Literature & Useful Links:

Karle, N., Wolf, T. et al. (2019): Satellite Remote Sensing of Chlorophyll and Secchi Depth for Monitoring Lake Water Quality – A Validation Study. Processings for the SPIE, Strasbourg

Bresciani M, Giardino C. et al. (2019): Monitoring water quality in two dammed reservoirs from multispectral satellite data, European Journal of Remote Sensing

Water Days (2022): High Resolution Bathing Water Monitoring

Range – Validation – Accuracy:

Chlorophyll is the parameter showing greater short-term variations due to intra-daily dynamics of phytoplankton.

Based on recent validation exercises comparing satellite with *in situ* measurements (Karle, 2019, Bresciani 2019), in large and small lakes, the mean value of both methods are very similar and their range of minimum and maximum values fits well, with r of 0.87 or an average remote sensing/*in situ* factor of 0.8–1.2 in different ecological water bodies.

Harmful Algal Bloom Indicator

Harmful Algal Bloom Indicator (HAB) is a proxy for cyanobacteria and is sensitive to the appearance of phycocyanin and phycoerythrin. Cyanobacteria, also called blue-green algae, are microscopic organisms found naturally in all types of water. In warm, nutrient-rich environments, cyanobacteria can multiply quickly creating blooms that spread across the water surface. Some cyanobacterial HABs can produce toxins and pose harm to people, animals, aquatic ecosystems, drinking water supplies, property values, and recreational activities, including swimming and fishing.

Algal Bloom in Lake Victoria

Typical Applications and Use Cases

- Recreational Water Monitoring
- Climate Change Studies
- Ecological Assessments

Technical Characteristics:

The data provide a qualitative indicator classifying the likelihood based on the identification of reflectance and absorption discrepancies between the 550 nm and 650 nm wavelength bands. These discrepancies indicate the appearance of the cyanobacteria-related pigments. The HAB Indicator is classified into four likelihood classes: no HAB, unlikely, likely and very likely.

The quantification of cyanobacteria is currently under development.

Additional Information:

Chlorophyll and similar pigments are also present in cyanobacteria and can be used as an indicator of algal bloom events. However, not all bloom events are necessarily harmful algal blooms.

Like chlorophyll, the applicability range for the HAB indicator is limited for water with exceptional optical properties, except for extremely humic, calcareous, ferruginous waters, or in rivers with high suspended sediment loads.

Literature & Useful Links:

Dörnhöfer, K., Klinger, P. et al. (2017): Multi-sensor satellite and *in situ* monitoring of phytoplankton development in a eutrophic-mesotrophic lake. Science of Total Environment 612C (2018)

International Journal on Hydropower & Dams, Vol. 31 - Issue 2

Range – Validation – Accuracy:

Latest validation of the HAB Indicator concludes that the peaks in the *in situ* data match well with the peaks found in the remote-sensing-based indicator, as shown in use cases in Spain, Germany, and Italy.

Also, seasonal trends are well-represented in the HAB Indicator, so it can be used as an early warning parameter for recreational water surveillance.

Secchi Disk Depth

Secchi Disk Depth (SDD) is a measure of visibility in the water column, indicating how deep the light can penetrate into the water body. Visibility is related to the euphotic zone in the water and is a useful source of information for divers.

The visibility within a water body as proxy for euphotic zones

Typical Applications and Use Cases

- Recreational Water Monitoring
- Lidar Survey Planning
- Trophic State Assessments

Technical Characteristics:

SDD is derived from the in-water scattering and absorption properties and is expressed in meters (m).

It is calculated from the attenuation coefficient Kd after Lee et al. 2005 and 2015 by calculating: SDD = 2.3 / (2.5 * Kdmin) with Kdmin being the min Kd from all channels of the visible spectrum.

Additional Information:

In general, SDD (and other water quality-related parameters) is only applicable for optically deep surface waters, which means that the bottom of the waterbody is not visible.

For optically shallow waters, increased errors will occur due to interferences of the seafloor or bed in the water signal.

Literature & Useful Links:

Lee, Z. P., Du, K.-P., Arnone, R. (2005): A model for the diffuse attenuation coefficient of downwelling irradiance, Journal of Geophysical Research, Vol. 110, C02016

Lee, Z. P., Shang, S. et al. (2015): Secchi disk depth: A new theory and mechanistic model for underwater visibility, Remote Sensing of Environment 169, 139-149

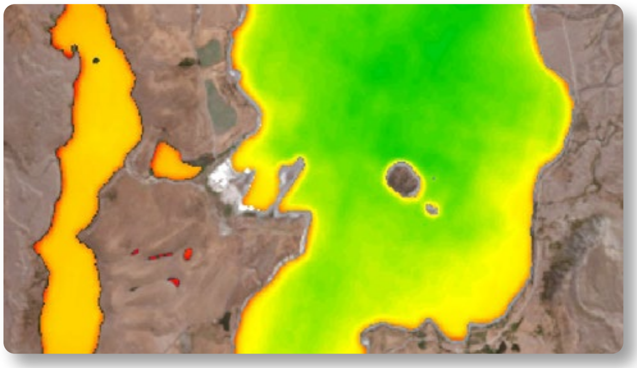
Range – Validation – Accuracy:

Visibility (SDD) determined by satellite data corresponds very well with the *in situ* measurements in both large and smaller lakes, rivers, or coastal areas.

For example, the comparison between satellite-based SDD and *in situ* show very good correlation with r = 0.93 and a RMSE of 0.41 in the case of two dammed reservoirs investigated. (Bresciani et al., 2019)

Water Surface Temperature

Water Surface Temperature (SST) corresponds to the temperature at the very surface of the water, also known as lake skin surface temperature. It is a fundamental parameter in the modelling of energy fluxes interacting with the water-air interface. It also affects the quality of water, because it can contribute to the growing and proliferation of aquatic algae and cyanobacteria.



Satellites directly observe spatial differences in water temperature

Typical Applications and Use Cases

- Monitoring of Desalination Plants
- Climate Change Studies
- Early Warning on Emerging Algal Blooms

Technical Characteristics:

Water Surface Temperature data are derived using thermal bands of the Landsat missions 5–9, delivered in 30 m resolution, but stemming from the original 100 m resolution TIRS band and with up to weekly coverage. For larger water bodies such as coastal areas, Sentinel-3A/B SLSTR temperature data in 1 km resolution up to daily coverage is used.

Further commercial high spatial and temporal resolution temperature data will be available in the future.

Additional Information:

Data from Landsat are available from 1984 onwards. In general, clear sky conditions at the satellite overpass time are required to generate Water Surface Temperature data.

The originally courser Landsat thermal bands are resampled to 30 m, which needs to be considered when analyzing small features such as rivers.

Literature & Useful Links:

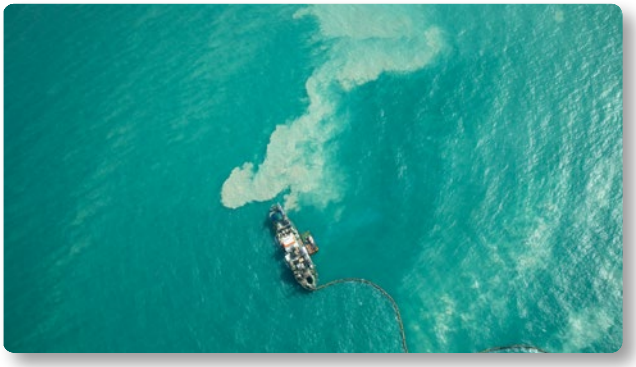
Bresciani M, Giardino C., Stroppiana D., Dessena M.A., Buscarinu P., Cabras L, Schenk K., Heege T., Bernert H., Bazdanis G. & Tzimas A. (2019): Monitoring water quality in two dammed reservoirs from multispectral satellite data, European Journal of Remote Sensing.

International Journal on Hydropower & Dams, Vol. 31 - Issue 2

Range – Validation – Accuracy:

Comparison between SST and surface temperatures derived from *in situ* measurements typically show a mean deviation between 0.5–2°C or 5–10% (Bresciani et al. 2019, Bauer et al 2024).

Turbidity and Total Suspended Matter



Observe and track turbidity plumes from above

Typical Applications and Use Cases

- Dredge Monitoring
- Drinking Water Monitoring
- Hydropower Planning and Operations

Technical Characteristics:

Satellite-based turbidity is determined by backward scattering of light in a range of 450 to 800 nm. The measurement unit is Nephelometric Turbidity Unit (NTU), which is similar to Formazin Turbidity Unit (FTU).

Mass concentrations of particles measured as Total Suspended Matter (TSM) are linearly related to turbidity at low to moderate values.

Additional Information:

As the shape, size, and spectral characteristics of particles vary, the exact relationship between scattering and TSM can vary from place to place and from season to season.

For example, this occurs when the composition of phytoplankton species changes or when other particles are introduced during snow melt periods with higher discharge.

A regional and seasonal calibration of TSM further assures the accuracy of TSM estimates.

Literature & Useful Links:

Heege, T., Kelleher, D. (2018): Reducing economic risks in hydropower developments through independent satellite-based turbidity and sediment measurements in the river systems of Georgia. Proc. Hydro 2018 conference, Gdansk 15.-17.10.2018

Bresciani M, Giardino C., et. al. (2019): Monitoring water quality in two dammed reservoirs from multispectral satellite data, European Journal of Remote Sensing

Online Story Map: "Starving the Mekong"

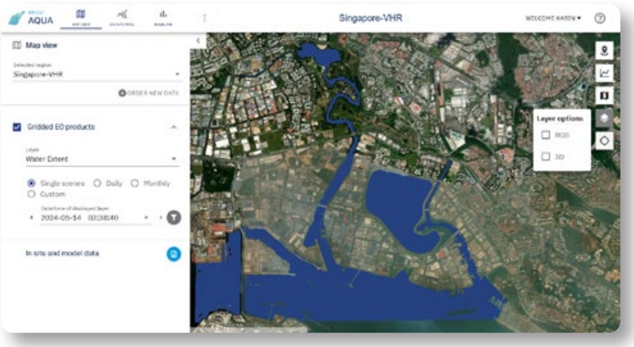
Range – Validation – Accuracy:

Turbidity and TSM compared to *in situ* measures typically with < 5% deviation over a large concentration range (0–30 NTU or mg/L). For higher concentrations, the deviations can increase.

When comparing satellite-based turbidity against *in situ* measured total suspended matter the deviations can be higher, most likely due to changing of sediment compositions resulting in accompanied changes in the TSM vs. TUR relations.

Water Extent

Water Body Extent (WEX) discriminates between land and water pixels. The water extent can be applied for studies in temporally dynamic areas, e.g., in areas influenced by tidal processes, or to map the extent of flooding. The storage capacity of reservoirs, calculation of river discharge, and changes in the shoreline are some applications of the water extent parameter.



Very high resolution water extent in Singapore visualized in eoapp AQUA, data source: Planet Superdoves

Typical Applications and Use Cases

- Flood Mapping
- Shoreline Changes
- Storage Capacity Calculations

Technical Characteristics:

The WEX parameter is based on typical reflectance features in the visible and near-to shortwave infrared region. The WEX parameter is based on optical satellite data (multi- to hyperspectral).

Additional Information:

The WEX parameter can be applied in any location to differentiate between water and land.

By combining data from additional data sources, especially from active remote sensing (i.e., radar) systems such as Sentinel-1, the value of the WEX parameter can be increased as these active systems are not subject to cloud cover, and therefore offer additional data to the purely optical-based WEX.

Literature & Useful Links:

Planet - Monitoring River Flushing and Hydropower from Space

Publications upon request available

Range – Validation – Accuracy:

The validation of the water extent mainly occurs by directly comparing the true color satellite imagery to the output parameter. From a spectral perspective, land and water have very different spectral properties (water: low reflectance, land: high reflectance), therefore it can differentiated successfully in almost any case.

Satellite Data Sources

The main data sources include non-commercial from Copernicus missions such as Sentinel-2A/B and Sentinel-3 A/B as well as Landsat missions 5-9, provided by NASA/USGS, dating back to 1984. In addition, Sentinel-1 is used to overcome gaps of passive optical sensors due to cloud coverage for the generation of water extent.

Satellite / Sensor	Spatial Resolution	Temporal Resolution	Start and End Date	Application range
Landsat 5	30 m	16 days	1984 – 2012	Finished satellite missions, but data can be used from archive since 1984
Landsat 7	30 m	16 days	1999 – now	Reservoirs and rivers with up to weekly coverage
Landsat 8	30 m	16 days	2013 – now	Reservoirs and rivers with up to weekly coverage
Landsat 9	30 m	16 days	2021 – now	Reservoirs and rivers with up to weekly coverage
Sentinel-2 A/B	10 m	5 days	2015/2018 – now	Reservoirs and rivers with weekly coverage
Sentinel-3 A/B	300 m	daily	2016/2018 – now	Large-scale, high temporal observations
MODIS Aqua/Terra	250 m	daily	1999/2002 – now	Can be used for large-scale, high temporal observations
VIIRS (NOAA-20/21, SUOMI-NPP)	750 m	daily	2011 – now	Can be used for large-scale, high temporal scale observations
MERIS	300 m	2–3 days	2002 – 2012	Instrument aboard Envisat-1, operational from 2002–2012
EnMap	30 m	27 days	2022 – now	Hyperspectral satellite (228 spectral bands), high potential for specialized vegetation/algae mapping
PRISMA	30 m	29 days	2019 – now	Hyperspectral satellite (237 spectral bands) , high potential for specialized vegetation/algae mapping

For specific events and applications, very high resolution satellite data from commercial service providers can be used, with additional data costs.

Satellite / Sensor	Spatial Resolution	Temporal Resolution	Start and End Date	Application Range
Planet Superdoves	3 m	daily	2019 – now	Small water bodies, lakes, rivers, and hotspots
Maxar WorldView-2/3	2 m	upon request	2009 – 2014	Commercially available, can be tasked over area of interest in a certain time window
Pleiades Neo 3,4	1.2 m	upon request	2021 – now	Hotspot analysis
Planet SkySAT	1 m	up to daily/ upon request		Commercially available, can be tasked over area of interest in a certain time window; Mainly used for visual / true color observations due to low number of spectral bands (4)
SPOT 6	6 m	upon request	2012 – now	Hotspot analysis
RapidEye 1–5	5 m	upon request	2009 – 2020	Retrospective hotspot analysis

Frequently Asked Questions

Ordering

1. **Can I try the app out before committing?**
   Yes! Navigate to xylem.eoapp.de and click on the button in the middle of the screen that says, "**Register for a free account**." Your account will be set up with demo data. If you are curious to try more, there is an option to request a few free credits.

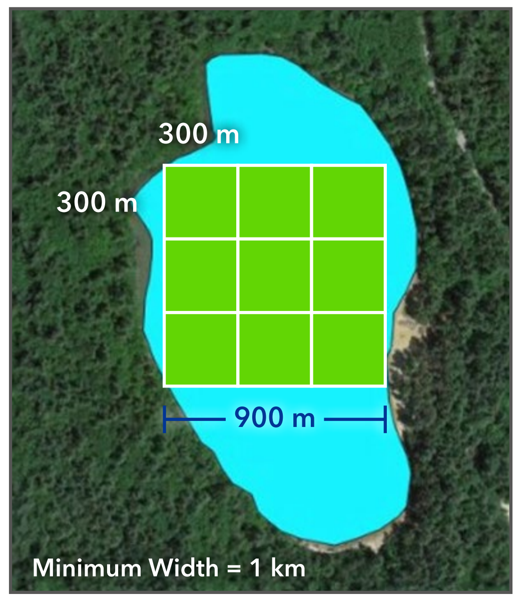
2. **How much does it cost?**
   eoapp AQUA uses a credit-based ordering system depending on the area, number of water bodies, parameters, and timeframe. We will work with you to optimize the best selections for your application and provide you with a quote for the number of credits you would need to order through the app. The credentials to your account will be shared with you within a few days, and your account will be populated with the credits you ordered. More credits can be purchased through the app as needed.

   Contact us at eoapp@xylem.com to get started!

Measuring

1. **What water bodies can be analyzed?**
   With eoapp AQUA, you can analyze the water quality of inland and coastal waters. The size of the body of water should be at least three times the sensor's spatial resolution and, therefore, depends on the satellite used for its observation. For example, for an observation with the Sentinel-3 satellites (spatial resolution of 300 m), an assumed round water body should have an area greater than 1 km^2. This required area increases for irregularly shaped bodies of water.

   Rivers can be observed using satellite data; however, the same guideline applies. Due to the dynamic nature of rivers, as opposed to standing waters, additional water pixels may be required to provide reliable information on the water body.



2. **What are the spatial and temporal resolution options when selecting data?**
   There are three options for resolution:
   a. Coarse and daily since 1999 (300 m)
   b. Fine and weekly since 1984 (10–30 m)
   c. Fine and daily since 2019 (3 m)

3. **What are the potential sources of error and limitations?**
   Optical satellites capture solar energy reflected off various Earth surfaces. Any object between the surface of interest and the satellite can cause interference or noise. Clouds and atmospheric particles are common sources of error in satellite sensor data. eoapp AQUA allows you to filter images by percent cloud cover when selecting tiles or images for analysis. For instance, choosing 75% coverage will exclude images with more than 75% cloud coverage.

   Another source of interference is sun glint, which occurs when the sun's angle causes intense light to reflect off the water. Data cannot be derived from image areas affected by sun glint.

4. **How does satellite-based water quality data compare to *in situ* data?**
   When comparing eoapp AQUA's water quality data with *in situ* data, it is essential to account for methodological differences between various in-water approaches and remote sensing techniques. For example, *in situ* turbidity measurements typically rely on light scattering at a 90-degree angle between the light source and detector. In contrast, remotely sensed turbidity products are based on a scattering angle of approximately 180 degrees (backscattering).

   In situ chlorophyll measurements are based on one of three methods: photometric, fluorescence, or HPLC. EOMAP's physics-based method used by eoapp AQUA relates remotely sensed chlorophyll to a linear relationship of pigment-specific absorption and scattering. Spectral satellite sensors measure the pigments contributing to this absorption and scattering, including various chlorophyll pigments and others like Phaeophytin.

   Also, any validation exercise must consider sampling differences between *in situ* data and remote-sensing products. These differences include sampling location, depth interval, and time. Water quality parameters can naturally vary by 20–100%, even for measurements taken close in time (e.g., a one-day difference) or space (e.g., 1 km horizontally or 3 m vertically), with potentially larger variations for more significant sampling distances.

5. **What is the accuracy of the data?**
   Please refer to the Parameter Specifications table on page 8.

eoapp AQUA-Specific

1. **Can I download my data?**
   Time series data can be downloaded as a PDF report or as a CSV file. Raster images for each parameter can also be downloaded for the tiles selected for the analysis.

2. **Can I upload *in situ* data?**
   Yes. Time series data can be uploaded using a specific format required by eoapp AQUA. A template can be downloaded from within the portal.

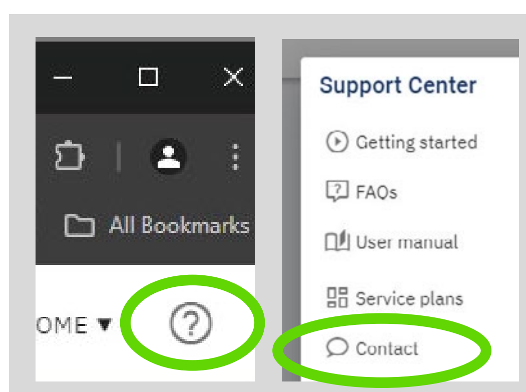
3. **How long does it take for the last measurement to appear in the portal?**
   Satellite data are typically assimilated into the data archives within a few hours to half a day after capture. Once available, the data are automatically selected and analyzed. In most monitoring projects, water quality information is delivered within one day of capture, often earlier.

Support

1. **Where do I go when I have questions?**
   Log into your eoapp AQUA account at xylem.eoapp.de and click on the '**?**' in the top right corner to access short training videos, FAQs, and the eoapp AQUA user manual.

   If you need more assistance, select '**Contact**' in the Support Center.

   For sales support, please reach out to eoapp@xylem.com.



Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services settings. Xylem also provides a leading portfolio of smart metering, network technologies and advanced analytics solutions for water, electric and gas utilities. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com

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