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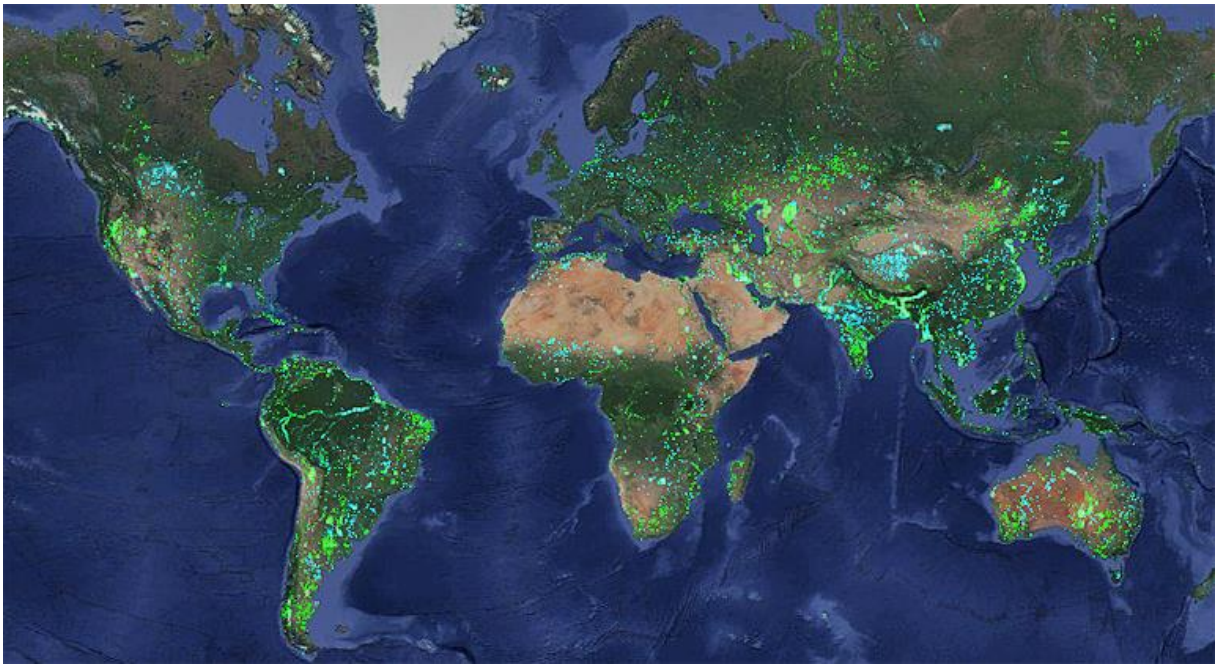
HYDROLOGICAL NETWORK AND SURFACE WATER DYNAMICS



Screenshot of the Deltares Aquamonitor showing changes in surface water dynamics (Source: Deltares)

PRODUCT DESCRIPTION

Category

☐ Topographic information	☐ Surface deformation
☐ Impact assessment	☐ Precision ortho-images
☒ Change detection / continuous monitoring	☐ Terrain information
☐ Land cover / use	☒ Water quantity & quality
☐ Near surface geology	

Uses

Environmental Assessment & Permitting – Water is a key aspect of mining. Mining will typically take place over a very large footprint and will have a large area of influence. Mining companies need to identify the water catchment, their water usage, and they need to understand what impact the mine may have on that catchment in terms of discharging into it and, for example, where this might cause an impact in terms of risk of flooding etc. If the mine pit resides below the groundwater table, the company will also need to understand how abstracting ground water surrounding the mine pit might impact on the water balance within the catchment and potentially deprive sensitive areas of water.

Environmental Assessment & Permitting - The concentration of various chemical parameters in the receiving environment will vary with some being more abundant than others. To understand the receiving environment, it is necessary to sample over extended periods of time to allow for seasonal

variation in water quality and quantity.

Design, Construction & Operations – To detect changes in routine water emissions often also the quantity of water changes, which results in changes in the hydrological network.

Design, Construction & Operations – Detection of illegal mining operations. Often illegal mining is accompanied with changes in water surface.

Closure and Aftercare – When leaks or seepage occur at large scale after closure of a mine changes in water can help to identify the changes in quantity.

Challenges addressed

Permitting Process – Water catchment

Development and Operations – Environmental Monitoring

Closure and Aftercare – Environmental Monitoring

Geo-information needs

P-1 Water Catchment (rivers lakes etc.)

P-5 Receiving waters characterisation & assimilative capacity

DO-20 Monitoring routine water emissions

DO-23 Monitoring seepage from mine structures (e.g. TSF, WRD)

DO-27 Mapping of any illegal mining operations

CA-10 Plume tracking of leaks or seepage

Description

This product provides information on the hydrological network and the catchment area by combining various types of topographic data (elevation, slope gradient and direction). Thus, the current and future, hydrological driven, utilization potential of the surrounding land based on satellite data can be estimated. Furthermore, information on the hydrological network and catchment area helps to identify potential areas of flooding.

A hydrologically correct elevation data set is generated by ensuring that surface features such as vegetation and buildings are removed and filling unwanted or incorrect sinks within the elevation data. The elevation data is used to calculate the direction of water flow for each pixel of the input data. This flow direction information is used to calculate accumulated overland flows, which are used to derive hydrological networks (streams/ watercourses). Further GIS operations are generally used to generate a hydrological network with stream orders (e.g. Horton-Strahler stream order). Streams can be defined by the number of cells draining into one cell. This information is used to delineate catchment and sub-catchment areas.

This product delivers maps or vector or raster digital files that delineate and identify:

- Hydrological network (Streams/ watercourses)
- Catchment areas (Basins and sub-basins)
- Global Lakes and Wetlands
- Global Reservoirs and Dams

These products can be used as an input for hydrological modelling, to derive e.g. sheet flows on plains or for modelling of potential flood areas for flood risk assessment.

Detection of water bodies from space is done by radar or optical imagery. Surface water change

detection has been done where by combining different data sources over 30 years of annual surface water can be detected. One way is by merging Landsat observations from different missions in google earth engine resulting in Aquamonitor. Another surface water change product has been developed by JRC in the Global Surface Water Explorer.

Known restrictions / limitations

The main input for this integrated product is an elevation model, which can be based on radar or optical data. By using optical data a higher resolution can be achieved (there are more and higher resolution optical VHR sensors than radar sensors), but the restrictions of optical data concerning cloud coverage in areas with high cloud cover (e.g. inner tropics) have to be considered.

Furthermore, high latitudes coverage is restricted. When generating a digital elevation model (DEM) from stereo pairs, good quality imagery needs to be available with 2 or more images showing the same area from different directions. This can be a time-consuming process. Lower resolution DEM data is available off the shelf.

An important issue is that the DEM is used to estimate surface flows, and in many regions the hydrology is heavily influenced by geology and surface flows, particularly in sedimentary geological regions (e.g. Karst).

Other options are using on the shelf integrated products as listed and specified under Product Specifications

Lifecycle stage and demand

Exploration	Environmental Assessment & Permitting	Design, Construction & Operations	Mine Closure & Aftercare
■	■■■■	■■	■■

General: Water is a key aspect of mining. Mining will typically take place over a very large footprint and will have a large area of influence. Mining companies need to identify the water catchment and they need to understand what impact they may have on that catchment in terms of discharging into it

Environmental Assessment & Permitting: The mining company needs to know where the locations of surrounding water bodies are and to know where mining might cause an impact (e.g. flooding). They also need to understand how abstracting (ground)water from the mine site might impact on the water balance within the catchment and potentially deprive sensitive areas of water. Also, the catchments need to abstractions and discharges from the mine site.

Design, Construction & Operations: During operations mining companies need to monitor their emissions of pollutants in the environment. An indirect, supporting parameter is the quantity of water where the dissolved components could possibly be in.

Mine Closure & Aftercare: During mine closure and aftercare operators need to implement a good closure protocol preventing potential leaks or seepage. Detection of change in open water bodies could support whether floods (dam breaches) occur or chemicals are possibly emitted in the environment through seepage/overland flow.

Geographic coverage

Coverage is global

EARSC Thematic Domain

Domain *Land*

Sub-domain *Inland water*

Product description *Assess and monitor water bodies*

PRODUCT SPECIFICATIONS

Input data sources

Satellite	*HydroSheds (Catchments and river networks)*	*Global Reservoirs and Dams (GRanD*	*Global Lakes and Wetlands Database (GLWD)*	*Aquamonitor (Surface Water Change)*	*Global Surface Water Explorer (Surface Water Change)*
Status	In operation	In operation	In operation		In operation
Operator	USGS	Global Water System Projet	WWF	Deltares/Google Earth Engine	JRC
Data availability	Public	Public	Public	Public	Public
Resolution (m)	500 m	n/a	1:1 – 1:3 million	30 m	30 m
Coverage	Global	Global	Global	Global	Global
Frequency (days)	n/a	n/a	n/a	annual	annual
Launch year	2008	2011	n/a	1985-2016	1985-2020
Website	link	link	link	link	link

Minimum Mapping Unit (MMU)

n/a (the product is directly based on the input data; the smallest unit is 1 pixel).

Accuracy / constraints

Thematic accuracy:

Inland Water – Assess and monitor water bodies. 80%

For the mining industry the catchments and hydrological networks are relevant. As well as the changes in surface water over time. This product, however, as result of its relatively coarse spatial resolution, mostly be used as supporting data product for monitoring routine water emissions or tracing of leaks after closure of mining activities.

Spatial accuracy:

See above. Required accuracy in the mining sector for detection of leaks and plumes in m-scale resolution, which is not available with the current available products. For the detection of catchments and hydrological networks the existing product resolution is sufficient

Accuracy assessment approach & quality control measures

This is done by field validation using in-situ measurements.

Timeliness

n/a

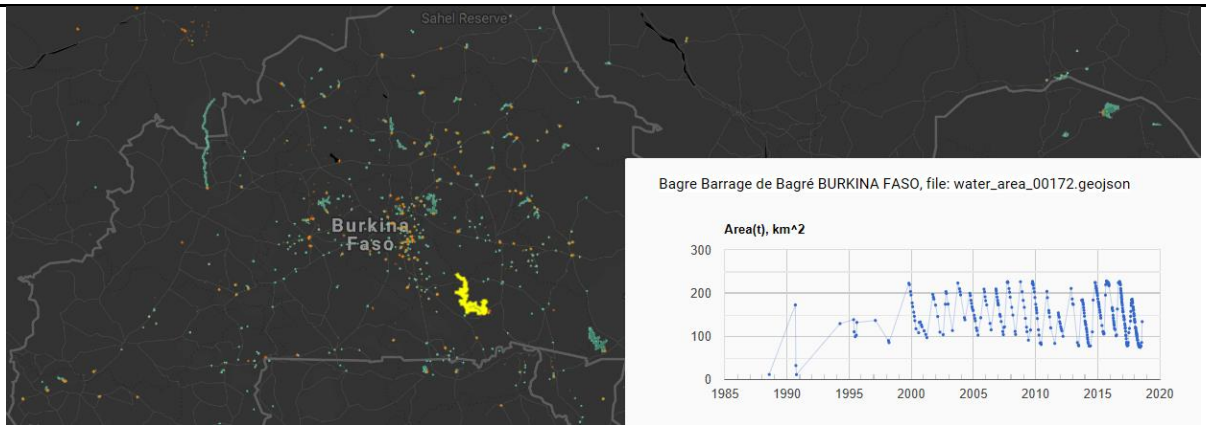
Availability

Data is typically freely available for non-commercial use through the open data policy of the different space agencies. See for an overview of the used satellites the table above.

Delivery / output format

Typically, the datasets are delivered in raster NetCDF format, TIFF or in shapefiles.

Use Case



Source: Deltares

Surface water dynamics of dam reservoirs can provide insight into the dynamics of water over time. In the picture above the orange dots show all the known dam locations, in blue/green the water reservoirs are shown. In the graph the EO observed changes of surface water over time are shown based on the Deltares Aquamonitor.