

Water colour of Pyramid Lake, Nevada

Sentinel-2 MSI acquired on **31 March 2017** at 18:49:21 UTC
Sentinel-2 MSI acquired on **10 May 2017** at 18:49:21 UTC
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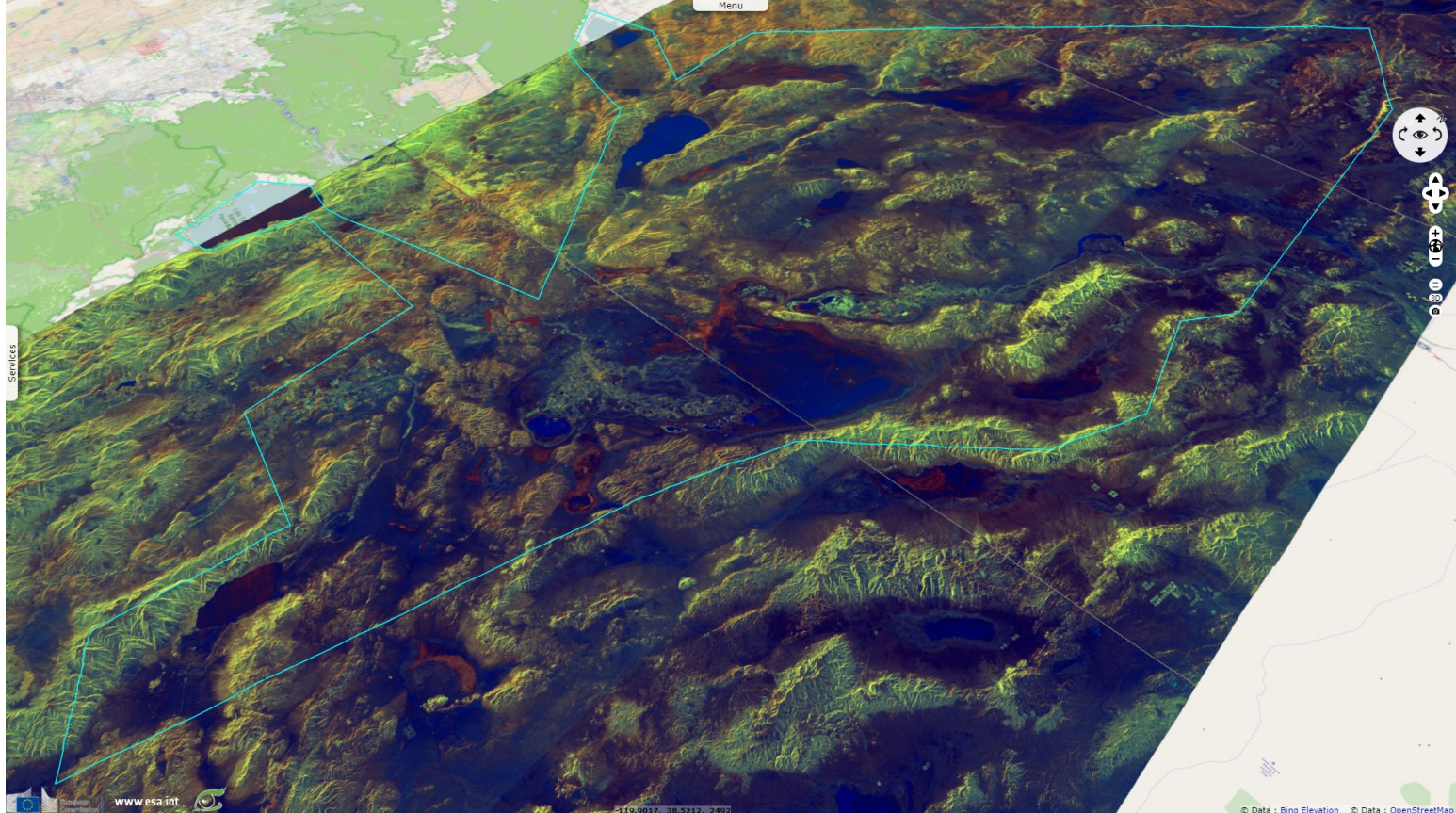
Keyword(s): Water colour, water quality, endorheic lake, runoff, eutrophication, algal bloom, cyanobacteria, USA, United States



[2D Layerstack](#)

[3D view](#)

Fig. 1 - S1 (15.07.2018) - vv,vh,ndi(vh,vv) colour composite - Approximate maximum extent of Lake Lahontan in cyan.

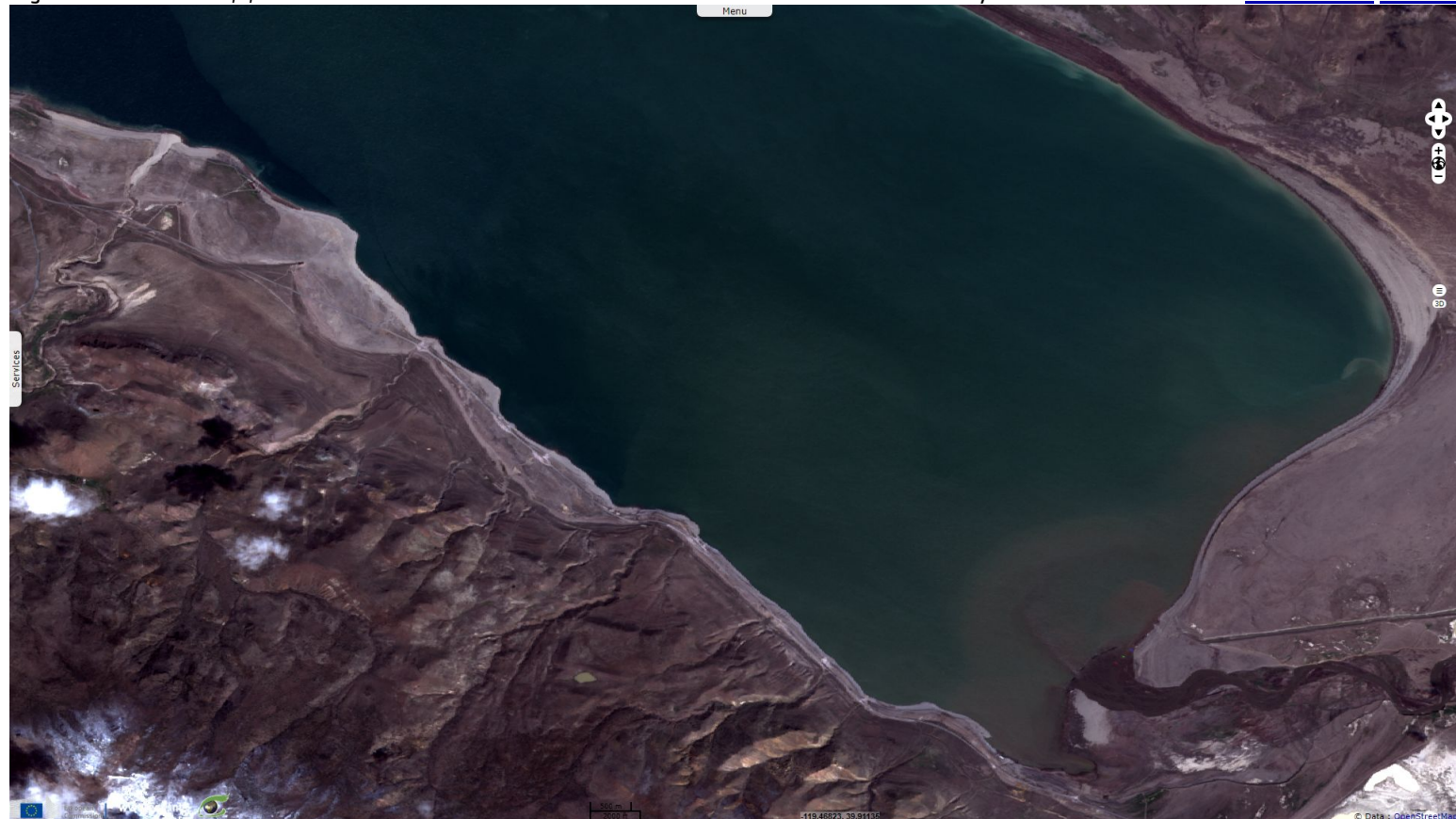


Pyramid Lake (top center Lake in fig.1) is located in Nevada state, close to the limit with California. It is 487km² wide and located 1155m high just east of the Sierra Nevada range, in the Basin and Range Province. 13000 years ago, Lake Tahoe, Pyramid Lake and its dry neighbour Winnemucca Lake were part of the much larger Lake Lahontan which maximum extent is show in fig.1 within the cyan polygon.

According to [ILEC World Lake Database](#), "Pyramid Lake occupies a large, north-south oriented endorheic graben wholly within the Pyramid Lake Paiute Indian Reservation at the western margin of the Great Basin Desert. It is the largest remnant of pluvial Lake Lahontan, which at maximum Pleistocene development was about 22,300 km². Presently, Pyramid Lake is the deepest terminal saline lake in the western hemisphere. Modern climate is typical of a mid-latitude steppe with low annual precipitation, most occurring during winter. Pyramid Lake receives about 85% of its annual water input from Truckee River, whose origin is Lake Tahoe in the Sierra Nevada mountains to the southwest."

Fig. 2 - 31.03.2017 - 4,3,2 natural colour - Reddish sediments from Truckee River enters endorheic Pyramid Lake.

[2D animation](#) [2D view](#)



ILEC World Lake Database [continues](#): "Lakewide precipitations of calcium carbonate ("whitings") occur irregularly, and massive calcium carbonate "tufa" deposits surround the lake. One of these tufa formations provides the lake's name. Anaho Island is the only major island, and hosts large nesting colonies of colonial birds, most notably, white pelicans."

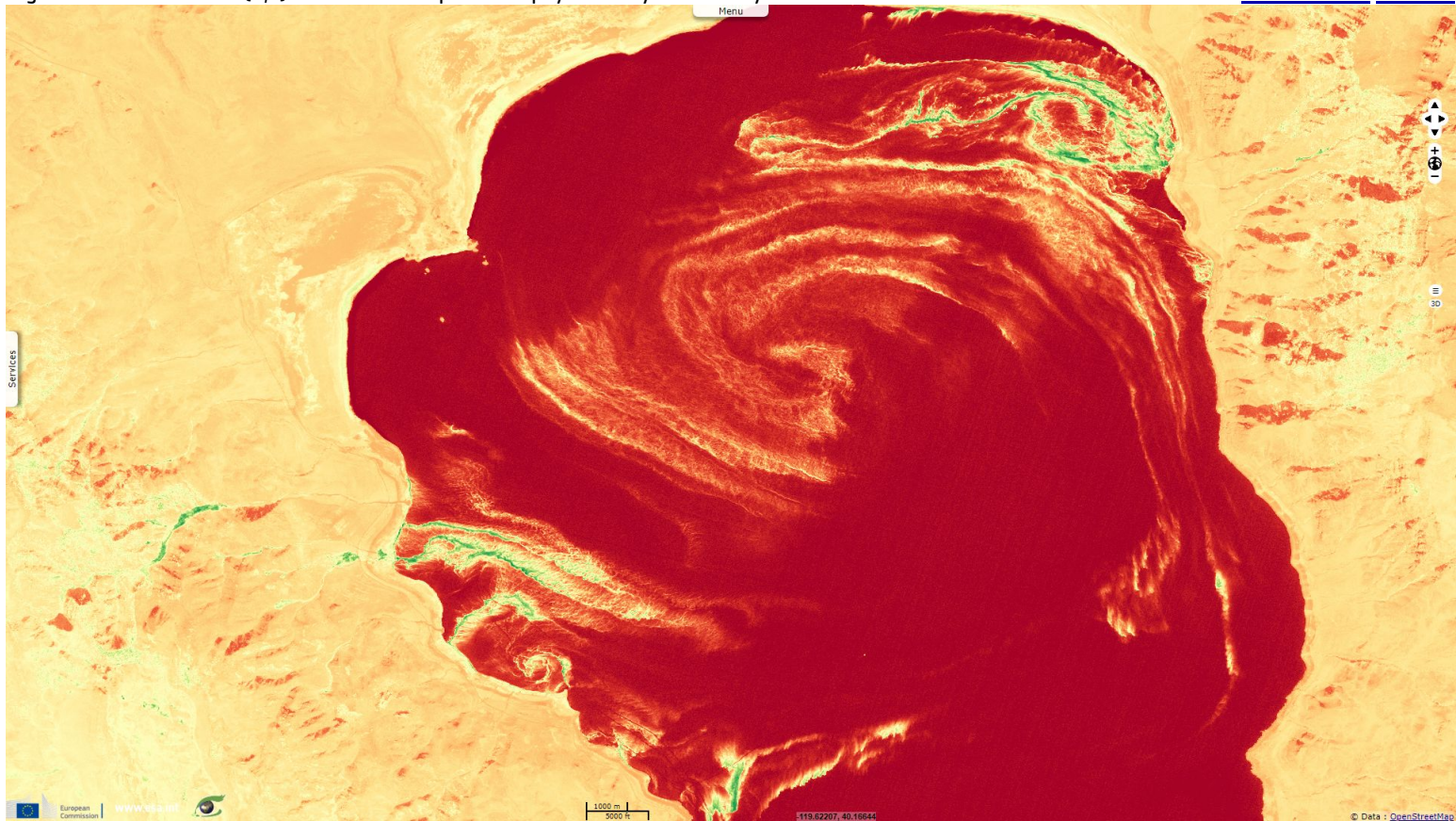
Fig. 3 - 10.05.2017 - 8,4,3 colour composite - The mouth of Truckee river & thin biogenic films north show low reflectance in Near InfraRed. [2D view](#)



US National Park Service [reminds](#) the close past of Pyramid Lake and its eastern neighbour Winnemucca Lake: "But fishing was not regarded as a "beneficial use" of water in 1902, and Derby Dam was built ten miles above the Pyramid Lake Reservation boundary. The dam diverted water from the Truckee River which flows out of Lake Tahoe, down through the cities of Reno and Sparks and then north into Pyramid Lake and in the past, Winnemucca Lake. The dam carried the diverted water into the 32-mile-long Truckee Canal, which carried it to the Carson River drainage where it was used for summer irrigation in Carson Valley. Project planners said [1400km²] of land could be reclaimed, which would 'make the desert bloom.'"

Fig. 4 - 01.11.2017 - ndi(8,4) with colour map - Chlorophyll activity shows in yellow and red.

[2D animation](#) [2D view](#)



The image above shows a biogenic raft (green) travelled to the north-east bank. Other organic films (yellow) organised alongside current patterns, forming a spiral.

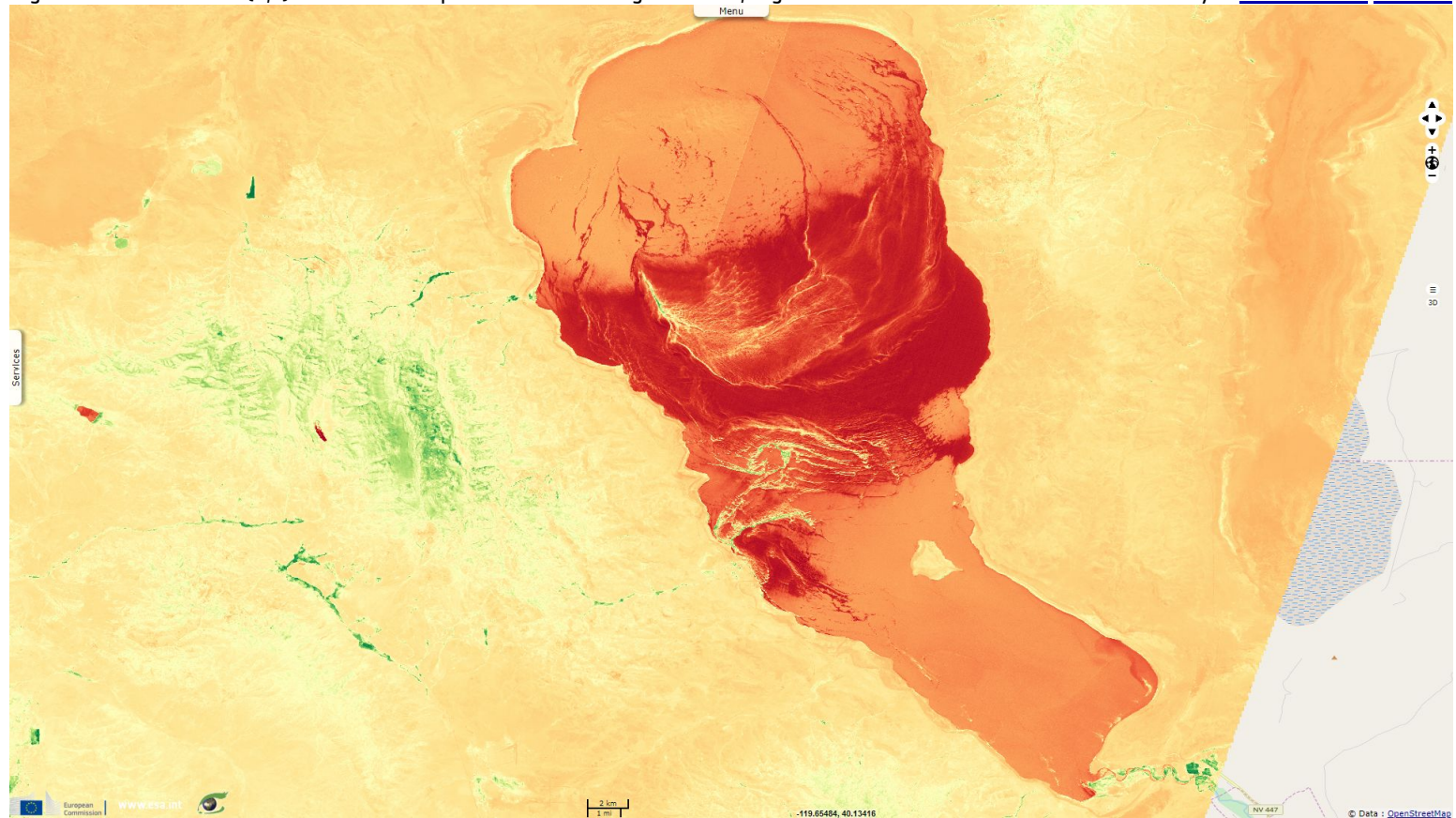
Fig. 5 - 04.07.2018 - Biogenic films show in bright in the sunlint, as dark as low-wind areas otherwise.

[2D animation](#) [2D view](#)



"The area around Pyramid Lake, including Winnemucca Lake, was designated a National Wildlife Refuge in the early 1900s. Winnemucca Lake was twenty miles long, three miles wide, and eighty feet deep. It was a major wetlands, fishery, and stop on the Pacific flyway, a path for migratory birds. Due to the construction of Derby Dam, Winnemucca Lake dried up and the plants and animals either died or had to find a new place to live. After the body of water dried up, the Refuge status was abandoned in 1938."

Fig. 6 - 19.07.2018 - ndi(8,4) with colour map - Well visible using the NDVI, a green bloom formed in the second half of July. [2D animation](#) [2D view](#)



Pyramid Lake has not yet recovered from the diversion of half of Truckee River waters toward Derby Dam until 1967. This did not change much the alkalinity, the lake's pH level remaining around 9. However, Pyramid Lake's elevation declined 26m between 1905 and 1967 and its salinity increased from about 3.7g/L to its present 5g/L level to compare with 35g/L for seawater.

Fig. 7 - 21.07.2018 - 5,3,2 colour composite - The big north bloom reflects red edge unlike the small southernmost bloom. [2D animation](#) [2D view](#)



ILEC World Lake Database [mentions](#) a long-term preoccupation that can be observed using optical images: siltation caused by the crossing of steep Sierra terrain is a severe menace to the lake and its biodiversity. "Bank erosion on the Lower Truckee River, especially in the Nixon area, has resulted in loss of crop land, and houses having to be moved. In 1986, material from eroded banks completely filled-in the Marble Bluff Reservoir below Nixon (approximately 5 km above Pyramid Lake). The declining lake level has adversely affected the hydraulics of the Lower Truckee River, resulting in bank erosion, and formation of a massive delta at the river mouth. In addition, spawning gravels have become heavily silted, resulting in low egg survival for threatened Lohontan Cutthroat Trout and endangered Cui-ui."

Fig. 8 - 24.07.2018 - 8,5,3 colour composite - The NIR reflects brighter than the fluorescence & reflectance in the red edge. [2D animation](#) [2D view](#)



Fig.8, east of Pyramid lake, the salty lake bed of Winnemucca Lake reflects stronger in red-edge than in near infrared, possibly because of algae fluorescence in the remaining water.

Regarding the fish stock of Pyramid Lake, ILEC World Lake Database [adds](#): "As the lake level declined a large delta formed at the terminus of Truckee River, preventing spawning migrations of cui-ui and cutthroat trout. This delta and Derby Dam impeded upstream migration resulting in demise of the Lahontan cutthroat trout in 1938."

Fig. 9 - 26.07.2018 - 4,3,2 natural colour - A mix of green, cyan and dark red colours in Pyramid Lake. [2D animation](#) [2D view](#)



"Lahontan cutthroat trout were reintroduced in the 1950's and a trophy sport fishery reestablished, although all recruitment is presently by artificial propagation. As a result of declines in both species, cui-ui were federally listed as endangered and Lahontan cutthroat trout as threatened. Major recovery efforts for both species are currently underway. Additional environmental concerns include maintaining lake water quality as populations upstream in the Truckee River watershed (primarily Reno and Sparks, Nevada), rapidly expand."

Fig. 10 - 05.08.2018 - 4,3,2 natural colour - A cyan bloom quickly took over shortly after.

[2D view](#)



Even more visible are the massive toxic algal blooms caused by cyanobacteria. Marcella Corona [interviewed](#) Vinton Hawley, Pyramid Lake Paiute Tribe chairman, for her article published the 17.08.2015 in the Reno Gazette: *"It happens every summer in the latter parts of the season, usually in August," Hawley said. "But with the recession of the water, it's been reoccurring a little bit more because the temperature of the water rises. It's been happening sooner than normal this year."*

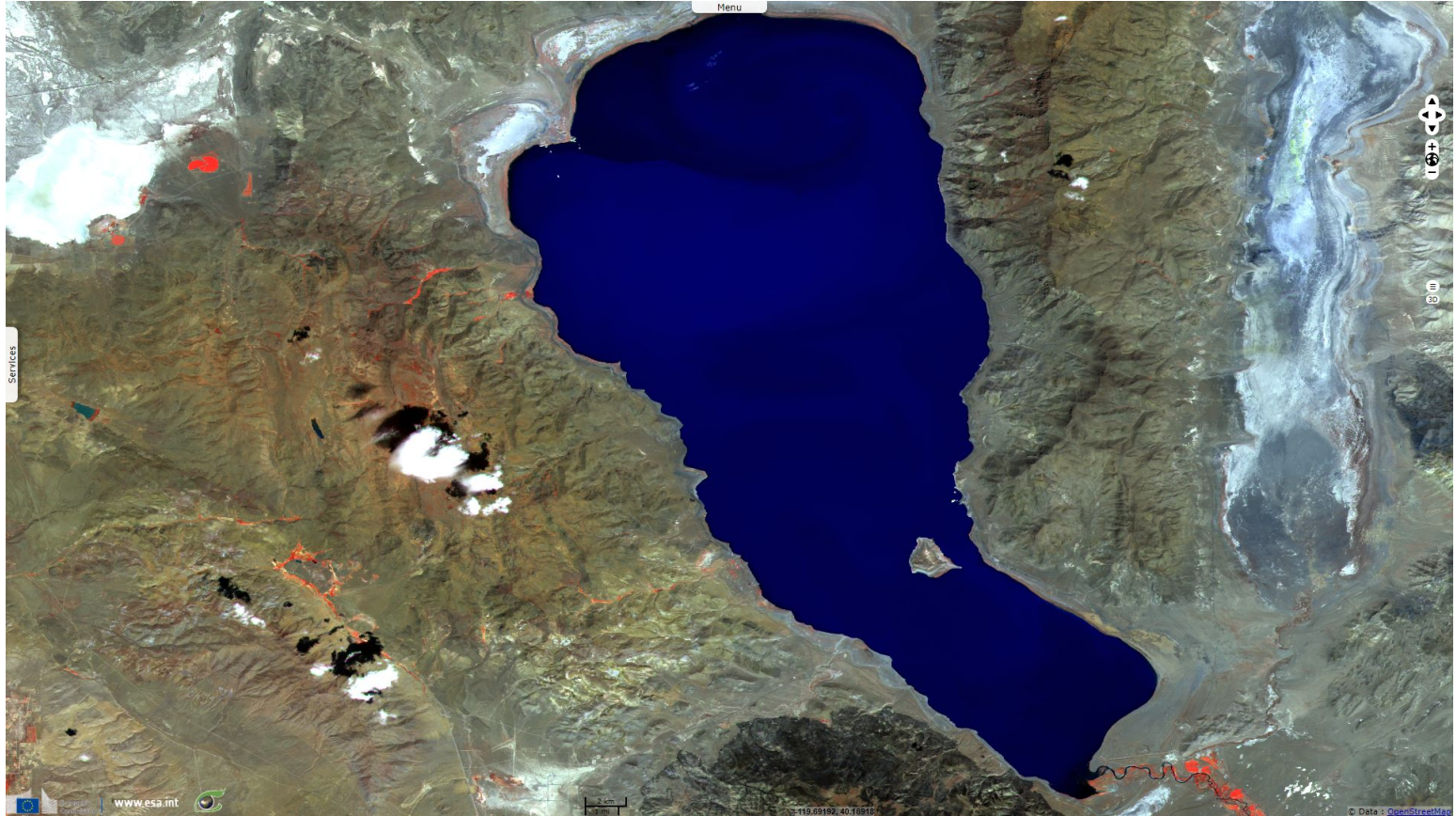
Fig. 11 - 08.08.2018 - 4,3,2 natural colour - The milky convolutions slowly change, lasting all August.

[2D view](#)



ILEC World Lake Database [points](#) *Nodularia spumigena*: "Large summer-autumn blooms of the nitrogen fixing cyanobacterium, *Nodularia spumigena*, occur regularly and contribute large amounts of nitrogen to the lake's annual nitrogen budget". AlgaeBase [writes](#) it "Produces a peptide, hepatotoxin, which can kill domestic and wild animals that drink from the shores of eutrophic ponds, lakes and reservoirs."

Fig. 12 - 15.08.2018 - 8,5,3 colour composite - The cyan bloom slowly becomes blue, this composite turning from blue to black. [2D animation](#) [2D view](#)



Microbiologists of Kenyon University [described](#) its mechanisms: "*Nodularia spumigena* has a photosynthetic metabolism. *Nodularia spumigena* produces the hepatotoxin nodularin. Hepatotoxins are toxins which affect the liver. Nodularin is a tumor promoter known to have killed wild and domestic animals by seriously affecting the liver. It is a liver carcinogen due to the inhibition of protein phosphatases. Research is focused on environmental factors affecting growth and toxin production. Higher salinity levels and lower ultraviolet radiation leads to more production of the nodularin toxin."

Learning more about these blooms in smaller areas can be an opportunity to limit the loss of wildlife and potential intoxications in larger waters where this bacteria is present such as the shallow Baltic Sea.

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