



In response to the environmental disaster on Croatia's Zrmanja river caused by leaks of hazardous materials from an abandoned aluminum oxide factory, Geolux has installed advanced HydroStations with integrated sensors, oil spill detectors, and remote monitoring capabilities to enhance early warning systems and protect the region's fragile ecosystem.



In December 2019, poor waste management practices at an abandoned thermally grown oxide (TGO) factory producing aluminum oxide in Obrovac, in Zadar County in Croatia, led to an environmental disaster on the Zrmanja river. Heavy rain caused waste material from the abandoned factory's facilities and two open-air pools to leak into the river. Alkaline mud had been kept in the pools since the plant's closure, with each containing significant amounts of red sludge (also known as red mud) created during the factory's operation. In addition to the main components of hydroxide, iron, aluminum and titanium, red sludge also contains high concentrations of other heavy metals, some of which are up to 20 times higher than the average composition of the surrounding soil. Red sludge, a waste by-product from the Bayer process for producing alumina from bauxite ore, consists of sparingly soluble metal oxides. Its high alkalinity makes it extremely corrosive due to the presence of sodium hydroxide

(NaOH) and potassium hydroxide (KOH), both of which are hazardous substances. After the cessation of production at the TGO factory, 750,000m³ of red sludge and 1,000,000m³ of lye waste remained at the site. Following the leak, the site was recognized for the danger it posed to the wider environment and was classified as a site needing to be rehabilitated as soon as possible.

Speleological wonder

Croatia's Zrmanja river is renowned for its clear waters, vast canyons and picturesque waterfalls. It flows southward and encircles the southern end of the Velebit Nature Park in Croatia via a 200m-deep canyon. After it turns westward, it reaches the town of Obrovac and, after a few kilometers, flows into the Adriatic Sea. Measuring 69km in length, and with a basin of 554km², the Zrmanja's influence is powerful, as the Bašćica, Draga and Slapača waterways, among others, also travel through the karst underground network within its basin. The area of the Zrmanja canyon and its tributary, the Krupa river, is part of the largest and the most complex protected area in the Velebit Nature Park, which is one of the most attractive karst complexes in the world – the Dinaric karst. The immense wealth of speleological objects characterizes the area, with karrens, sinkholes and vertical solitary rocks, as well as caverns and caves. Velebit is also situated along a significant dividing line between the Mediterranean and continental climate, making the

weather variable and unstable with frequent extremes. Due to the characteristics of the karst terrain, the leaching of pollutants from the TGO factory occurs often, especially during heavy rains. Toxic alkaline materials, carcinogenic oils and radioactive canisters enter the river and spread downstream through the canyon. Massive quantities of the fuel oil from the production tanks in the abandoned factory has also leaked into the karst terrain and, with stronger rainfall, has been carried into the Zrmanja river for up to 10km, ending up in the Novigrad Sea (Adriatic Sea). Following heavy rains, the Novigrad Sea becomes contaminated and can also be dangerous for navigation as it becomes covered with a layer of fuel oil. European hydrology radar and sensor specialist Geolux has been engaged to help remedy the environmental disaster. Several HydroStations, have been installed at the site to prevent similar events. Stations have been installed in the Zrmanja river near Obrovac, in the city of Knin near the source of the Krka river, and downstream at the entrance to the Krka National Park on a bridge over the Krka. In addition to hydrological sensors for measuring water level and flow, the stations have a camera and a contactless oil spill detector. Oil-on-water detectors have been set up to provide early warning and enable response before the pollution spreads. The all-in-one HydroStations provide a complete integrated solution for hydrology measurements that are self-sustainable, with a battery, solar panel and datalogger, along with an integrated maximum power point tracker (MPPT) battery charger. Integrating third-party hydromet sensors is easy and the robust modular mechanical design with IP68-compliant watertight enclosure ensures the devices are protected even from large amounts of windblown dust and other particulate matter. The Geolux HydroStation is used for water level monitoring (mounted with a Geolux LX-80 radar sensor) in rivers, channels and lakes; early flood warning and accurate discharge monitoring (combined with RSS-2-300W surface velocity radar) in rivers; flow tracking in salt and copper mine channels; and water reservoir monitoring and irrigation control. In addition to standard LX and W sensors, the stations at Knin and Krka National Park have also been fitted with contactless temperature sensors and a multidepth sensor at Minerska. This is in the Šibenik Channel, where the Krka flows into the Adriatic Sea, allowing insight into how the water from the river mixes with seawater with measurements of the temperature at multiple depths (depending on the amount of water in the Krka, tides and the temperature of the sea). New Geolux HydroCam site inspection cameras have also been installed at all locations, taking periodic snapshots at monitoring sites for remote inspection. These have been fitted with an infrared reflector for night mode, a day/night switchable filter and a remotely controllable zoom/focus lens. They have an operating temperature range of -20°C to +60°C.

