

Although these are low concentrations, it is important that they are under constant monitoring

Scientists from the Ruđer Bošković Institute (RBI), in collaboration with colleagues from the Institute for Medical Research and Occupational Medicine, published the first findings on the atmospheric deposition of trace metals on the surface waters of the Central Adriatic.

Atmospheric transmission is not only significant, but often also the dominant route by which natural and anthropogenic substances are transferred from land to sea. Once introduced through dry and wet sedimentation processes, atmospheric suspended particles or aerosols become an external source of nutrients as well as toxic substances for aquatic ecosystems. Atmospheric deposition can be of particular importance for oligotrophic waters that are poor in nutrient salts, such as the Central Adriatic area.

The coastal area of the Adriatic Sea is under the constant influence of anthropogenic aerosols of urban and industrial parts of continental Europe as well as the yield of Saharan dust, especially in spring and summer. It is also an area of very high risk of open fires, which are a significant source of aerosol emissions, and whose impact on surface water systems has not been investigated to date.

It is estimated that the complex interactions of surface water biology and chemistry, atmospheric chemistry and climate could become even more significant in future climate scenarios of warmer atmospheres and increased emissions, and deposition rates of natural and anthropogenic aerosols as well as more intensive water column stratification. It is therefore to be expected that the influence of the atmosphere, as a significant external source of matter for surface oligotrophic waters, will increase in the future.

That is why the main goal of the **Bireadi** project, within which this paper was published, is to evaluate the biochemical responses of surface waters to the deposition of materials from the atmosphere.

“In this paper, we investigated the variability of concentrations of biologically significant trace metals (ie zinc, copper, lead, cobalt, nickel and cadmium) and their sediment flows to the surface waters of the Middle Adriatic. At the Martinska sea station, a six-month sampling of aerosol particles (PM10), total sediment, seawater from a depth of one meter and the surface microlayer of the sea as the sea-atmosphere phase boundary was carried out “, explains the first and corresponding author **dr.sc. Abra Penezić**, from the **Laboratory for Physical Chemistry of RBI Traces**.

Dr. Penezic adds that the results suggest that during the colder part of the year, increased concentrations of zinc, cadmium and lead are influenced by local and regional sources

related to household heating as well as the dominant long-range cross-border transfer of anthropogenic substances from continental Europe, emissions from transport affect atmospheric concentrations of nickel, cobalt and copper.

Also, intense local fires in open areas and the yield of mineral dust from the Sahara have been shown to be responsible for increasing the concentrations of trace metals in the particles as well as their wet and dry deposition. Although dry, ie gravitational deposition of atmospheric particles is continuously present, wet deposition due to precipitation is an important route of transfer of substances from the atmosphere to the sea and land. Intense episodes of open fires and Saharan dust yields significantly affected metal deposition flows, suggesting that even a small number of such extreme events, common to Mediterranean coastal areas, may be responsible for much of the total deposition.

“The accumulation of total metal traces in marine microlayer samples collected after open fires indicates that such events, especially those accompanied by precipitation, significantly affected the distribution of metal traces in the surface layers of the sea. This study shows that the deposition of materials from the atmosphere is a significant source of traces of metals in the shallow coastal area of the Central Adriatic”, explains one of the corresponding authors at the work of **Ph.D. Sanja Frka Milosavljević**, from the **Laboratory for Marine and Atmospheric Biogeochemistry of the RBI**.

The specificity of the study is in the research of the connection between the atmosphere and the sea, ie the thin layer of the sea that separates them – **the surface microlayer of the sea**. As the upper millimeter of the sea surface, the surface microlayer represents a natural interfacial area of exceptional environmental importance for all processes of metabolism and energy between the atmosphere and the sea.

The surface microlayer is also the habitat of marine organisms that are directly exposed to solar radiation and atmospheric influences and that indirectly participate in the processes of exchange of gases and particles between the sea and the atmosphere. Due to rapid changes in biological and physicochemical properties due to external influences, including atmospheric deposition, the surface microlayer of the sea is a key area for early detection of human impact and climate change on the marine system.

However, its sampling is a technical challenge. Surface microlayer samples were collected using a specialized **microlayer sampler** designed and constructed at the RBI by **Dr. sc. Dario Omanović**, Head of the Laboratory for Physical Chemistry of Traces at the Institute for Marine and Environmental Research. The developed prototype of the sampling instrument enabled the sampling of microlayers up to only 20 micrometers thick, and ensured the collection of a sufficient amount of samples to perform a large number of

RBI scientists have published the first findings on atmospheric precipitation in the surface waters of the Adriatic

analyzes of different components of the mycolayer.

The obtained results will contribute to further knowledge of the processes in this specific interphase area and the interaction of the atmosphere and the sea.

The results of the research were published in the paper “**Atmospheric Deposition of Biologically Relevant Trace Metals in the Eastern Adriatic Coastal Area**”, and the research was conducted within the project of the Croatian Science Foundation IP-2018-01-3105 **BiREADI** – Biochemical responses of the surface layer of the Adriatic Sea oligotrophic area on atmospheric deposition (Biochemical responses of oligotrophic Adriatic surface ecosystems to atmospheric deposition inputs), led by Dr. sc. **Sanja Frka Milosavljevic**.

Source: Ekovjesnik