Report for the year 2022 and future activities

SOLAS ‘Turkey’
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This report has two parts:

- **Part 1:** reporting of activities in the period of January 2022 - Jan/Feb 2023
- **Part 2:** reporting on planned activities for 2023 and 2024.

The information provided will be used for reporting, fundraising, networking, strategic development and updating of the live web-based implementation plan. As much as possible, please indicate the specific SOLAS 2015-2025 Science Plan Themes addressed by each activity or specify an overlap between Themes or Cross-Cutting Themes.

1. Greenhouse gases and the oceans;
2. Air-sea interfaces and fluxes of mass and energy;
3. Atmospheric deposition and ocean biogeochemistry;
4. Interconnections between aerosols, clouds, and marine ecosystems;
5. Ocean biogeochemical control on atmospheric chemistry;
   Integrated studies of high sensitivity systems;
   Environmental impacts of geoengineering;
   Science and society.

**IMPORTANT:** This report should reflect the efforts of the SOLAS community in the entire country you are representing (all universities, institutes, lab, units, groups, cities).

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<th>First things first...Please tell us what the IPO may do to help you in your current and future SOLAS activities. ?</th>
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**Mucilage Problem in the Marmara Sea (Turkey).**

Related to SOLAS Theme 3: Atmospheric deposition and ocean biogeochemistry and Science and Society

Marine mucilage outbreaks occurred in the Sea of Marmara in 2021 which severely affected the marine ecosystem. The thick mucilage blankets with different colors became a public concern due to the toxicity potential related to pathogens that accumulate in prolonged presence of mucilage. Extensive mucilage outbreaks occurred in the Sea of Marmara in 2021 with an increasing intensity in the spring season. Intense and kilometers long yellow-grey-brown mucilage patches were observed in the surface seawater. This mucilage event in the Marmara Sea was the first after the less intense mucilage event occurred in 2007-2008.
The mucilage assemblages in the Marmara Sea were observed as suspended marine mucilage in the water column and floating on the surface sea as grayish, brownish and yellowish strings and sheets that is intensely accumulated in the coasts and several harbors (Fig 1). Marine mucilage production in the Sea of Marmara was recorded as between 0-30 m of water depths. The intensity of mucilage gels were so high that caused catastrophic deaths of marine animals and several severe impacts on the fisheries, marine transportation and tourism. The water column presence of the mucilage patches were intense that the affected the optical properties of the water column with a significant reduction of the sunlight in the photic zone.

Ministry of Environment, Urbanization and Climate Change of the Republic of Türkiye had taken actions for cleaning the mucilage accumulations in the coasts and in the open sea, due to dense mucilage accumulations which caused toxic environment for both marine life and also for social life. Also a ‘Marmara Action Plan’ was published and several special issues projects were funded by the The Scientific and Technological Research Council of Türkiye (TÜBİTAK), the Ministry and the Universities.

Increased collaborations with SOLAS scientists on the Mucilage Problem is needed to understand the causes and results of the organic gel accumulations.

**Citation:** Tuzcu-Kokal A., Olgun N., Musaoğlu N., 2022. Detection of Mucilage Phenomenon in the Sea of Marmara by Using Multi-Scale Satellite Data, Environmental Monitoring and Assessment, https://doi.org/10.1007/s10661-022-10267-6
1. Scientific highlight

Describe one scientific highlight with a title, text (max. 300 words), a figure with legend and full references. Please focus on a result that would not have happened without SOLAS, and we are most interested in results of international collaborations. (If you wish to include more than one highlight, feel free to do so).

Scientific Highlight: Aerosol Nutrient Sources and Impacts on Ocean Biogeochemistry.

Related to SOLAS Theme 3: Atmospheric deposition and ocean biogeochemistry


SOLAS National Contact Dr. Nazlı Olgun attended the SOLAS Open Science Conference in 2019 in Sapporo Japan. The travel expenses of Nazlı Olgun was covered by SOLAS. During the conference, new collaborations were established which leaded a paper on Annual Reviews journal (Fig. 2). The review paper brought together existing literature, experimental evidence of impacts, and new atmospheric nutrient observations and evaluated the contribution and spatiotemporal variability of nutrient-bearing aerosols from desert dust, wildfire, volcanic, and anthropogenic sources, including the organic component, deposition fluxes, and oceanic impacts.

2. Activities/main accomplishments in 2022 (e.g., projects; field campaigns; workshops and conferences; model and data intercomparisons; capacity building; international collaborations; contributions to int. assessments such as IPCC; collaborations with social sciences, humanities, medicine, economics and/or arts; interactions with policy makers, companies, and/or journalists and media).

Project:

Possible Influence of atmospheric micro/micro nutrients on mucilage events in the Sea of Marmara. 2022, TÜBİTAK Mucilage Project 121G005, Coordinator Dr. Mustafa Koçak, Middle East Technical University.

The aim of the project is to assess the influence of atmospheric fluxes of macro and micro nutrients to the primary productivity and the mucilage formation observed in the Sea of Marmara by obtaining atmospheric samples as well as evaluate the effect of macro and micro nutrients on the phytoplankton abundance, possible mucilage bearing species and relationship between nutrients.
by microcosm experiments adding macro and micro nutrients to the surface water samples from the Sea of Marmara (Fig. 3). Atmospheric bulk and aerosol samples will be obtained from Istanbul while Marmara surface waters will be taken to carry out macro and micro nutrient addition experiments (microcosm) for winter and spring. Experiments and measurements will be performed in IMS-METU DEKOSIM laboratories. It will be exhibited how much of the observed primary production in surface water of Sea of Marmara supported by atmospheric macro and micro nutrients input via calculating fluxes for atmospheric macro and micro nutrients. On the other hand, with the aid of addition experiments, polysaccharides levels will be related with the remain parameters to elucidate possible mucilage bearing phytoplankton as well as zooplankton species and feedback mechanism with macro and micro nutrients.

Figure 3. Scheme summarizing the controls on the marine biogeochemistry including atmospheric chemistry and climate (Mustafa Koçak, TÜBİTAK Project 121G005).

Project:
Assessment of spatial and temporal changes in the Marmara Sea marine primary productivity by using satellite data and sediment bio-geochemistry, 2020-2023, TÜBİTAK Project #119Y269, Coordinator. Dr. Nazli Olgun, Istanbul Technical University, Turkey.

Marine primary production (phytoplankton) is the first and largest chain of the marine ecosystem. Increase in the nutrient concentrations can cause phytoplankton blooms which affect the water quality, zooplankton and fish. Today, Marmara Sea is under a great damage due to pollution. Phytoplankton blooms that form red or turquoise colors is a phenomenon commonly recorded in the Sea of Marmara. It is however still not clearly understood whether these algal blooms are usual blooms or is there an important change in the bloom frequency due to eutrophication/ pollution. Seawater chlorophyll-a (chl-a) are the most common parameter used in evaluating the primary production. However, chl-a concentrations from discrete water sampling locations are unable to represent entire sea basin. Remote sensing data and methods can provide fast and reliable information on chl-a for large water bodies. In this study, chl-a distributions in the Marmara Sea will be studied with high spectral satellite data for the first time. In addition, it is aimed to determine the chl-a changes over the past 20-years using several satellite data (OLCI, SLSTR, VIIRS-N, MODIS-Aqua, MERIS, SeaWiFS). In situ chl-a measurements will be compared with the ‘satellite derived chl-a’ data for ground truthing. Usual phytoplankton blooms (e.g. the spring, summer blooms) and unusual (episodic) blooms will be investigated in terms of their occurrence frequencies, total durations, chl-a concentrations and possible sources of reason (Fig. 4).

Primary productivity in the Marmara Sea had changed several times in geological-scales due to paleoceanographic and paleoclimate changes. However, high resolution changes in the nutrient and primary production in the past 1000-years has not been studied so far. In this study, we will investigate the nutrient and primary productivity changes in the last 1000 years in high time-resolution (~50 years). Marine sediment cores from Tekirdağ and Çınarcık basins that were taken within the framework of MARsite Project will be used for dating (210Pb and 14C), sediment proxy
parameters such as ‘organic production’ (TOC, biogenic barium, phytoplankton, pigments, Ca, Sr etc.), ‘nutrient’ ($\delta^{15}N$), paleoceanographic ($\delta^{18}O$, $\delta^{13}C$) and pollution (PAH, heavy metals). So that, it will be possible to better understand to what extent the industrialization and pollution impacted the Marmara Sea ecosystem compared to the changes in the longer time-scales. The outputs of this project can provide valuable data and methods for monitoring the ‘environmental status’ of the Marmara Sea.

Figure 4. Sentinel 3 OLCI chl-a maps of Marmara Sea, Turkey (14.06. 2022, 15.06. 2022, 16.06. 2022 and 25.09.2022).

Project

Establishing the Infrastructure of the Pollution Monitoring System Specific to the Sea of Marmara by Using Information Technologies, 2022, funded by TÜBİTAK Mucilage Project #121G142, Coordinator Prof. Dr. Nebiye Musaoğlu, Istanbul Technical University, Turkey).

The mucilage recently seen in the Marmara Sea leading to significant environmental problems has clearly caused the deterioration of the marine ecosystem. The land-sea interaction will be examined, mucilage-covered areas will be determined from satellite images and the relationship and spread of these areas will be examined with bathymetry and current directions (Fig. 5). Thus, a feasible monitoring and control infrastructure model (mechanism) will be developed when a possible future mucilage threat will be experienced. Moreover, high resolution data will be provided with a thermal camera attached to the UAV, and its usability in inspection will be tested in an area where temperature changes are frequently detected from satellite images. An infrastructure system in which all the produced results are evaluated together will allow the sharing, analysis and use of data by different institutions. In a workshop to be held at this stage, the opinions of the experts working on the subject and possible stakeholders will be taken and the system design will be created in line with these views and mutual discussions. Within the scope of the project, the utility of the project will be demonstrated in practice with the training to be given to both the Ministry of Environment and Urbanization and to related institutions and local governments such as municipalities.
3. Top 5 publications in 2020 (only PUBLISHED articles) and if any, weblinks to models, datasets, products, etc.


4. Did you engage any stakeholders/societal partners/external research users in order to co-produce knowledge in 2022? If yes, who? How did you engage?

An atmospheric sampling site was built in 2022 in a High School Campus located near the Istanbul Bosporus in Beşiktaş in Istanbul (Istanbul Technical University High School İTÜ MTAL). Atmospheric sampling site was built within the context of TÜBİTAK #121G005 project focusing on the atmospheric nutrient inputs in the Marmara Sea (METU-İTU collaboration). High school students gain knowledge on atmospheric inputs into the marine environments and atmospheric sampling.
### PART 2 - Planned activities for 2023 and 2024

#### 1. Planned major national and international field studies and collaborative laboratory and modelling studies (incl. all information possible, dates, locations, teams, work, etc.).

- Modelling studies on the circulation of Marmara Sea will be carried on (Dr. Mehmet Ilicak, Istanbul Technical University, Turkey).
- Meteorological and oceanic controls on the mucilage formation (PhD study, Istanbul Technical University).
- A new ‘Biogeochemistry Laboratory’ is going to be established in Eurasia Institute of Earth Sciences in Istanbul Technical University. This will provide a new infrastructure for geochemical studies on seawater and atmospheric chemistry.
- Satellite data and molecular biology studies will be carried on (ITU-UHUZAM Center).

#### 2. Events like conferences, workshops, meetings, summer schools, capacity building etc. (incl. all information possible).

- A new research center ‘Climate Change and Sustainable Development Application and Research Center’ has been established in Marine Sciences Institute in Middle East Technical University.
- A workshop is planned in context with TÜBİTAK 119Y269 project with a focus on marine primary productivity in the Marmara Sea. The collaborators Istanbul Technical University, İstanbul University, Marmara University and Middle East Technical University.

#### 3. Funded national and international projects/activities underway.

- Assessment of spatial and temporal changes in the Marmara Sea marine primary productivity by using satellite data and sediment bio-geochemistry, 2020-2023, TÜBİTAK Project #119Y269, Coordinator. Dr. Nazlı Olgun, Istanbul Technical University, Turkey.

#### 4. Plans / ideas for future national or international projects, programmes, proposals, etc. (please indicate the funding agencies and potential submission dates).

- A project proposal on the Marmara Sea was submitted to Republic of Türkiye Ministry of Environment, urbanization and Climate Change in 2023.

#### 5. Engagements with other international projects, organisations, programmes, etc.

| Comments |