Surface Water Pollution Assessment in the Dnipro River Based on Hydrochemical and Satellite Data

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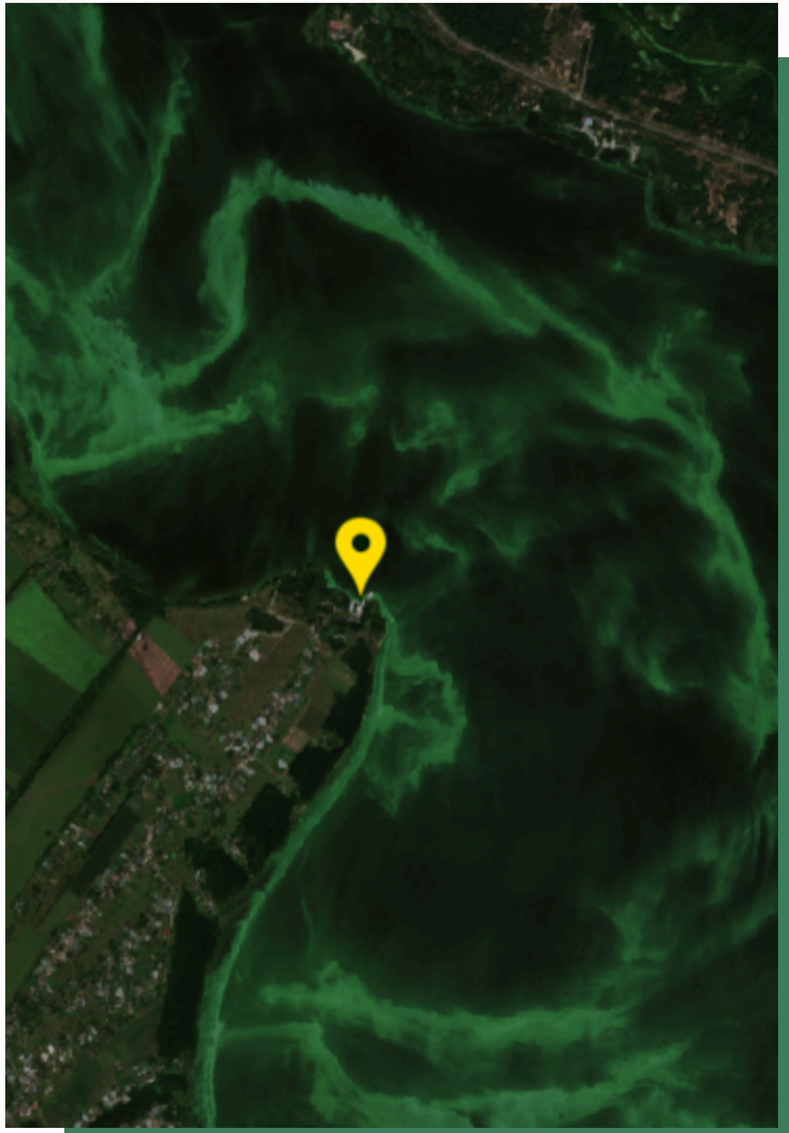
Introduction

Surface water resources represent a critical component of national sustainability and security. As the Dnipro River provides drinking water for 70% of the population, studying its pollution dynamics is strategically vital. The Dnipro River's surface waters are under constant anthropogenic pressure due to various wastewater discharges. These discharges introduce nutrients to the water that negatively impact the aquatic ecosystem, driving eutrophication. To effectively research the state of water resources, it is essential to integrate advanced methodologies, including the application of satellite remote sensing and hydrochemical analysis.



PROBLEM

Surface Water Pollution

Urban Wastewater

Industrial Wastewater

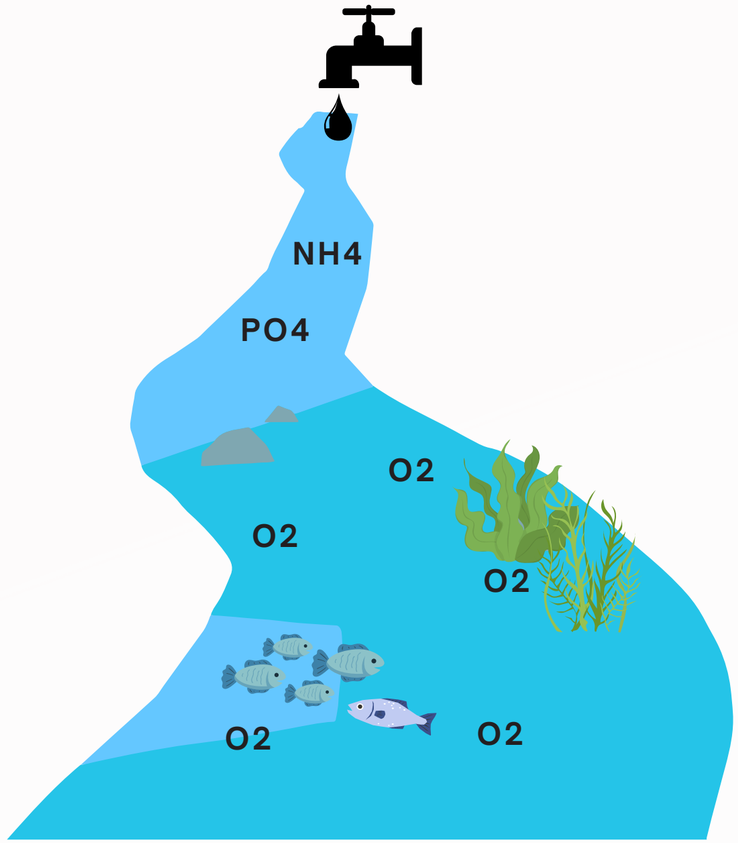
Agriculture runoff

Total Ukrainian surface water pollution - 540 million cubic meters per year
Dnipro River pollution - 250 million cubic meters per year

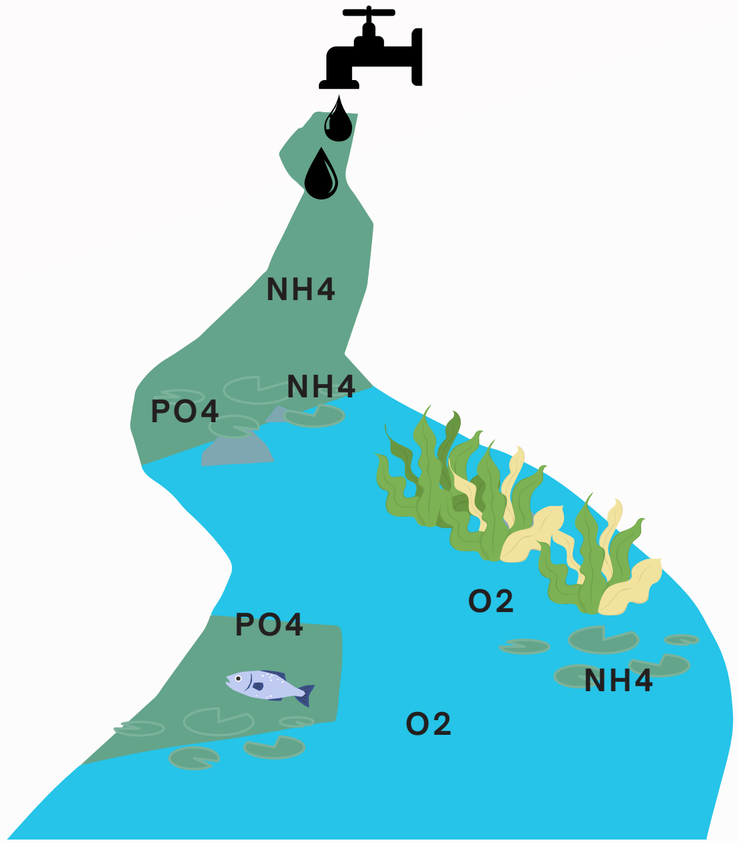

Nitrogen and Phosphorus compounds - the main pollutants of Dnipro Surface Water, cause Eutrophication

Stages of Surface Water Pollution with Nutrients

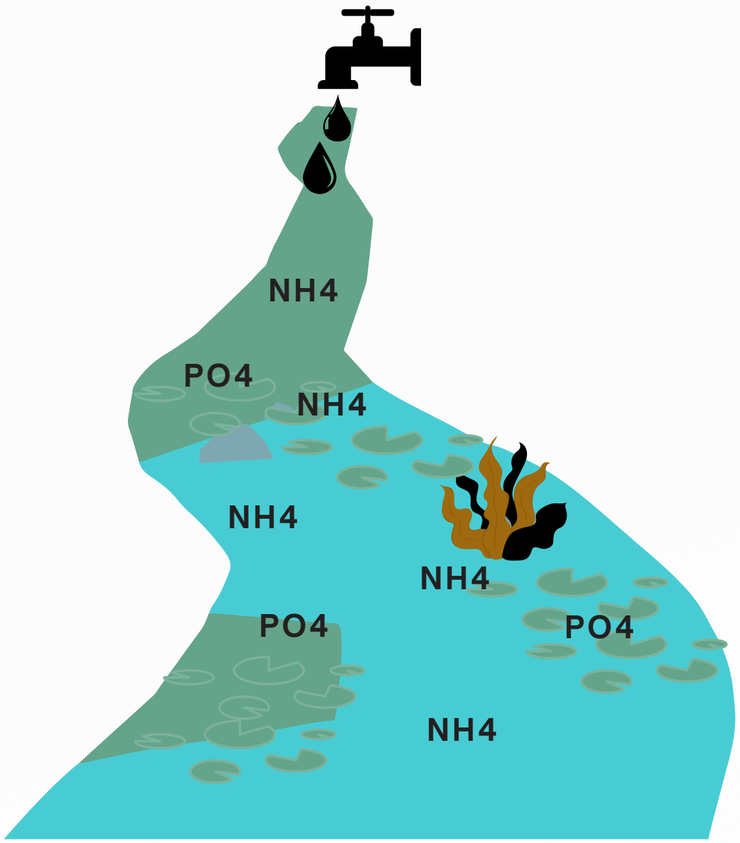
1 Stage
Ecosystem balance



2 Stage
Ecosystem changes



3 Stage
Ecosystem Disruption
Eutrophication



Hydrochemical Components

Obtained from the monitoring stations of the Water Agence of Ukraine

NH4

ammonium

NO3

nitrites

PO4

phosphates

BOD

biochemical oxygen demand

NO2

nitrates

DO

disolved oxygen

Satellite data

Obtained from the ESA databases and calculated with QGis

NDWI

normalized difference water index

NDVI

normalized difference vegetation index

SWM

sentinel water mask

Territory

Sampling points are located on the territory of the city water intakes

S1	Kyiv
S2	Cherkasy
S3	Kremenchuk
S4	Gorishni Plavni
S5	Kamianske
S6	Dnipro city 1
S7	Dnipro city 2

Results

Multi-year increase in pollutant components concentrations

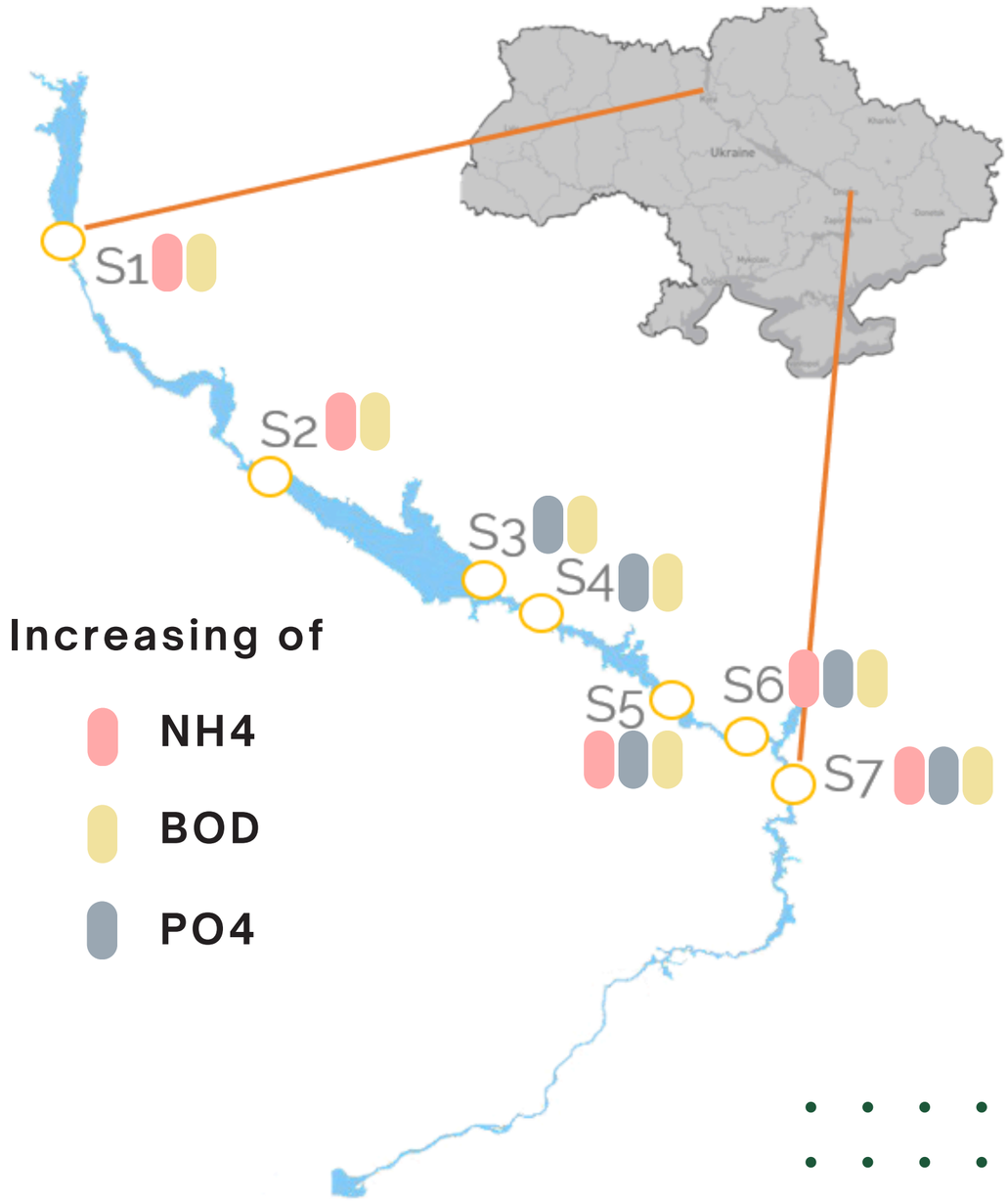
Compare 2023 with 2020

Maximum increase

Kyiv - 220% increase in the median year NH4 concentration

Cherkasy - 67% increase in median year BOD concentration

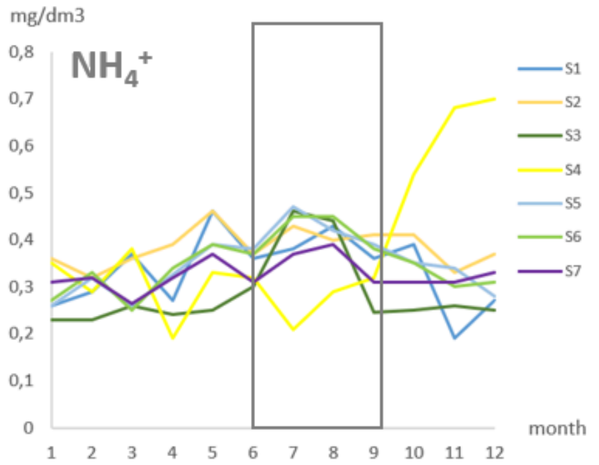
Kamyanske and Dnipro - 80-97% increase in median year PO4 concentration

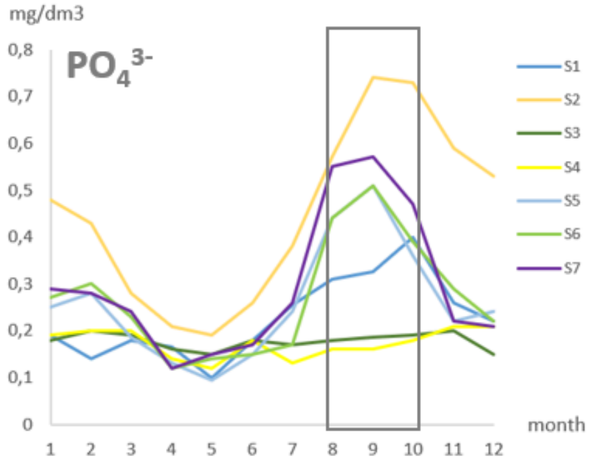


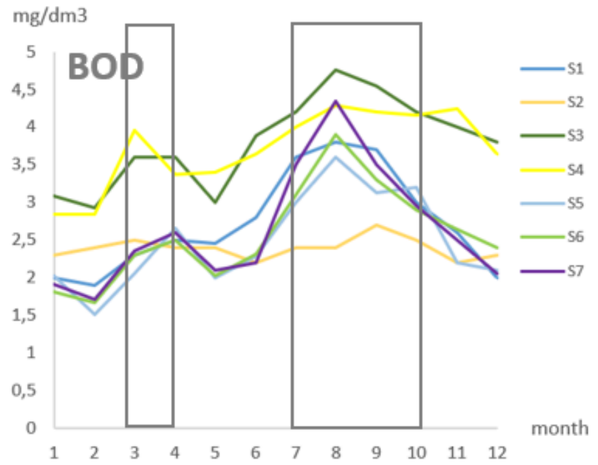
Results

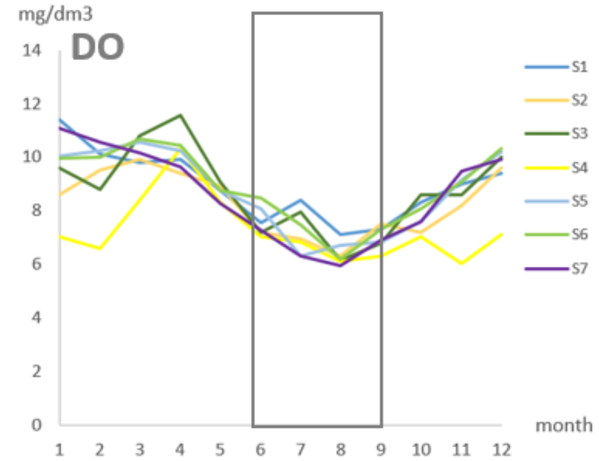
Seasonal Variation

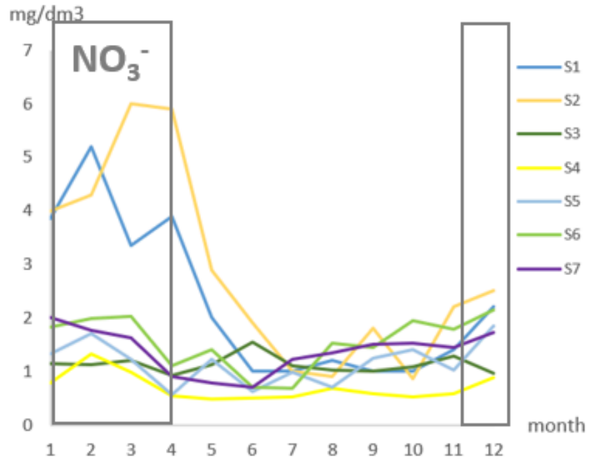
The main pollution with nutrients is typical on the vegetation period, mostly in August and September

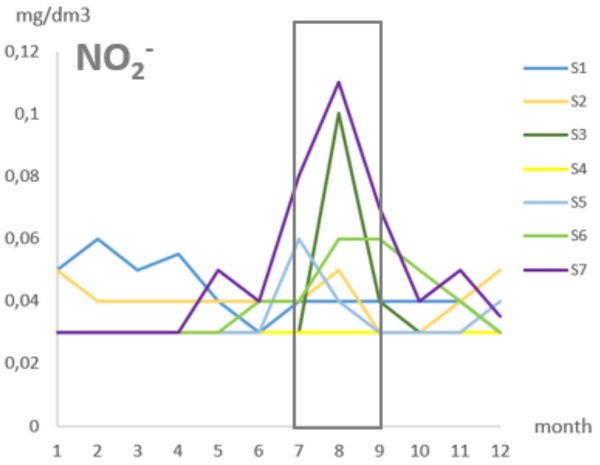












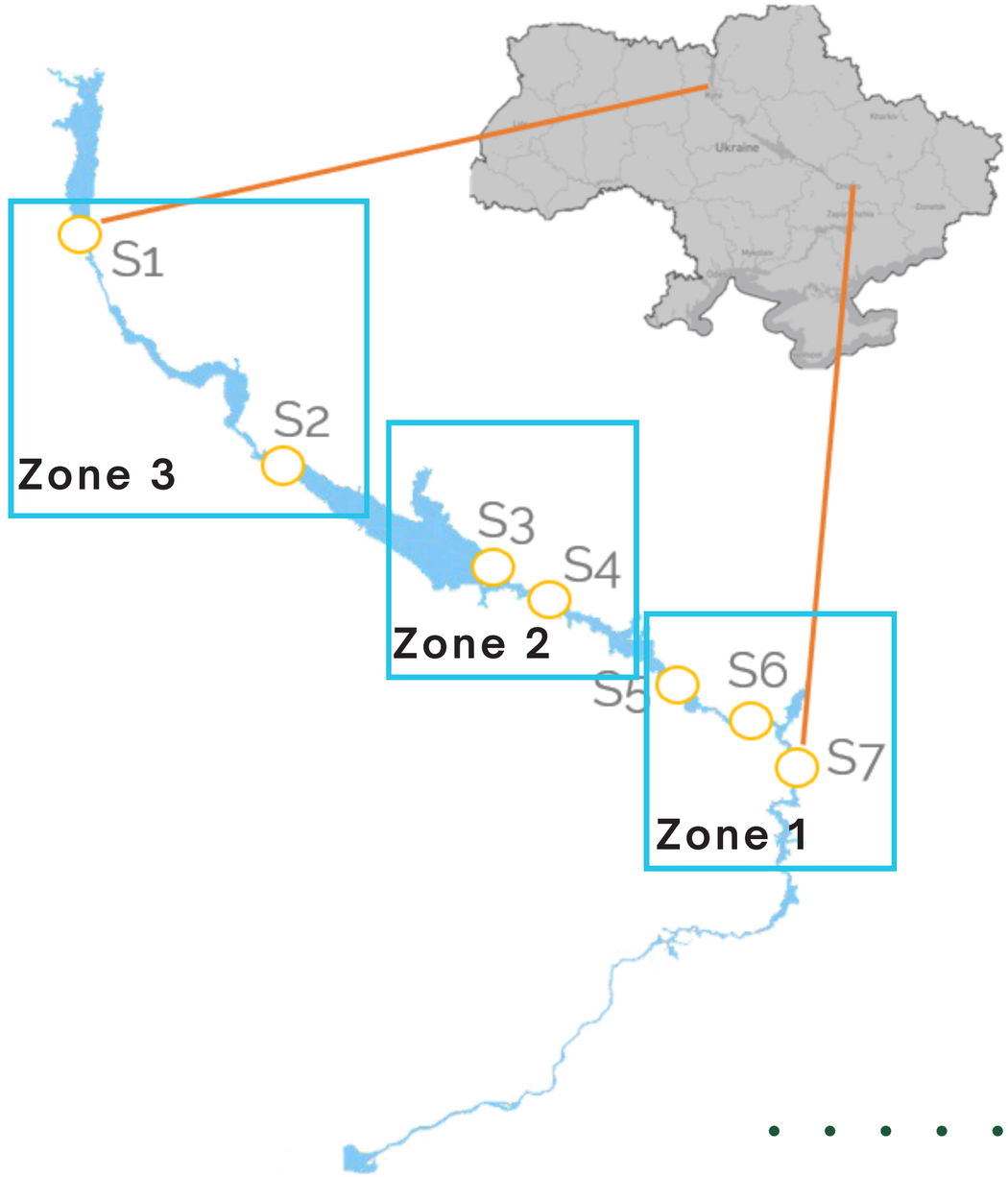
Results

Spatial zoning

based on spatiotemporal, correlation, and factor analysis of hydrochemical components

Zone 1

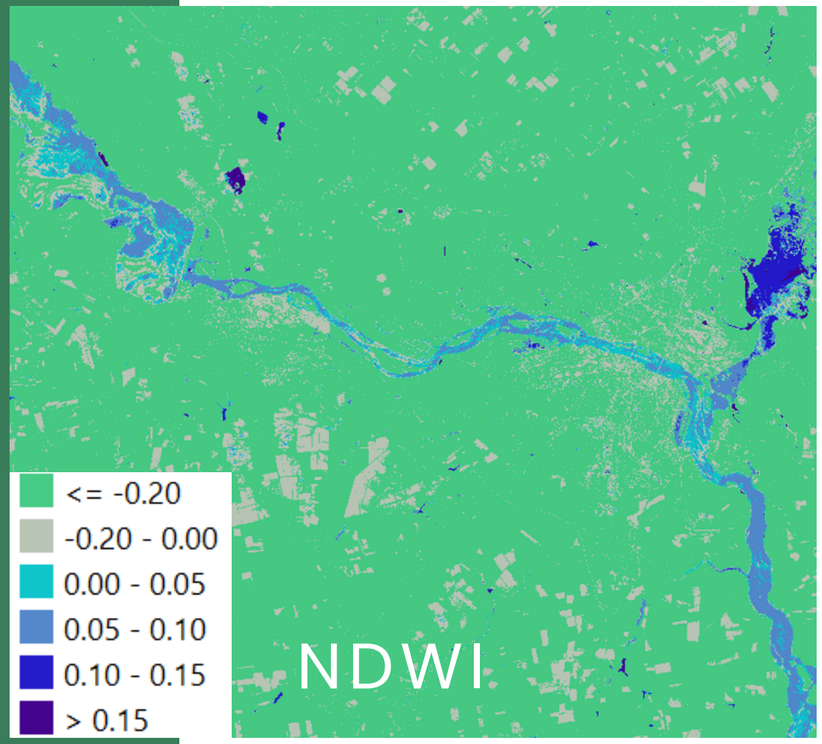
Persistent increase in hydrochemical pollution indicators

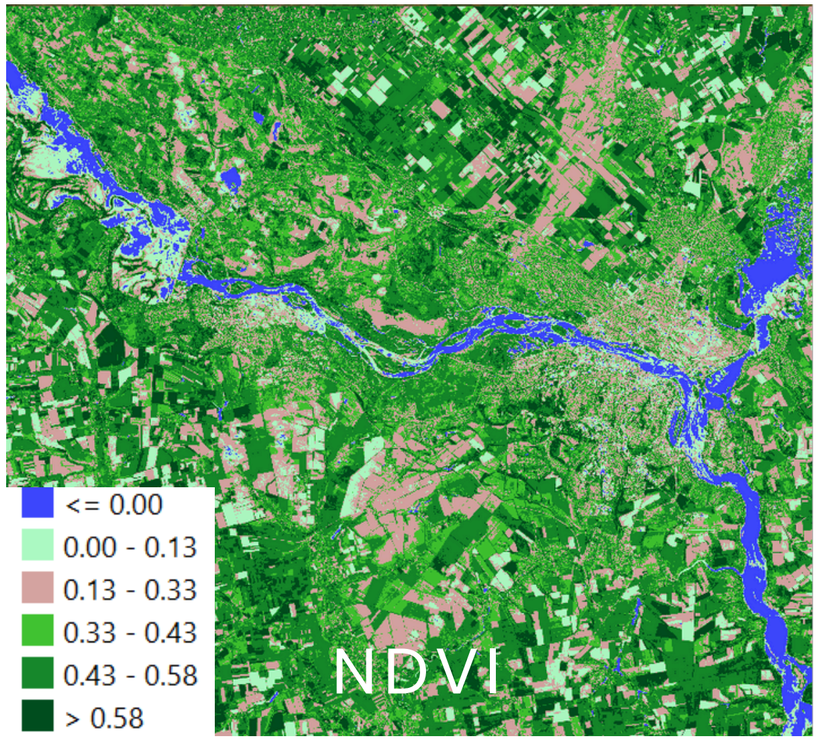


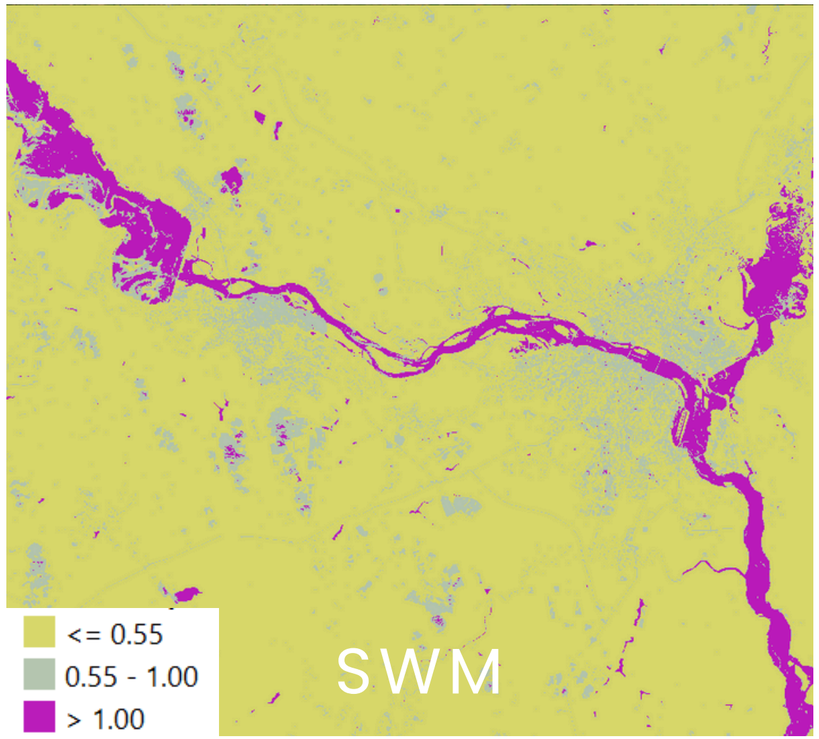
Results

Satellite indexes for eutrophication detection

Zone 1 territory



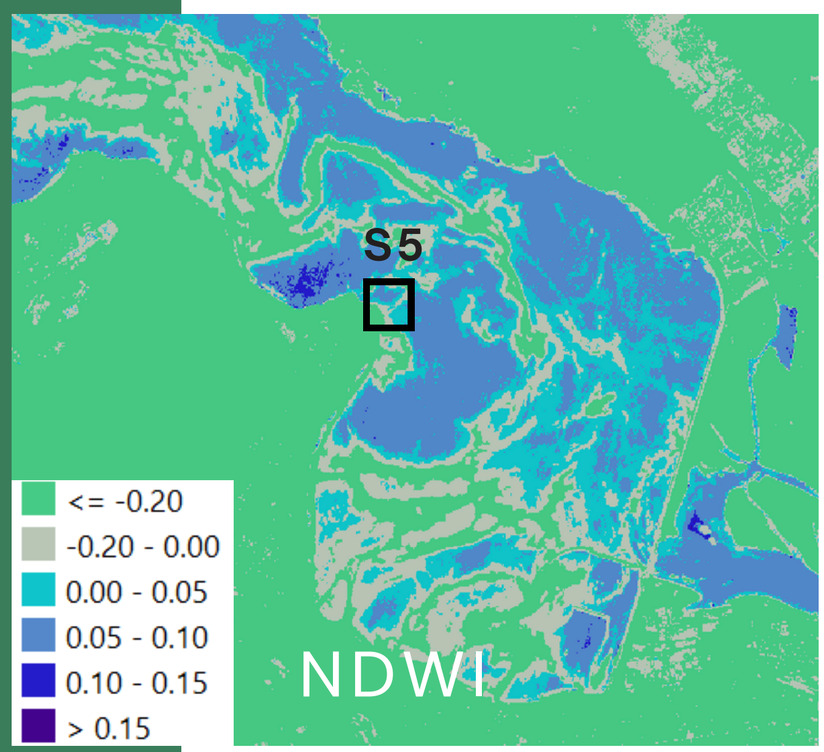


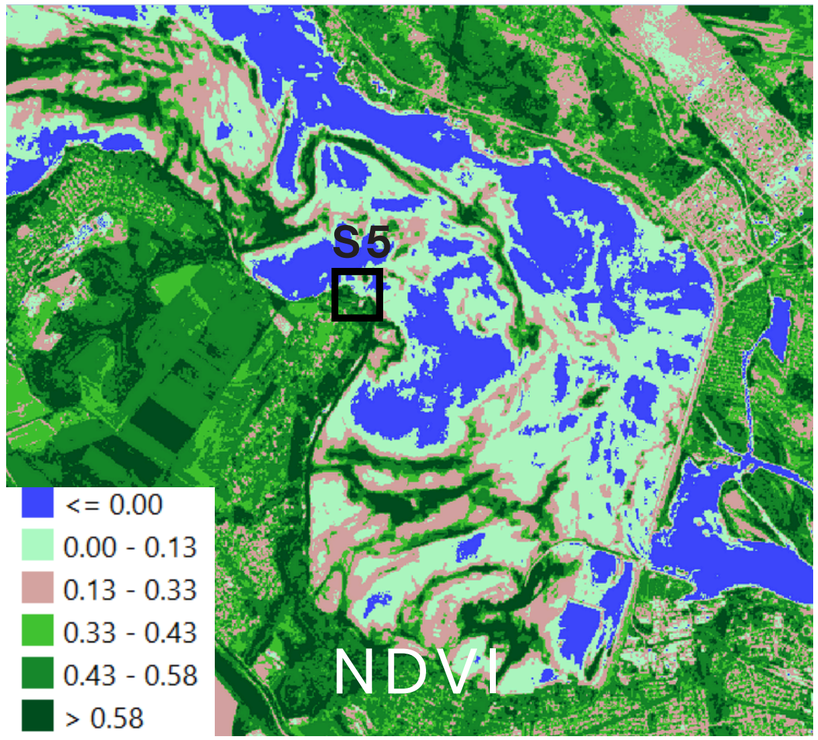


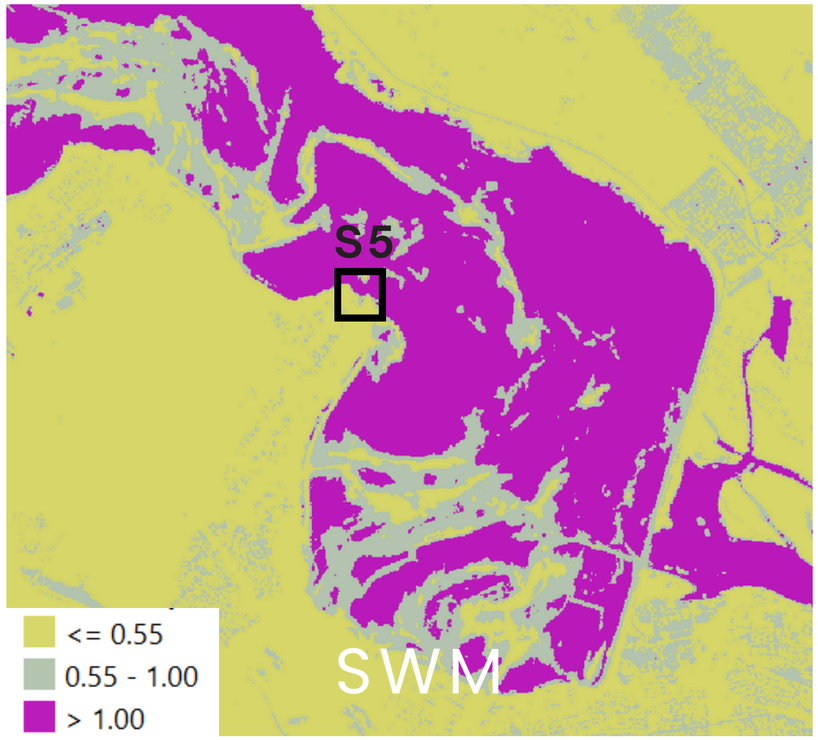
Results

Role of indexes for eutrophication detection

The lover part of the Kamianske Reservoir





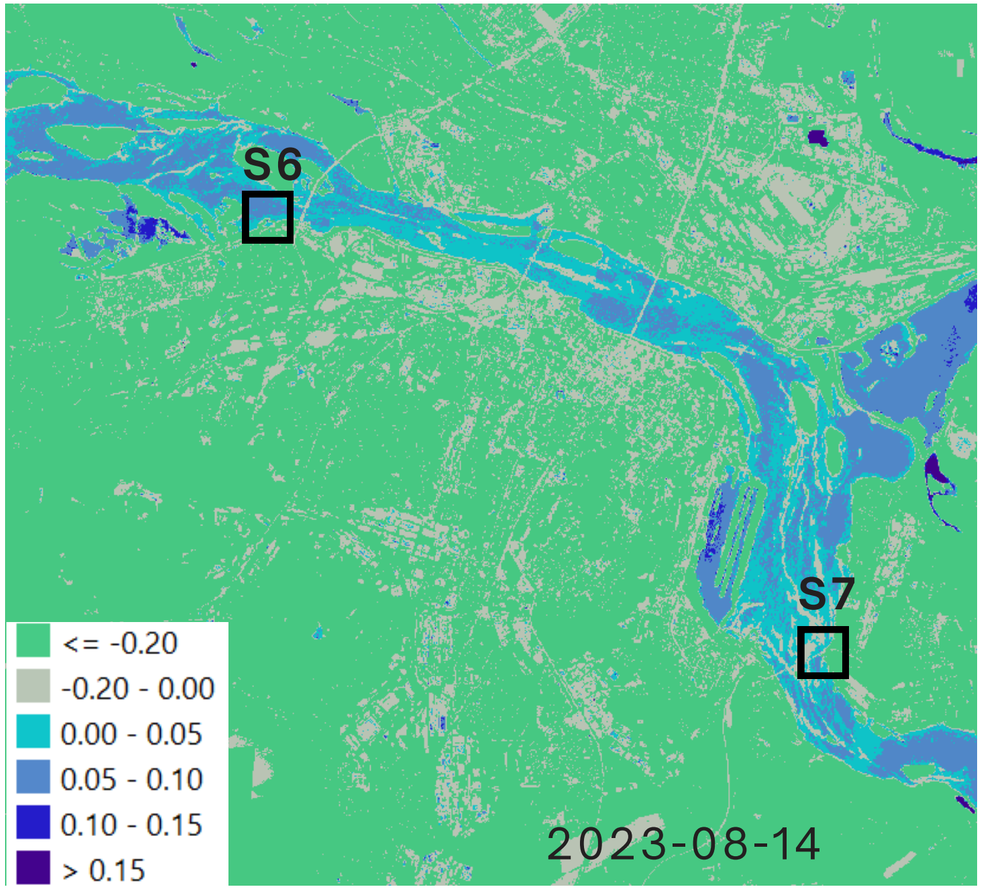


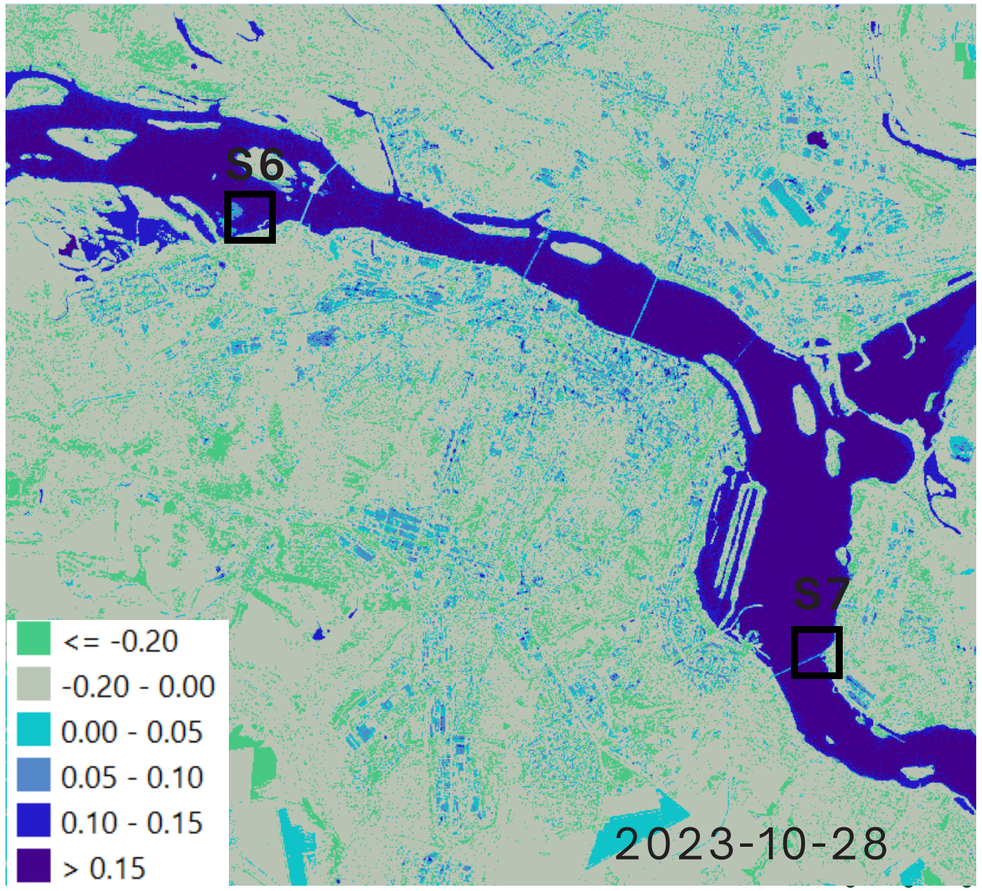
NDWI and NDVI - structure of algae bloom to monitor eutrophication process

SWM - most polluted areas of water body detection

Results

NDWI for algae bloom period and clear water period





Results

NDWI and nutrient compounds

Based on 342 satellite data and 9 years of hydrochemical research

Algae bloom index values

-50 < NDWI < 15

The clearest water index values

NDWI > 40

NDWI and NH4

Similar seasonal changes with consistent increases in pollution during the growing season, followed by a decrease in colder months

NDWI and PO4

Typical peak in August and the beginning of September

Thank you!

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