# Heavy metal and organic chemical bioaccumulation in wetlands

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CLASS XII

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**LAKE 2022-23**

**Monitoring of ecosystems – Big Data (Remote Sensing Data), Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning techniques**

**[THE 13TH BIENNIAL LAKE SYMPOSIUM]**

## OBJECTIVES

- To estimate amount of heavy metal and organic chemical bioaccumulation in a wetland considering all natural processes.
- To determine the rate at which metal bioaccumulation takes place for a specified time period.

# Principle

- Heavy metals in air, soil and water have become a global issue as a consequence of the increasing human impact in the last few decade.
- Because of their toxicity, accumulative and non-biodegradable nature, heavy metals are potentially hazardous to terrestrial and aquatic ecosystems, and thus to human and animal life
- Heavy metals are present in the environment as a result of natural sources and human activities (He et al., 2005; Li et al., 2009).
- In natural systems, heavy metals originate from rocks, ore minerals, volcanoes, and release of metals during weathering leading to soil formation (Szyczewski et al., 2009). On the other hand, anthropogenic causes of heavy metals are mostly related to urban development, generation of electricity, and the metal industry including mining, extraction, and refining processes

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- Wetlands occupy 6% of the Earth's ecosystems.
- Wetlands have vegetation which is adapted to unique hydric soil.
- Wetlands include some of the most carbon-dense ecosystems in our planet.
- Peatlands, that account for just 3% of the world's land surface, store twice as much carbon as forests.

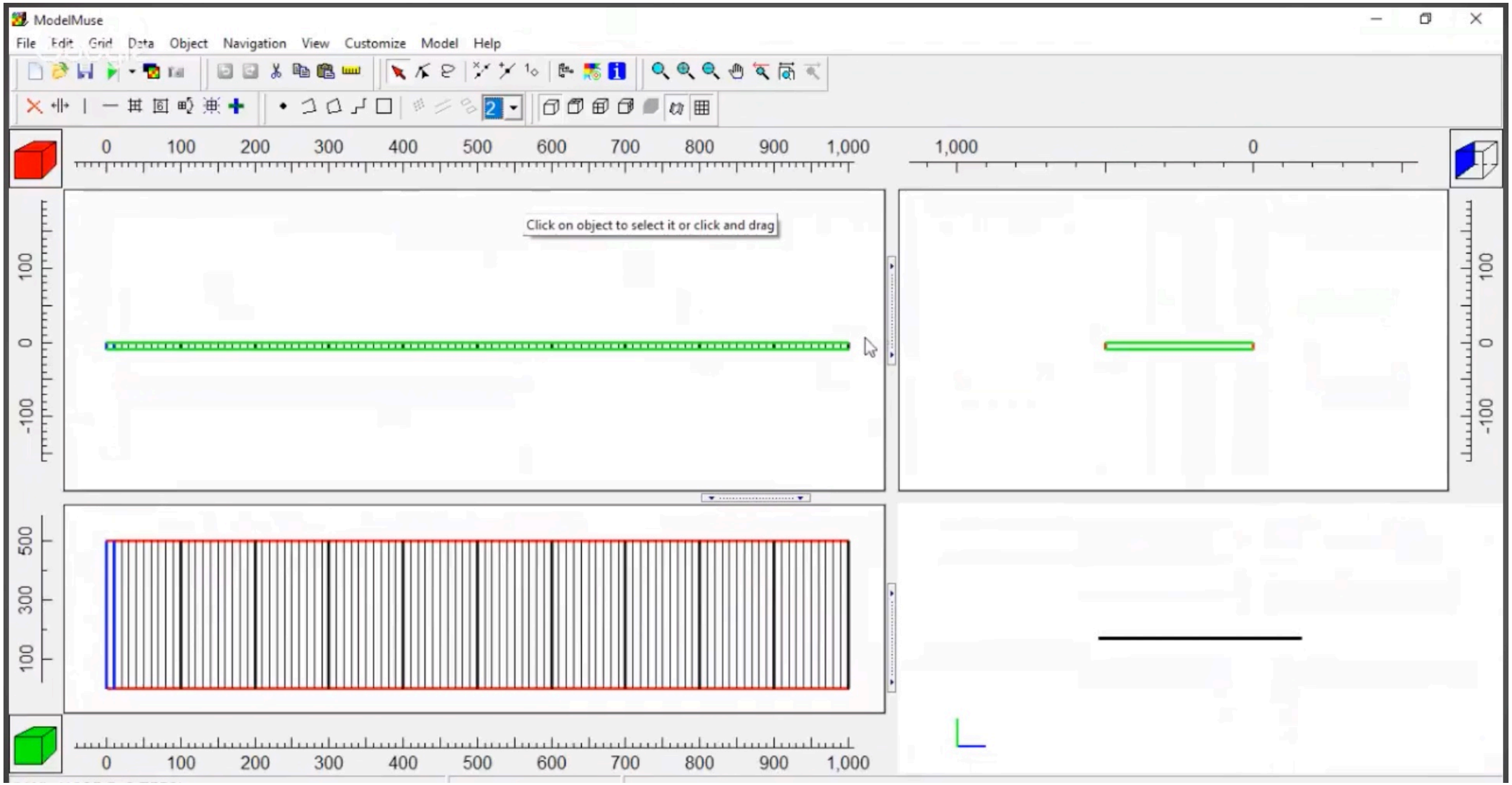
- Wetlands have been playing an important role in purifying the contaminated water for centuries. Majority of wetlands have been exploited for their natural cleansing capacity for assimilating various pollutants including heavy metals and pesticides.
- Wetland plants, in this direction, help in accumulating various contaminants from aquatic bodies. Different metals like Cd, Cu, Cr, Co, Fe, Pb, Zn, and Mn are dissolved in wetlands.

Sources of heavy metals include mining, industrial production (foundries, smelters, oil refineries, petrochemical plants, pesticide production, chemical industry), untreated sewage sludge and diffuse sources such as metal piping, traffic and combustion by-products from coal-burning power stations. Wetland plants, in this direction, help in accumulating various contaminants from aquatic bodies. Different metals like Cd, Cu, Cr, Co, Fe, Pb, Zn, and Mn are dissolved in wetlands.

Sources of Organic chemicals include pollutants that are washed by rainfall from urban and agricultural lands and are carried overland to water bodies. Pollutants include soil particles, fertilizers, pesticides, grease and oil from cars and trucks, and road salts.
Nitrogen and phosphorus from agricultural and lawn fertilizers, pet waste, sewer and septic systems

# Procedure

- Using modelmuse and modflow it is possible to determine the amount of heavy metal bioaccumulation in wetlands for a specified time period.
- The time period is taken for 1000 years and copper concentration at the start of this time period is taken as 0.05 PPM.
- The simulation is run taking all natural processes as standard.
- The model was built by assigning two layers of peat having an even thickness of 3.4 meters and sand and having variable thickness at different locations.


ModelMuse
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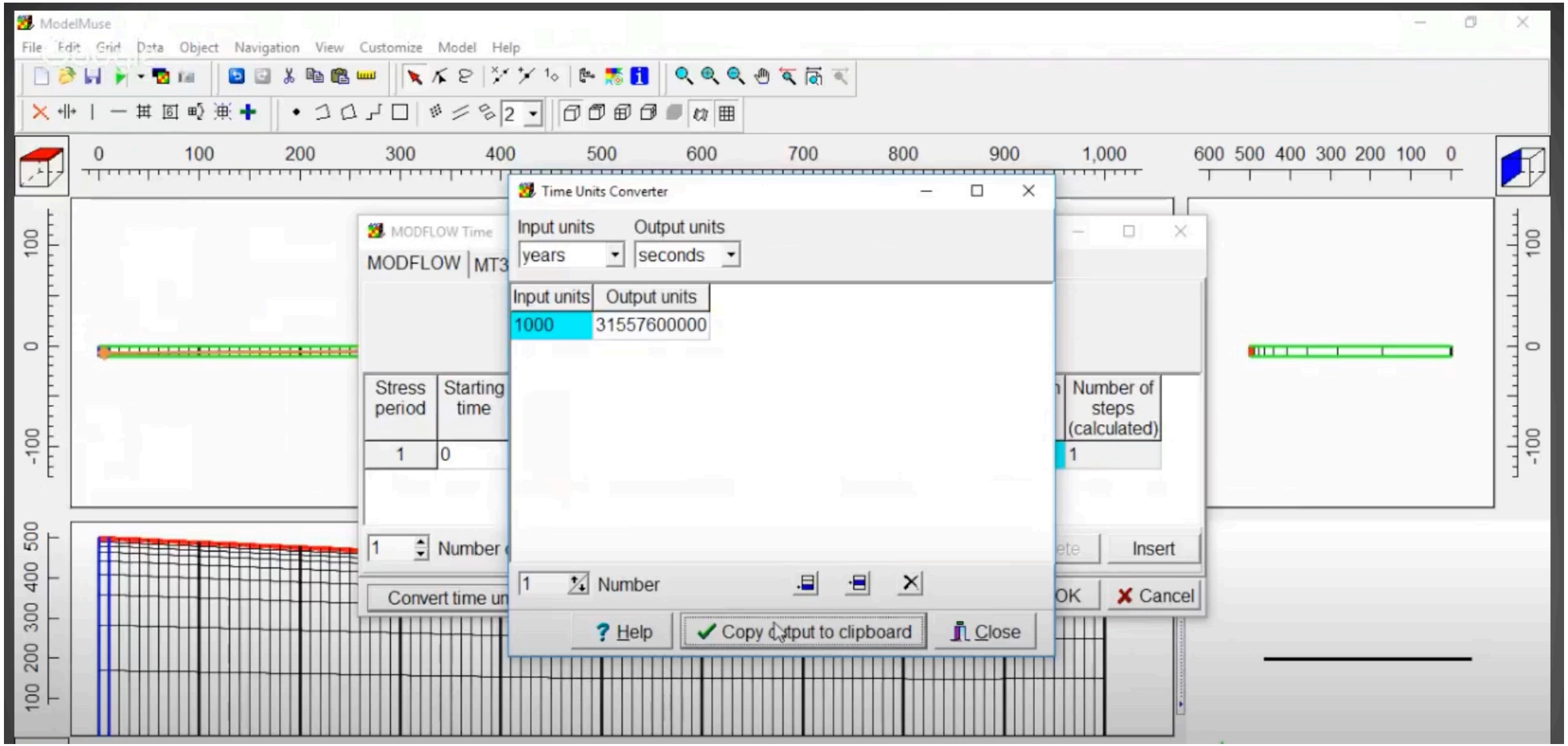
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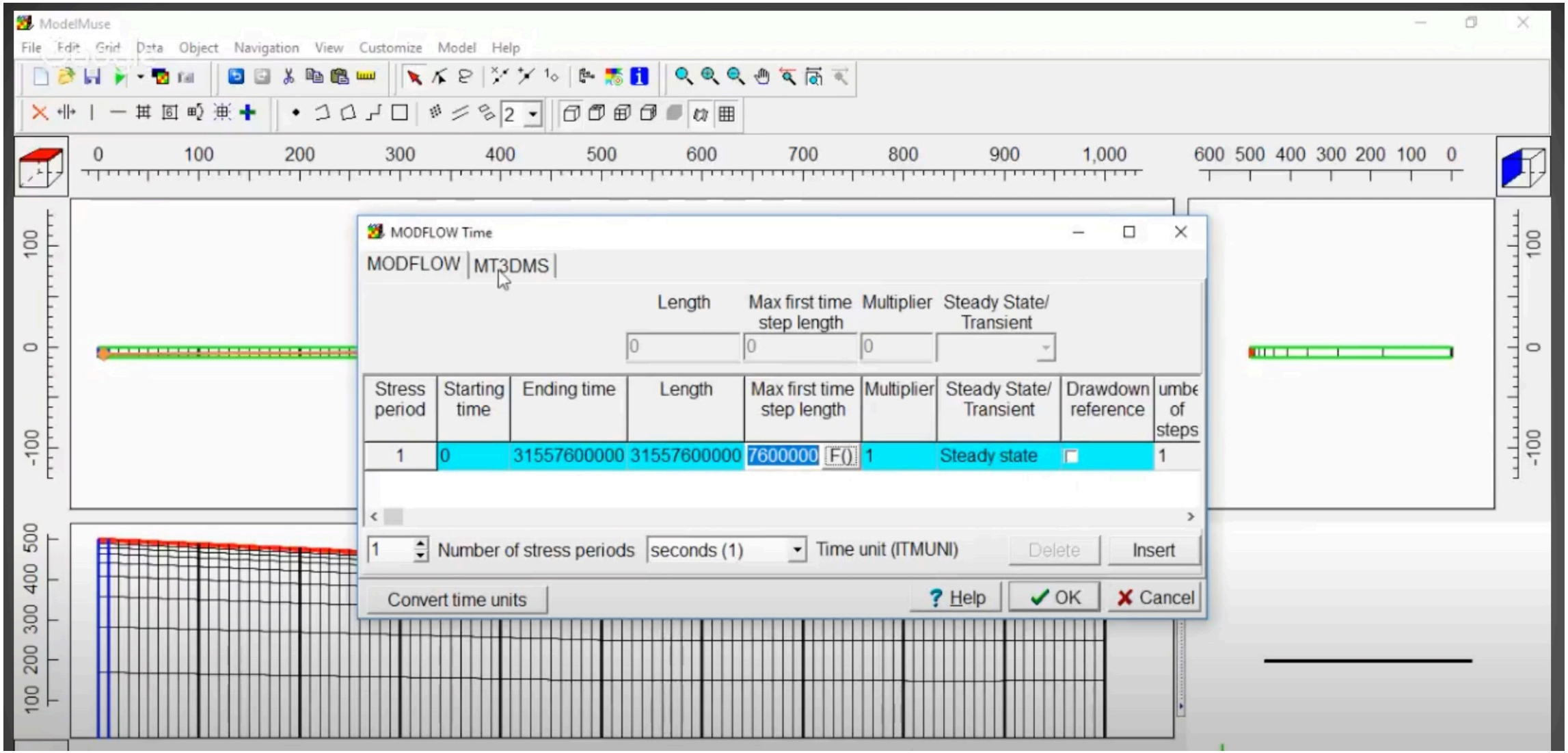
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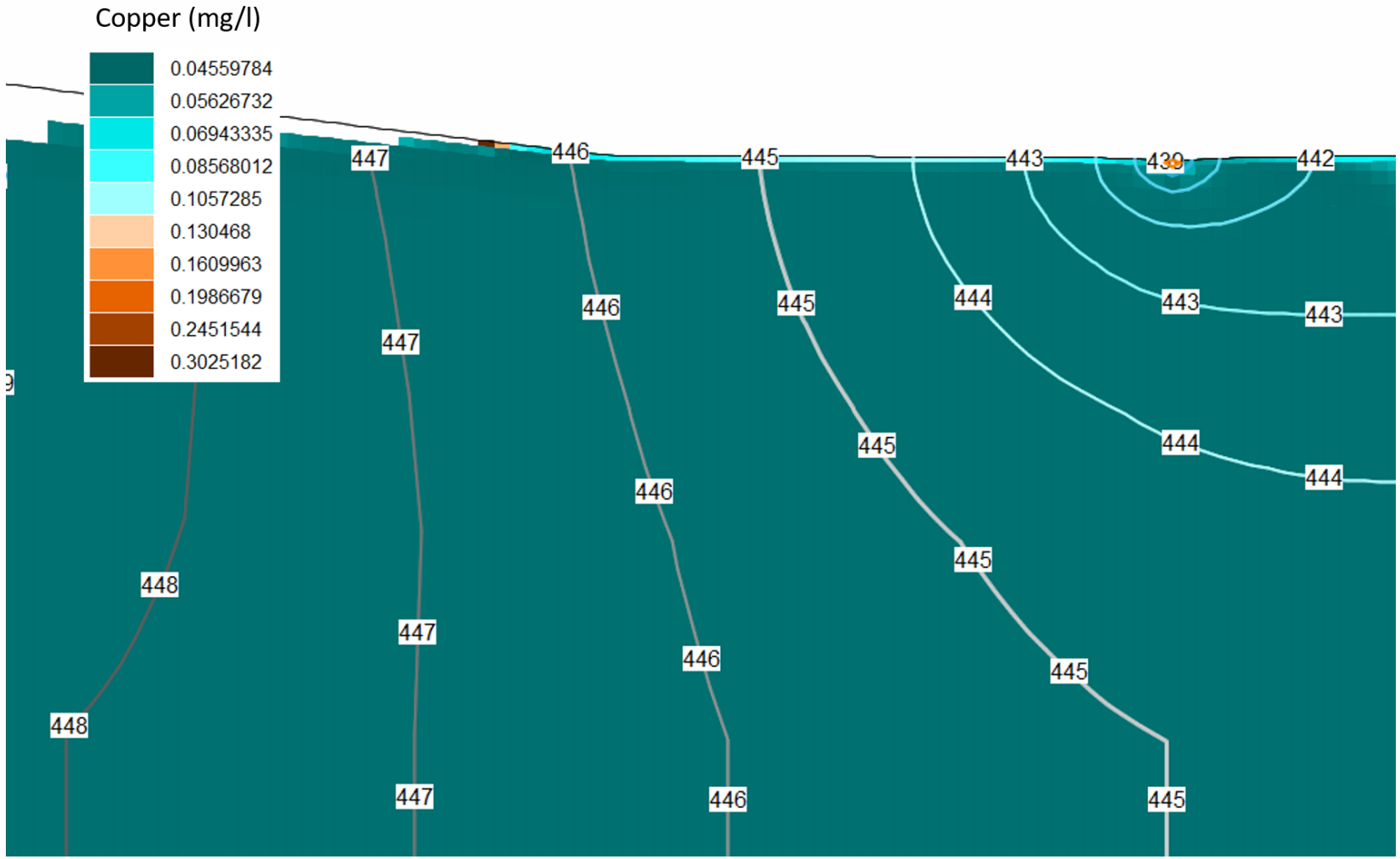
# Result


Copper (mg/l)
0.04559784
0.05626732
0.06943335
0.08568012
0.1057285
0.130468
0.1609963
0.1986679
0.2451544
0.3025182
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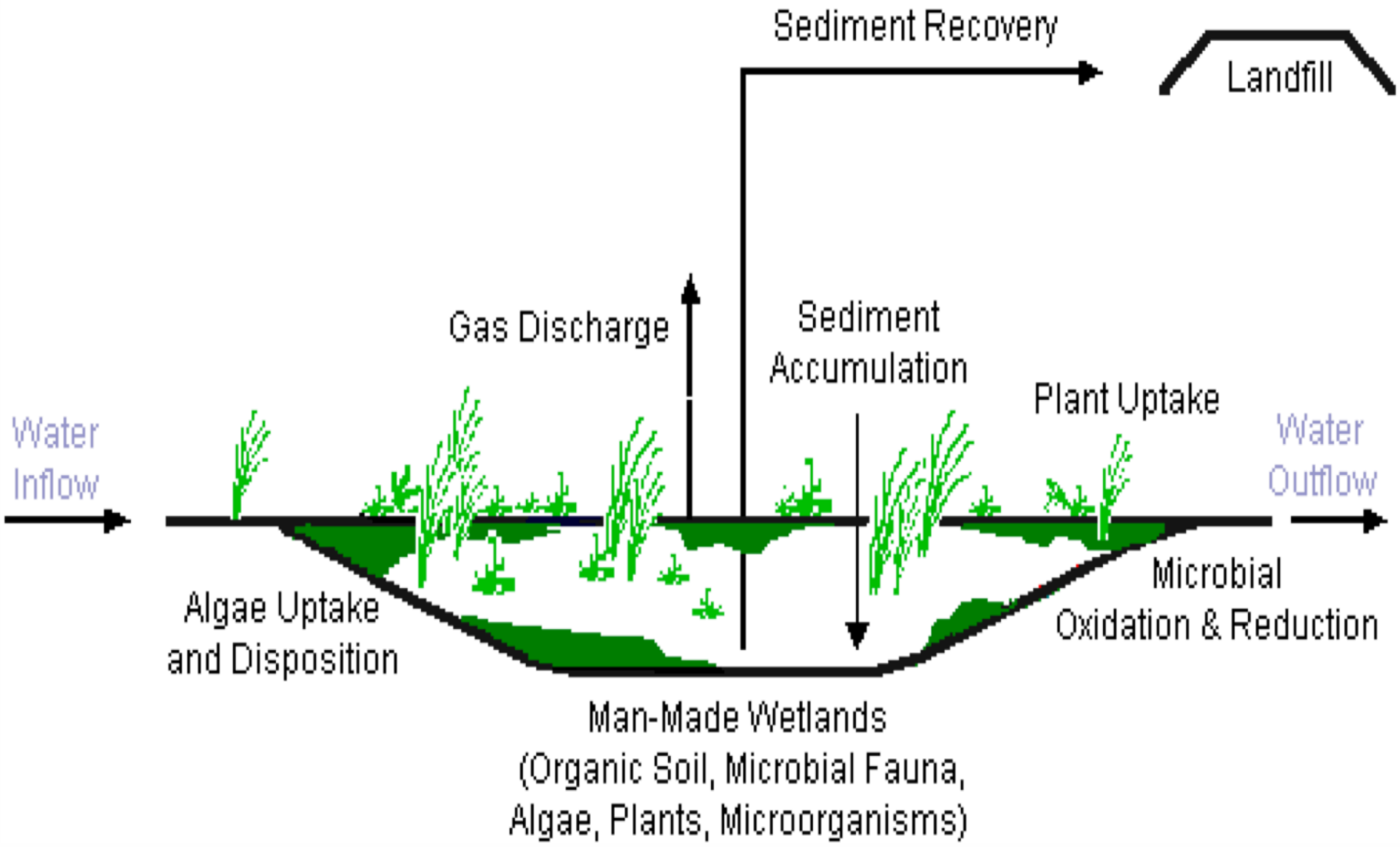
- Over thousands of years, the components in the soil solution tend to accumulate in wetlands, making them zones where major ions and metals are trapped.
- According to the simulation and calculations, metal concentration can increase from 3 to 4 times in comparison to the original values over the time period the simulation ran for.

# SOLUTION

A constructed wetland is "a designed and man-made complex of saturated substrates, emergent and submergent vegetation, animal life, and water that simulates natural wetlands for human use and benefits."

A plot of land is chosen near the wastewater that is to be purified

- A shallow pond is built and plants found in natural wetlands such as cattails, reeds, and rushes are set out
- The wastewater is then routed through the wetland
- Microbial utilization and plant uptake of nutrients results in cleaner water leaving the constructed wetland than what entered


Sediment Recovery
Landfill
Gas Discharge
Sediment
Accumulation
Plant Uptake
Water
Inflow
Water
Outflow
Algae Uptake
and Disposition
Microbial
Oxidation & Reduction
Man-Made Wetlands
(Organic Soil, Microbial Fauna,
Algae, Plants, Microorganisms)

# Conclusion :

- Heavy metals are major pollutants that pose threats to wetland environments.
- It is important to reduce the bioaccumulation of metals and measures should be employed to reduce this.

# References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- https://water.usgs.gov/water-resources/software/ModelMuse/readme5_1_1.txt

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