जल शक्ति मंत्रालय
MINISTRY OF JAL SHAKTI

9th INDIA INTERNATIONAL WATER WEEK

IIWW

MODERATE PRE-OXIDATION–ENHANCED COAGULATION FOR EFFICIENT CYANOBACTERIA REMOVAL IN DRINKING WATER TREATMENT

Presented By:
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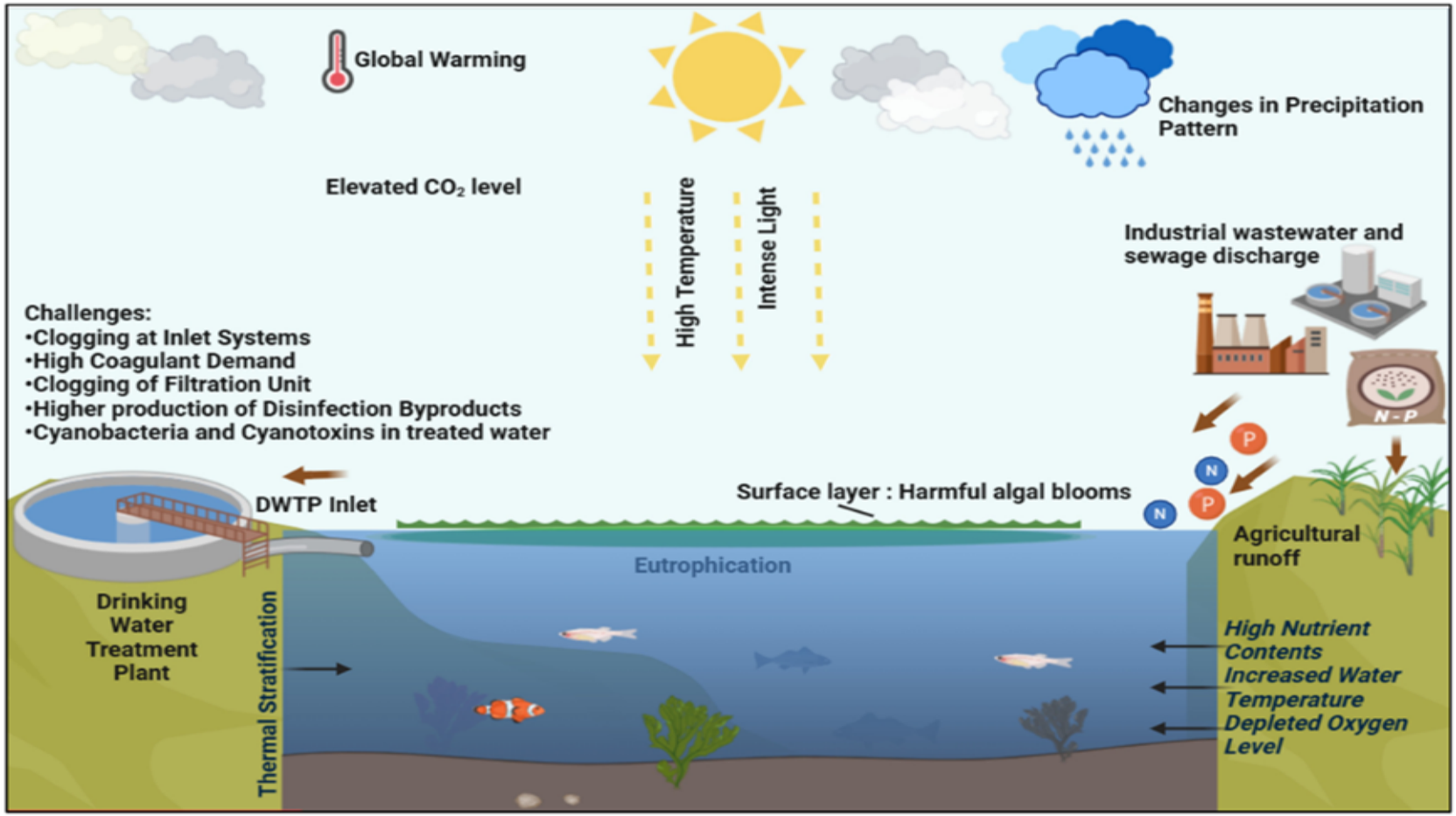
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Introduction



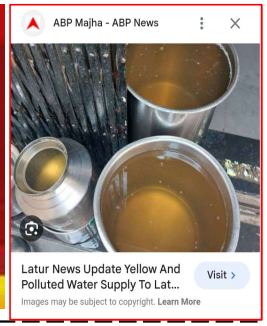
Reference: Sahu, N., Maldhure, A., & Labhasetwar, P. (2025). Management of cyanobacteria and cyanotoxins in drinking water: A comprehensive review on occurrence, toxicity, challenges and treatment approaches. *Science of The Total Environment*, *976*, 179260. 10.1016/j.scitotenv.2025.179260

Problem Statement



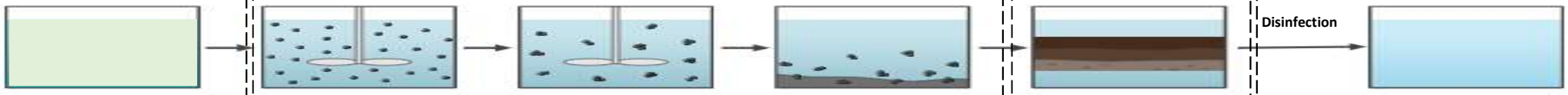






Degraded water quality
Altered pH, Turbidity , Dissolve oxygen, Taste & Odor, Toxins

Raw water → Coagulation → Flocculation → Sedimentation → Filtration → Disinfection → Treated water



Clogging of filtration system, Frequent backwashing

- **Cyanobacteria**
- **Cyanotoxins**
- **Taste & Odour**

Negatively charged algae & elevated Algal Organic Matter limits the coagulation efficiency

Disinfection Byproducts (DBPs)

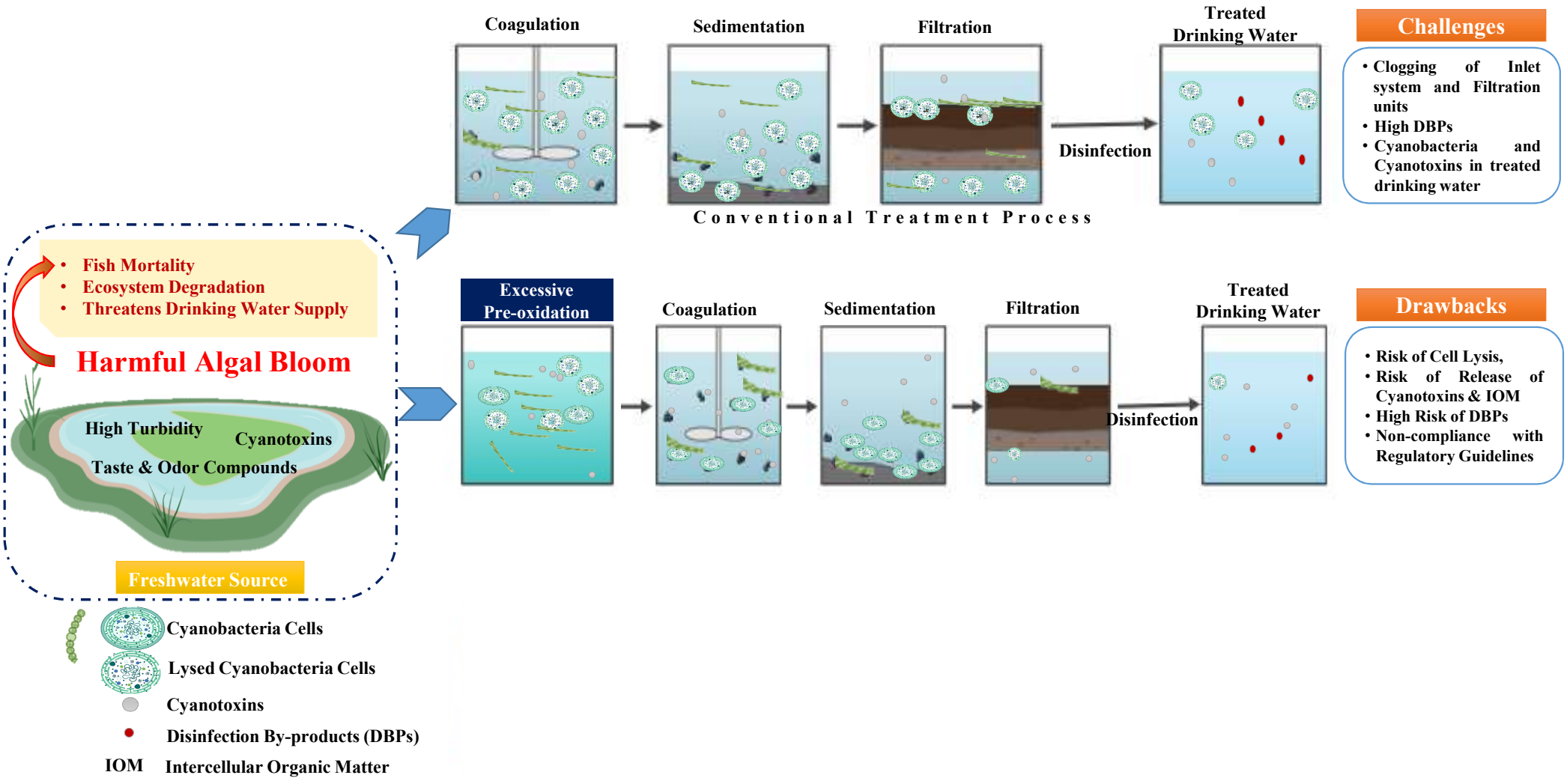


Increased Coagulant Demand → **Increased slugde production** → **Increased cost**

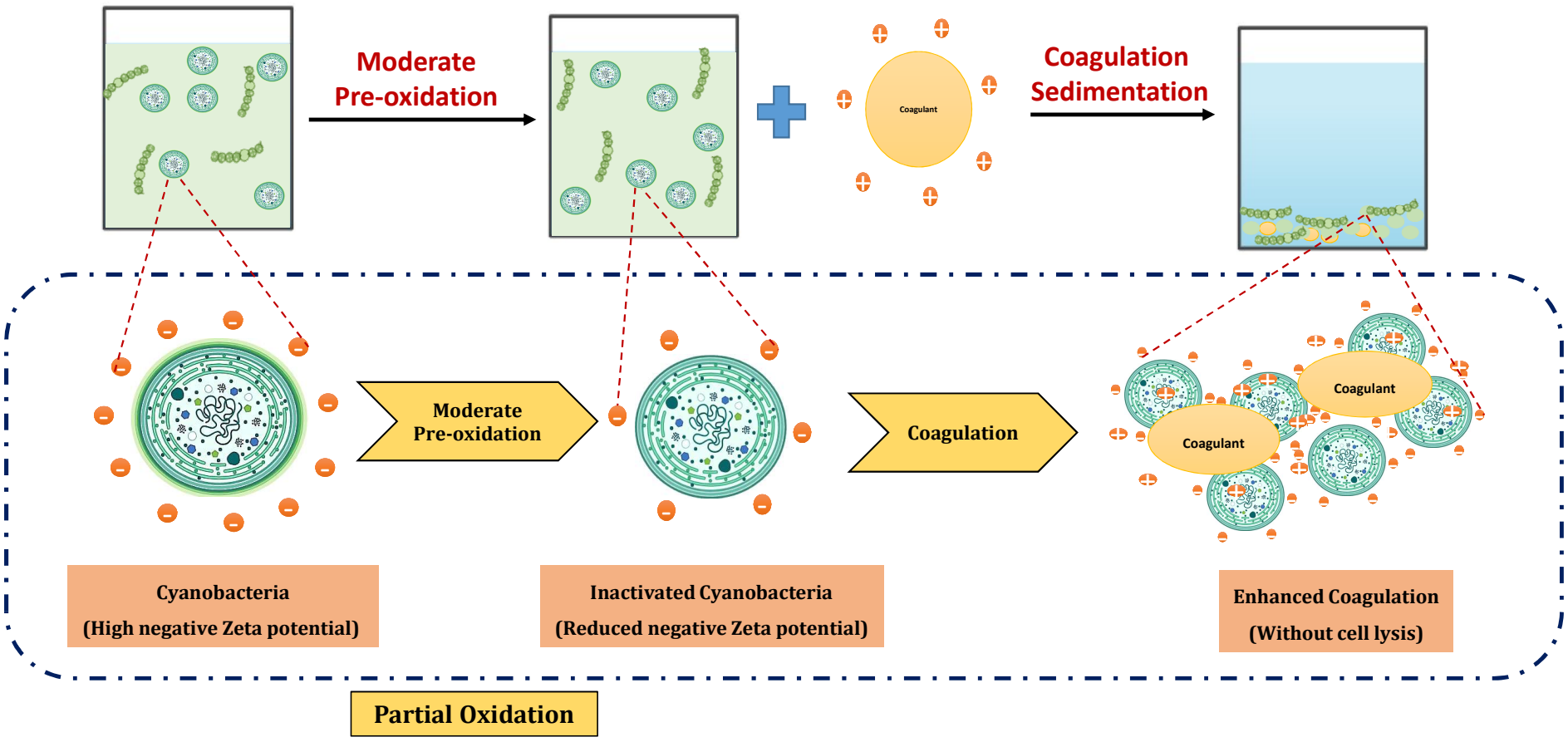
Recently reported cases

- **Latur**
- **Wena Dam - Nagpur**
- **Surat**
- **Solapur**

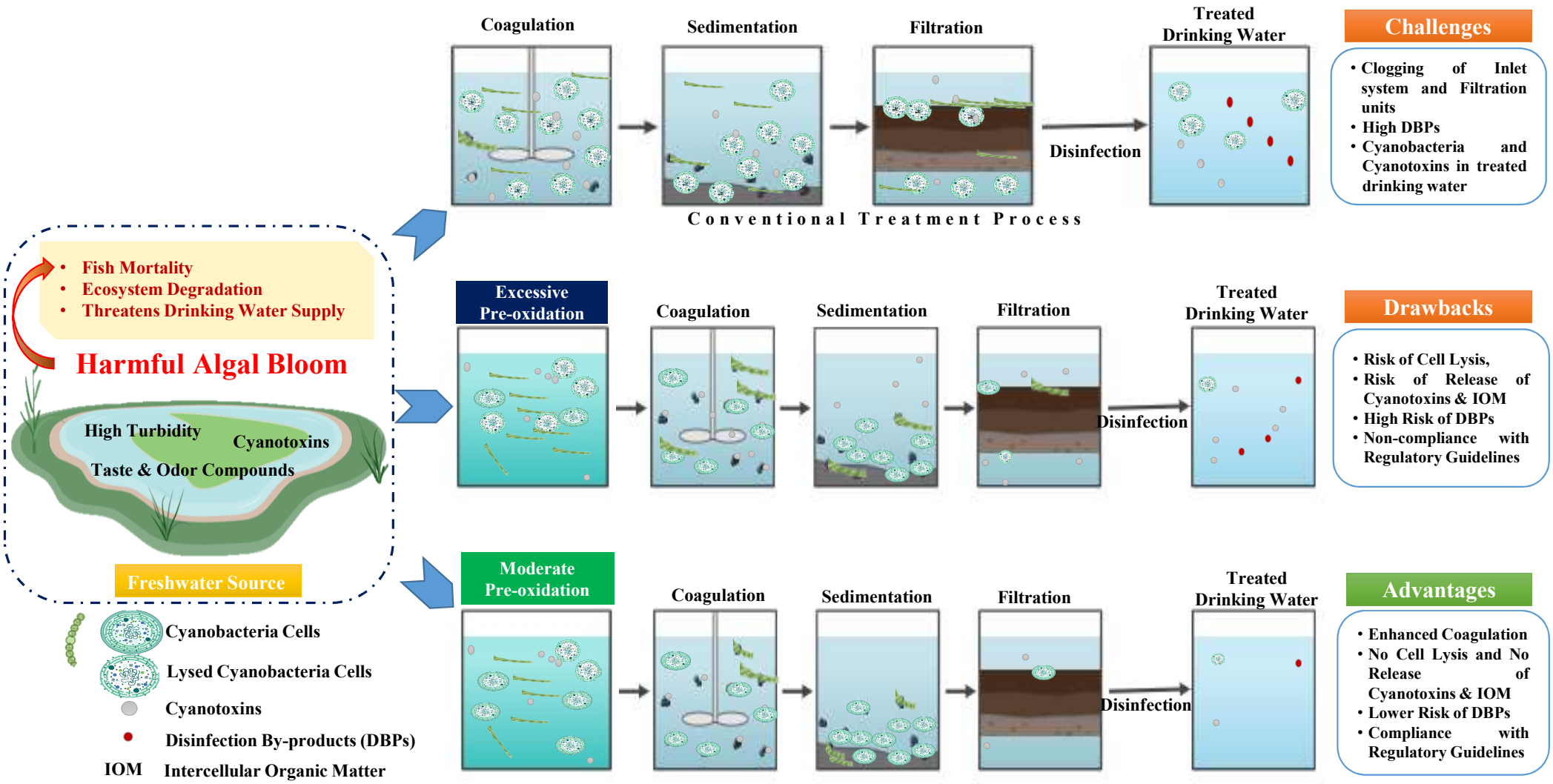
Solution


Coagulation
Sedimentation
Filtration
Disinfection
Treated Drinking Water
Challenges
• Clogging of Inlet system and Filtration units
• High DBPs
• Cyanobacteria and Cyanotoxins in treated drinking water
Conventional Treatment Process
• Fish Mortality
• Ecosystem Degradation
• Threatens Drinking Water Supply
Harmful Algal Bloom
High Turbidity
Cyanotoxins
Taste & Odor Compounds
Freshwater Source
Excessive Pre-oxidation
Coagulation
Sedimentation
Filtration
Disinfection
Treated Drinking Water
Drawbacks
• Risk of Cell Lysis,
• Risk of Release of Cyanotoxins & IOM
• High Risk of DBPs
• Non-compliance with Regulatory Guidelines
Cyanobacteria Cells
Lysed Cyanobacteria Cells
Cyanotoxins
Disinfection By-products (DBPs)
IOM
Intercellular Organic Matter

Moderate pre-oxidation to enhance coagulation



Solution


Coagulation
Sedimentation
Filtration
Disinfection
Treated Drinking Water
Conventional Treatment Process
Challenges
• Clogging of Inlet system and Filtration units
• High DBPs
• Cyanobacteria and Cyanotoxins in treated drinking water
• Fish Mortality
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Harmful Algal Bloom
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Freshwater Source
Excessive Pre-oxidation
Coagulation
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Filtration
Disinfection
Treated Drinking Water
Drawbacks
• Risk of Cell Lysis,
• Risk of Release of Cyanotoxins & IOM
• High Risk of DBPs
• Non-compliance with Regulatory Guidelines
Moderate Pre-oxidation
Coagulation
Sedimentation
Filtration
Disinfection
Treated Drinking Water
Advantages
• Enhanced Coagulation
• No Cell Lysis and No Release of Cyanotoxins & IOM
• Lower Risk of DBPs
• Compliance with Regulatory Guidelines
Cyanobacteria Cells
Lysed Cyanobacteria Cells
Cyanotoxins
Disinfection By-products (DBPs)
IOM Intercellular Organic Matter

Ozonation as moderate pre-treatment

Methodology

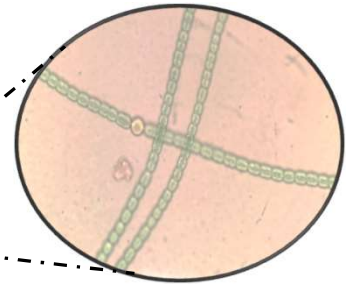
Culturing

Anabaena (Filamentous)

National Collection of Industrial Microorganisms, (NCIM), Pune

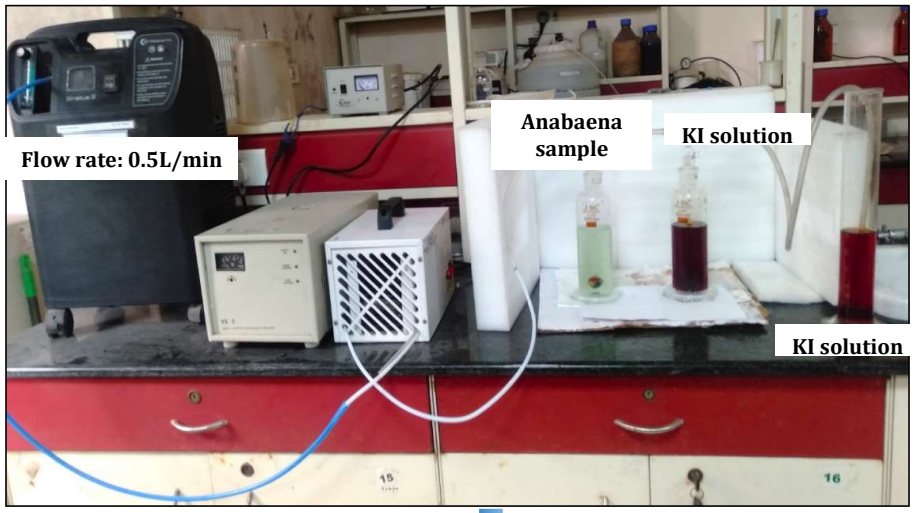
Cultured in Fogg's Medium, @22°C, 100 rpm





@100x magnification using Fluoroscene Microscope

Ozonation



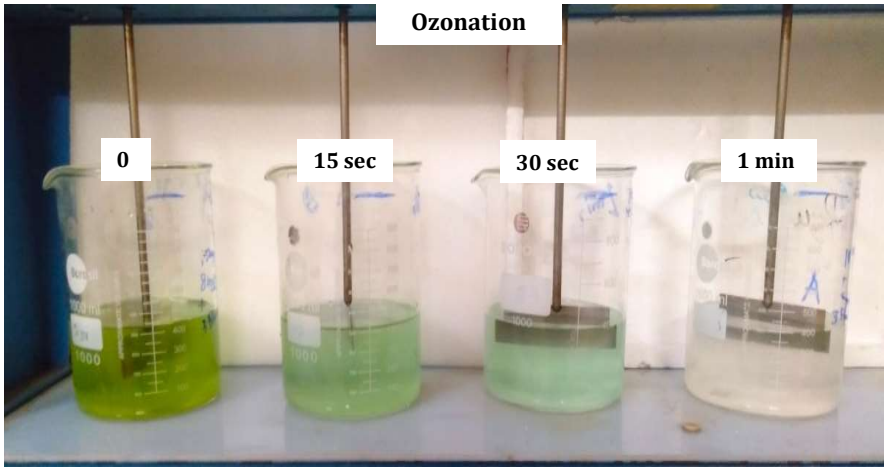
Different concentration of ozone gas was bubbled and allowed to react for 15 minutes

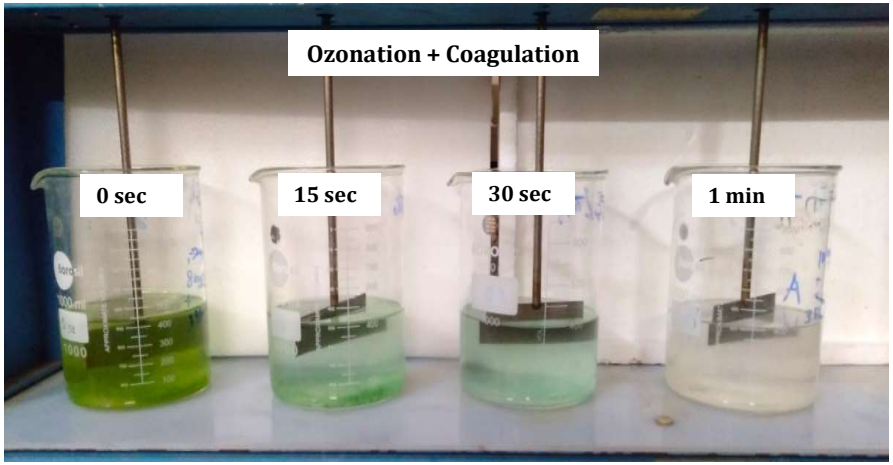
Coagulation



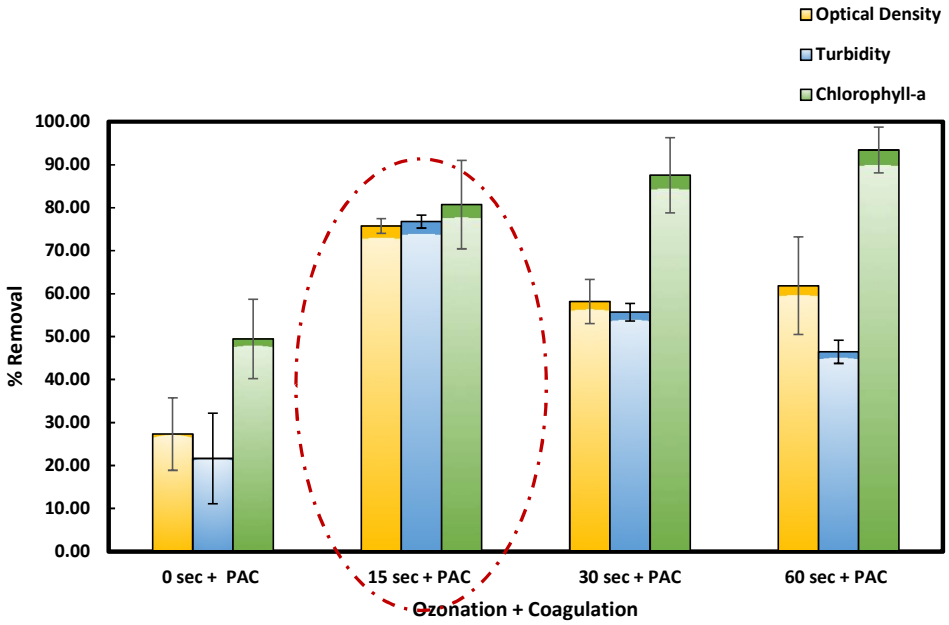
10 ppm of polyaluminium chloride (PAC) dosing was given for coagulation process.

Results





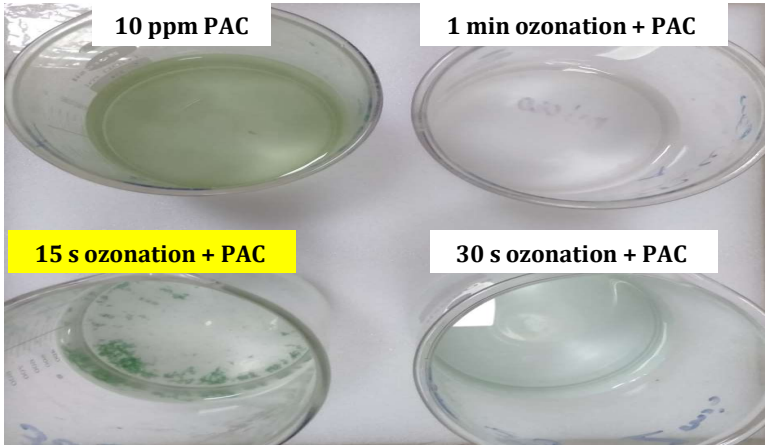
- Moderate pre-oxidation followed by coagulation achieved >80% removal of algal cells.
- Excessive ozonation degrades Chl-a pigments, leading to cell lysis and the release of intracellular organic matter, thereby reducing the efficiency of coagulation.

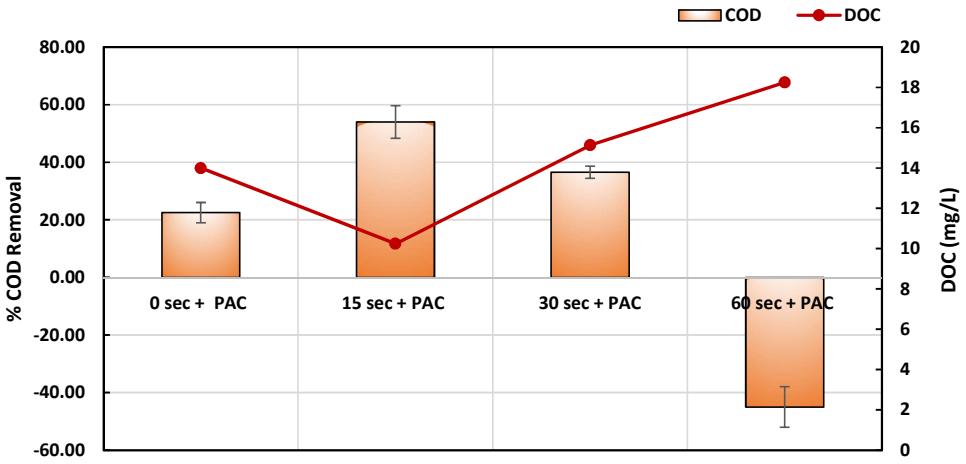


Results

- An increase in COD and DOC values also indicates the presence of high levels of algal organic matter after excessive ozonation, which may act as a precursor to disinfection by-products (DBPs).

- Post-chlorination, high algal organic matter can lead to high formation of DBPs.





Conclusion

- Coagulation alone was insufficient due to the inherent stability of cyanobacterial cells.
- The application of **moderate pre-ozonation** significantly improved treatment performance by partially oxidising surface constituents, thereby enhancing cell destabilisation and promoting effective aggregation without compromising cell integrity.
- **Excessive ozonation** resulted in reduced removal efficiencies for turbidity and optical density, despite achieving high reductions in chlorophyll a. This behaviour is indicative of extensive cell lysis, **releasing intracellular organic matter and increasing dissolved organic carbon,** which interferes with coagulant and inhibits floc formation.
- This increased organic matter can lead to increased DBPs formation post-chlorination.
- Moderate pre-ozonation is a effective methods for enhancing coagulation cyanobacteria during drinking water treatment process.

Thank You