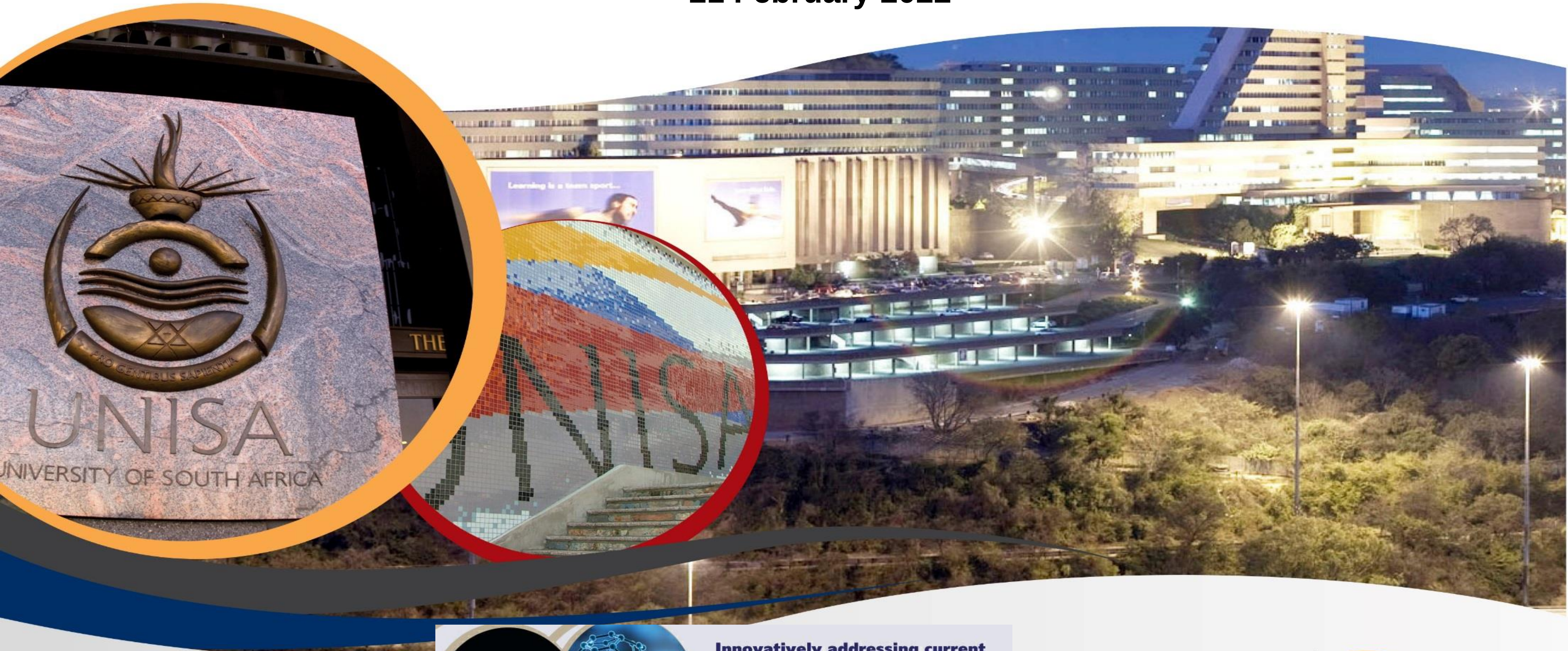
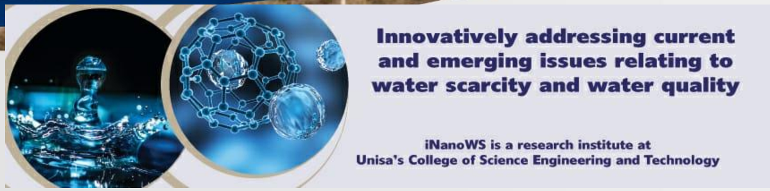
ABUNDANCE, SCARCITY AND INNOVATION: A WATER QUALITY TRIPARTITE ALLIANCE CENTRED ON NOM

By Prof Thabo T.I Nkambule

21 February 2022



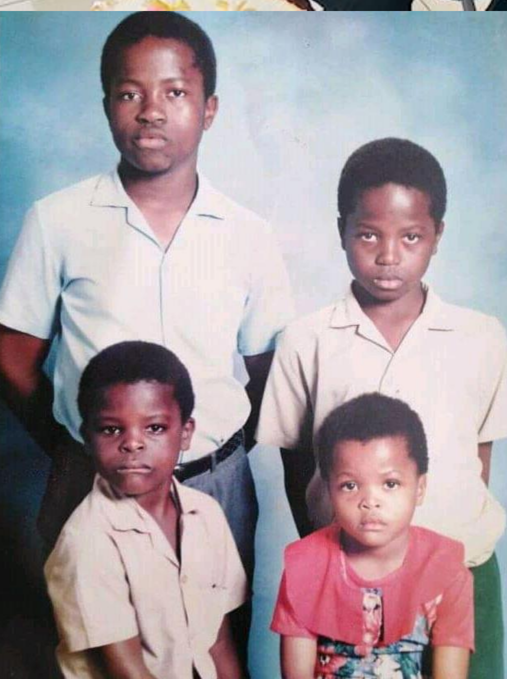


Define tomorrow.

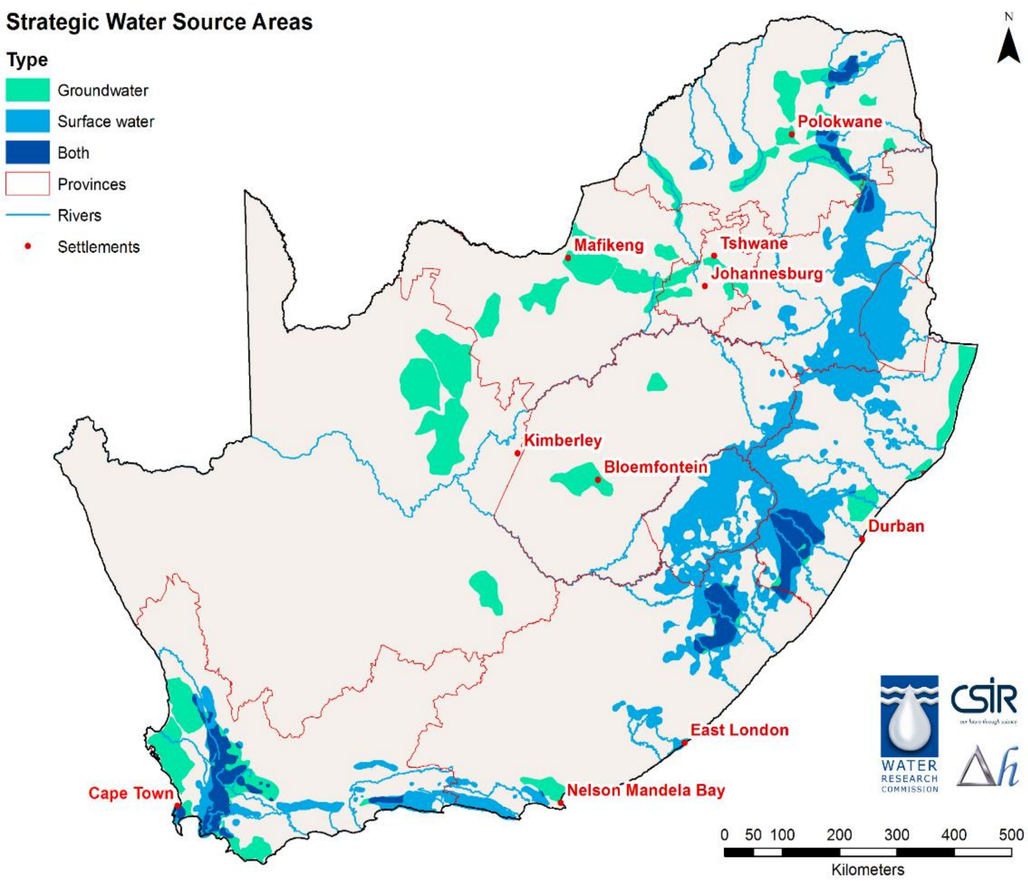
UNISA | university of south africa

Open Rubric

"The strength of a family, like the strength of an army, lies in its loyalty to each other." – Mario Puzo



SURFACE & GROUNDWATER SOURCES

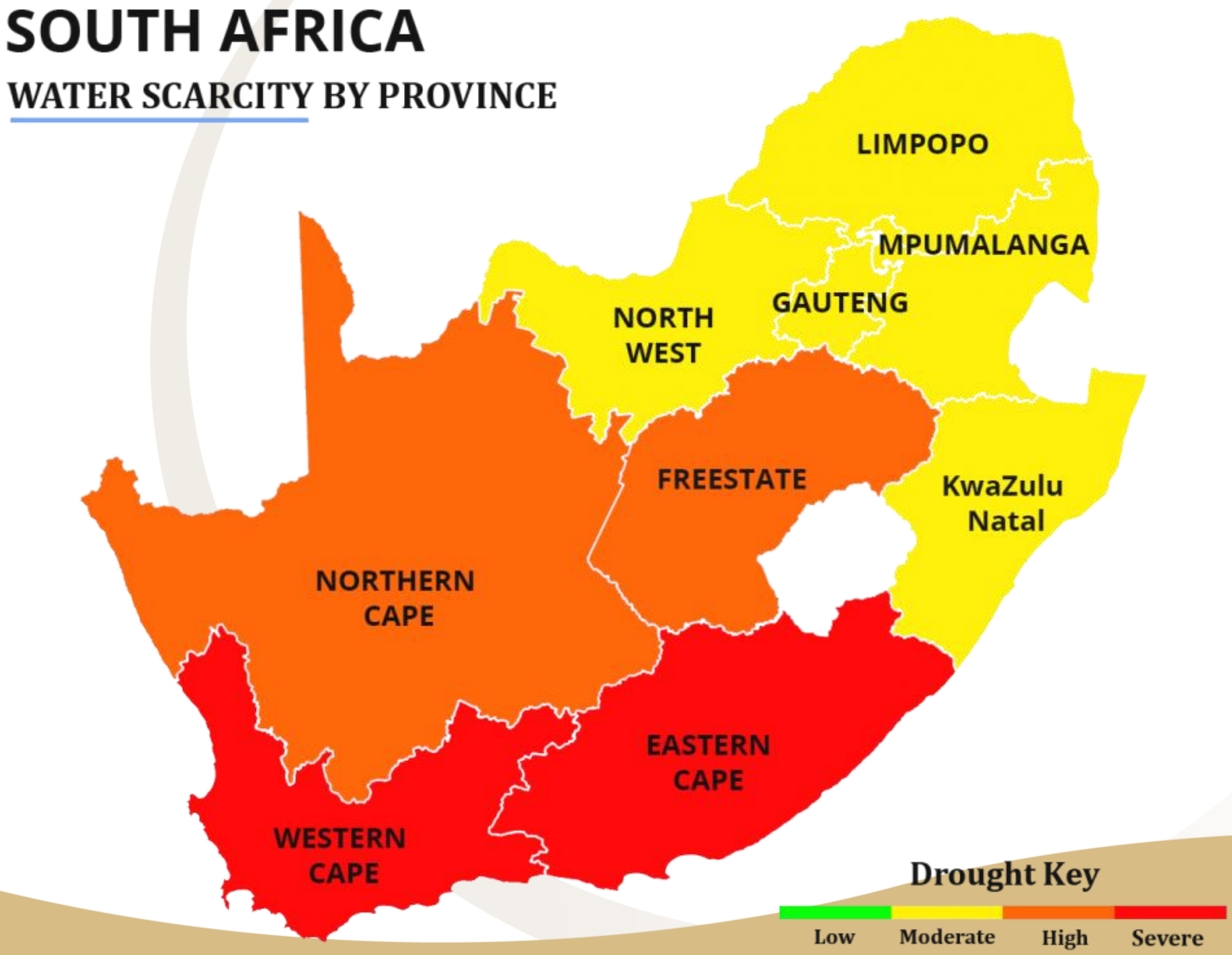


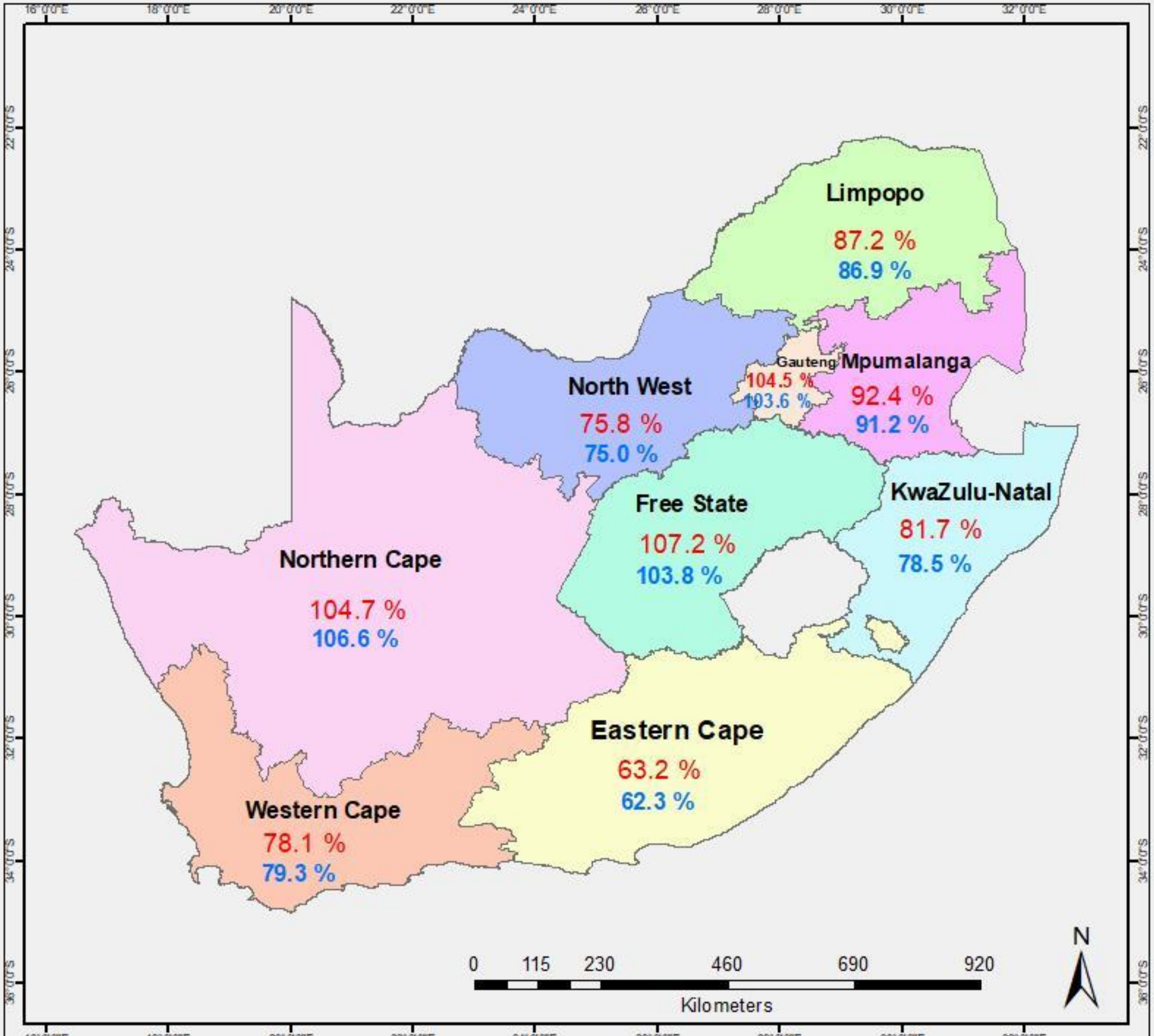
	SA	Africa	Global (continents)
Mean annual precipitation (mm)	465	670	718
Evaporation loss (%)	91%	83%	64%
Mean annual runoff (mm)	40	114	266

Water source areas

- **22 water source areas** on 8% of land providing 50% of our surface run-off

NATIONAL VULNERABILITY: WATER SERVICES CHALLANGES





water & sanitation

Department
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Provincial Dam Average Levels

Week of 17/01/2022

Description:
This map depicts the average dam levels per province in percentages, which is a summary of weekly averages for last year around the same period and the current week. The current average is depicted in red and the average for the previous year is depicted in blue. The summary only refelects the storages for those dams listed in the weekly state of resevoirs report.

Data Sources:
Reservoir Data: Department of Water & Sanitation, HYDSTRA Database.

LEGEND

Average Dam Levels (indicated in percentage)

% Current week's average

% Previous week's average

Provinces

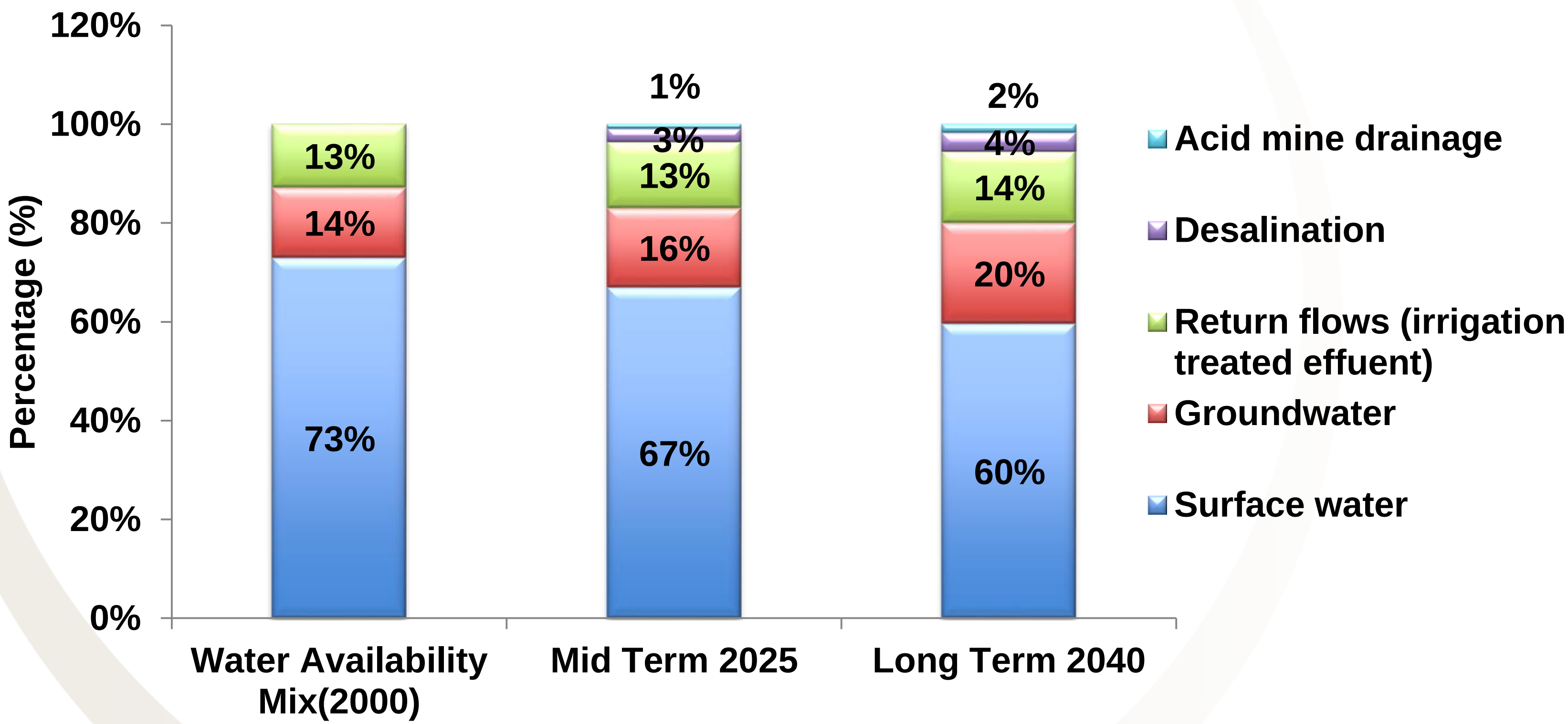
- Eastern Cape
- Free State
- Gauteng
- KwaZulu-Natal
- Limpopo
- Mpumalanga
- North West
- Northern Cape
- Western Cape

Directorate: Surface & Groundwater Information
Sub-Directorate: Groundwater Information

PARADIGM SHIFT IN WATER SUPPLY

As per National Water & Sanitation Master Plan

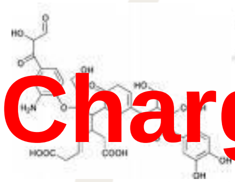
Supply: water mix approach with progressively increased use of unconventional water sources



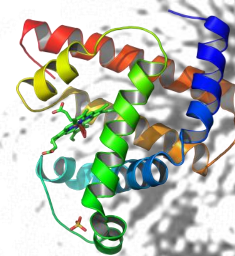
KEY MESSAGE: Percentage usage of unconventional sources (such as groundwater, reuse, desalination, etc.), is progressively increased with time, while reliance on the oversubscribed surface water decreases. Improved water security = adaptation

NOM- AN IMPOSSIBLY COMPLEX MATRIX THAT VARIES TEMPORALLY AND SPATIALLY

Charge

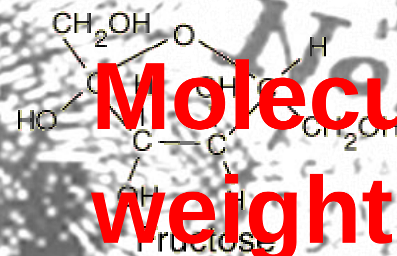


Humic acid

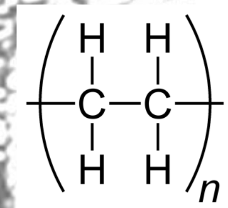


Proteins

Molecular weight

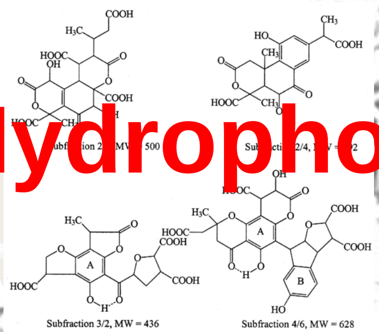


Sugars



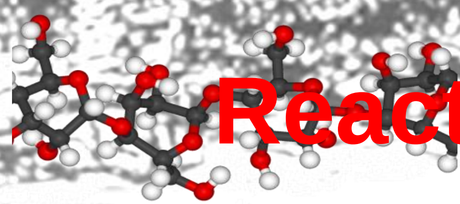
Hydrocarbons

Hydrophobicity

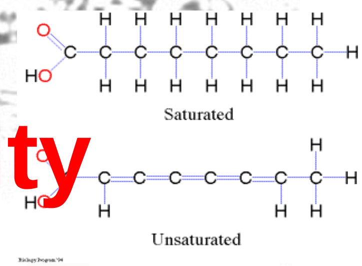


Fulvic acids

Reactivity

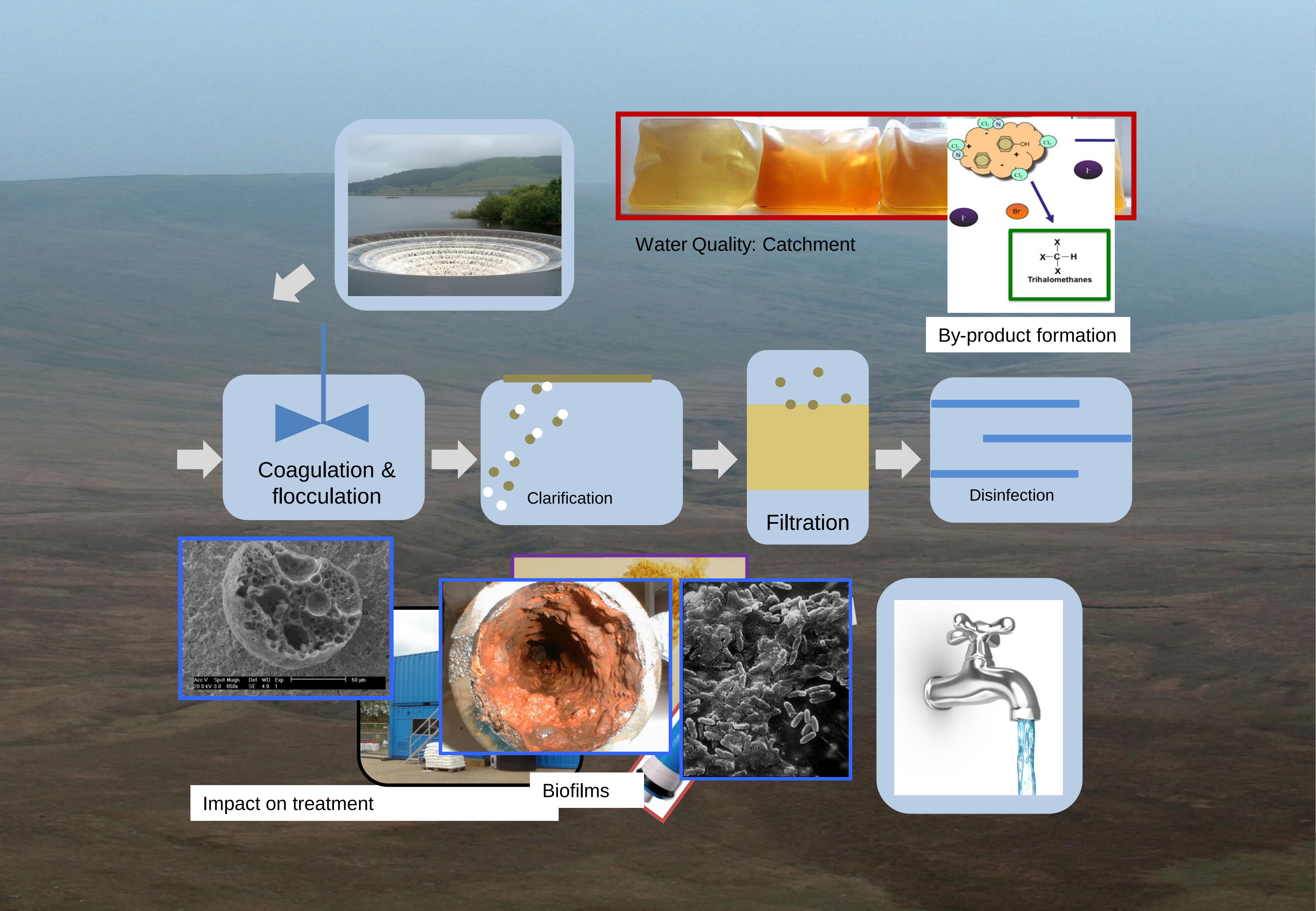


Polysaccharides



Fatty acids

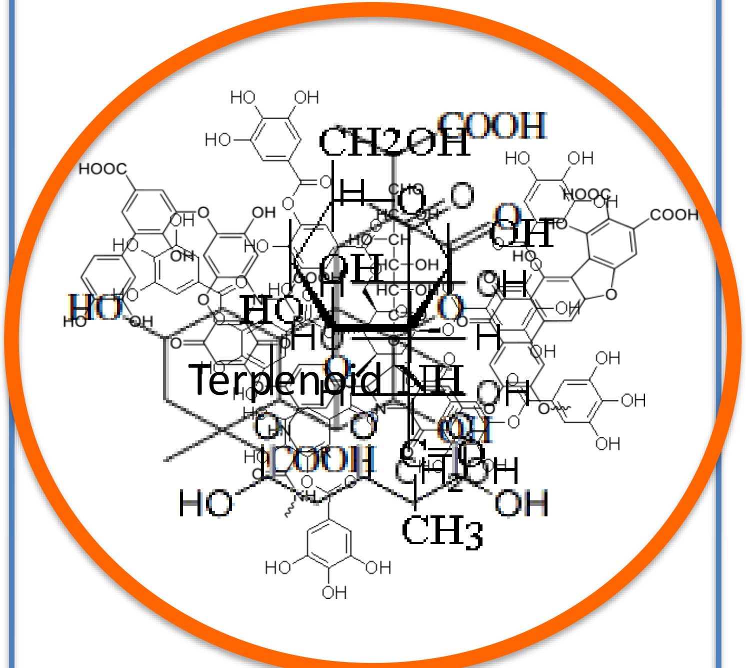
No one method will be suitable


Water Quality: Catchment
Trihalomethanes
By-product formation
Coagulation &
flocculation
Clarification
Filtration
Disinfection
Biofilms
Impact on treatment

NOM IN THE ENVIRONMENT

Hydrophobic HPO	Transphilic TPI	Hydrophilic HPI

Natural Organic Matter (NOM)



Tannic acid	Terpenoid	Amino Sugars
Humic Acid	3-Acetonedicarboxylic acid	D-xylose

OUR APPROACH: URBAN WATER CYCLE AND WATER TREATMENT TECHNOLOGIES

1. Re-Use
2. Toxicology

NOM CHARACTERIZATION PROTOCOLS

NOM REMOVAL AND DEGRADATION METHODS

NOM TREATABILITY

Character, DBPs, Process selection

OPTIMIZATION OF CONVENTIONAL METHODS

Enhanced coagulation

Filtration with various media

AVDVANCED TECHNIQUES

Ceramic membranes

AOP

IEX

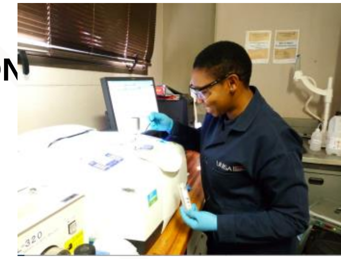
Sensors

Biological Methods

UPSCALING TECHNOLOG IES

&

RESOURCE RECOVERY



SAMPLING - NOM CHARACTER

1.EB
DOC:0.13; SUVA:5.6

2.OL
DOC:3.04;
SUVA:2.85

3.FB
DOC:11.3;
SUVA:1.87

11.RV
DOC:7.42;SUVA:3.14

10.MV
DOC:5.45;SUVA:2.29

9.UM
DOC:4.46;SUVA:1.14

8.HL
DOC:4.82;SUVA:10.6
5

7.AM
DOC:4.26; SUVA:2.92

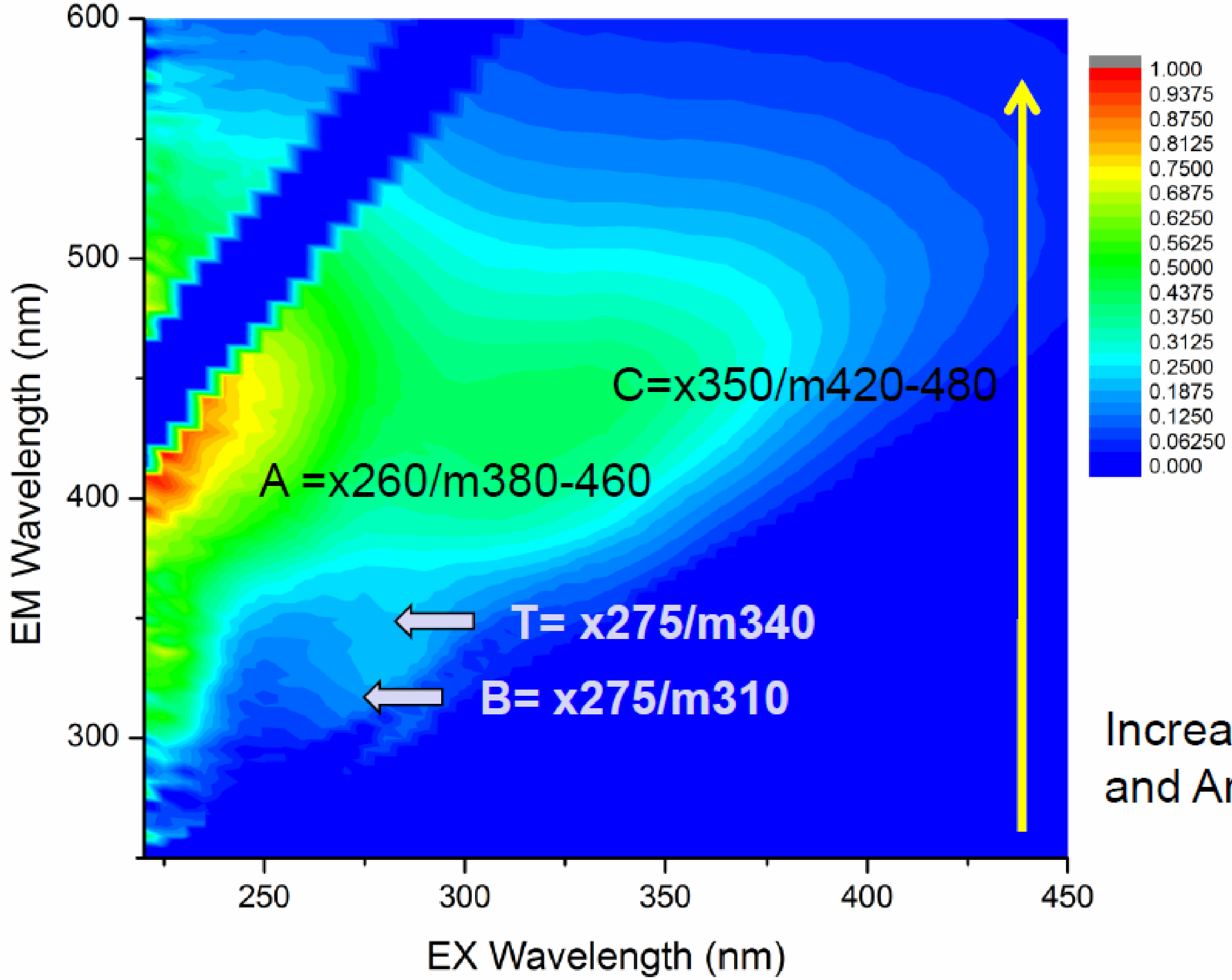
6.MT
DOC:3.75;SUVA:3.75

4.P
DOC:6.19;SUVA:8.91

5.PB
DOC:21.11;SUVA:48.7
5

Units
DOC = mg/L C; SUVA = L.mg^{-1}m^{-1}C

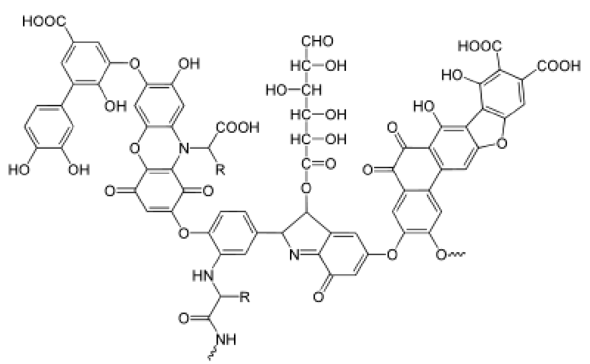
TYPICAL RAW SURFACE WATER FEEM



A=Humic
C=Humic/Fulvic
T=Tryptophan
B=Tyrosine

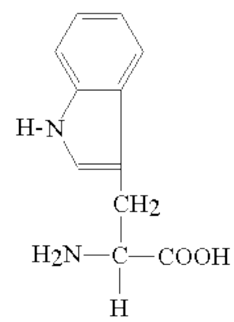
Increasing Molecular Weight and Aromaticity

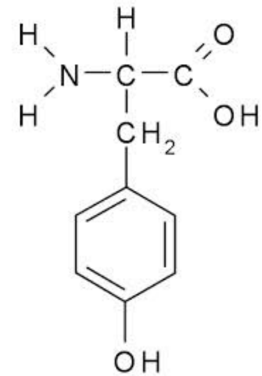
COLORED DISSOLVED ORGANIC MATTER (CDOM)



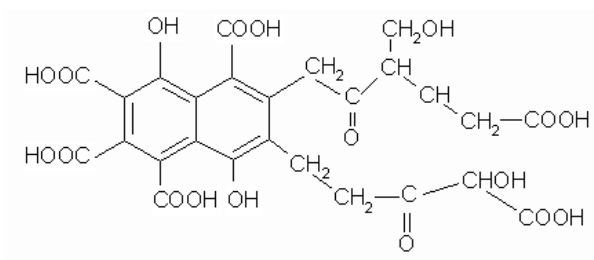
C2: Humic acids

- ✓ High MW
- ✓ Hydrophobic
- ✓ Highly Aromatic
- ✓ Adsorbed by Coagulants
- ✓ Main SUVA Component





C3: Tryptophan C: Tyrosine



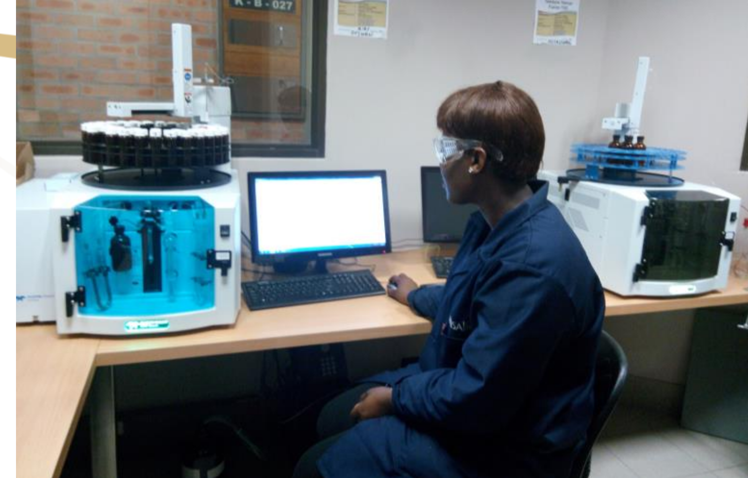
C1: Fulvic acids

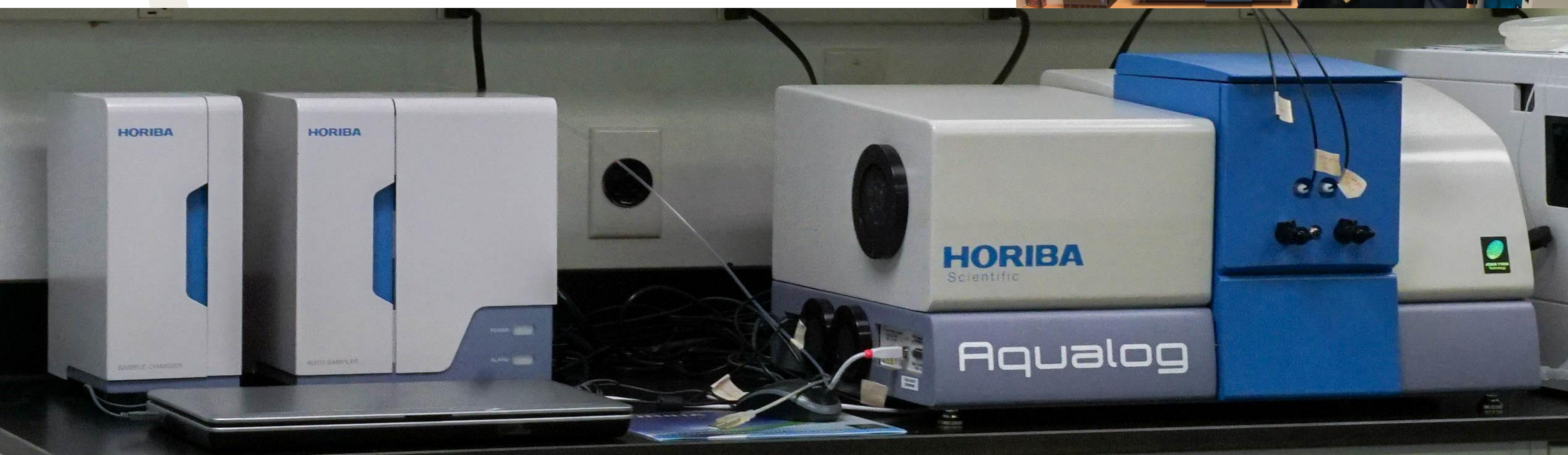
- ✓ Lower MW
- ✓ Hydrophilic
- ✓ Less Aromatic

- ✓ Associated with Wastewater Effluent
- ✓ Biopolymers

FEED STREAM ANALYSIS

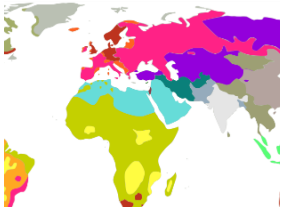
- ❑ Identify: -Type/class/Character
- ❑ Fractionate into various Fractions
- ❑ Determine the treatability Influence of each





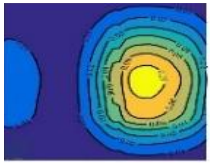
THREE-DIMENSIONAL CORRELATION BETWEEN NOM AND ITS HETEROGENEOUS ADSORPTION BEHAVIOR ON ACTIVATED CARBON USING EEM-PARAFAC

Ms Sikelelwa Ndiweni

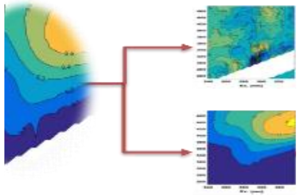


Sampling in South African and Belgian WTPs influent

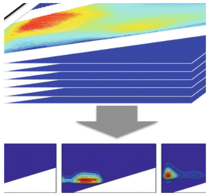
NOM characterization



FEEM dataset



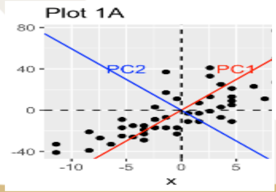
PARAFAC model



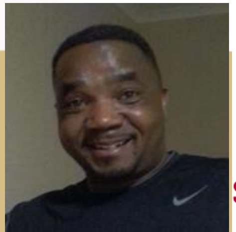
NOM separation, online monitoring and prediction

UNIVERSITEIT GENT

Indicators



PCA



SOL PLAATJE UNIVERSITY

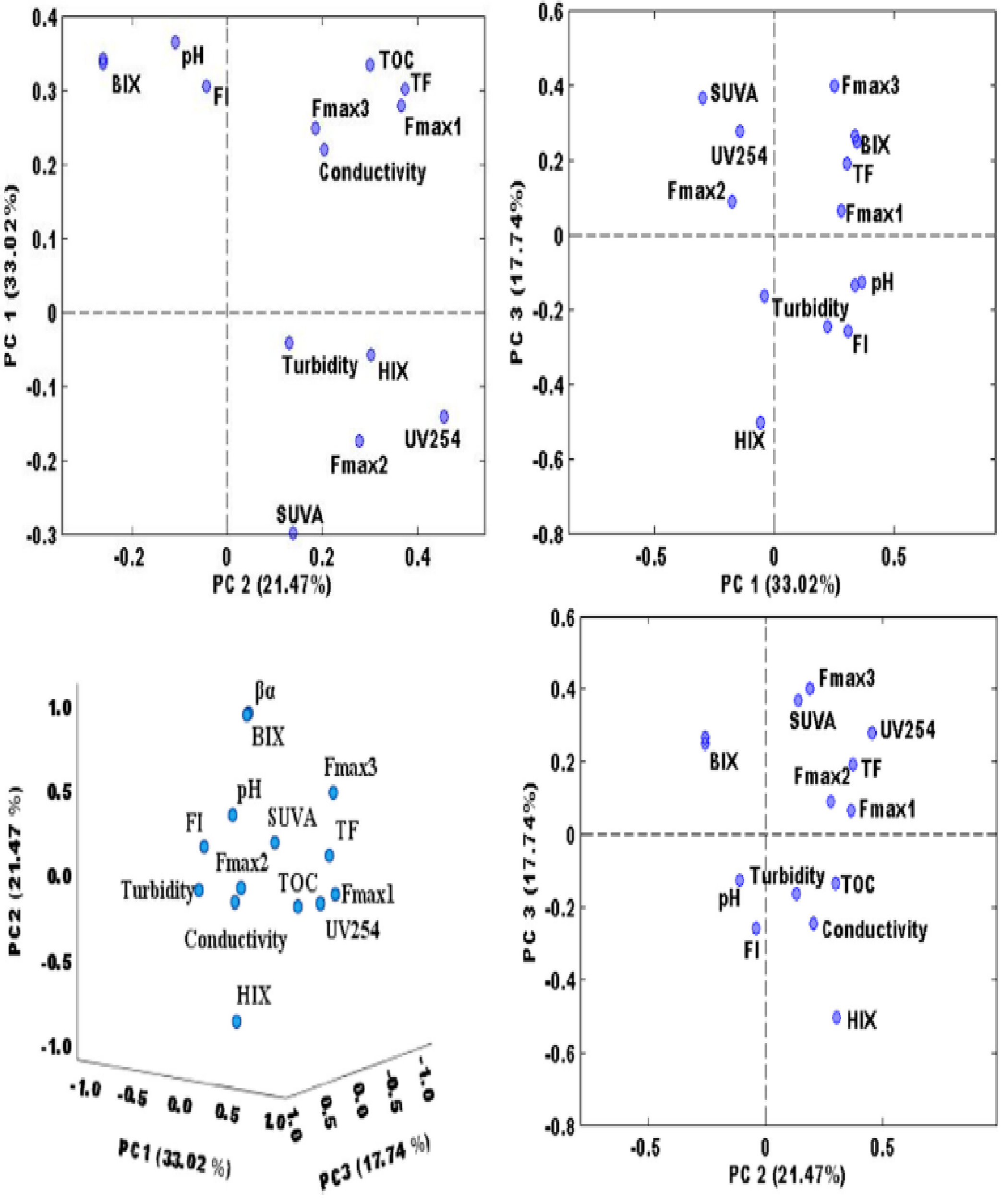


Figure 4. Principal component analysis for WTPs in South Africa and Belgium.

ENVIRONMENTAL TECHNOLOGY
https://doi.org/10.1080/09593330.2019.1575920

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Assessing the impact of environmental activities on natural organic matter in South Africa and Belgium

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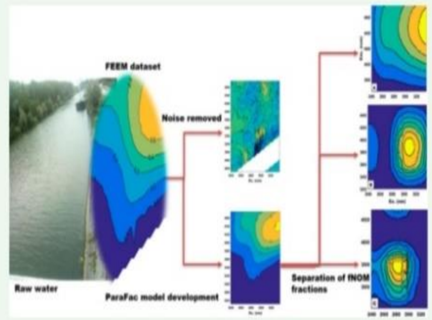
[a]Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa, Johannesburg, South Africa; [b]LIWET, Department of Green Chemistry and Technology, Ghent University, Kortrijk, Belgium

ABSTRACT

The presence and persistence of natural organic matter (NOM) in drinking water treatment plants (WTPs) requires a robust and rapid monitoring method. Measurement and monitoring of NOM fractions using current technology is time-consuming and expensive. This study uses fluorescence measurements in combination with Parallel Factor (ParaFac) analysis to characterize NOM fractions. This was achieved through: (1) determining the origin and composition of NOM fractions using fluorescence index (*FI*), humification index, biological index, and freshness index, and (2) using multivariate analysis to reveal key parameters and hidden NOM fraction characteristics influenced by seasonal changes and environmental activities. The ParaFac model revealed that the NOM fractions for Belgium plants are mainly hydrophobic acids, aromatic proteins, biological activity, humic acid-like, and fulvic acid-like moieties. The NOM fractions in South African plants were mainly aromatic protein, humic acid-like, fulvic acid-like, tryptophan-like, and protein-like moieties. For Belgium plants in spring *FI* >1.7, indicating high microbial sources, whereas *FI* < 1.3 for South African plants, signifying terrestrial sources of NOM. On the one hand, the first principal component (PC1) interpreted 33.02% of the total variance, and is a measure of fluorescent NOM relative concentration. On the other hand, the PC2 interpreted 21.47% and contains most of the information on fluorescence, freshness, and biological indicators, while PC3 interpreted 17.74% and contains information on the origin and variation in environmental conditions. These results will assist in developing a method for online monitoring of NOM fractions in water sources based on environment activities and spectral measurements.

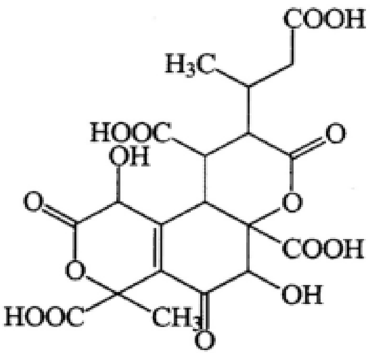


ARTICLE HISTORY
Received 18 December 2018
Accepted 23 January 2019

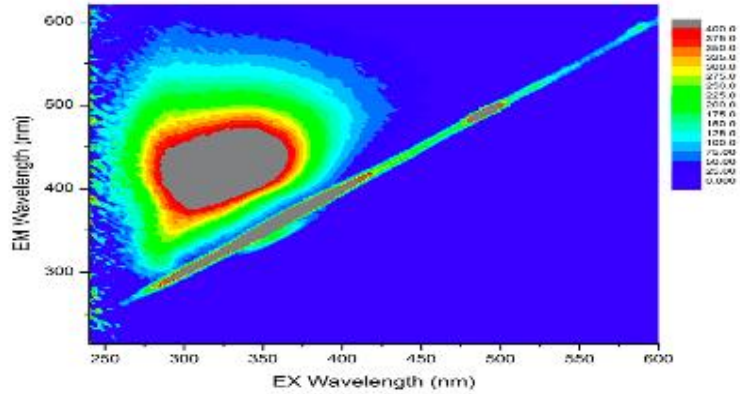
KEYWORDS
Fluorescence excitation-emission matrix; fluorescence index; natural organic matter; parallel factor (ParaFac) analysis; principal component analysis

WHAT ARE THE RESEARCH QUESTIONS AND RESEARCH GAPS?

WHAT IS THE PROPERTY OF INFLUENCE?

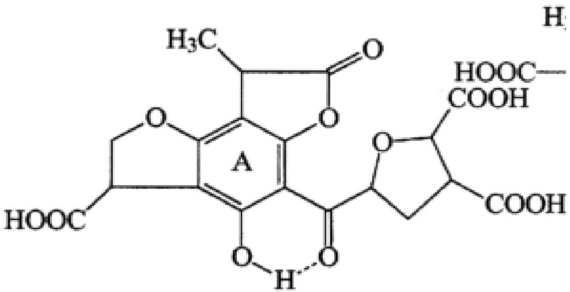


Subfraction 2/1, MW = 500

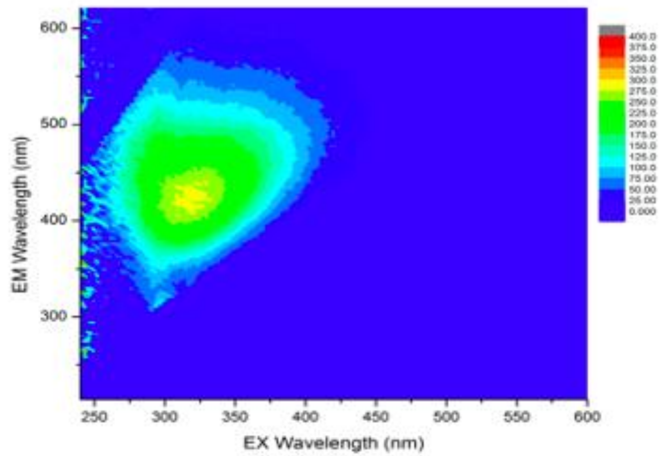


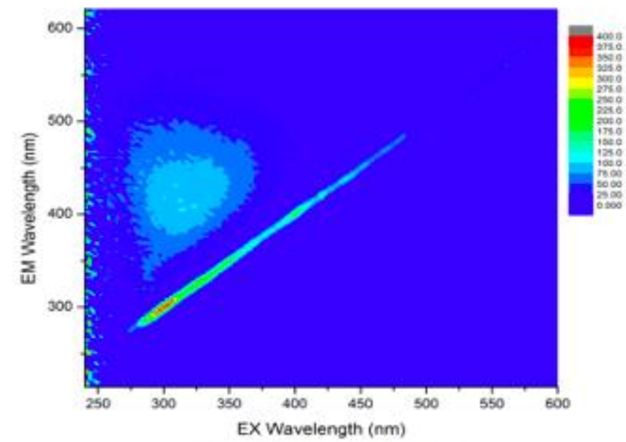
P1, P2 and P3

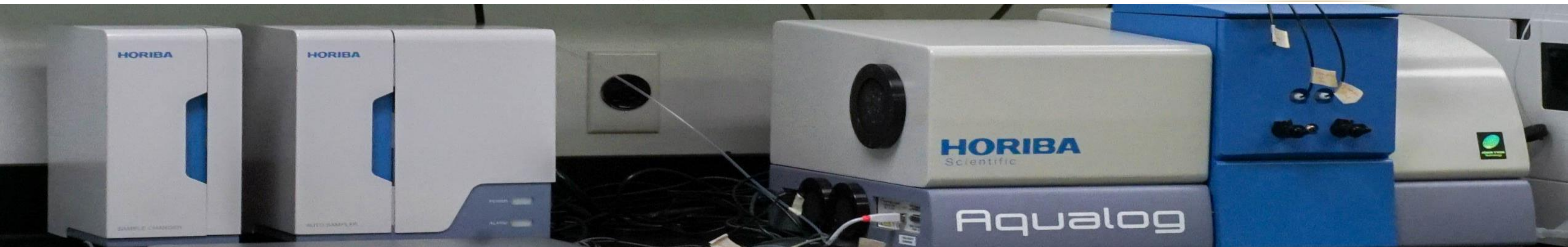
✓Hydrophobic acids, humic acid like and related to humic acid.



Subfraction 3/2, MW = 436







WHAT SHOULD AN IDEAL MEASUREMENT OF DOC TELL ME?

TREATABILITY

Is it removed by (different) treatment processes?

- Bulk DOC removal
- Specific fractions of DOC removed/untreated

PROCESS IMPACTS

Will it influence the performance of other processes?

- Delicate Floc
- Membrane fouling
- Competition for Binding sites

DOWNSTREAM REACTIVITY

What is the downstream influence of DOC in treated water?

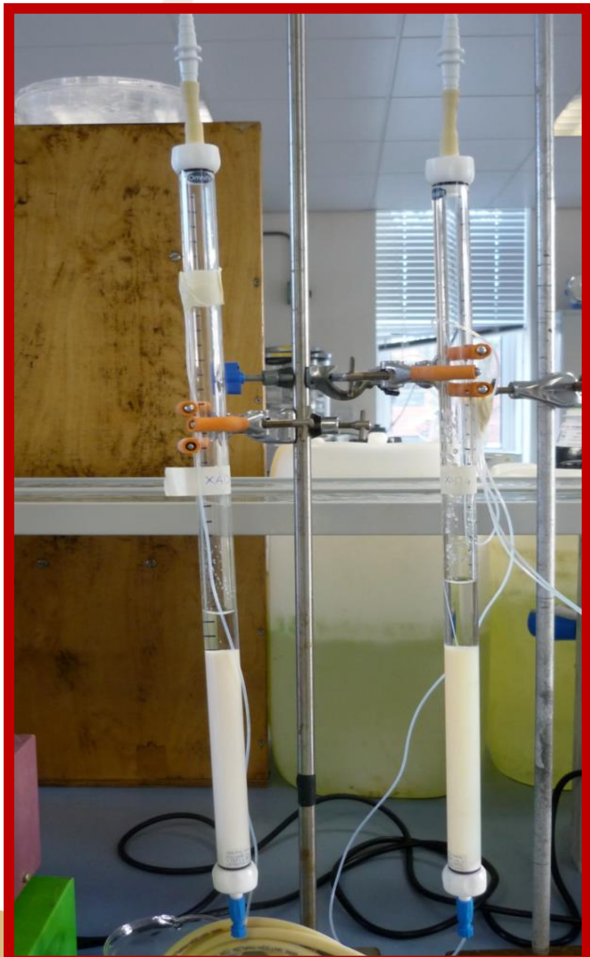
- DBPs
- Biostability of water
- Taste & odour

PREDICTION BASED ON MODELS

Can it be measured online?

- Control systems
- Diagnostic tools

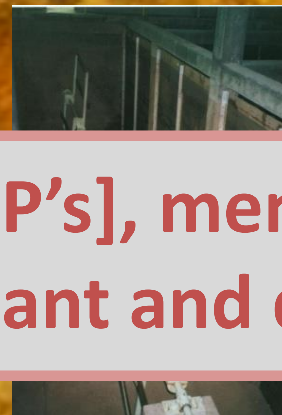
TO DEVELOP A RAPID TOOL TO IDENTIFY NOM TREATMENT LIMITS ACHIEVABLE BY ANY METHOD



- Rapid
- Robust
- Portable
- Inexpensive

UNDERSTANDING NOM TREATABILITY

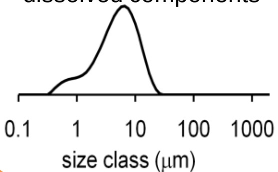
High [NOM]

High [DBP's], membrane fouling, higher coagulant and disinfectant dosages

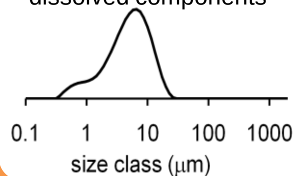
Raw water

- Wide range of solid & dissolved components



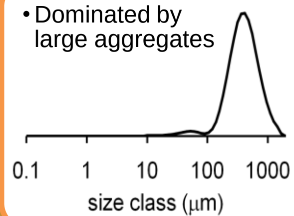
Destabilisation

- Wide range of solid & dissolved components



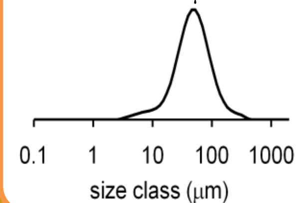
Flocculation

- Dominated by large aggregates



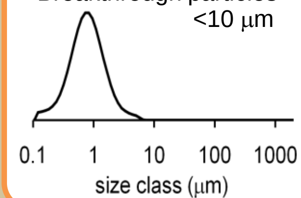
Solid/liquid separation

- Particles <100 µm



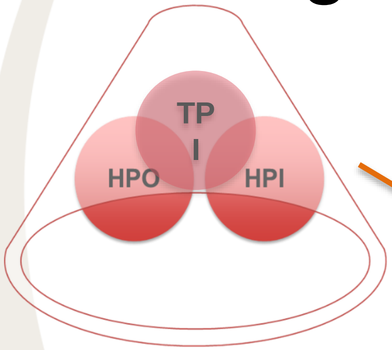
Filtration

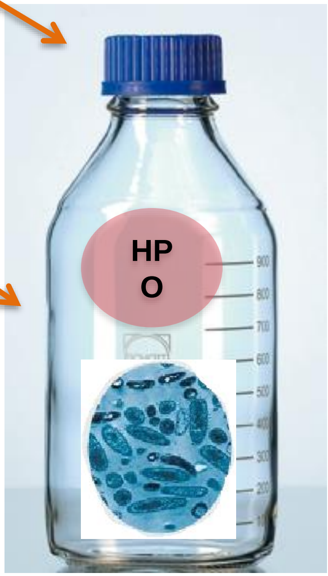
- Breakthrough particles <10 µm



BIODEGRADABILITY OF NOM

Investigate biodegradability of NOM





Simultaneously measure:

- Organic carbon available to bacteria in each fraction (BDOC method)
- Bacterial growth

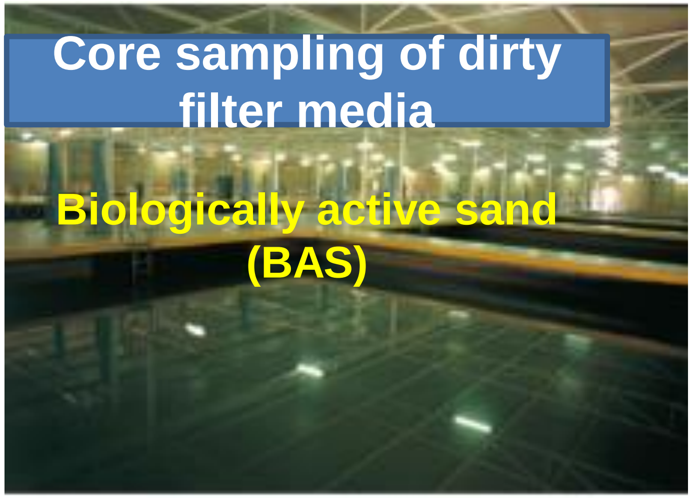
Identify:

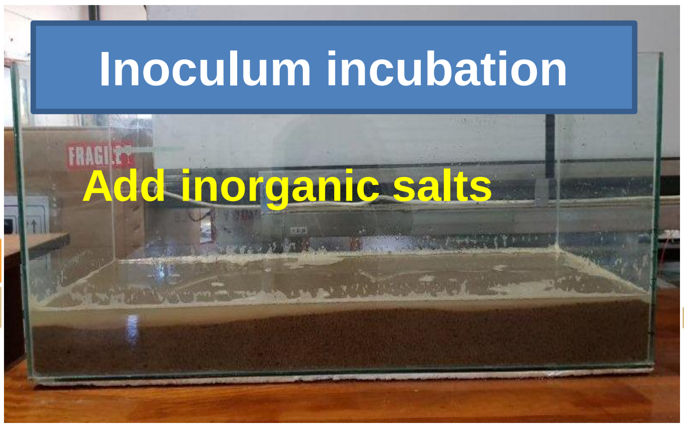
- Problematic NOM fraction (abundant bacterial growth)

Develop:

- Characterization technique

RAND WATER





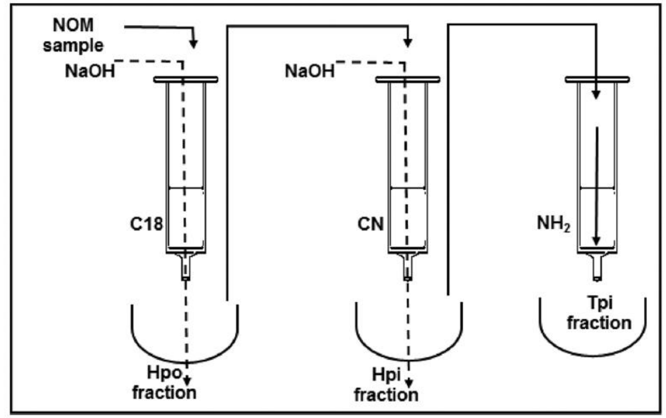


Fig. 2. A set-up of the SPE cartridges during m-PRAM method [7].

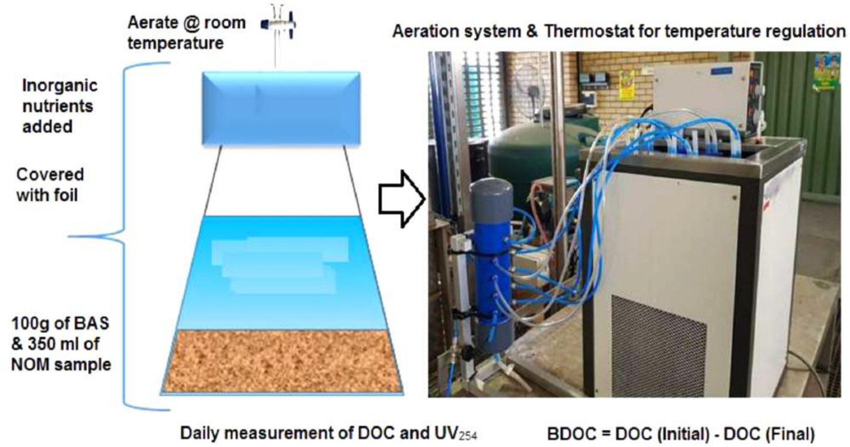


Fig. 3. The biodegradable dissolved organic carbon (BDOC) set-up.

Journal of Water Process Engineering 36 (2020) 101332

Contents lists available at ScienceDirect

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Quantification of biodegradable natural organic matter (NOM) fractions and its impact on bacterial regrowth in a South African Water Treatment Plant

Sifiso P. Sambo[1,2], Savia S. Marais[1], Titus A.M. Msagati[2], Bhekie B. Mamba[2], Thabo T.I. Nkambule[2,*]

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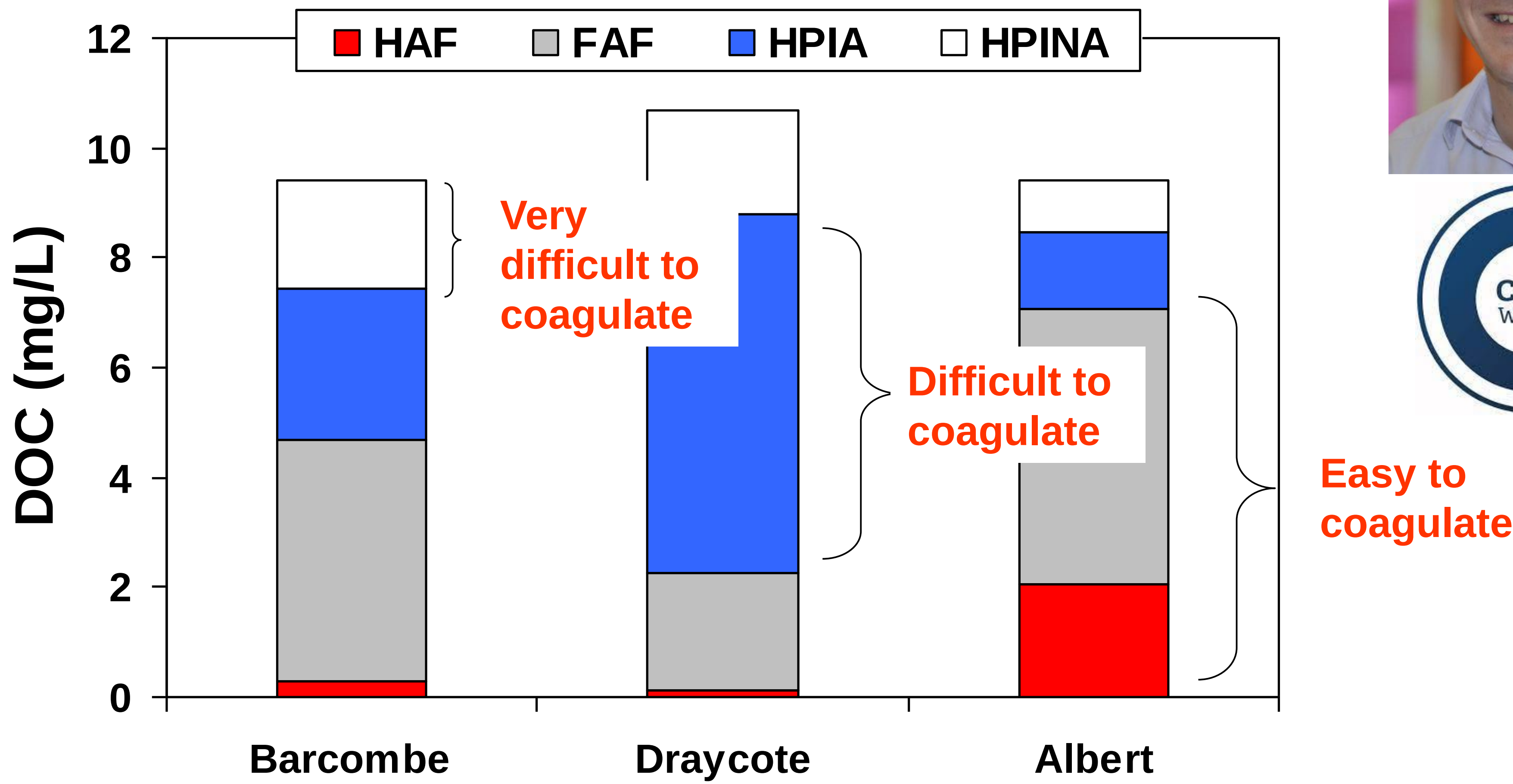
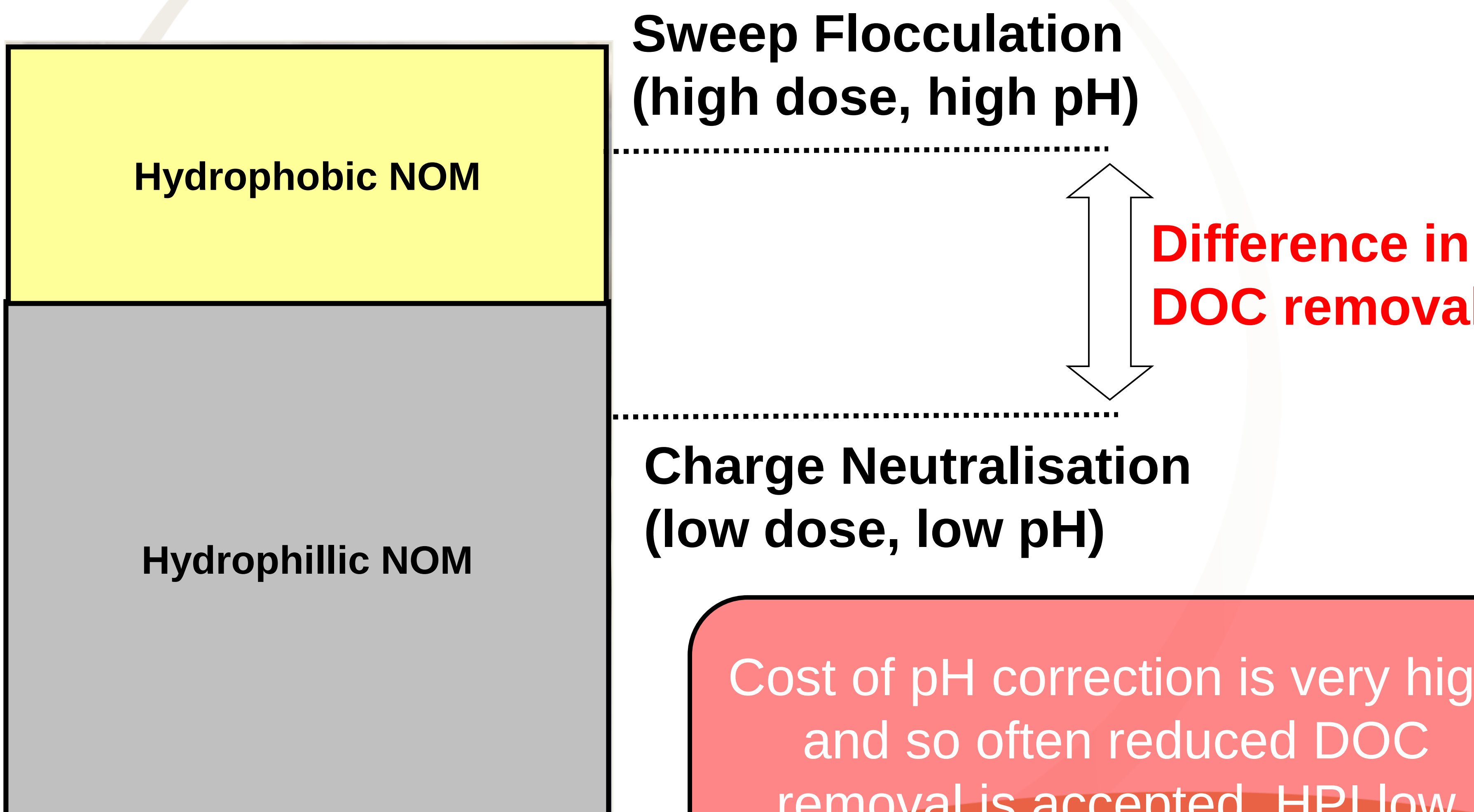
[2] Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa, Florida Campus, 1709, Johannesburg, South Africa

SO WHAT ARE THE PROPERTIES OF NOM

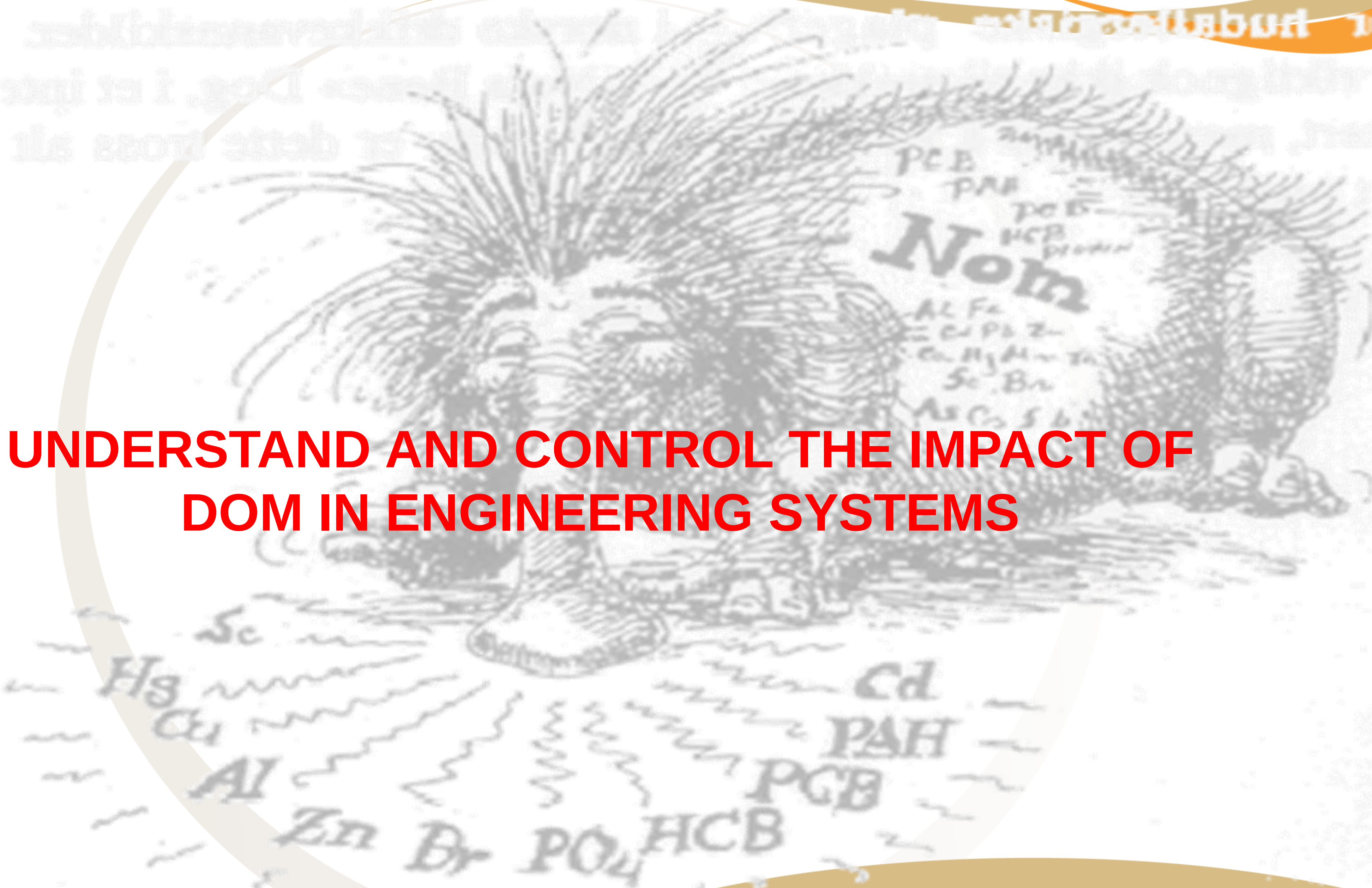


LOW COLOUR, MODERATELY HARD WATER

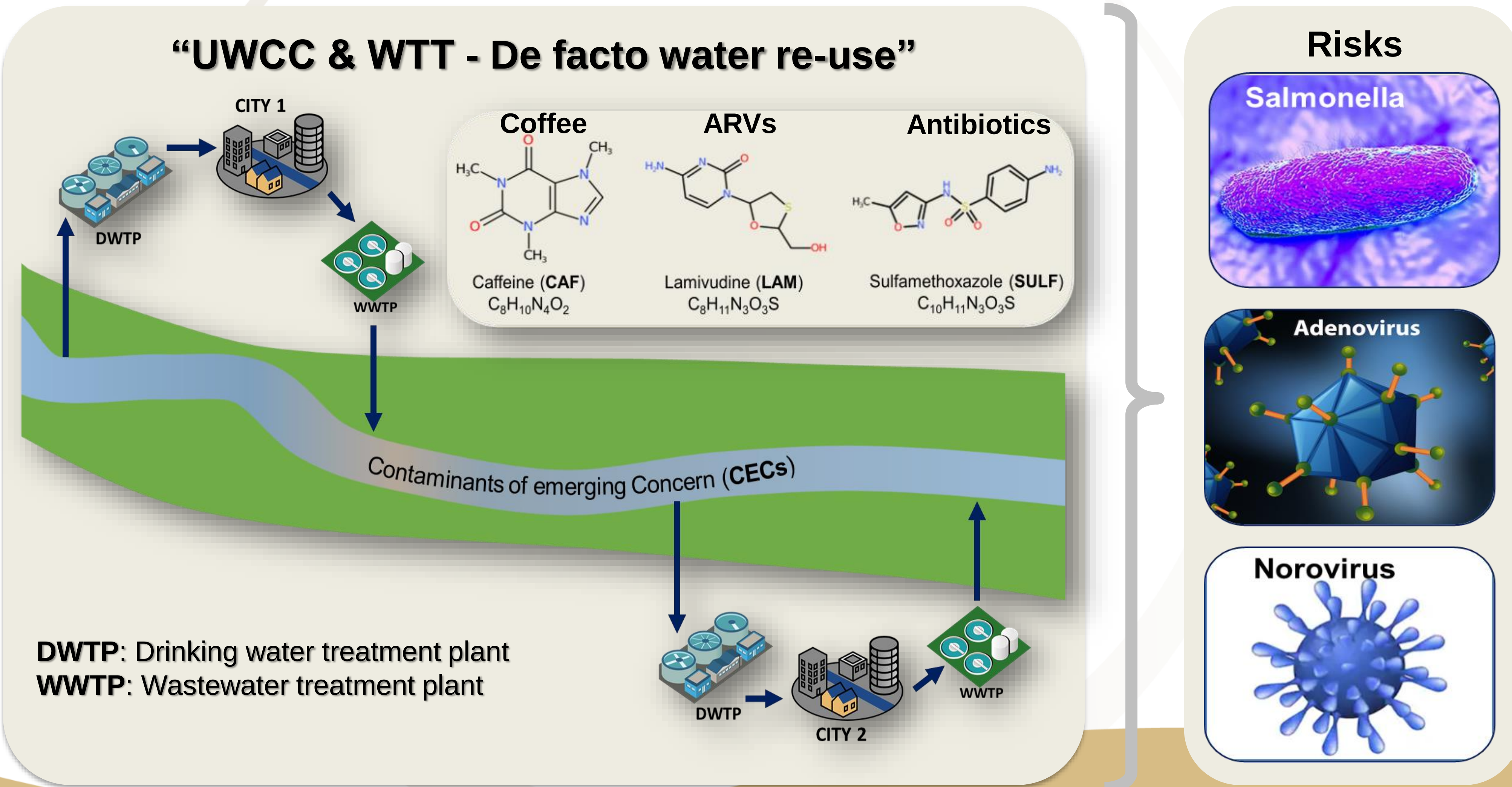


Cost of pH correction is very high and so often reduced DOC removal is accepted. HPI low THM formation so probably OK

UNDERSTAND AND CONTROL THE IMPACT OF DOM IN ENGINEERING SYSTEMS



URBAN WATER CYCLE AND WATER TREATMENT TECHNOLOGIES



COMPETITION FOR BINDING SITES ON ADSORBANTS (PORE BLOCKAGE)

PERGAMON

Carbon 40 (2002) 2147–2156

CARBON

Simultaneous adsorption of MIB and NOM onto activated carbon II. Competitive effects

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[b]Department of Civil Engineering, North Carolina State University, Campus Box 7908, Raleigh, NC 27695-7908, USA

Received 24 June 2001; accepted 10 February 2002

Abstract

The adsorption of an odour compound common in drinking water, 2-methylisoborneol (MIB), was studied on six activated carbons in the presence of six well-characterised natural organic matter (NOM) solutions. It was found that, although the carbons and the NOM solutions had a wide range of characteristics, the major competitive mechanism was the same in all cases. The low-molecular-weight NOM compounds were the most competitive, participating in direct competition with MIB for adsorption sites. Equivalent background compound calculations indicated a relatively low concentration of directly competing compounds in the NOM. Some evidence of pore blockage and/or restriction was also seen, with microporous carbons being the most affected by low-molecular-weight NOM and mesoporous carbons impacted by the higher-molecular-weight compounds.

Keywords: A. Activated carbon; D. adsorption properties, Surface properties

Humic acid as a model for natural organic matter (NOM) in the removal of odorants from water by cyclodextrin polyurethanes

BB Mamba*, RW Krause, TJ Malefetse, SP Sithole and TI Nkambule

Department of Chemical Technology, University of Johannesburg, PO Box 17011, Johannesburg, South Africa

Abstract

Current practices in some water-treatment facilities have reported that natural organic matter (NOM) blocks the adsorption sites of activated carbon resulting in lower geosmin and 2-methylisoborneol (2-MIB) removal. Humic acid has been reported to compete with geosmin and 2-MIB removal in the same way. The removal of odour chemicals such as geosmin and 2-MIB is important for potable-water treatment by water supply companies and municipalities. We have previously demonstrated that cyclodextrin polyurethanes are capable of removing a number of organic pollutants from water, but are not able to reduce the levels of NOM significantly. We wished to determine if the polymers would selectively remove geosmin and 2-MIB, despite the presence of NOM. Humic acid was chosen as a model for NOM since NOM constitutes about 70% of humic acid. Results obtained from this study indicate that the presence of humic acids at different concentrations could not affect the removal of geosmin and 2-MIB when cyclodextrin polymers were used since 90% removal was achieved. However the UV-Vis analysis showed a low removal of humic acids (3 to 20%).

Keywords: cyclodextrin polymers, geosmin, 2-methylisoborneol (2-MIB), humic acids

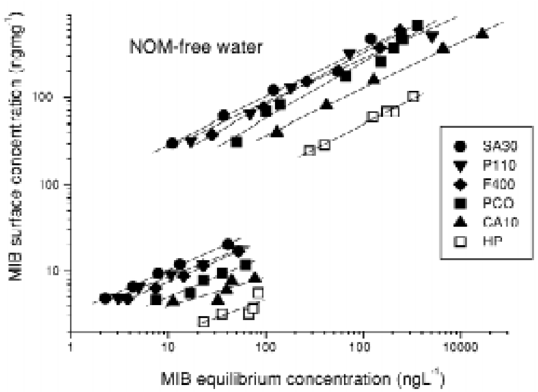


Fig. 1. Adsorption isotherms of MIB onto six activated carbons in the presence and absence of competing NOM.

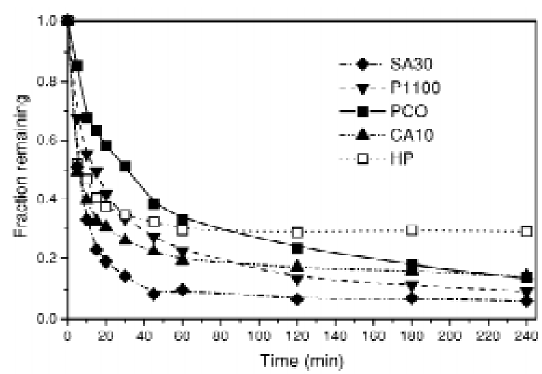
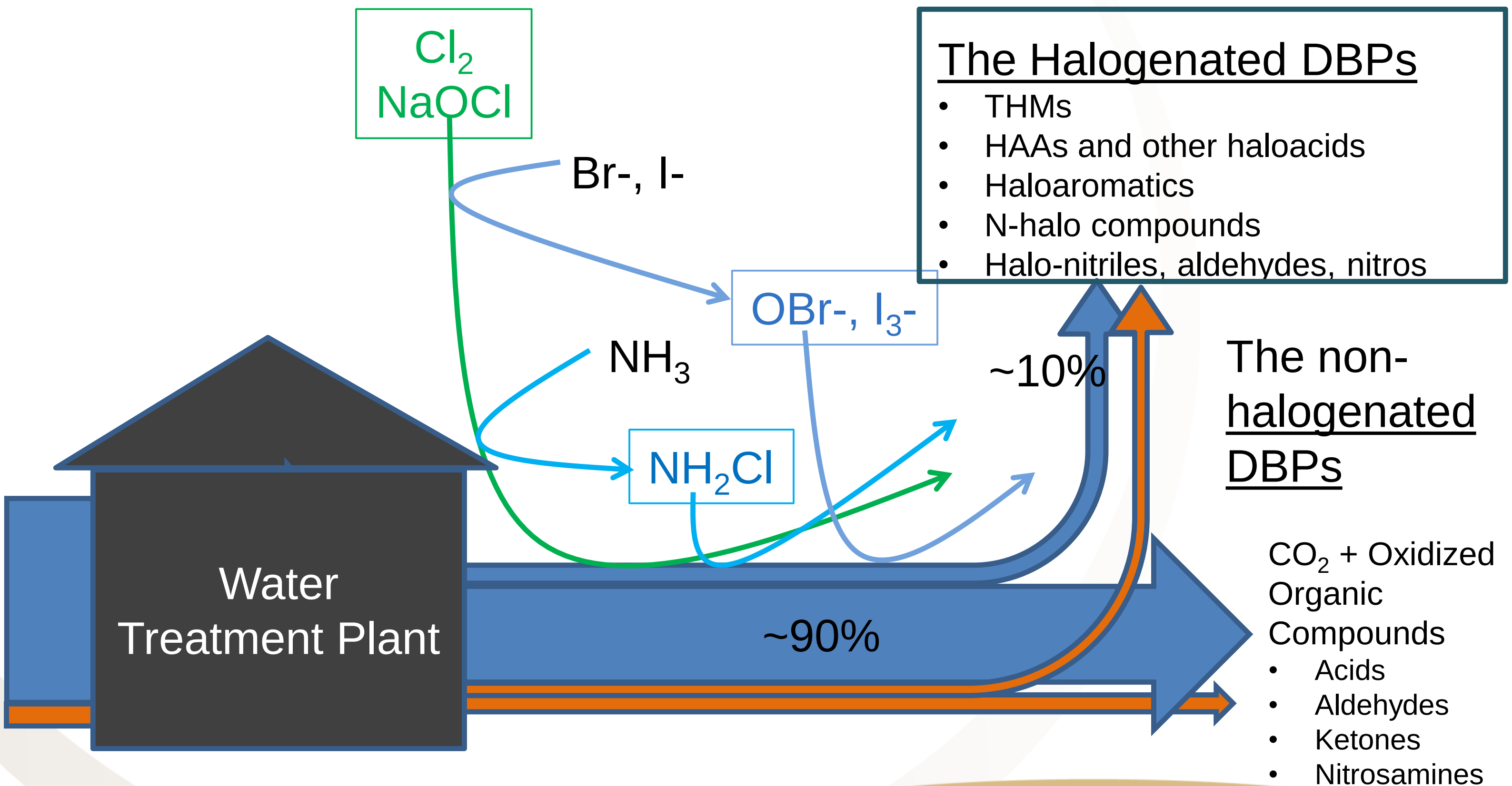


Fig. 3. Adsorption of MIB as a function of contact time in F1 NOM.

NOM AND DBP CONTROL

University of Massachusetts Amherst

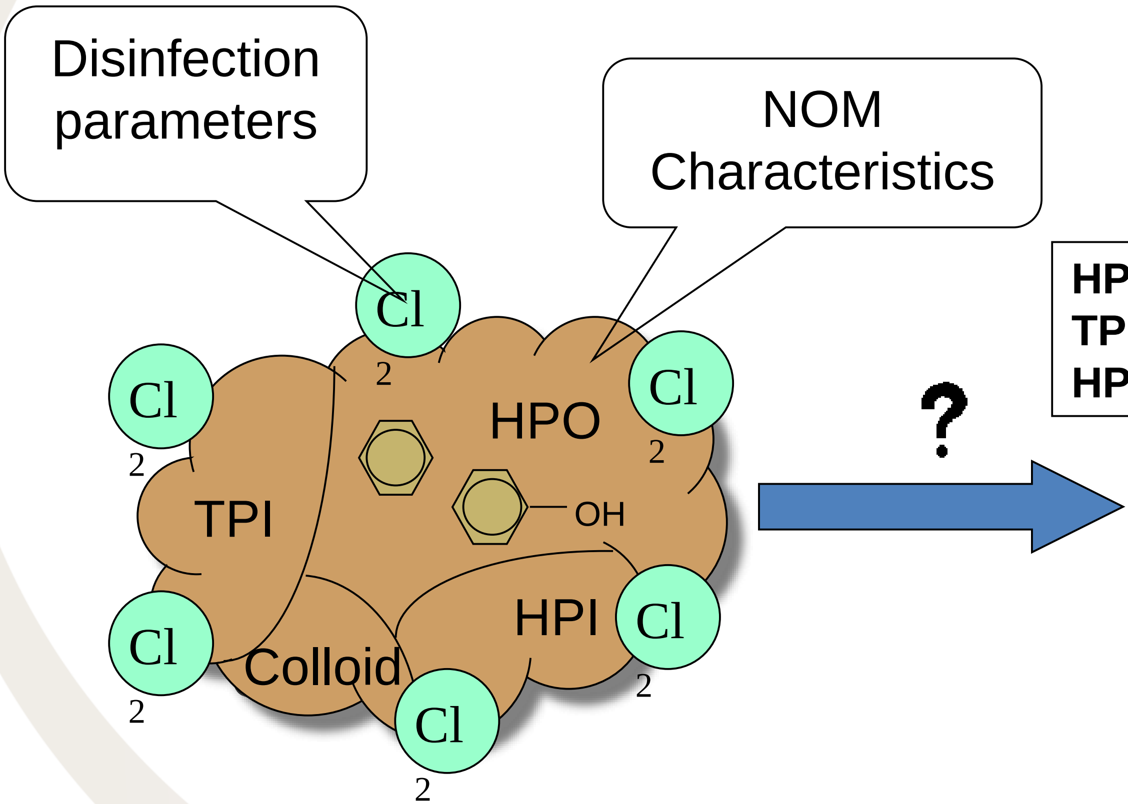


Natural Organic Mater

Anthropogenic Chemicals

(PPCPs, Ag & industrial products)

FORMATION OF DBPS



HPI – hydrophilic
TPI – transphillic
HPO - hydrophobic

DBPs

Trihalomethanes THMs

Haloacetic acids HAAs

……………

NOM FRACTION IN TREATED WATER & DBP RELATIONSHIP

HPI – present in greater proportions after disinfection

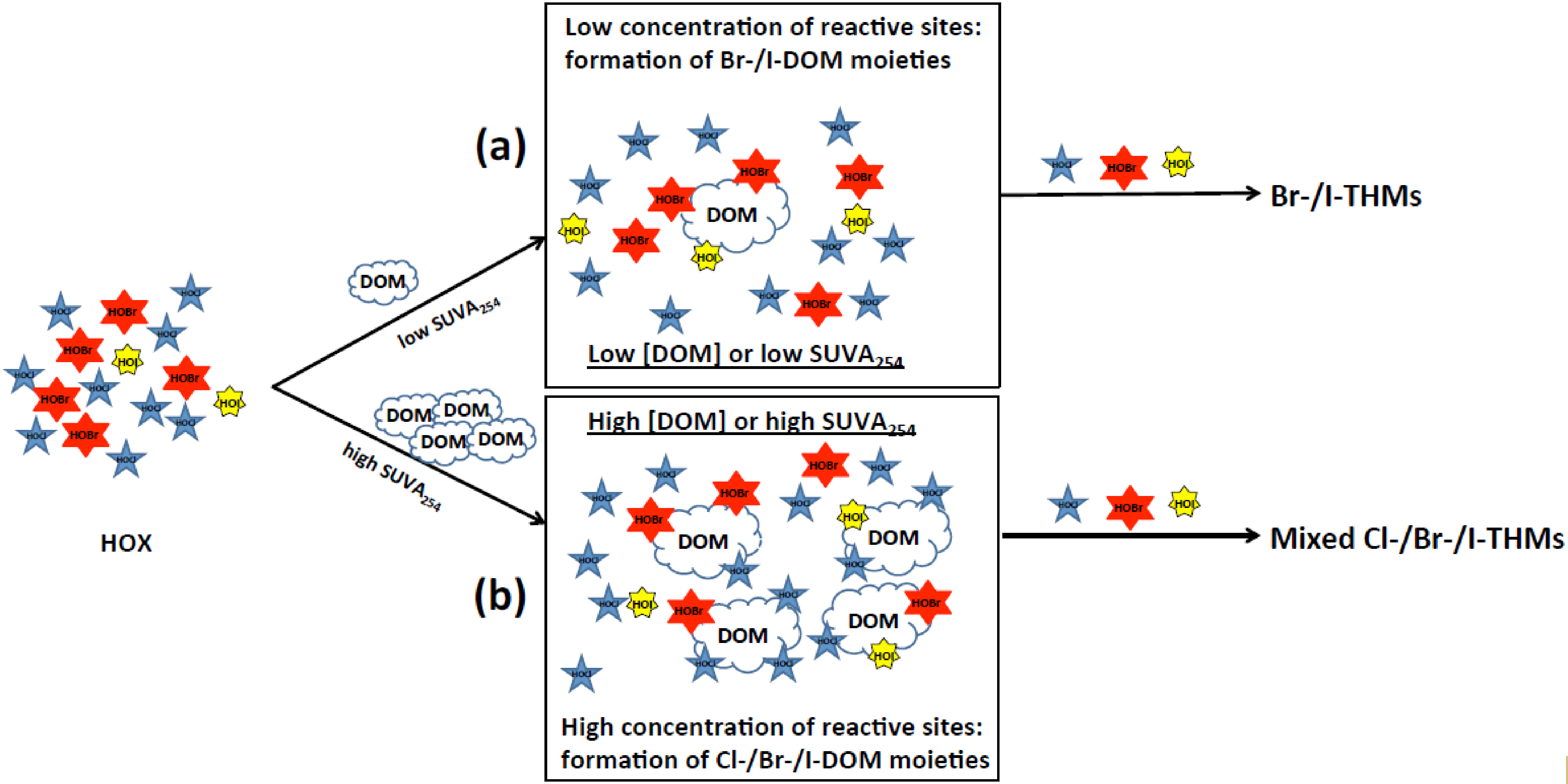
TPI – variable & different from stage to stage

HPO – very reactive & variable (thus easy to remove)

Use fractionation to identify "problematic" NOM fraction thus informing choice of treatment methods

Apply alternative combination regimes or specific treatment technologies

IMPORTANCE OF DOM REACTIVITY ON THE INCORPORATION OF Br AND I IN DBPs PRODUCED DURING CHLORINATION AND CHLORAMINATION



Journal of Water Process Engineering 44 (2021) 102402

Contents lists available at ScienceDirect

Journal of Water Process Engineering

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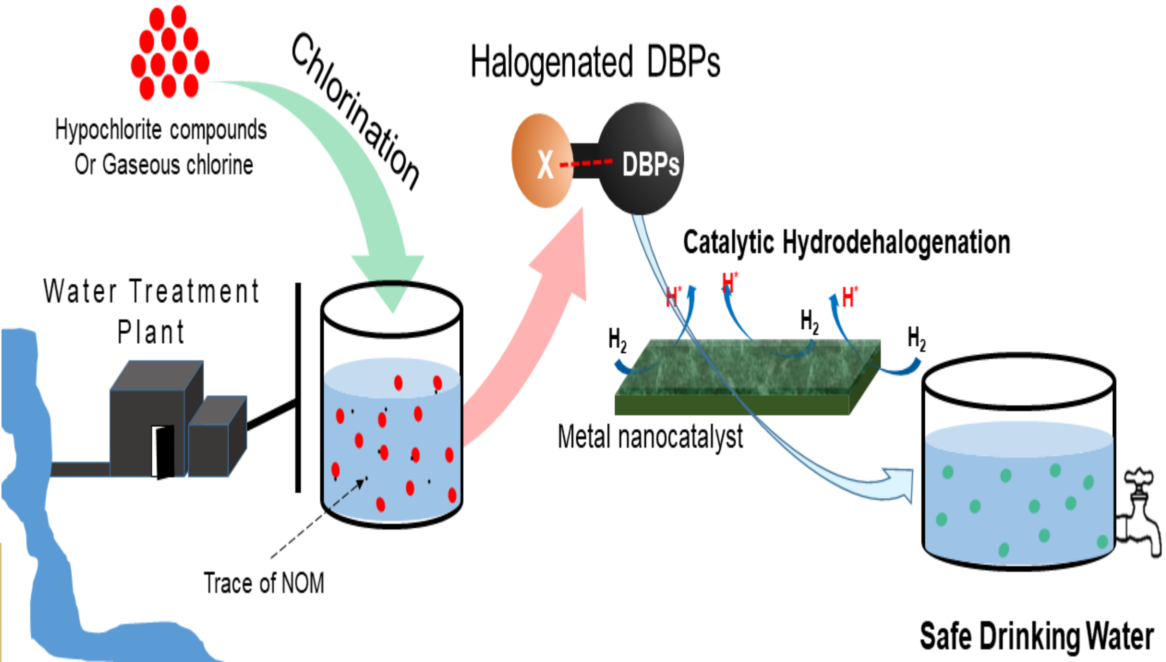
Nanocatalysts and Disinfection By-Products Degradation “Nano-DBPs”

Catalytic hydrodehalogenation of halogenated disinfection byproducts for clean drinking water production: A review

Ali K. Ilunga*, Bhekie B. Mamba, Thabo T.I. Nkambule

Institute for Nanotechnology and Water Sustainability (iNanoWS), University of South Africa, UNISA Science Campus, Florida (Johannesburg), P.O. Box 392, Pretoria 0003, South Africa

Dr Ali Iunga



Chemical Engineering Journal 398 (2020) 125623

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Ferricyanide reduction to elucidate kinetic and electrochemical activities on the metal nanocatalysts surface

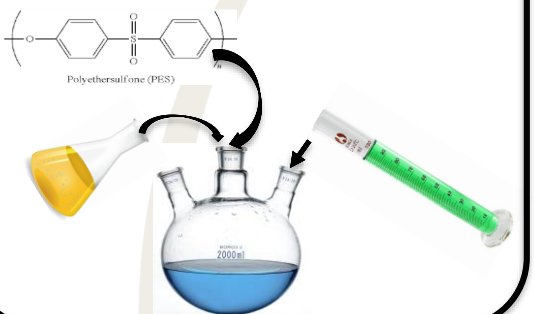
Ali K. Ilunga*, Bhekie B. Mamba, Thabo T.I. Nkambule

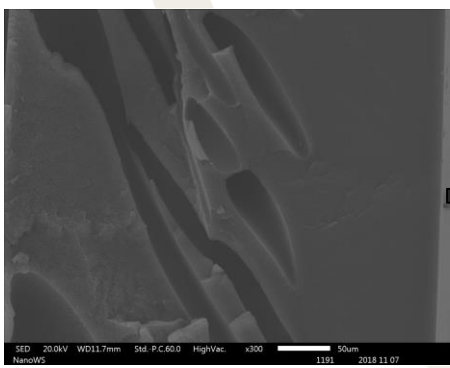
Nanotechnology and Water Sustainability (NanoWS) Research Unit, University of South Africa, UNISA Science Campus, Florida (Johannesburg), P.O. Box 392, Pretoria 0003, South Africa

HIGH-PERFORMANCE MEMBRANES FOR NOM REMOVAL

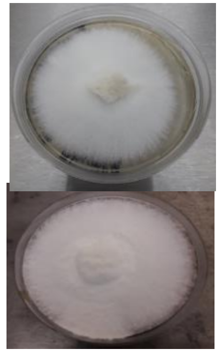
Membrane preparation

Laboratory-scale polymer processing

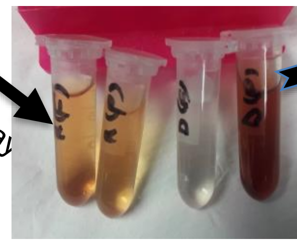


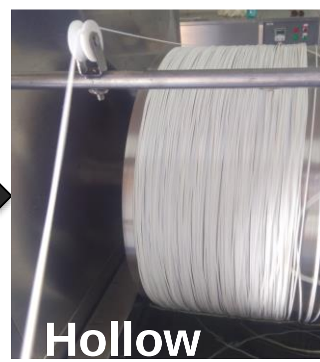


Culture growth and enzyme extraction

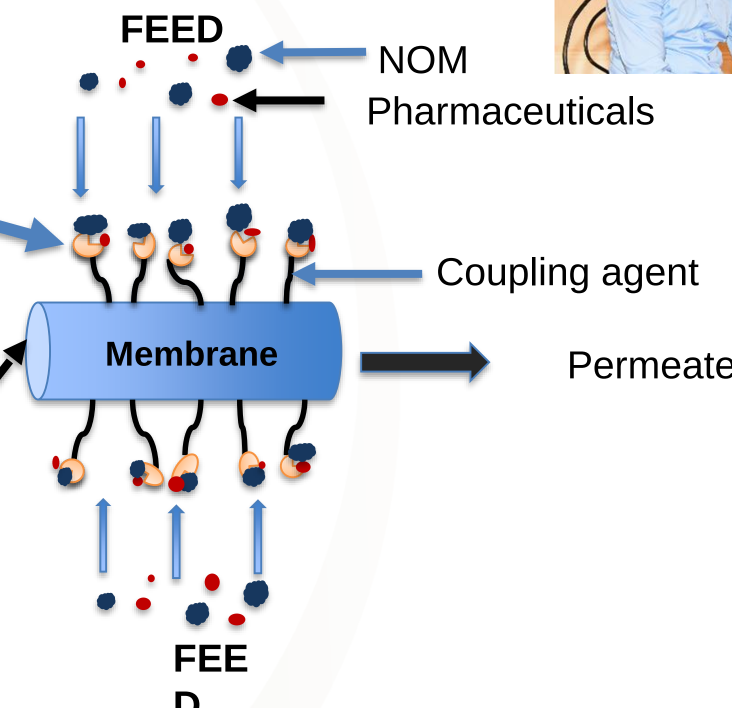


Enzyme assay





Membrane evaluation



❖ Catalytic degradation and removal of NOM and Pharmaceuticals

LACCASE-COATED POLYETHERSULFONE MEMBRANES FOR ORGANIC MATTER REMOVAL

White rot fungi

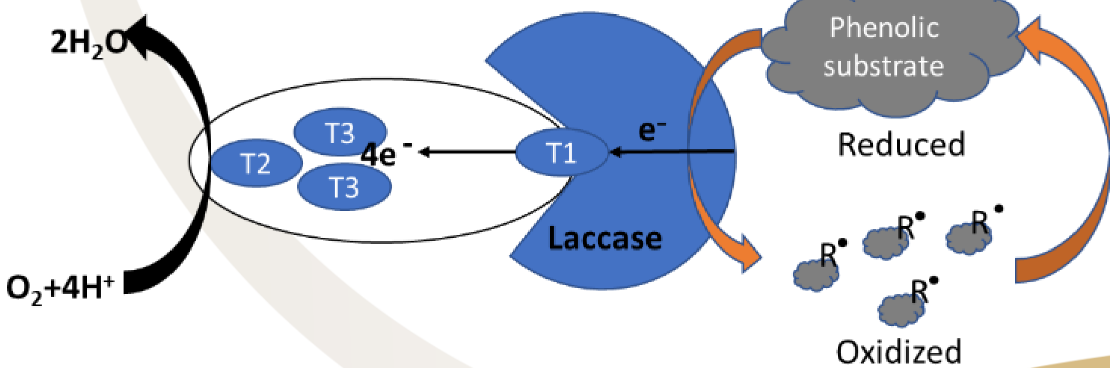
Lignolytic enzymes:

- **Laccase**
- **Manganese dependent peroxidase**
- **Lignin peroxidase**

Application:

- Bio-pretreatment of biomass
- Water and wastewater treatment
- Biodegradation of dyes
- Bio-pulping and bio-bleaching

Laccase mechanism



LACCASE-COATED POLYETHERSULFONE MEMBRANES FOR ORGANIC MATTER REMOVAL


Journal of Membrane Science & Research
Home | Browse | Journal Info | Guide for Authors | Submit Manuscript | Reviewers | Contact Us

Laccase-coated polyethersulfone membranes for organic matter degradation and removal

Document Type : Research Paper

Authors
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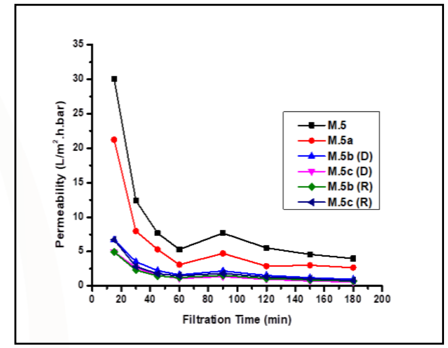
10.22079/JMSR.2021.139576.1418

Fungal isolation and enzyme extraction

Fungal collection

Plating and culturing



Isolates screening

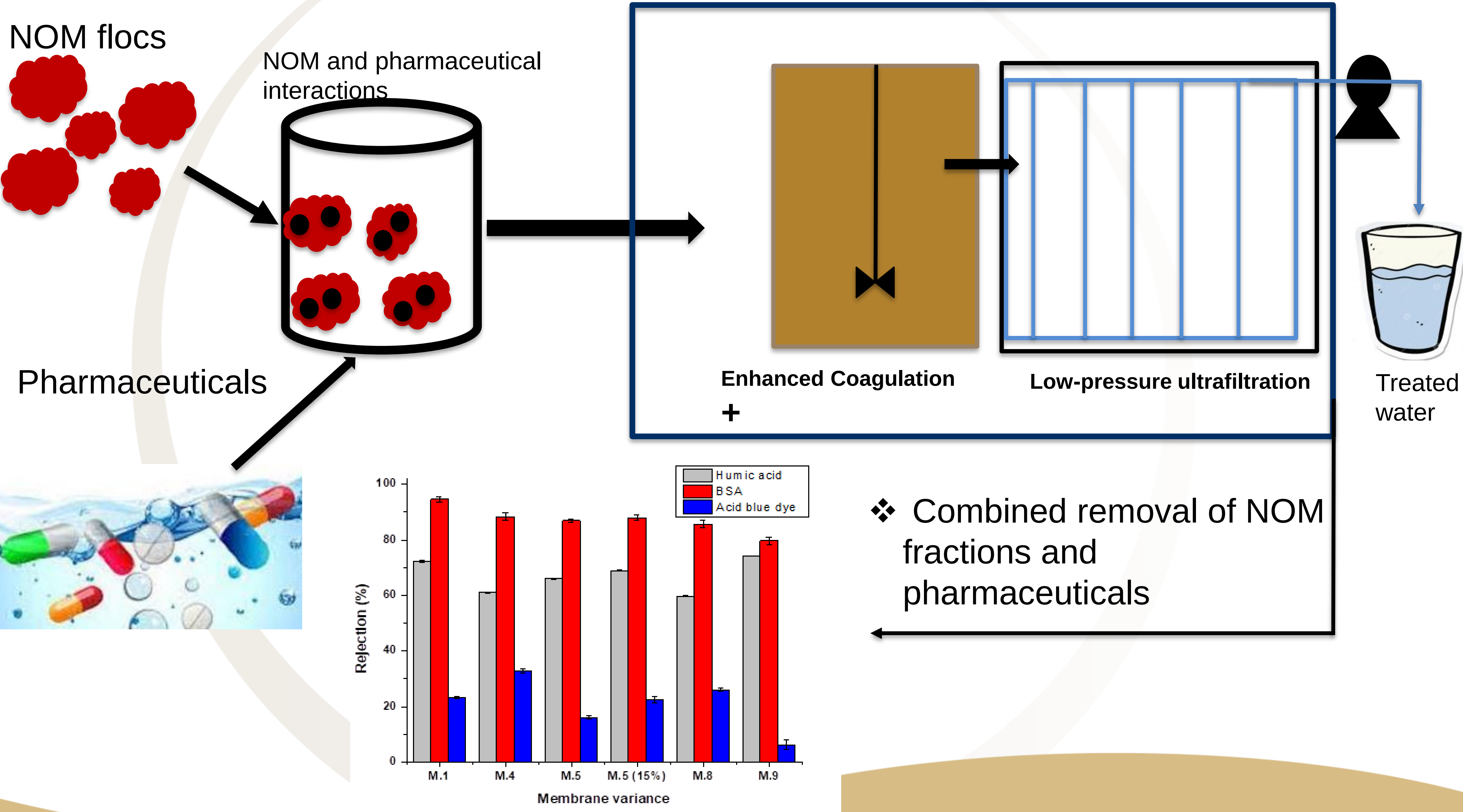
Pure fungal culturing

Fermentation

Enzyme extraction

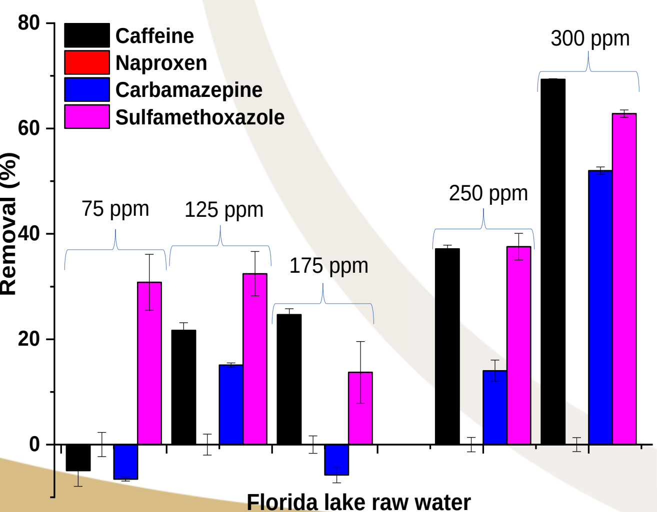
Enzyme purification

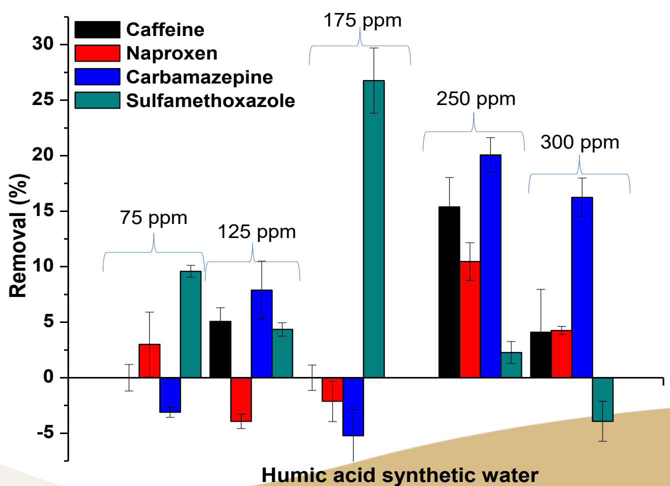
Hybrid system development

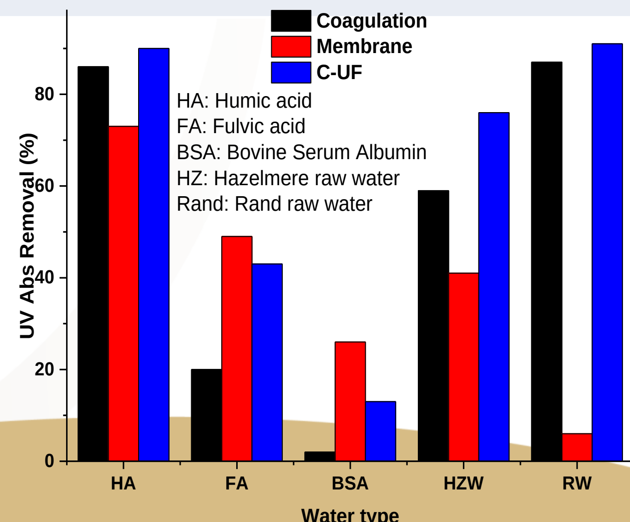


THE MONITORING AND REMOVAL OF EMP’S AND NOM THROUGH HIGH FLUX UF MEMBRANES

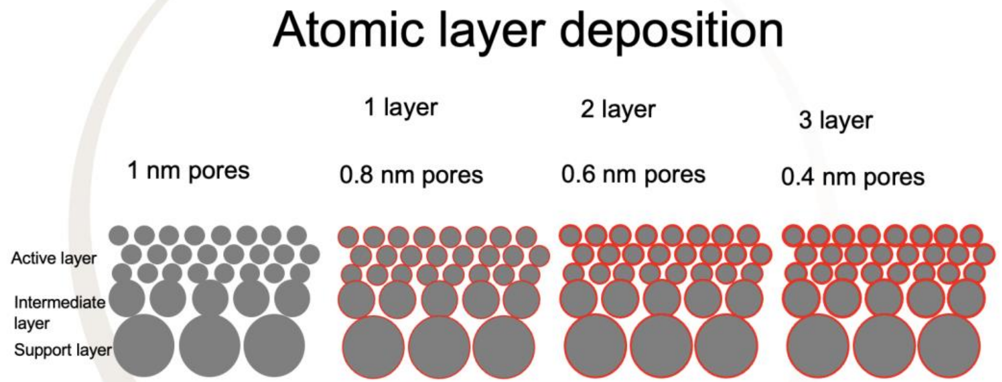
Part of projects	Method	Findings
Removal of EMPs through alum coagulation-flocculation	• 10 min rapid mix at 200 rpm • 10 min slow mix at 20 rpm • 10 min settling	• Humic acid fraction of NOM interacts better with EMPs • Water with high DOC and ionic strength is more suitable for EMP removal
Membrane preparation and coagulation-ultrafiltration hybrid system	• Polymer dissolving at 60°C • Casting at 150µm thickness • Immersing in non-solvent solution • Flux at 3 bar and rejection of DOM • Membrane filtration post coagulation-flocculation.	• Rapid phase inversion produces highly permeable membranes • Hybrid system enhances removal of NOM

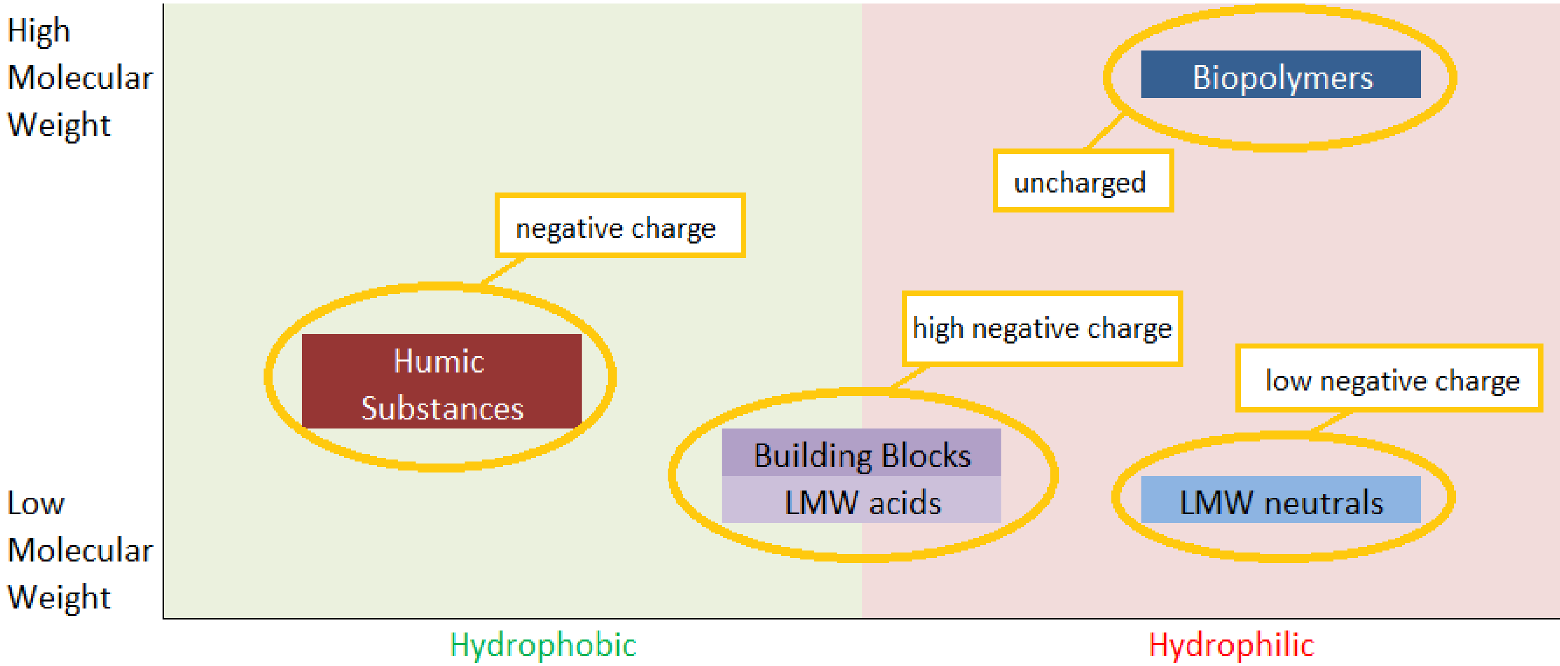




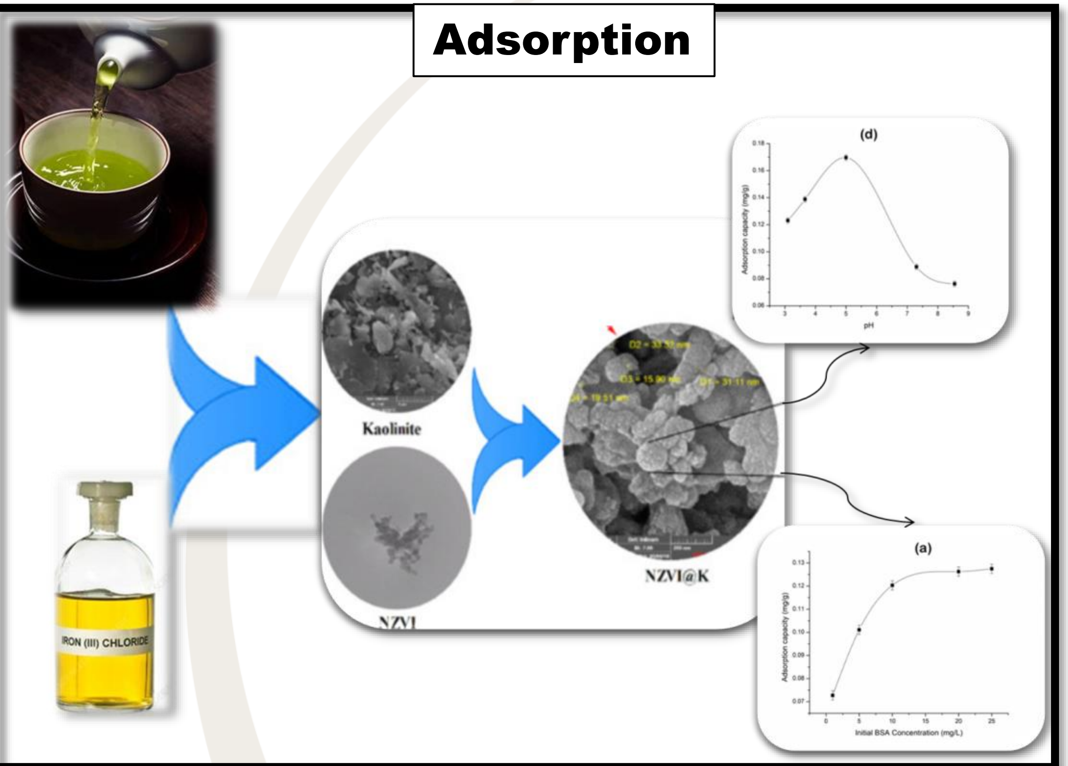


UNLOCKING THE POTENTIAL APPLICATION OF SOUTH AFRICAN CLAYS TO THE WATER TREATMENT INDUSTRY

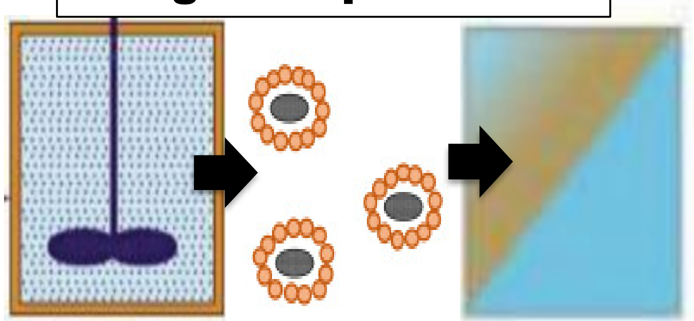




Adsorption



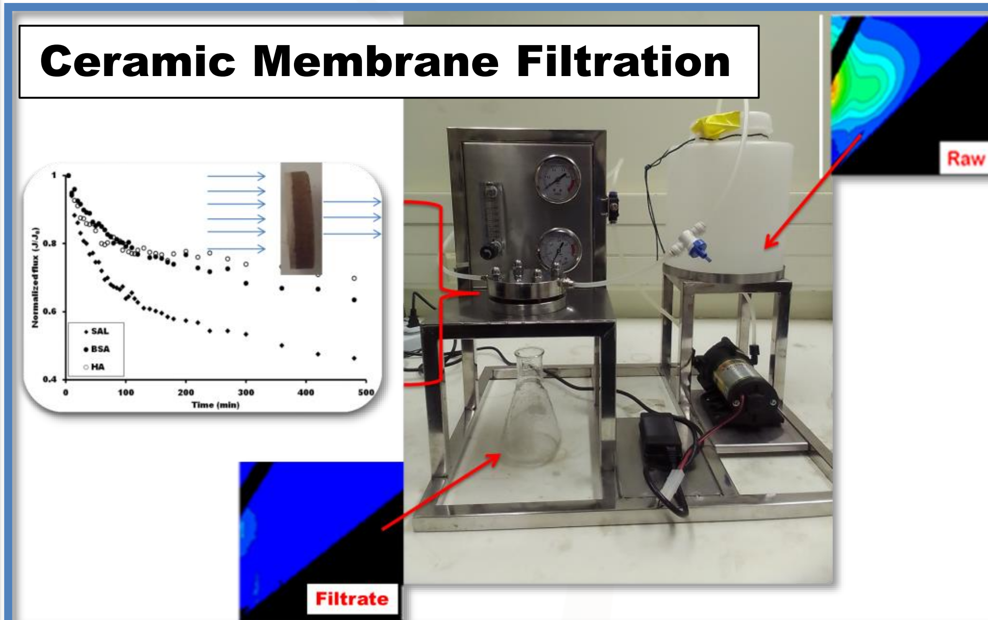
Integrated processes



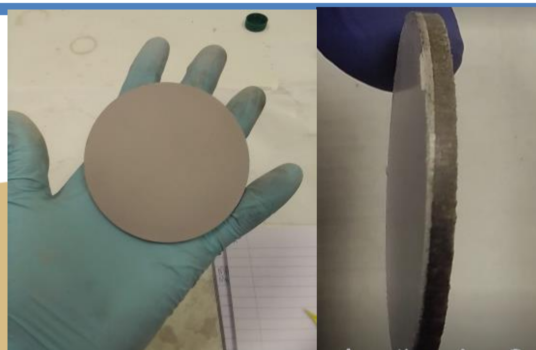
Coagulation – Adsorption - Membrane

FOR COMMUNICATION

Ceramic Membrane Filtration

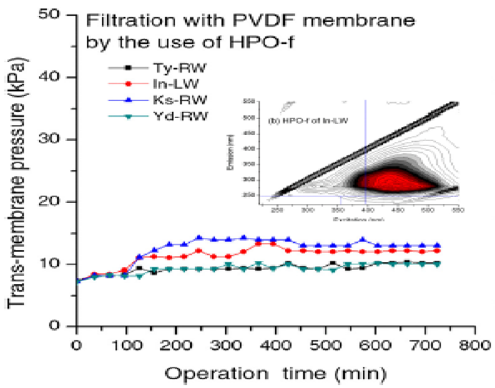


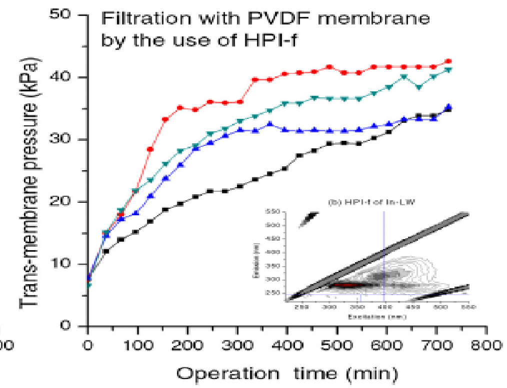
1. Removal of natural organic matter fractions by low cost adsorptive asymmetric ceramic membrane functionalized with *in situ* phytogenic nanoscale zero valent iron **(In Preparation)**
2. Characterization and performance low cost ceramic membrane functionalized with *in situ* phytogenic nanoscale zero valent iron for efficient Fenton degradation and filtration of natural organic matter fractions **(In Preparation)**



WHICH NOM FRACTION(S) IS RESPONSIBLE FOR MF & UF MEMBRANE FOULING?

River Water





Extend of irreversible fouling from HPI depends on Membrane material and NOM characteristics

Filloux et al., WR 2012
Treated Secondary Effluent

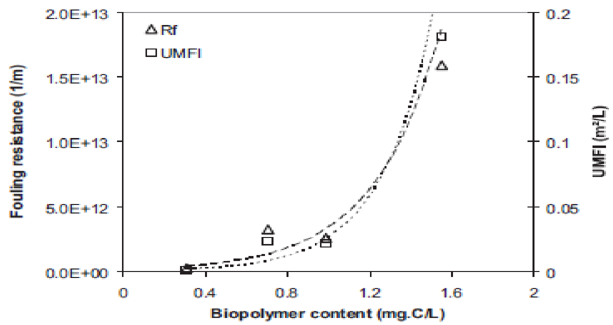
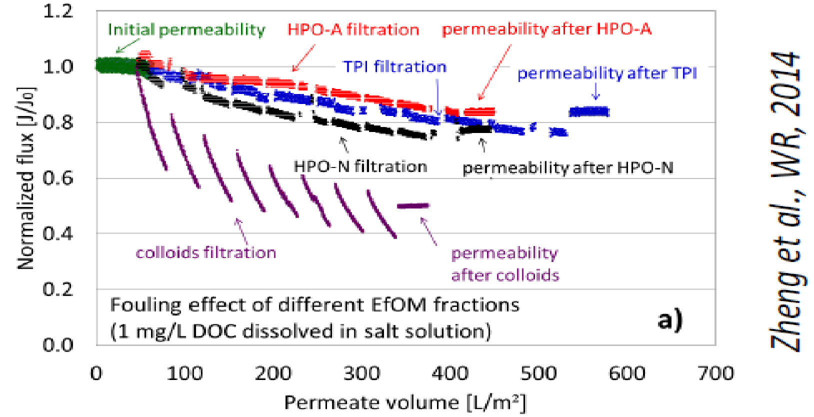


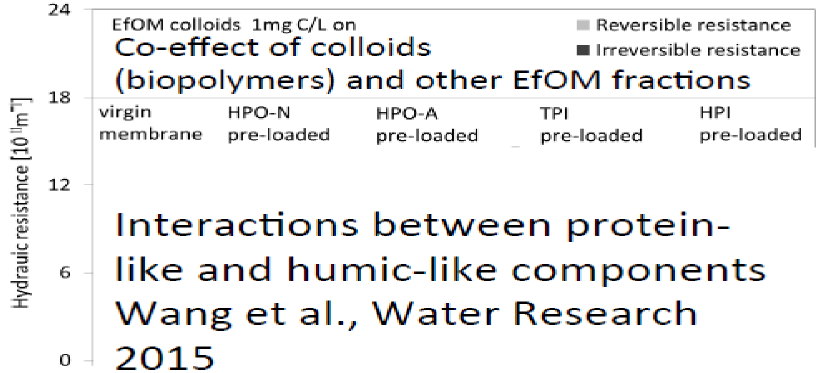
Fig. 5 — Correlation between the fouling rate and biopolymer concentration (Lines are exponential correlations).

Treated Wastewater

Capillary UF membranes (hydrophilized PES, MWCO 150 kDa)



Zheng et al., WR, 2014

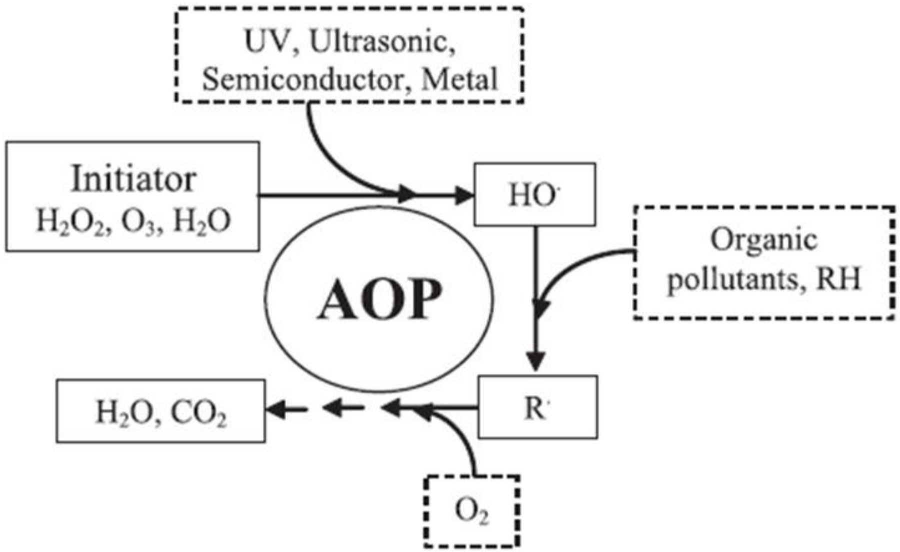


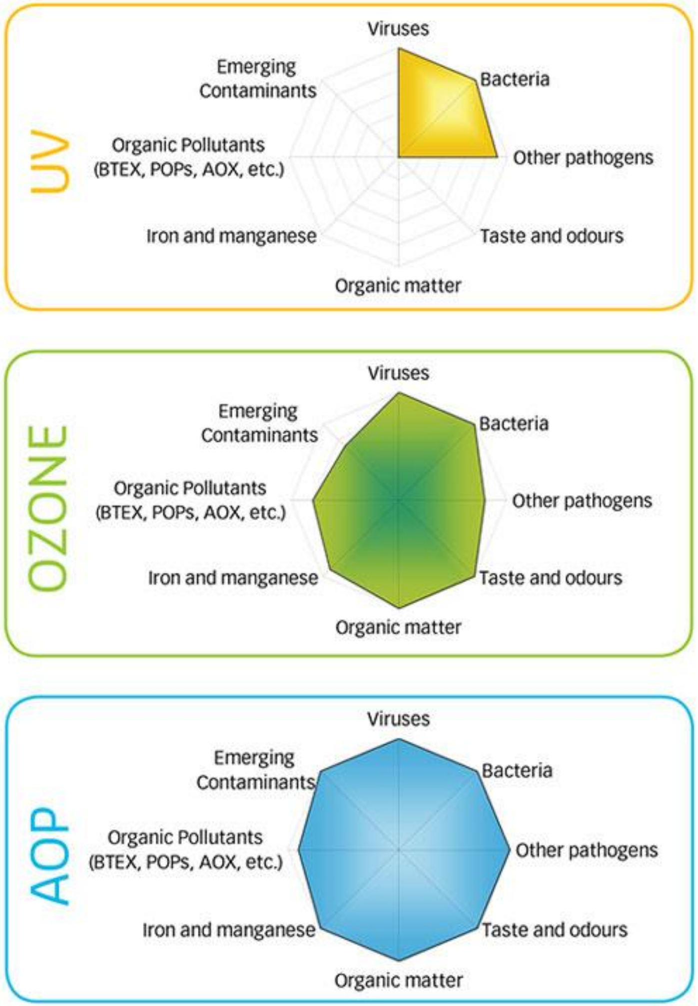
Interactions between protein-like and humic-like components
Wang et al., Water Research 2015

Humic substances play a major role in irreversible fouling (Filloux et al., submitted)

EXPLORING AOP FOR NOM REMOVAL

- Production of OH°-> react with organic pollutants (to CO_2, or partial)





ULTRASONIC-ASSISTED SYNTHESIS OF BINARY NANOCOMPOSITES FOR PHOTOCATALYTIC WATER TREATMENT
(JULY 2018-AUGUST 2021)

AIM: To design and prepare visible light active photocatalysts using ultrasound-assisted synthesis for the abatement of emerging pollutants in water

METHODOLOGY

Colloids and Surfaces A: Physicochemical and Engineering Aspects 634 (2022) 127969

Contents lists available at ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

ELSEVIER

journal homepage: www.elsevier.com/locate/colsurfa

Ultrasonic assisted anchoring of Yb_2O_3 nanorods on In_2S_3 nanoflowers for norfloxacin degradation and Cr(VI) reduction in water: Kinetics and degradation pathway

M. Murugalakshmi [a], G. Mamba [b], Sajid Ali Ansari [c], V. Muthuraj [a,*], T.I.T. Nkambule [b]

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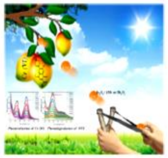
[b] Institute for Nanotechnology and Water Sustainability, College of Science, Engineering and Technology, University of South Africa, Florida, 1709 Johannesburg, South Africa
[c] Department of Physics, College of Science, King Faisal University, P.O. Box 400, Hofuf, Al-Ahsa 31982, Saudi Arabia

HIGHLIGHTS

- Hydrothermally synthesised In_2S_3 and Yb_2O_3 were coupled via an ultrasound assisted method.
- In_2S_3/Yb_2O_3 nanocomposites displayed enhanced visible light activity towards norfloxacin degradation and Cr(VI) reduction.
- Composites showed improved charge separation and transfer compared to In_2S_3 and Yb_2O_3.
- In_2S_3/Yb_2O_3 nanostructures present remarkable stability and recyclability.

GRAPHICAL ABSTRACT



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PAPER

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Cite this: New J. Chem., 2021, 45, 22697

Simple fabrication and unprecedented visible light response of $NiNb_2O_6$/RGO heterojunctions for the degradation of emerging pollutants in water†

Benjamin Moses Filip Jones,[a] G. Mamba,[b] Sajid Ali Ansari,[c] D. Maruthamani,[d] V. Muthuraj*[a] and T. T. I. Nkambule[b]

Utilization of environmentally friendly and effective synthesis methods to fabricate visible light responsive photocatalysts with impressive catalytic performance is desirable in photocatalytic water treatment. Herein, we employed the powerful and environmentally benign ultrasonic synthesis to hybridize hydrothermally prepared $NiNb_2O_6$ with varying amounts of RGO (5, 10 and 15 wt%) obtained *via* a modified Hummers' method. The samples were characterized extensively using analytical techniques such as XRD, SEM-EDX, TEM, UV-Vis DRS, PL, XPS, M-S and EIS, and subsequently employed for the degradation of doxycycline (DOX) and tetracycline hydrochloride (TC) in water under visible light exposure. The binary nanocomposites displayed enhanced activity compared to $NiNb_2O_6$, with the highest activity attained over the 10 wt% RGO sample ($NiNb_2O_6$/10 wt% RGO) which achieved 89.2% and 94.1% DOX and TC removal in 80 min, respectively. This was ascribed to improved visible light response, and charge separation and transfer. Furthermore, the influence of pH, pollutant initial concentration and photocatalyst dose was investigated. The hydroxyl radicals and holes were identified as the predominant reactive species responsible for degradation of both DOX and TC. Finally, a feasible charge transfer pathway was proposed to explain the formation of the reactive species and GC-MS analysis was employed to track the degradation route of DOX. This work presents a simple and effective route for coupling RGO and $NiNb_2O_6$ nanoparticles for antibiotic pollution abatement which is currently a major environmental concern.

Received 1st October 2021,
Accepted 2nd November 2021

DOI: 10.1039/d1nj04693d

rsc.li/njc

Journal of Materials Science: Materials in Electronics (2020) 31:11434–11447
https://doi.org/10.1007/s10854-020-03692-1

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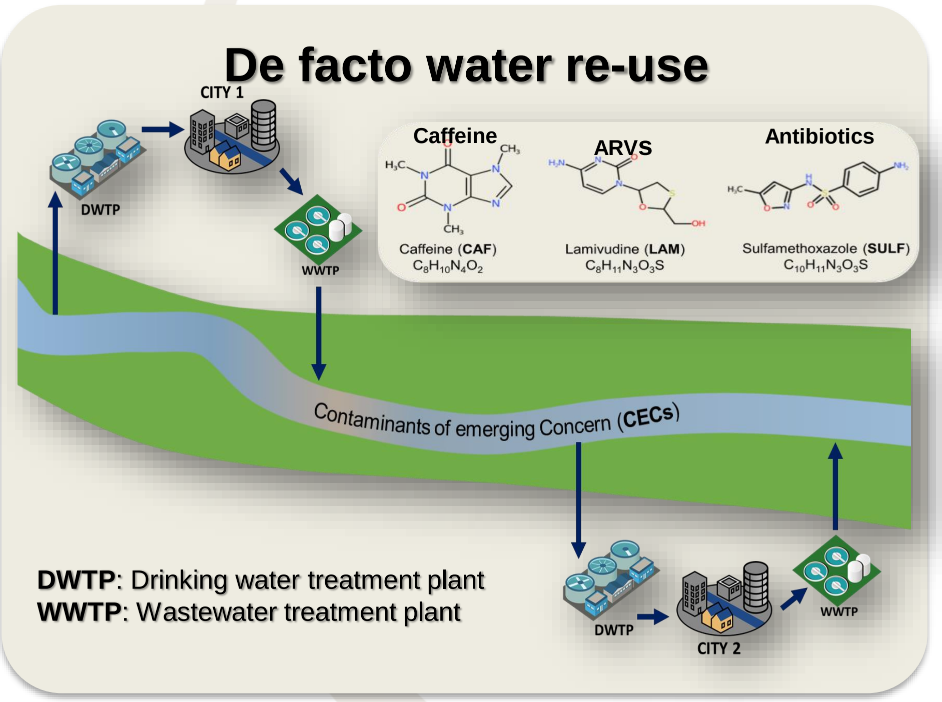
Enhanced photoactivity of cerium tungstate-modified graphitic carbon nitride heterojunction photocatalyst for the photodegradation of moxifloxacin

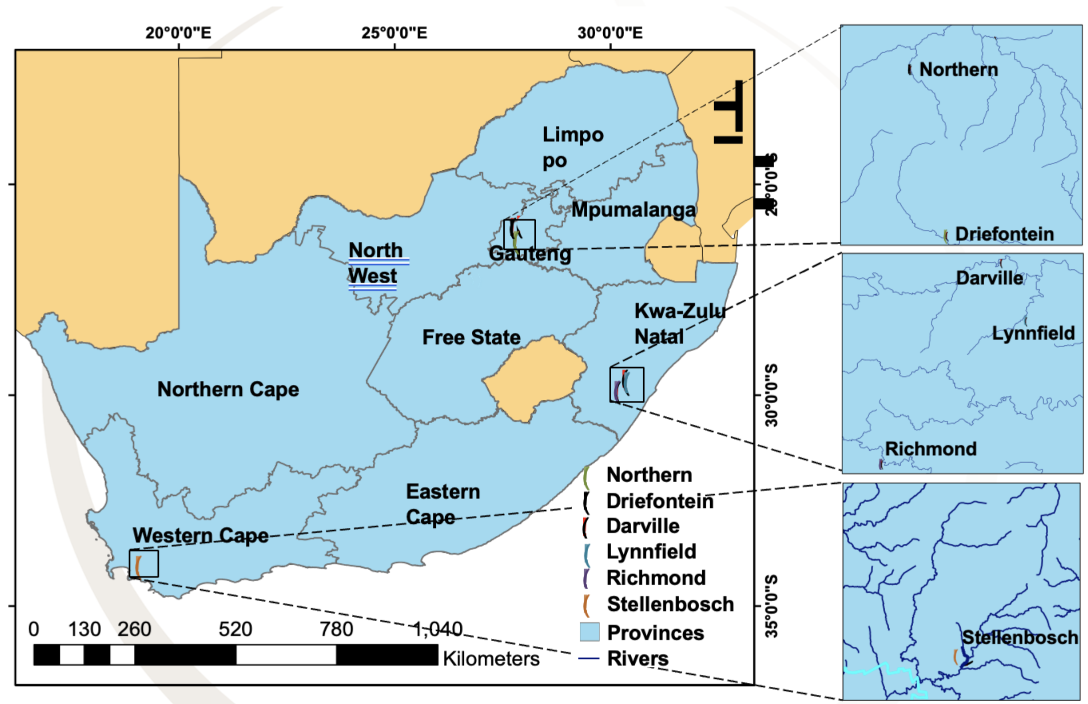
S. Lakshmi Prabavathi[1] · K. Saravanakumar[1] · T. T. I. Nkambule[2] · V. Muthuraj[1] · G. Mamba[2]

Received: 21 February 2020 / Accepted: 26 May 2020 / Published online: 31 May 2020

Abstract
Design and optimization of visible-light-driven photocatalysts for degradation of organic pollutants is an important step towards environmental decontamination. In this study, wolframite cerium tungstate ($Ce_2(WO_4)_3$, (CW)) hybridized with $g-C_3N_4$ (CN) nanosheets was synthesized via a simple hydrothermal route followed by an ultrasound-assisted synthesis method. The prepared $Ce_2(WO_4)_3@g-C_3N_4$ (CW@CN) heterojunction was investigated for photocatalytic degradation of the antibiotic moxifloxacin (MXF) under visible light irradiation. Structural, morphological, and optical properties as well as chemical composition of the as-synthesized heterojunction were investigated by transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), UV–Vis diffuse reflectance spectroscopy (UV–Vis DRS) and photoluminescence (PL). MXF photocatalytic degradation by the binary nanostructure ($Ce_2(WO_4)_3@g-C_3N_4$) (94.1%) was the highest compared to $g-C_3N_4$ (53.6%) and $Ce_2(WO_4)_3$ (46.4%). Such enhanced activity could be ascribed to efficient suppression of the charge carriers' recombination, leading to adequate formation of the reactive species responsible for MXF degradation. Furthermore, the $Ce_2(WO_4)_3@g-C_3N_4$ heterojunction showed remarkable stability over five consecutive cycles, with only 11.5% reduction after the 5th cycle. This work established the potential applicability of $Ce_2(WO_4)_3@g-C_3N_4$ nanostructures towards photocatalytic removal of MXF.

DETERMINING THE EXTENT OF DE FACTO WATER RE-USE IN SOUTH AFRICA: THE CASE OF CITIES IN GAUTENG, WESTERN CAPE AND KWA-ZULU NATAL PROVINCE





SAMPLING AREAS

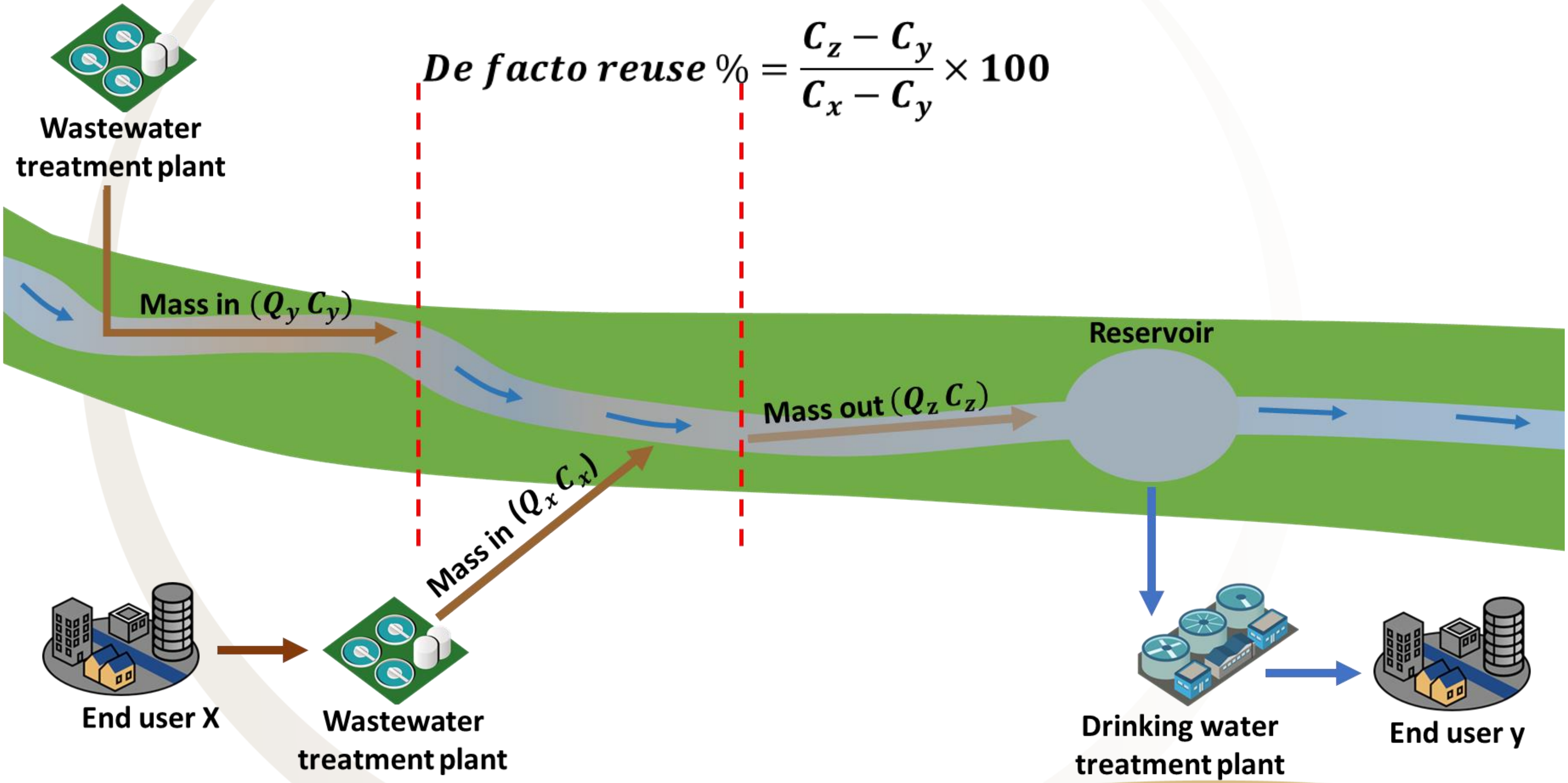
Upstream

Wastewater effluent

Downstream

Calculation model for wastewater tracers

$$De\ facto\ reuse\ \% = \frac{C_z - C_y}{C_x - C_y} \times 100$$



DE FACTO WATER RE-USE: LESSONS LEARNED

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Water Practice & Technology Vol 15 No 2
doi: 10.2166/wpt.2020.021

The status and quantification of de facto water reuse in South Africa – a review

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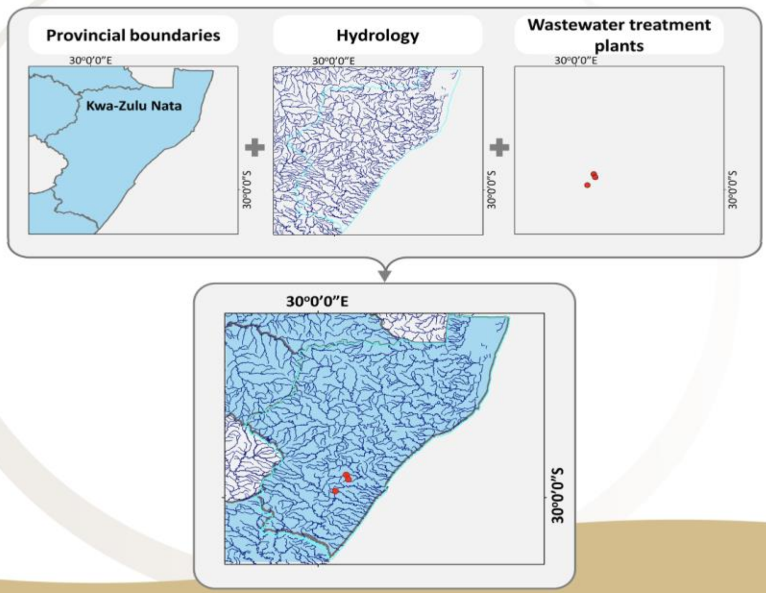
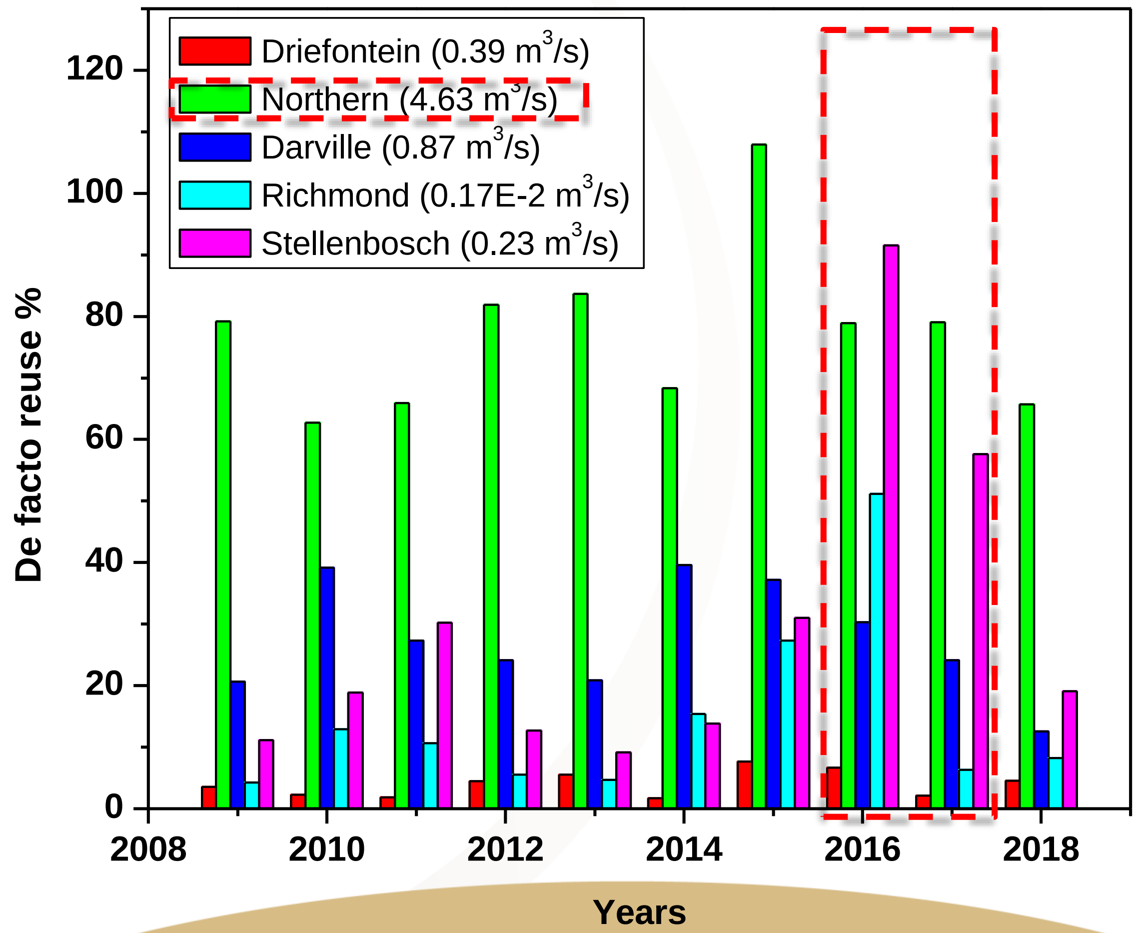
Data incorporation to ArcMap 10.6.1 (GIS soft ware)

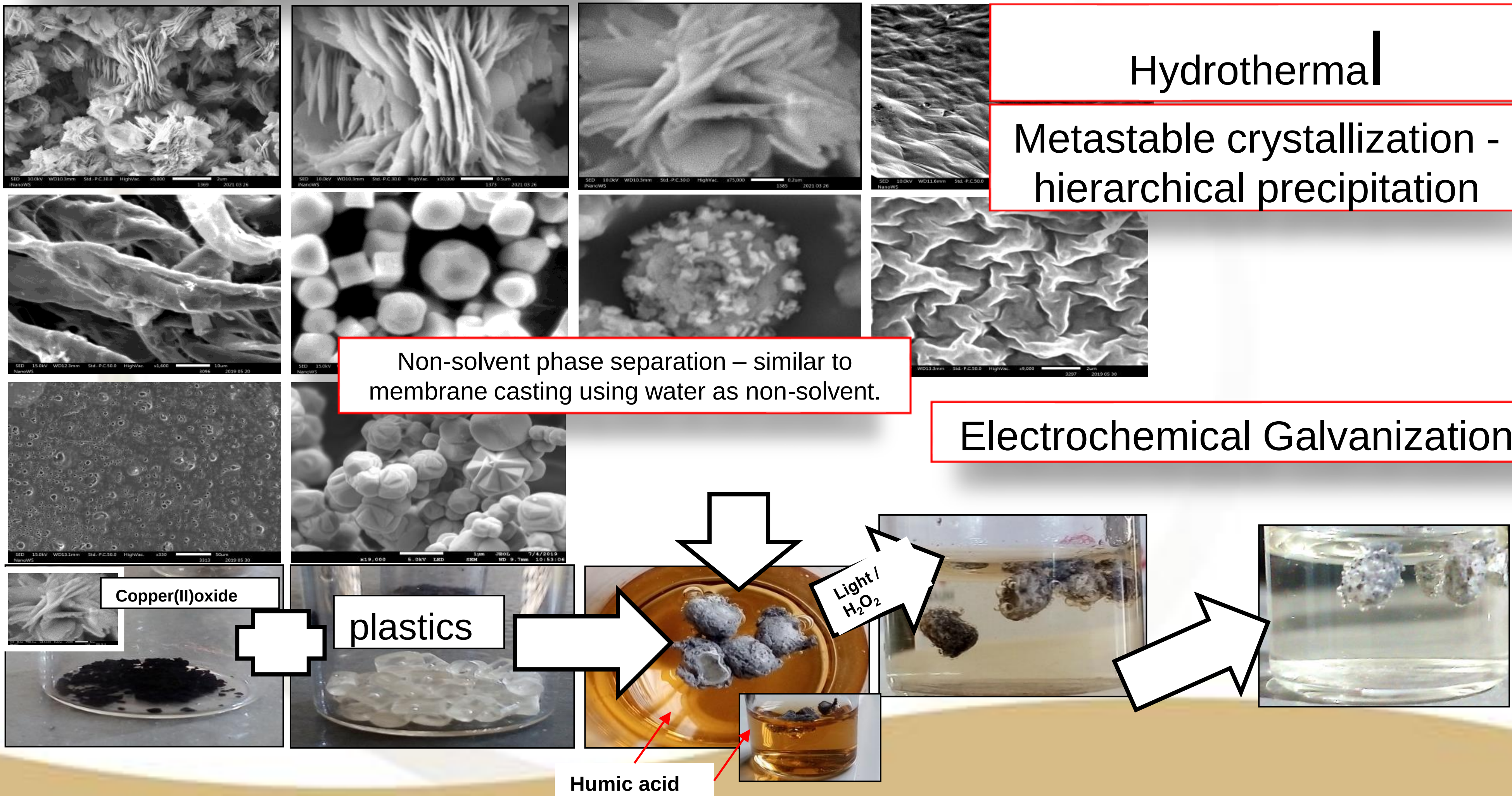




ELECTROCHEMICAL DETECTION AND DEGRADATION OF NOM IN WATER

Dr Olayemi Fakayode

Materials and Methodology



SUSTAINABLE MATERIALS AS SENSORS/DEGRADING TOOLS FOR NOM

Journal of Water Process Engineering 46 (2022) 102530

Contents lists available at ScienceDirect

Journal of Water Process Engineering

journal homepage: www.elsevier.com/locate/jwpe

Development of floating 3D-microfloral CuO-polysulfone beads for wastewater treatment

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Analyst

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Detection of humic acid in water using flat-sheet and folded-rod viscous alkaline glucose syrups†

Olayemi J. Fakayode, *[a] Sharon Williams, [b] Abolanle S. Saheed [a] and Thabo T. I. Nkambule [a]

Food Chemistry 348 (2021) 129146

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Chromametric and spectroscopic determinations of natural organic matter in water and caffeine/phosphoric acid-containing soft drink using grape (*V. vinifera*) extract

Olayemi Jola Fakayode *, Thabo T.I. Nkambule

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Microelectronic Engineering 230 (2020) 111364

Contents lists available at ScienceDirect

Microelectronic Engineering

journal homepage: www.elsevier.com/locate/mee

Research paper

Nanosilver dumbbell electronic sheet for cyanide and glucose detection

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MRS Communications (2020), 1 of 9

doi:10.1557/mrc.2020.61

MRS Communications — Research Letter

Electrochemical detection of natural organic matter (humic acid) and splitting of hydrogen peroxide on a micropore 3D catalytic polysulfone–copper oxide nanocomposite surface

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(Received 26 March 2020; accepted 3 August 2020)

MRS Communications (2019), 1 of 6

doi:10.1557/mrc.2019.128

MRS Communications — Research Letter

Detection of low-level humic acid in water using room temperature-synthesized copper (I) oxide colloids

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(Received 11 July 2019; accepted 5 September 2019)

KEY POINTS TO REMEMBER

1. **NOM** is a complex, heterogeneous mixture, but not hopelessly complex
   - Faster progress can be made by treating it as such
   - Categorize based on underlying structural features rather than methods of extraction
   - Recognize the distinction between microstructure and macrostructure
2. **Sources set the stage**
   - Terrestrial → Atmospheric
   - Aquatic Anthropogenic (EfOM, etc.)
3. **Processes** change the outcome
   - Natural Systems
     - Aerobic degradation & Anoxia (sediments)
   - Engineered Systems (Treatment – topic for another day)

Role of Climate Change?

4. **Innovation and adaptability**
   - New and emerging trends
   - Costs (effectiveness vs performance)
   - Abundace, scarcity and Innovation

To all my past and present students & PDF’s:
“I am because you are”

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