WaterTOP: Taste and Odor in early diagnosis of source and drinking Water Problems

Reyhan Akcaalan & Tri Kaloudis
Chairs, WaterTOP CA18225

WaterTOP Meeting
25-28 October 2021
Porto, Portugal

COST ACTION CA18225
www.watertopnet.eu

EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

A bit of history…

The Ninth IWA Symposium on Off-Flavours in the Aquatic Environment: RGU, 14-18 August 2011

ROBERT GORDON UNIVERSITY•ABERDEEN

Water T&O Workshop, 10-12 May 2017, Istanbul University

Why a COST Action?

Home > COST Actions > What are COST Actions?

The changing nature of science

The nature of science has changed. It has become more interconnected, interdisciplinary, collaborative and data-intensive. Collaboration has become critical to solving complex problems.

COST creates spaces where scientists are in the driving seat (bottom-up) and ideas can grow through a flexible and open approach. By enabling researchers from academia, industry and the public and private sector to work together in open networks that transcend borders, COST helps to advance science, stimulates knowledge sharing and pools resources.

National governments make a real difference by ensuring that research cooperation optimises national investments in research and technology and unlocks thereby the full potential of science.

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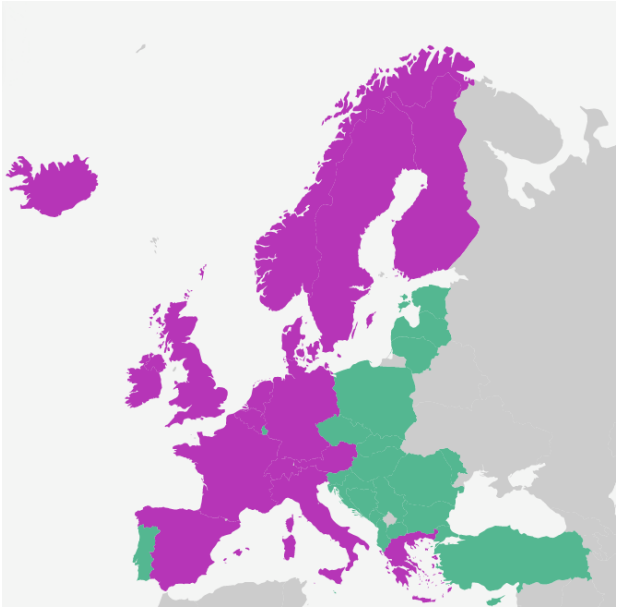
IN SCIENCE & TECHNOLOGY

COST Actions

- Pan-European networks.
- Near-neighboring countries, International partners
- Scientists, researchers, industry, policy makers, stakeholders.
- Advancement of science and technology.
- Increase capacities and capabilities.
- Scientific, research, societal, economic impacts.
- Support for Early Career Investigators (ECIs).
- Support for Inclusiveness Target Countries (ITCs).
- **Inclusive, participative, open, flexible.**



COST Tools:

- Training Schools
- Workshops
- Short-term Scientific Missions (STSMs)
- Conferences

Products-outcomes:

- Publications
- Tools
- Guidelines, newsletters
- **Publicly available**

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Water is tasteless and odorless !?

Article Talk Rea

Water

From Wikipedia, the free encyclopedia

For other uses, see Water (disambiguation).
"H2O" redirects here. For other uses, see H_2O (disambiguation).
For a detailed look at the chemistry of water, see Properties of water.

Water is an inorganic, transparent, tasteless, odorless, and nearly colorless chemical substance
Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent[1]).
life, even though it provides no calories or organic nutrients. Its chemical formula is H_2O, meanin

WIKIPEDIA
The Free Encyclopedia

Why was WaterTOP funded?

Drinking water fact:
T&O is the most frequent source of consumer complaints

A plethora of T&O can occur at various stages of drinking water production

Lakes (e.g. plankton metabolites and degradation products)

Geosmin, MIB, α- and β-ionones, β-cyclocitral, pyrazines, sulfurous compounds aldehydes, amines

(earthy, musty, fishy, swampy etc odors)

Water treatment

Chlorinated compounds, chloramines, degradation products etc

Distribution network

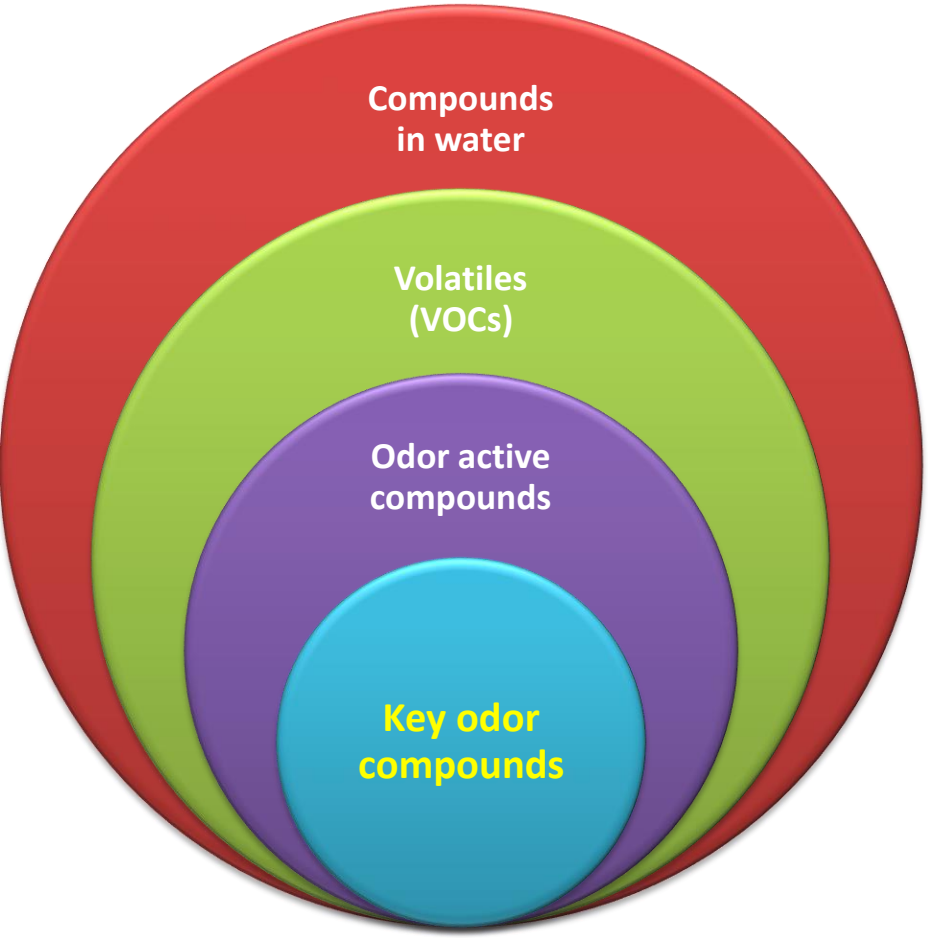
Trichloroanisole, compounds migrating from contact with materials

Household network

Plasticizers, fuels (BTEX), industrial solvents etc etc

Which compounds contribute to water T&O ?

Volatiles vs odor compounds



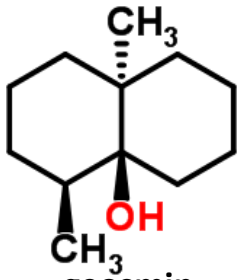
Examples of Threshold Odor Concentrations (TOC)

Compound	Mean Odor Threshold in water (µg/L)	Descriptor
geosmin	0.004	earthy
2-MIB	0.015	musty
2-Isobutyl-3-methoxypyrazine	0.0001	stale, musty
2,4,6 TCA	0.0009	musty, earthy
naphthalene	6	mothballs
chloroform	30000	chemical, antiseptic
b-cyclocitral	19	tobacco, woody
dimethyl trisulfide	0.010	septic
b-ionone	0.007	violets

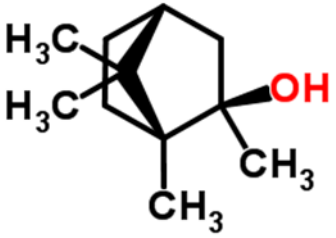
Young et al. (1996), Water Research, 30(2),331-340
Cotsaris et al. (1995), WST, 31(11), 251-258.

Examples of water T&O

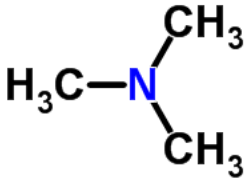
Surface Water Reservoirs
Algal metabolites



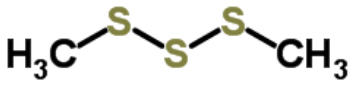
geosmin
(earthy)



2-methylisoborneol
(musty)

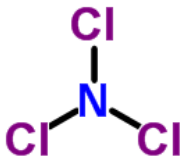


trimethylamine
(fishy)

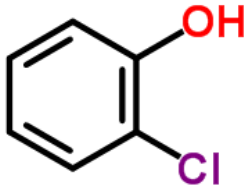


Dimethyl trisulfide
(septic)

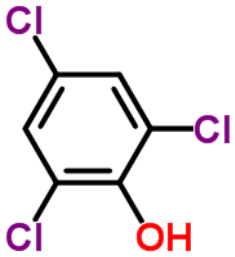
Water treatment
Chlorination products



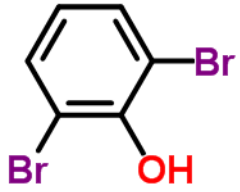
Trichloramine
(swimming pool)



2-chlorophenol
(chemical)

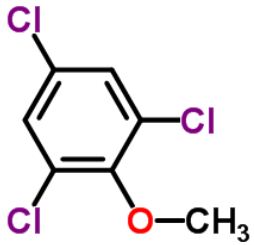


2,4,6-trichlorophenol
(medicinal)

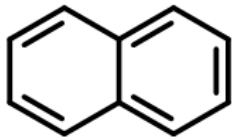


2,6-dibromophenol
(medicinal)

Distribution network
biofilm activity, materials in contact

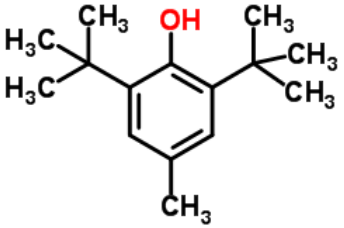


2,4,6-trichloroanisole
(musty)



naphthalene
(mothballs)

benzothiazole
(plastic)



BHT
(plastic)

Sensory analysis

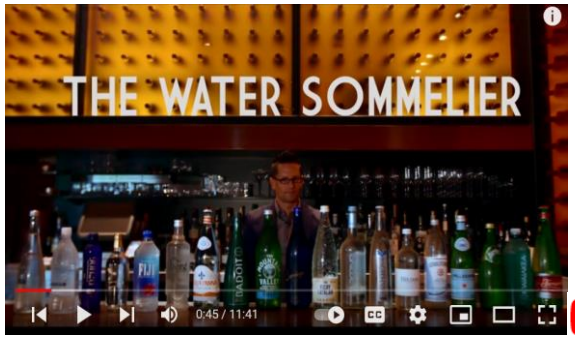
Descriptive and intensity tests

- Flavor Profile Analysis
- TON/TFN
- …

Methods must be suitable for the intended use.

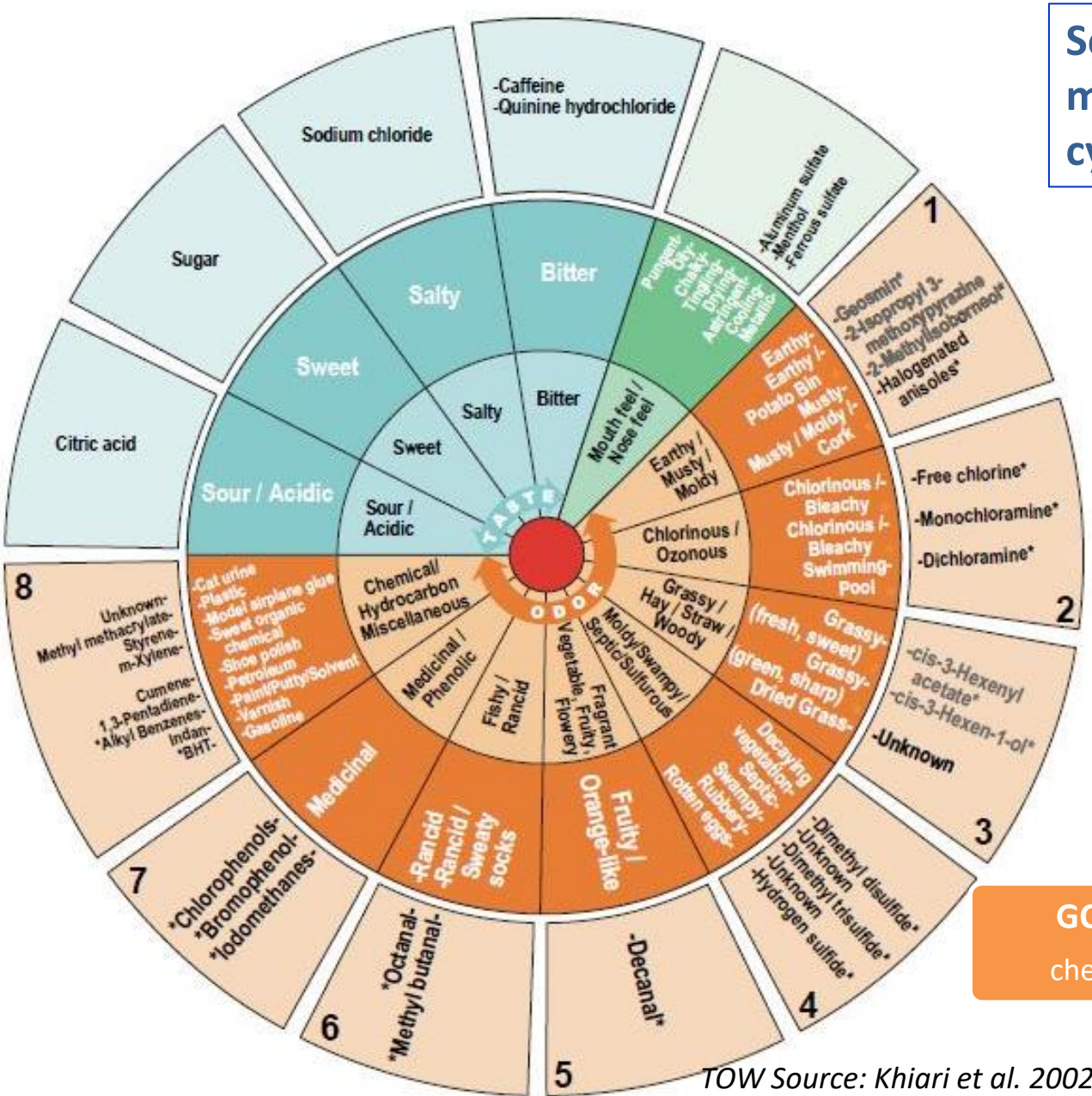
Discriminating tests

- Triangle tests
- Paired comparisons
- …



Flavor Profile Analysis & water T&O Wheel

Sectors 1,3,4,6 of the TOW may indicate cyanobacterial T&O.



Analysis of water T&O

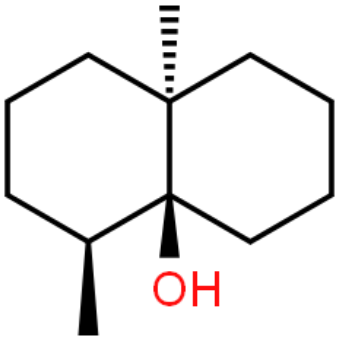
FPA
sensory

GC-MS
chemical

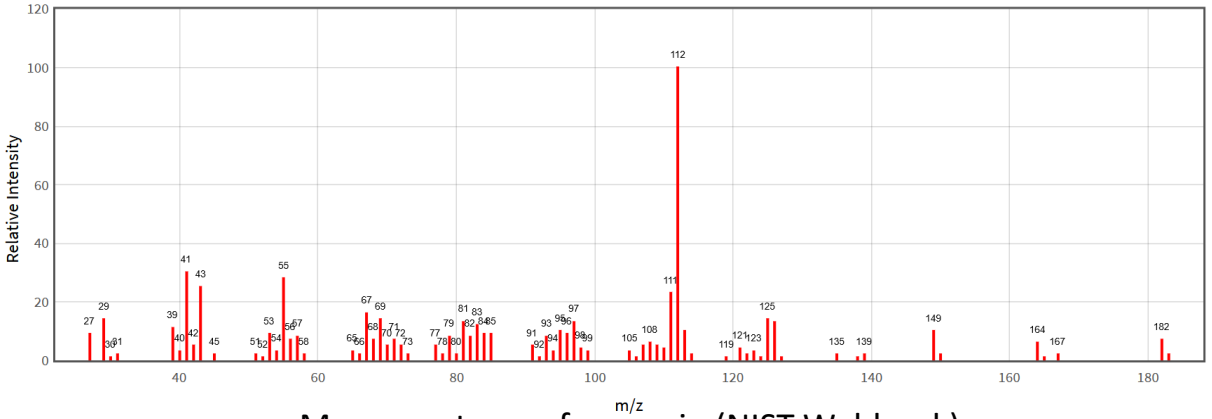
GC-O
hybrid

TOW Source: Khiari et al. 2002, AWWARF, p340.

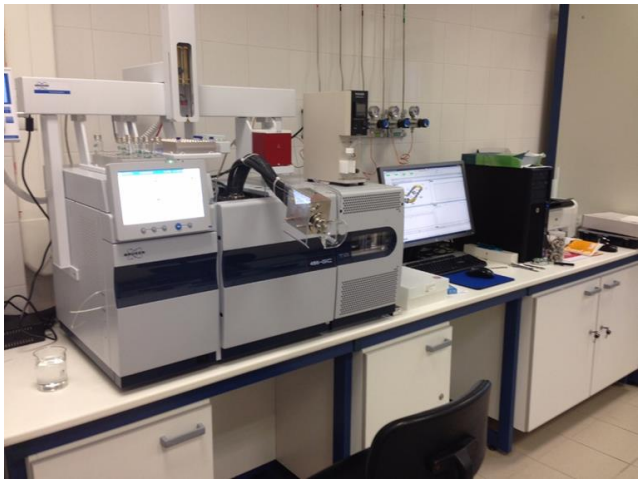
Chemical analysis (GC-MS, GCxGC-MS, GC-HRMS etc)



geosmin



Mass spectrum of geosmin (NIST Webbook)



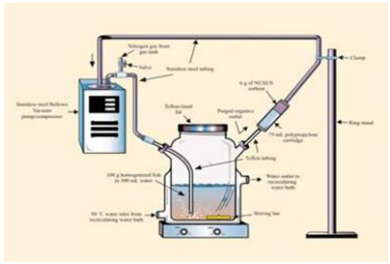
GC-MS-Olfactometry

Liquid-liquid Extraction, LLE

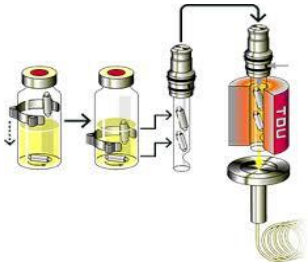
Solid Phase Extraction, SPE

Static Headspace Extraction

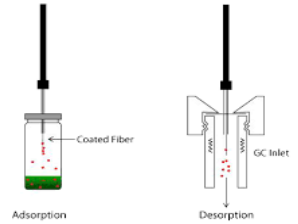
Dynamic Headspace (Purge & Trap)



Closed-Loop Stripping Analysis (CLSA)



Stir Bar Sorptive Extraction (SBSE)

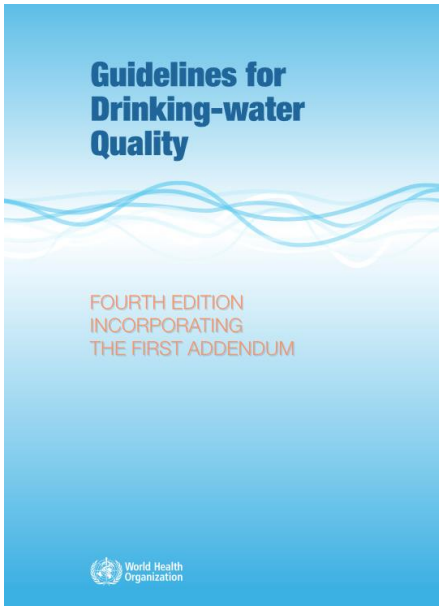


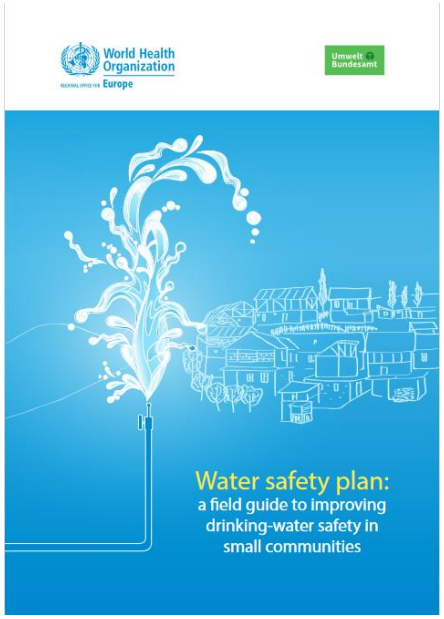
Solid Phase Micro-extraction (SPME)

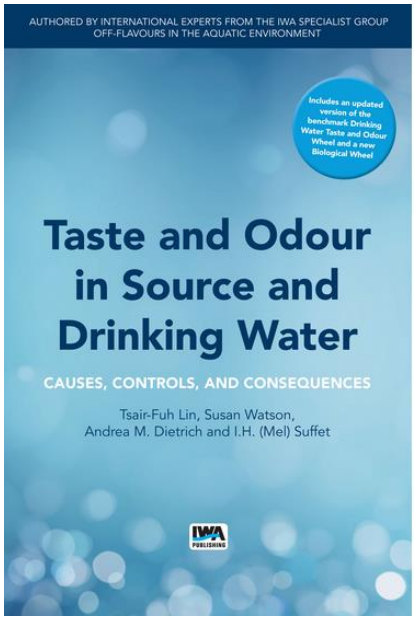
Extraction methods for water T&O

Risk assessment – Risk Management

- Are water T&O compounds toxic at drinking water relevant concentrations?
- Any modes of bioactivity?
- Ecological and environmental impacts?
- Early warnings for other serious water quality problems? (e.g. geosmin/MIB as early warning for cyanobacterial toxins?)
- Databases-lists of water T&O compounds?
- Risk communication to consumers?
- How can water T&O be implemented in Water Safety Plans?





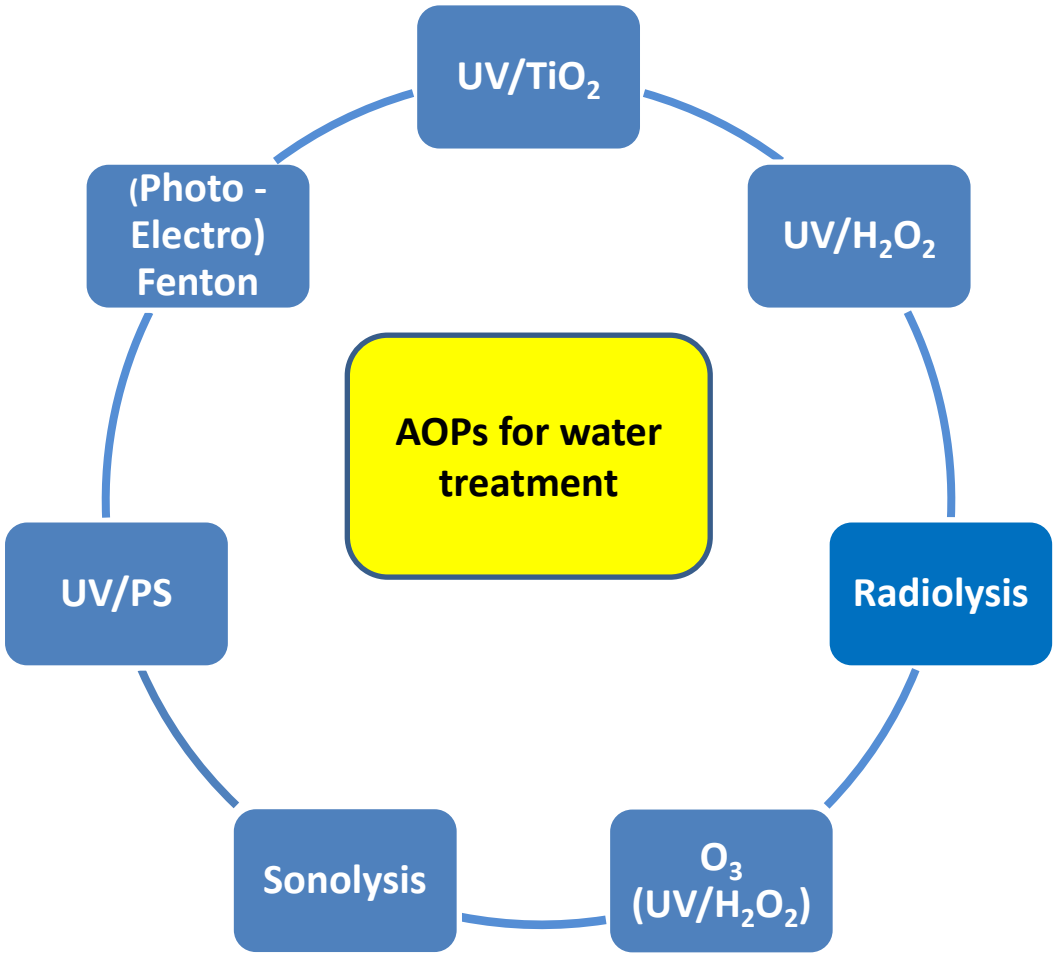


Water treatment for T&O

The challenge: Concentrations of water T&O must be reduced to **levels below the OTCs.**

- Coagulation, flocculation, sedimentation and filtration are generally ineffective.
- GAC/PAC effectiveness may be limited by competition with NOM *(Newcombe et al., 2002).*
- Common disinfectants and oxidants (e.g. Cl_2, ClO_2, $KMnO_4$) may not be effective, ozone is more efficient *(Peter & von Gunten, 2007, Bruchet & Duguet, 2004).*

Advanced Oxidation Processes (AOP) based on formation of **highly reactive radicals and oxygen species (ROS)** are a promising alternative.



WaterTOP (CA18225)

Taste and Odor in early diagnosis of source and drinking Water Problems

2019-2023

- Albania
- Austria
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Cyprus
- Czech Republic
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Israel
- Italy
- Latvia
- Lithuania
- Malta
- Netherlands
- North Macedonia
- Norway
- Poland
- Portugal
- Romania
- Serbia
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom

Total: 33

NNC/IPC:

- Russian Federation
- Canada
- Australia
- United States

WaterTOP MC meeting, 28/8/2019, Brussels

WaterTOP

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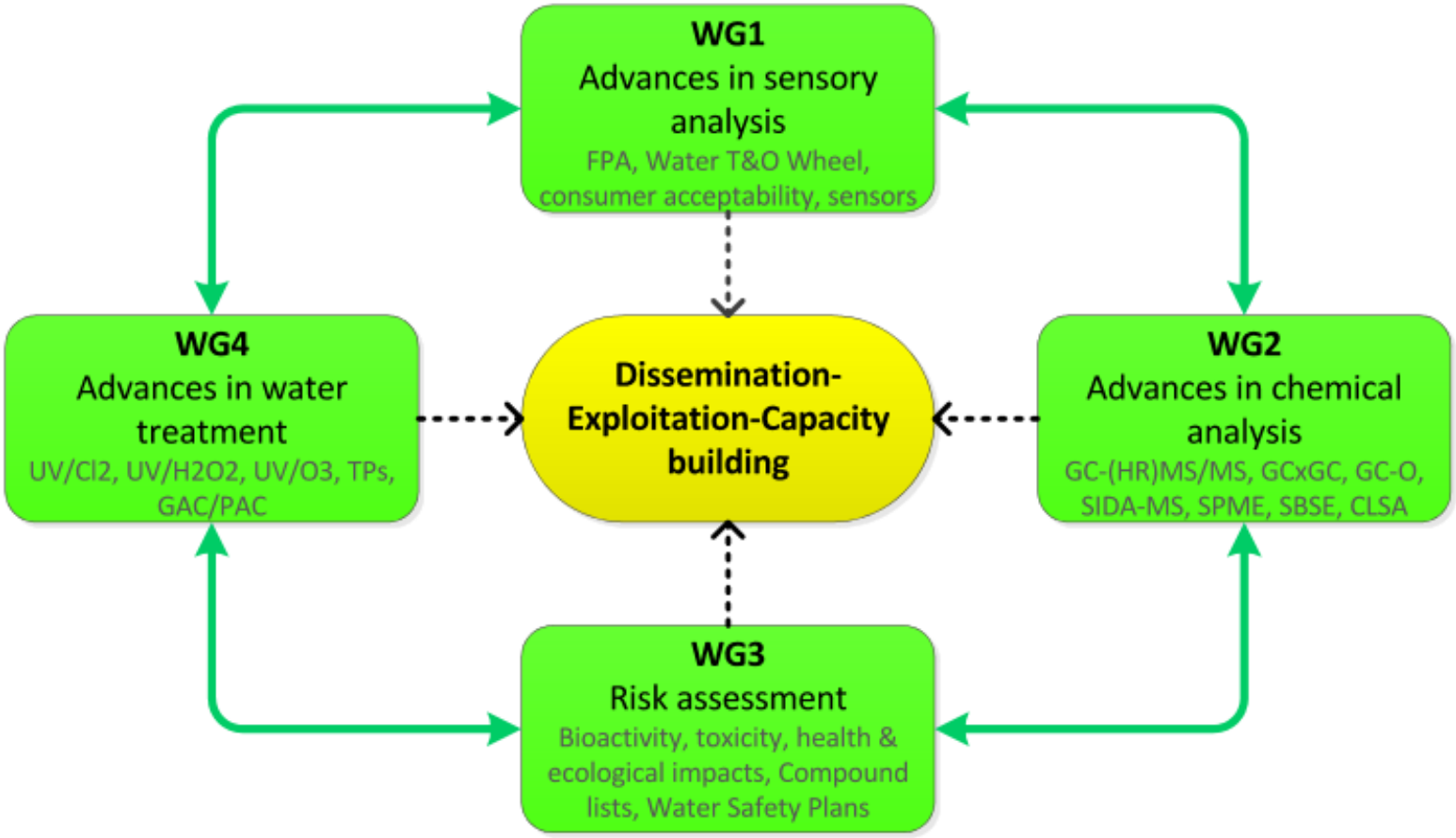
Core Group (CG+) and Working Groups (WG)



Chairs: Tri Kaloudis, Reyhan Akcaalan
Grant Holder: Theodoros Triantis
Communications manager: Galina Dimova
STSM managers: Popi Karaolia, Latife Koker, Kristel Panksep
ITC Conference manager: Radoslav Tonev
CG+: Rita Lado and Maura Manganelli

WG Leaders:
WG1: Ricard Devesa
WG2: Martin Steinhaus
WG3: Emanuela Testai
WG4: Anastasia Hiskia

WaterTOP Activities

1st WaterTOP CG Meeting, Istanbul University, 13-14 Feb 2020
Organizers: Reyhan Akcaalan, Meric Albay

Work and Budget Plan for 2nd Period (1 May 2020 - 30 Apr 2021)

Plan included among others:

- 1 Training School on Chemical Analysis in Freising, TUM (Martin Steinhaus)
- 1 Training School on AOPs for water T&O in Athens, NCSR Demokritos (Anastasia Hiskia)
- 1 Training School on basics of Sensory analysis & GC-MS in Athens, EYDAP SA (Tri Kaloudis)
- STSMs

- **Activities were cancelled till August 2021, due to the pandemic**

Training School: Introduction to Water Sensory Testing

13 March 2020, Barcelona

Organizer: Ricard Devesa

- Originally planned for 60 trainees
- Combined with WG and MC meeting
- Due to the outbreak of the pandemic, only 3 trainees participated.

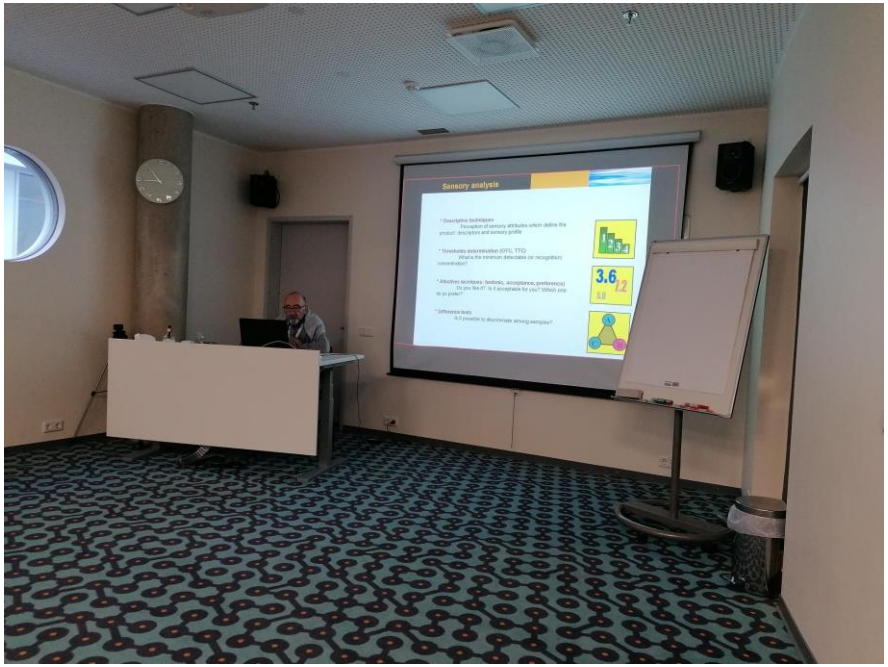
Editorial Meeting, 27-30 Sep 2021, Nafplion, Greece

Organizer: Theodoros Triantis

- Prepararti on of a “perspectives” paper on water T&O for Chemical Engineering Journal Advances.
- Translation of the Taste & Odor Wheel (TOW) (R. Devesa)
- Virtual presentations on Water Trεatment (A. Hiskia), Geosmin & MIB in Turkey (R. Akcaalan), Citizen Science (T. Kaloudis).

Editorial Meeting, 7-9 Oct 2021, Tartu, Estonia

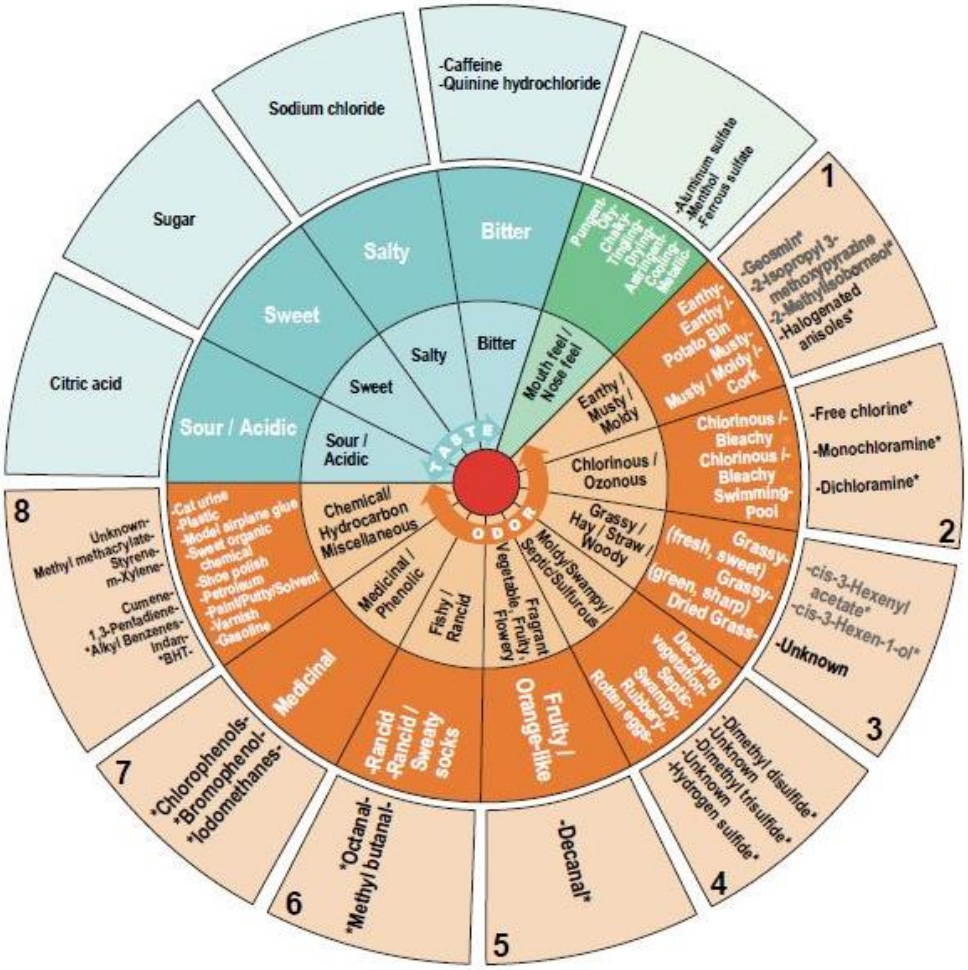
Organizer: Kristel Panksep



- Translation of the Taste & Odor Wheel (TOW), (R. Devesa)
- Proposal for a WaterTOP citizen science project (T. Kaloudis).
- Virtual presentations on sensory analysis (A. Dietrich), water treatment (A. Zamyadi), historical development of TOW (R. Devesa).

On-going work: TOW translation and dissemination

Coordinator: Ricard Devesa



- Translate TOW in EU, COST countries and NNC languages.

Future development:

- Development of TOW as a web-tool (translations, links to information).
- TOW as a mobile app.

On-going work: WaterTOP Citizen Science Project

Proposer: Tri Kaloudis

Involving citizens in sensory evaluation of water.

The proposal can be downloaded here: Link

Products and Outcomes

Special Issue in Chemical Engineering Journal Advances (CEJA)

Home > Journals > Chemical Engineering Journal Advances

Chemical Engineering Journal Advances

Publishing options: OA Open Access ↗

↗ Guide for authors Track your paper

ISSN: 2666-8211

Editor-in-Chief > Editorial board

Bingcai Pan, Ph.D.

Chemical Engineering Journal Advances, a partner title to the highly-regarded Chemical Engineering Journal, is a new online only, open access, peer reviewed journal.

Ana Rita Lado Ribeiro, PhD

Special Issues Editor

University of Porto Laboratory of Separation and Reaction Engineering Laboratory of Catalysis and Materials, Porto, Portugal

Environmental engineering; Analytical chemistry; Water/wastewater monitoring; Water/wastewater treatment; Advanced oxidation processes.

Gianluca Li Puma, PhD

Loughborough University Department of Chemical Engineering, Loughborough, United Kingdom

Photocatalysis, Environmental nanocatalysis, Advanced oxidation processes, Environmental remediation, Solar energy conversion and Photoreaction engineering.

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CEJA: Invitation to submit articles

WaterTOP Special Issue in CEJA

Special Issue on Water taste and odour (T&O): challenges, gaps and solutions

July 2021

Summary

We invite submissions for the Special Issue entitled " ***Water taste and odour (T&O): challenges, gaps and solutions***", guest edited by Triantafyllos Kaloudis, Andrea Dietrich, Arash Zamyadi, Tsair-Fuh Lin and Ana Rita Lado Ribeiro.

The access to safe & clean drinking water (DW) is recognized by the United Nations as an elementary human right to protect human health. A number of taste and odour (T&O) substances of natural or anthropogenic origin (e.g. bacteria/algae metabolites, industrial pollutants) can occur in tap water as result of contamination at the source, during treatment or in distribution networks. As result, the unpleasant T&O of DW can lead to a great mistrust in tap water by consumers and a consequent higher consumption of bottled water.

Although the scientific community has been widely addressing the environmental concerns about contaminants of emerging concern, T&O substances have been receiving much less attention. In this regard, water treatment for removal of T&O needs attention in order to provide solutions that are able to achieve extremely low concentrations after treatment, otherwise T&O would be sensed by consumers. Adsorption, chemical disinfectants and advanced oxidation processes have been studied in the last years for removal of T&O substances. The knowledge on this topic is still limited and other related research gaps include the generation of transformation products, the sensory properties of treated water, and the potential use of T&O substances as indicators of point sources of contamination of other potentially harmful substances.

We warmly invite research and review papers on all aspects of water T&O in aquatic systems such as source waters, drinking water, wastewater and aquaculture. Special focus is given to detection and identification of natural & anthropogenic T&O compounds with sensory panels and advanced analytical techniques, assessment of risks and impacts, prevention - control measures and water treatment to remove T&O.

Important Dates

Submission opening on September 2020

Submission closing on 31st December 2021

[Link to WaterTOP CEJA Special Issue]

Published papers (acknowledging WaterTOP and COST)

1. C. Christophoridis, C.J. Pestana, T. Kaloudis, L.A. Lawton, T.M. Triantis, A. Hiskia, Radiolytic degradation of 2-methylisoborneol and geosmin in water: reactive radical species and transformation pathways, *Chemical Engineering Journal Advances*, 2021, 100196, https://doi.org/10.1016/j.ceja.2021.100196.
2. Z. Tunç , R. Akçaalan , L. Köker and M. Albay , "The first report of geosmin and 2-mthylisoborneol producer cyanobacteria from Turkish freshwaters", *Trakya University Journal of Natural Sciences*, vol. 22, no. 2, pp. 163-171, Oct. 2021, https://doi.org/10.23902/trkjnat.884423
3. Hammoud, N.A.; Zervou, S.-K.; Kaloudis, T.; Christophoridis, C.; Paraskevopoulou, A.; Triantis, T.M.; Slim, K.; Szpunar, J.; Fadel, A.; Lobinski, R.; Hiskia, A. Investigation of the Occurrence of Cyanotoxins in Lake Karaoun (Lebanon) by Mass Spectrometry, Bioassays and Molecular Methods. *Toxins* **2021**, *13*, 716. https://doi.org/10.3390/toxins13100716
4. Andrea M. Dietrich, Zhen Pang, Huiming Zheng, Xiaoyan Ma (2021). Mini review: Will artificial sweeteners discharged to the aqueous environment unintentionally "sweeten" the taste of tap water? *Chemical Engineering Journal Advances*, Vol.6, 100100. https://doi.org/10.1016/j.ceja.2021.100100
5. Maria Antonopoulou, Nikolaos Ioannidis, Triantafyllos Kaloudis, Theodoros M. Triantis, Anastasia Hiskia (2020). Kinetic and mechanistic investigation of water taste and odor compound 2-isopropyl-3-methoxy pyrazine degradation using UV-A/Chlorine process. *Science of The Total Environment* 732, 138404. https://doi.org/10.1016/j.scitotenv.2020.138404.

Presentations

(can be downloaded from "Products" page at www.watertopnet.eu)

Presentations:

Andrea M. Dietrich – Understanding sensory analysis of drinking water: challenges for describing taste and odor. Tartu, 2021.

Dietrich T&O Tartu 2021 Download

Nicolas Clercin – Tracking taste & odour producers and potential degraders in a drinking water supply reservoir. Tartu, 2021

Clercin 2021. Tracking T&O Producers and Potential Degraders Download

Arash Zamyadi – Investigating water treatment processes for removal of taste & odour compounds. Tartu, 2021

Arash Zamyadi watertop oct 2021 Download

Tri Kaloudis – Involving citizens in sensory evaluation of water. Proposal for a pan-European citizen science exercise. Nafplio, 2021.

Kaloudis Citizen Science Nafplion 2021 Download

Anastasia Hiskia – Water treatment for T&O. Challenges, gaps and perspectives. Nafplio, 2021

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WaterTOP message on World Water Day2020

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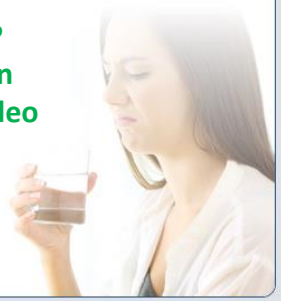
Taste and odour in water: early warnings of possible troubles?

WaterTOP featured in AlphaGalileo



Towards effective protection of water resources and human health – WaterTOP Featured in News Medical

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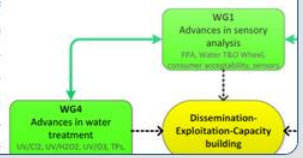
WaterTOP Featured in "BULAQUA"of the Bulgarian Water Association

WaterTOP featured in CYANOnews

Research

WaterTOP : A new COST Action in Taste and Odours

Unpleasant taste and odour (T&O) of water can indicat possible risks for human health and can make water sumers. A plethora of water T&O of natural or anthrop ter water at the source, during water treatment or in Resolution of water T&O problems requires integration of a) sensory analysis to describe



12-15 Nov 2019: Presentation of WaterTOP in 3rd Int. Water 7 Health Congress, Turkey

3rd international water and health congress
everything about water...

WaterTOP was presented at the 3rd International Water and Health Congress held in Antalya, Turkey.

31 Oct-3 Nov2019: Presentation of WaterTOP in Envirochem, Turkey

WaterTOP was presented in the 2nd International Environmental Chemistry Congress (EnviroChem), held in Antalya, Turkey.

WaterTOP Poster at EnviroChem Download

nviro Chem
2 INTERNATIONAL ENVIRONMENTAL CHEMISTRY CONGRESS
31 October - 03 November 2019 Antalya / TURKEY

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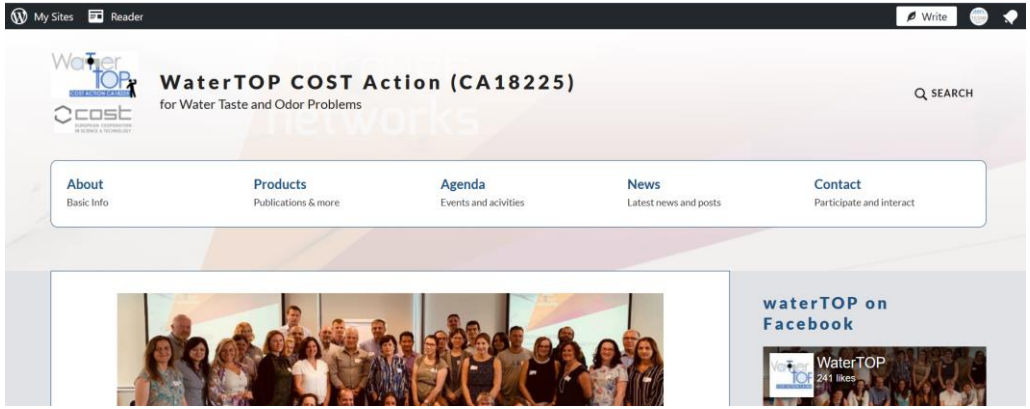

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New YouTube Channel: [Link]

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Rita Lado - Porto

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