



DE GRAAFF, DANNY

Soil and Groundwater  
Consultant



## MICROBIOME BASED REMEDIATION AND OTHER NATURE BASED TECHNIQUES

**Danny de Graaff (TAUW), Tobias Praamstra (TAUW), Cosimo Masini (DND Biotech)**



# Content presentation

---

- Scope and context (remediation challenge, sustainability, removal mechanisms)
- Nature based solutions (NBS) and current EU-projects
- Set up of EU project MIBIREM (biodegradation)
- Field experience with: The Natural Catch (adsorption)



# Scope and context

---

Immense soil & groundwater remediation task in EU-countries due to large number of sites + complexity ([technical, financial and organizational](#)):

- 14% of 2.8 million potentially polluted sites from industrial activities are expected to require remediation, that is 390,000 sites. By 2018, only 65,500 of these sites were remediated
- HCH was handled at about 300 sites in 22 EU countries. Major part still needs to be remediated

Environmental, social and economic value of the remediation work should be optimized ([ISO 18504](#))

Nature based solutions (NBS) are often the key: cheaper, less disturbing, less CO<sub>2</sub>, less extensive maintenance ([a pro for remote, large sites with diffuse contamination](#)) and serving ecological services

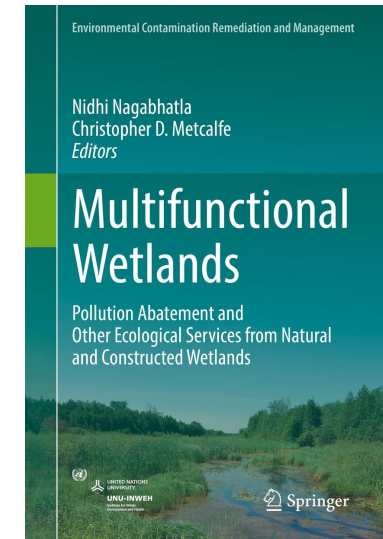


# Examples of NBS processes and mechanisms

---

Some natural processes and removal mechanisms we can use:

- Natural flowrate of (ground)water as driving force (*instead of motor pumps*)
- Capping with natural minerals (*dry cover*)
- Green (*organic*) adsorbents or natural minerals for adsorption
- Bacteria and fungi, atmospheric oxygen and solar-UV for degradation
- Limestone gravel beds to decrease pH and increase immobilization / degradation
- Trees and vegetation for phytoremediation (*f.e. hydrological isolation, extraction, degradation*)



# Nature based solutions and current EU projects

Innovative EU initiatives relevant for HCH-isomers & pesticides and focused on NBS:

- [H2020 GREENER](#) (2019-2023). Integration of several bioremediation strategies with innovative bio-electrochemical technologies for PH, **pesticides**, PAH and heavy metals. Partners: 20
- [Interreg RESANAT](#) (2019-2023). Nature-based remediation pilots (reactive mat, phytoremediation, injection electron acceptors) for PAH, PH and BTEX. Partners: 9
- [Life POPWAT](#) (2020-2023). This project promotes innovative technology based on constructed wetlands for treatment of **pesticide/HCH** contaminated waters. Partners: 7
- [H2020 RECYCLE](#) (2020-2025). Removal and Mitigation of Pollution from the Use of **Pesticides**: Prevention, Recycling and Resource Management. Partners: 12
- [H2020 REMEDI](#) (2021-2025). Trapping and Removal of X-ray Contrast Medium agents from water resource and stream Sediments. Partners: 5
- [Horizon Europe MIBIREM](#) (2022-2027). Toolbox for Microbiome based remediation of sites contaminated with **HCH**, PH and cyanide. Partners: 11



Horizon 2020  
Programme



# MIBIREM: PROJECT FACTS

- **Title:** MIBIREM – Innovative Toolbox for Microbiome-based Soil Remediation
- **Funding programme:** EU Horizon
- **Funding Agency:** EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)
- **EU contribution:** EUR € 6 Mio.
- **Partner contribution:** ± EUR € 6 Mio
- **Start:** 1 October 2022
- **End:** 31 March 2027
- **Duration:** 4,5 years
- **Number of partners:** 11 partners, 6 countries



Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)]. Neither the European Union nor the granting authority can be held responsible for them



Coming soon:  
[www.mibirem.eu](http://www.mibirem.eu)



# PROJECT CONSORTIUM

□ Project period: 2022 - 2027



*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)]. Neither the European Union nor the granting authority can be held responsible for them*



**Coming soon:**  
[www.mibirem.eu](http://www.mibirem.eu) 

# MIBIREM GOAL & CHALLENGE



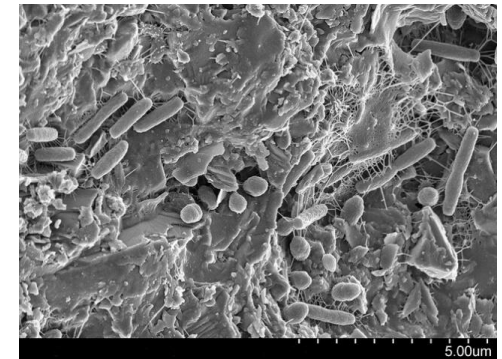
- The MIBIREM project will leverage the potential of microbiomes for bioremediation of contaminated sites by developing a unique and **innovative technological toolbox**



- The MIBIREM project will **identify** (by using/developing molecular methods), **isolate, cultivate and upscale microbiomes** for bioremediation to pilot scale at sites contaminated with cyanides, **HCH** and petroleum hydrocarbons



- Long-term upscaling of microbiome-based bioremediation will benefit **humans** and the **environment**



*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)]. Neither the European Union nor the granting authority can be held responsible for them*



Coming soon:  
[www.mibirem.eu](http://www.mibirem.eu)





# MIBIREM workpackages

- WP1: Quest for contaminated sites; sampling soil and/or groundwater; field data
- WP2: Microbiome analyses and cultivation
- WP3: Microbiome and strain collection
- WP4: Bioremediation prediction tool
- WP5: Upscaling & field testing
- WP6: Regulation and business development
- WP7: Sharing results and communication

*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)]. Neither the European Union nor the granting authority can be held responsible for them*



**Coming soon:**  
[www.mibirem.eu](http://www.mibirem.eu)



# Potential HCH-sites preselected

- Jaworzno site, Poland. Cooperation/synergy with EU LIFE POPWAT
- Bitterfeld (Germany)
- Tavaux site (France)
- Le Pont de Claix (France)
- Jata, Lemoiz (Spain)
- PCUK Wintzenheim (France)

Now: permission owners and planning field work

*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or [EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)]. Neither the European Union nor the granting authority can be held responsible for them*



Coming soon:  
[www.mibirem.eu](http://www.mibirem.eu)





## Natural Catch<sup>TAUW</sup>

Reactive mat on riverbed passively catches groundwater contaminants



# Situation



- Ghent (Belgium)
- Former tar and carbon-black factory site
- Large residual S&GW contamination
- Site largely redeveloped (car dealers)
- Contaminated groundwater flows into **draining canal** 'Lieve'
- Influx: 100 mg/m<sup>2</sup>/day hydrocarbons (10% benzene, 30% naphthalene, 18% phenanthrene, 7% acenaphthene)
- Surface water concentrations exceed up to 300 times environmental quality standard



# Challenge & approach

---

## Goal

Structural improvement of the surface water quality (elimination of ecological/human risks)

## Demands OVAM / Interreg for approach

Sustainable nature-based solution

## Solution

Reactive mat (*Natural Catch*<sup>TAUW</sup>) on bed of canal. Three nature-based pillars:

1. Natural drainage capacity of the canal
2. Use of a green adsorbent in the mat
3. Biologically active interface on mat surface for aerobic biodegradation



# The Natural Catch<sup>TAUW</sup>



Total length 110 m. Mat elements: 16 upstream with biochar, 11 downstream with peat.



# Results & conclusions

---

Reduction of contaminant concentration in surface water:

- PAH, (B)TEX and C6-C10: 80-99%
- Benzene 70-80% (higher mobility)

Aerobic and anaerobic bacteria are present to biodegrade BTEX, PAH and alkanes at mat / surface water interface in low to moderate numbers

On base of sustainability assessment on 22 indicators the Natural Catch<sup>TAUW</sup> is a more sustainable alternative than excavation or smart pump&treat (flow interception)

This Natural Catch<sup>TAUW</sup> also works for pesticides (e.g. lindane), isomers (e.g.  $\beta$ -HCH) and other by-products (e.g. chlorobenzenes) and intermediates (e.g. MCB) □ similar sorption



# Take-away messages

---

- Nature based solutions are key regarding the number and complexity of sites in EU (also in accordance with ISO 18504)
- A lot of EU-projects on this subject have been initiated:
  - First results have been booked (like RESANAT)
  - Promising new NBS-approaches are expected within 3-5 years (like MIBIREM)
- NBS can be feasible for HCH-sites: cost-effective and applicable on large remote sites (low-tech, low maintenance)

