

Bioremediation: Nature's way or a Green Technology to combat marine oil spills?



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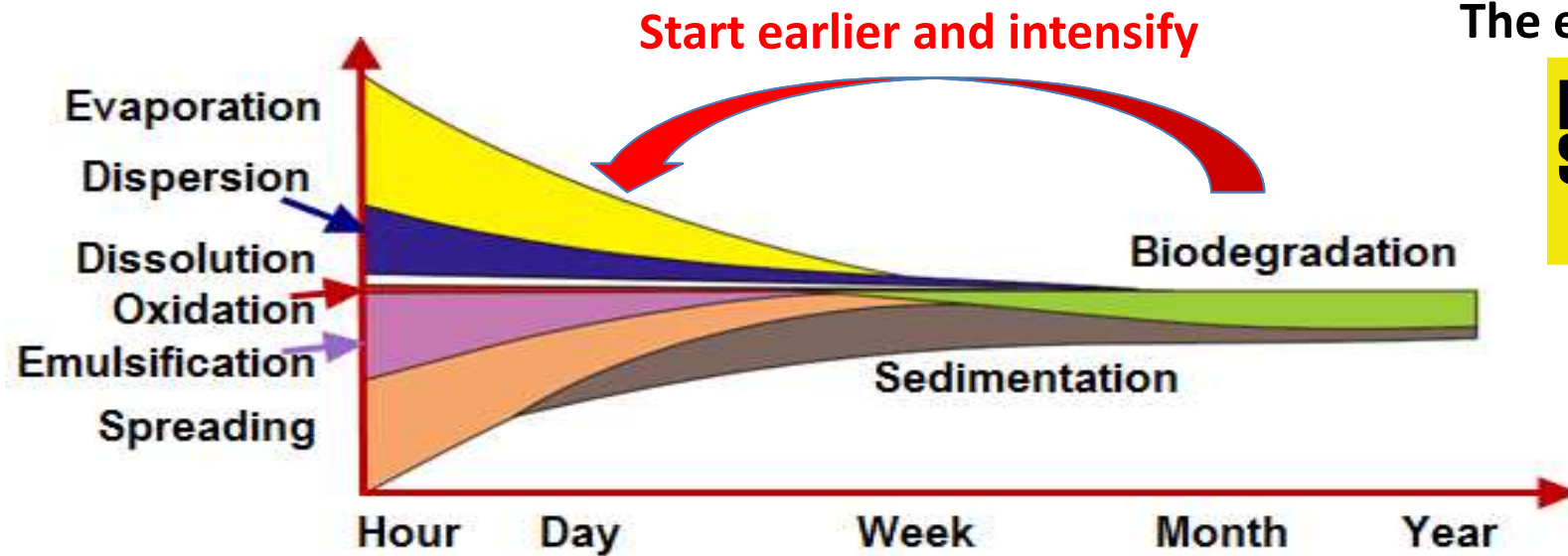
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interspill
AMSTERDAM 2015

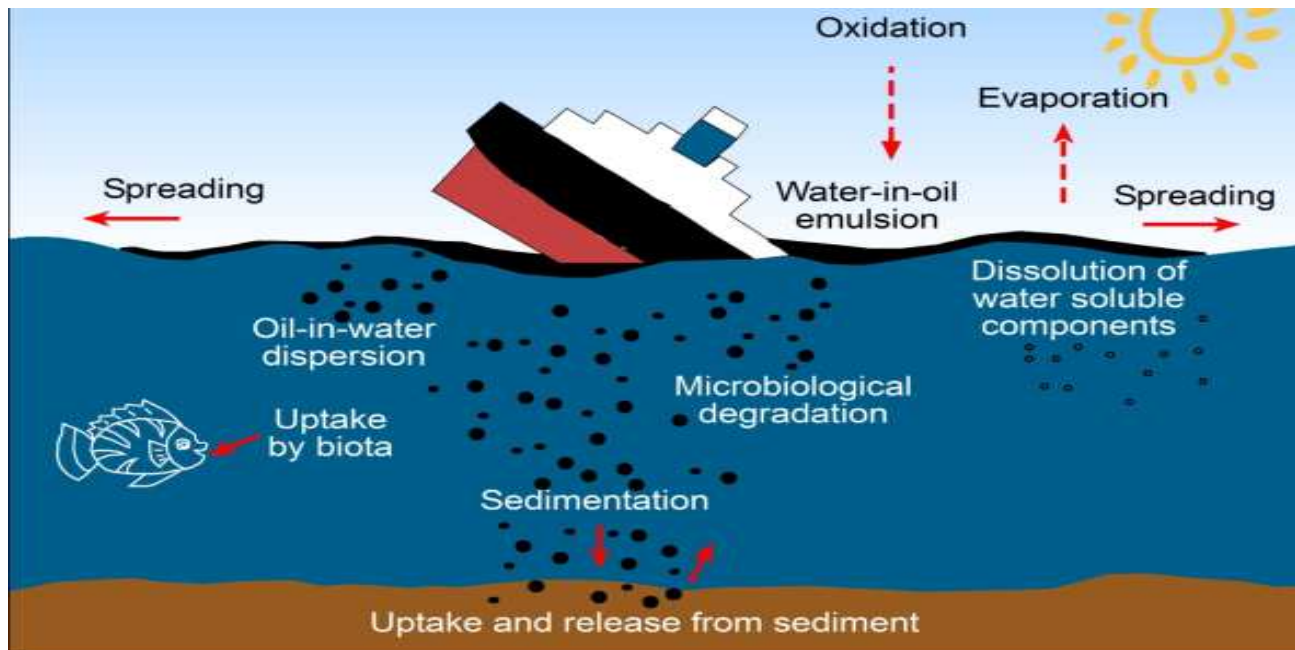
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Weathering processes & period of activation



The essence of



Bioremediation (naturally occurring)

- Bioremediation (is a weathering process) by CO_2 & H_2O indigenous microbes (mineralizing hydrocarbons → reduces HC toxicity in the marine environment) and takes place (**without any human intervention**); however,
 - It takes several days to weeks for the **hydrocarbon degraders to build up** their densities.
 - Naturally occurring **bioremediation rates are often low** (due to other limiting substrates).
 - In **extreme and pristine** environments – bioremediation rates are **even lower**.

Can we make bioremediation (nature's way) a Green Technology?

- To turn bioremediation from a weathering process into an attractive technology, several “problems” must be overcome (by human intervention):
 - Speed up the **growth of indigenous** hydrocarbon degraders **or add** (previously grown & lyophilized degraders) - **bioaugmentation**.
 - Add missing **nutrients** (primarily N&P) in oligotrophic environments - **biostimulation**.
 - Disperse oil into **fine droplets** (surfactants)
 - **Oxygen limitations** can be a real challenge.

Bioaugmentation – a controversial strategy?

- Usual Question: Is it really needed?
 - **NO**, if we look at longer term effectiveness (established from many field tests).
 - **YES**, if time is of essence – i.e., we want biodegradation to start “immediately” and at a high rate.
 - **Autochthonous Bioaugmentation** Approach (ABA) is a better choice.
 - Bioaugmentation may be **necessary in truly pristine environments where there are no hydrocarbon degraders**

Biostimulation – It matters how you do it!

- **Biostimulants:**

- *Source of N & P – Is an external supply needed?*

Depends on background concentrations, seawater currents & amount of oil spilled. Choices:

- **Inorganic fertilizers**
- **Slow release**
- **Oleophilic**
- *(Bio)surfactants – Are they needed? YES, but*
 - Most of the hydrocarbon degraders are also biosurfactant producers
 - If supplied externally – production stops and microbes simply degrade the hydrocarbons.

Bioremediation challenges (for use as an attractive technology)

Issues that have not been adequately addressed:

- **Slow degradation of Heavies** - they reach the bottom before they are degraded (**PAHs, asphaltenes**, etc)
- Treatment of **In Situ Burning (ISB) “Left overs”**
- **Toxicity of oxygenated HC** (e.g., naphthenic acids)
- What is the **optimum dispersion** (trade off between increased dispersion for **bioavailability vs. toxicity** of the finely dispersed oil & dispersant used)?
 - *biosurfactants & novel solvents will play a critical role.*
 - **High cost of biosurfactants.**
- **Bioremediation of sediments.**

**Bioremediation is a Green Technology
that should be considered within an
integrated approach to combat marine
oil spills...**

i.e., Do also the right things to promote bioremediation!

Thank you for your attention!

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