FROM BIOAVAILABILITY SCIENCE TO REGULATION OF ORGANIC CHEMICALS: A COMMUNICATION EXPERIMENT

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HOW TO COMMUNICATE BIOAVAILABILITY?

The scientific research area on the bioavailability of organic chemicals in soil and is only partially recognized by regulators and industries working in the environmental sector. After the positive experiences already made with metals, regulators have recently started to consider bioavailability within retrospective risk assessment (RA) frameworks (e.g. of contaminated sites) for organic chemicals.

Based upon outcomes of the Special Science Symposium, organized in 2014 by SETAC Europe [1], which led to a featured paper published in 2015 [2], we propose a simplified approach in which the concept of bioavailability considers the importance of an organism's cell membrane (Figures 1 & 2). In the integrated bioavailability approach for the implementation into the RA and management of contaminated systems, the following should be taken into account:

1. **Organic chemicals are sorbed to soil/sediment and sorption becomes stronger with time (ageing);**
2. **Desorption and remobilization from these sites will take more time and, therefore, putative toxicity will decline;**
3. **Only the rapidly desorbing molecules within the soil or sediment and the aqueously dissolved molecules of the contaminant have the potential to interact with the organism and, hence, are considered as bioavailable.**

In the present concept, we consider slowly/very slowly desorbing chemicals to be non-bioavailable at the time of measurement. This is a simplification, in terms of science but not in terms of application within RA of soil and sediment.

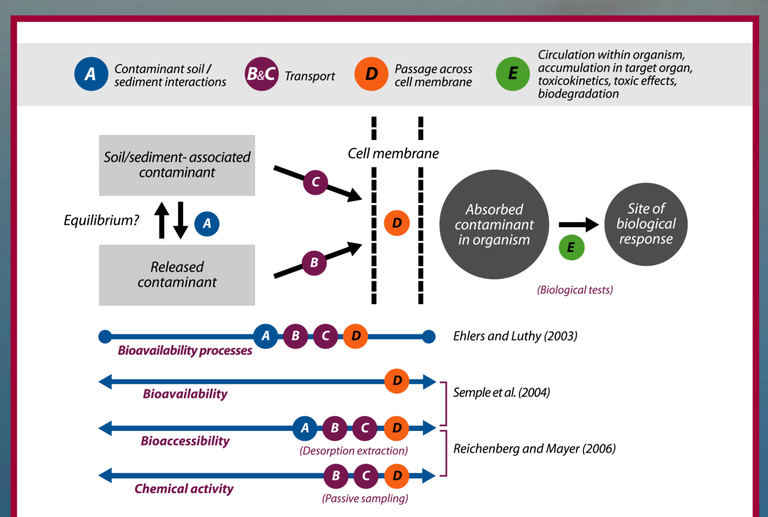
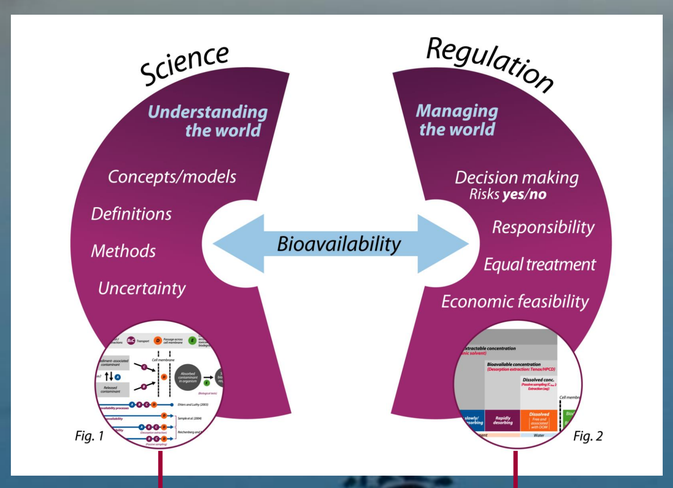


Figure 1. Overview of scientific **concepts of the bioavailability** of organic chemicals. Using the same framework, the figure places different schools of thought that have dissected bioavailability into the different processes that are involved (A to E), the dissimilar end points (bioaccessibility and chemical activity), and the different methodologies (desorption extraction, passive sampling and biological tests).



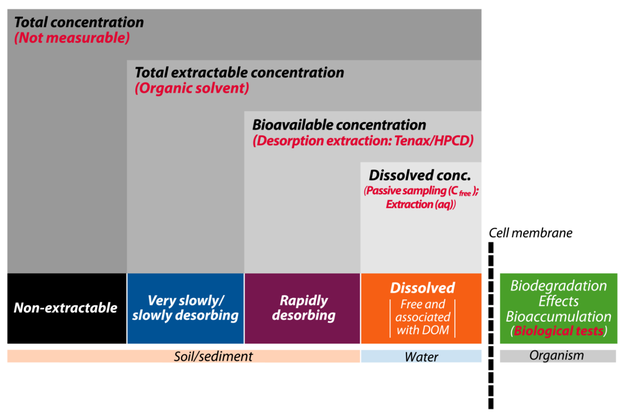


Figure 2. **Measurement of bioavailability**: a simplified scheme for use in **regulation**. The color boxes at the left of the cell membrane represent the distribution of pollutant molecules among four classes (nonextractable, very slowly/slowly desorbing, rapidly desorbing and water-dissolved) in soils and sediments. In our scheme, the bioavailable chemical is represented by the rapidly desorbing and dissolved concentrations.

CONCLUSIONS

The assessments of soil/sediment and the target chemical should be based on two measurable values: the total extractable concentration measured with a suitable reference method, and the bioavailable concentration as measured with a robust and reproducible chemical method (desorption extraction, passive sampling or aqueous extraction) or the effect of the bioavailable concentration on an organism (biological tests). Our presentations, leading to face-to-face discussions of this model with the scientific and regulatory communities [3-6], revealed this communication effort as opportune and timely.

To engage, at a global scale, with scientists, engineers and regulators working similarly, a new session, entitled "Bioavailability of Organic Chemicals for Retrospective Risk Assessment: Measurement, Applications and Communication", is currently in the scientific program of the 7th SETAC World Congress to be held November 5-10, 2016 in Orlando, FL.

REFERENCES

[1] SETAC Europe Special Science Symposium "Bioavailability of organic chemicals: Linking science to risk assessment and regulation". Brussels (Belgium), 14 and 15 October 2014 (http://sesss10.setac.eu/).
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[3] Session RA02 - Bioavailability of organic chemicals: Linking science to risk assessment and regulation SETAC Europe 25th Annual Meeting, Barcelona (Spain), 3-7 May 2015 (https://c.ymcdn.com/sites/www.setac.org/resource/resmgr/Abstract_Books/SETAC-Barcelona-abstracts.pdf).
[4] Session MA3 – Bioavailability/Bioaccessibility of contaminants. 6th International Contaminated Site Remediation Conference – CleanUp 2015, Melbourne (Australia), 3-17 September 2015 (http://www.crccare.com/files/dmfile/CLEANUP_2015_PROCEEDINGS-web.pdf).
[5] ECHA Topical Scientific Workshop on Soil Risk Assessment, Helsinki (Finland), 7-8 October 2015 (http://qsb.webcast.fi/e/echa/echa_2015_1008_workshop_day2_part2/#/webcast).
[6] The 8th International Workshop on Contaminant Bioavailability in the Terrestrial Environment, Nanjing (China), 18-21 October 2015 (http://hjxy.nju.edu.cn/bte/).