

Environmental Risk Assessment of Primary Alkylamine Surfactants in Soils

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Abstract

This study investigates concentrations of two primary alkylamine surfactants in soil pore water which become cationic in the protonated form, in dependence on the physico-chemical characteristics of the soils. Pore water concentrations of chemicals are useful as marker for environmental risk assessment in the context of equilibrium partitioning.

Introduction

The Equilibrium Partitioning Theory (EqP) describes the assumption that chemical activity is the same between each compartment at equilibrium. The quantified bioavailability and the concentration-response curve of biological effects for chemicals of concern in sediments and soils can be correlated with interstitial water concentration (Di Toro *et al.* 1991). This hypothesizes that pore water of soils may be used indicative for bioavailability of substances hence suitable to derive BCFs (bioconcentration factor) for future ecotoxicological and environmental risk assessment.

Objectives of the study:

- Quantitative analysis of primary alkylamine surfactants in pore water under the context of EqP in different soils.
- Investigation of the amount of these substances under equilibrium as marker for environmental risk assessment issues.

Tab 1: Physico-chemical properties of LUFA soils

Standard LUFA Soil	2.2	2.3	2.4
C _{org}	1.33	0.41	1.80
N (%)	0.17 ± 0.01	0.08 ± 0.01	0.22 ± 0.02
pH	5.4 ± 0.2	5.9 ± 0.6	7.4 ± 0.1
CEC (meq/100g)	9.7 ± 0.4	7.6 ± 0.8	32.9 ± 4.5
Soil type (German DIN)	Loamy sand (IS)	Silty sand (uS)	Clayey loam (tL)
WHC (g/100g)	44.8 ± 2.9	35.6 ± 1.4	44.8 ± 2.1

CEC= Cation Exchange Capacity; WHC = Water Holding Capacity

Methods

Three different LUFA soils* were used for the study, compare Tab. 1.

Determination of biological activity (OECD guideline 307)

Determination was done to estimate effects of biodegradability in relation to pore water concentration of tested substances during experiments. By using the OxiTop® system unsterile and sterilized soils were included. Mercury chloride and a triplet of antibiotics were used for sterilization.

Pore Water Analysis

LUFA Soils were spiked with **dodecylamine** and **octadecylamine** to 10 mg/kg dry weight. Pore water samples were obtained by centrifugation to determine equilibrium phase between solid and water phase. An additional sample set was established with sterilized soils by mercury chloride. Chemical analysis was done using LC-MS/MS. Method validation was conducted according to SANCO 3029/99 rev. 4 (2000).

Tab. 2: Physico-chemical properties of dodecylamine and octadecylamine (ECHA data)

Substance	# C-atoms	Molecular weight	Log P _{ow}	H ₂ O solubility
Dodecylamine	12	186.16	2.19	0.559 -3500 x 10 ³ µg/L (25 °C, pH 7)
Octadecylamine	18	270.33	3.99	0.559 -3500 x 10 ³ µg/L

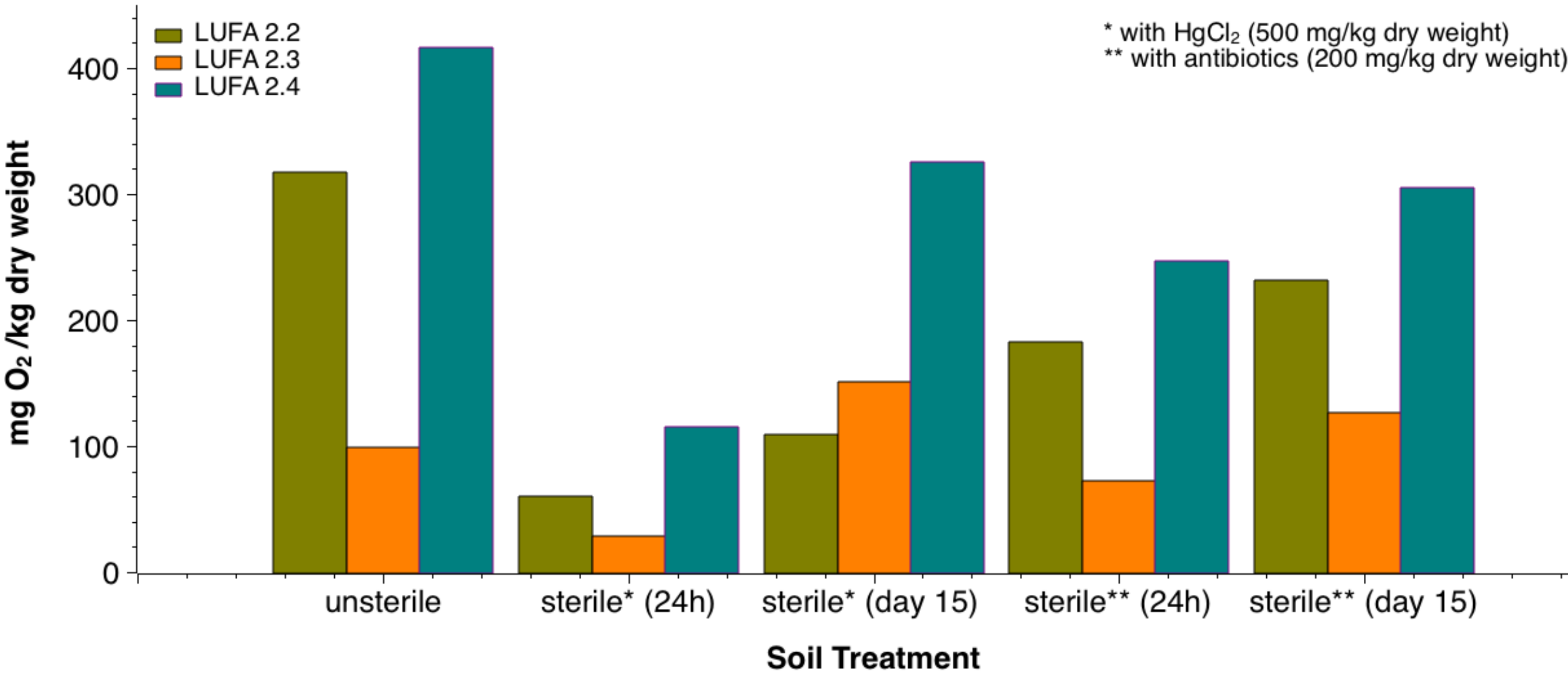


Fig. 1: Microbial activity of LUFA soils experiencing no sterilization, or sterilization by mercury chloride or a triplet of antibiotics (n = 1).

Results & Discussion

Method validation fulfilled all criteria concerning specificity, linearity, accuracy and precision according to SANCO 3029/99 rev. 4 (2000).

Biological Activity

Soil respiration values ranged from 28.7 to 416.4 mg O₂/kg dry weight (see Fig. 1) corresponding to 0.81 and 2.70 biomass (as percentage of organic carbon). Both sterilization methods reduced microbial activity within 24 h whereby HgCl₂ was more effective than the antibiotic triplet. Reduced microbial activity recovered within 15 days, due to regrowth of soil microorganisms.

Pore Water Analysis

A steady state between pore water and solid phase was not detectable. Amounts in pore water of dodecylamine ranged from < LOQ (limit of quantification) to 88.9 µg/L and <LOQ to 32.5 µg/L of octadecylamine, see Fig. 2. Although sterilization enhanced the concentration of dodecylamine, yield of test items in pore water were extremely low within the study.

Independent of an unknown fraction of cationic alkylamine surfactants adsorbing to soil particles - slightly varying due to substance properties - it is most likely that the tested items available in pore water are readily degraded in short time by microbial activity, inhibiting equilibrium partitioning between solid and water phase.

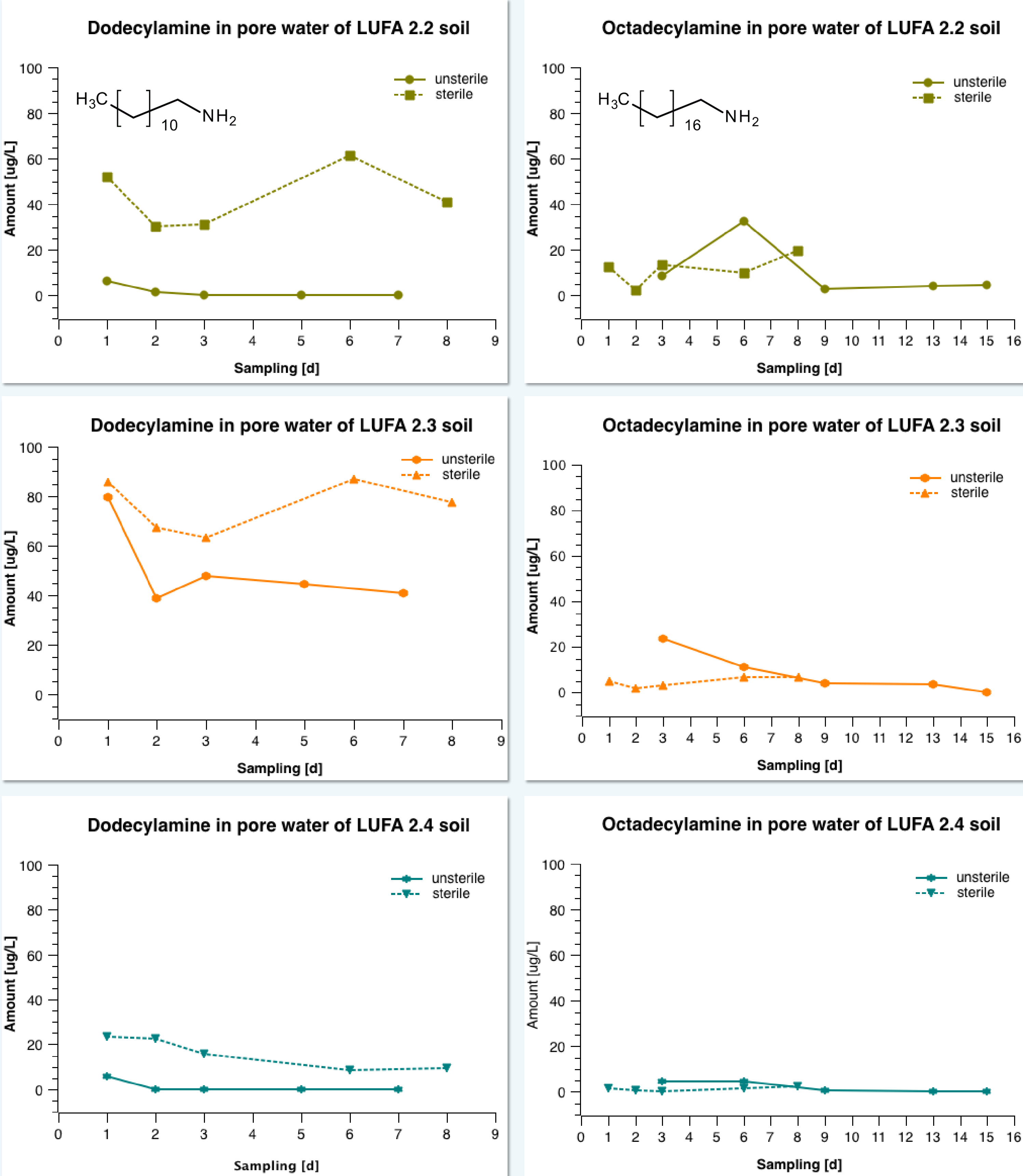


Fig. 2: Amount of the test items dodecylamine and octadecylamine in pore water of unsterilized and sterilized (HgCl₂) LUFA soils (n = 1).

Conclusions

We summarize that for the investigated cationic alkylamine surfactants pore water is not suitable in order to correlate physico-chemical properties of the tested soils with substance concentration. The potential bioavailability is low due to fast microbial degradation. With regard to detectable low amounts, pore water seems not to be a good exposition pathway for these substances. Therefore, implementation of long-term evaluation in the context of environmental risk assessment including the equilibrium partitioning model is difficult at this stage.

Di Toro, D. M., Zarba, C. S., Hansen, D. J., Berry, W. J., Swartz, R. C., Cowan, C. E., Pavlou, S. P., Allen, H. E., Thomas, N. A. and Paquin, P. R. (1991), Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. Environmental Toxicology and Chemistry, 10: 1541–1583.