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Soil quality — Environmental availability of non-polar organic compounds — Determination of the potential bioavailable fraction and the non-bioavailable fraction using a strong adsorbent or complexing agent

Qualité du sol — Disponibilité environnementale des composés organiques non polaires — Détermination de la fraction potentiellement biodisponible et de la fraction non biodisponible en utilisant un agent adsorbant fort ou un agent complexant

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 7, *Soil and site assessment*.

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Introduction

The solubility of most non-polar organic contaminants is limited and they are sorbed to the soil matrix. They may desorb and become available for organisms, which may result in an effect (toxicity, degradation or bioaccumulation). Not all sorbed (adsorbed and absorbed) contaminants will desorb and become available.

Extractions used in chemical analysis to measure the total concentration, release more contaminants from the soil than are available. It is however also possible that contaminants are so strongly bounded by the soil that they will not be released by chemical extraction. This strong sorption may also be caused by incorporation of the contaminant (or a degradation or reaction product of the contaminant) in the organic soil structure. The distribution of contaminants over sorption sites of varying sorption strength is not constant in time and contaminants will shift, with increasing contact time, to the stronger sorption sites.

Figure 1 shows schematically the differentiation between:

— extractable residues that are also bioavailable (i.e. the potentially bioavailable fraction);

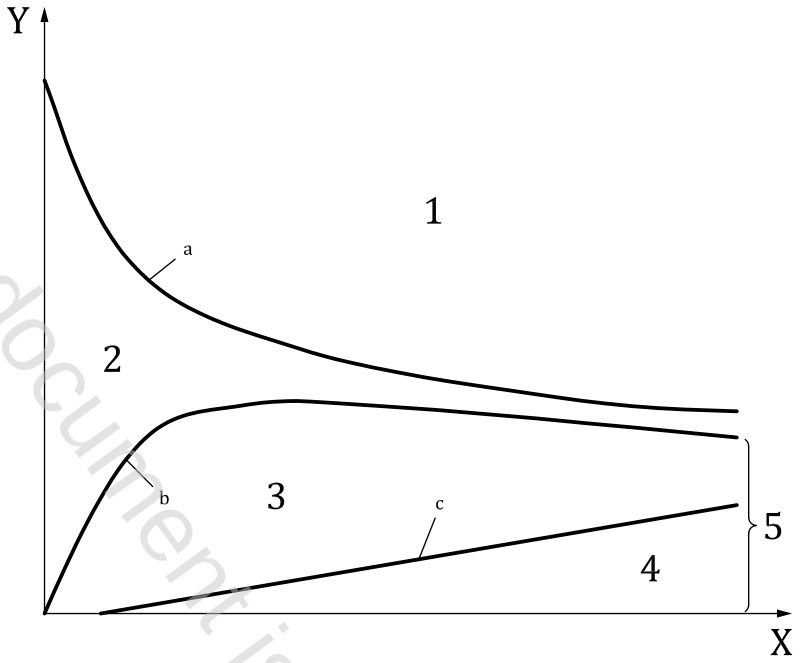
— residues that are extractable by harsher extraction methods but are non-bioavailable;

— residues that are neither extractable nor bioavailable.

If a degradable substance enters a soil, part of it will degrade over time (curve a). The area between curve a and c is extractable by exhaustive chemical procedures. For risk assessments, this part is considered as the “total concentration” for which values are defined in many regulations. However only a part of this amount is bioavailable. The area between curves a and b is the bioavailable fraction and the area between curves b and c is the non-bioavailable fraction. The method described in this document enables the measurement of the potential bioavailable and the non-bioavailable fraction of a contaminant in soil.

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Key

X time
Y contaminant concentration
1 degradable
2 bioavailable
3 extractable, non-bioavailable
4 non-extractable: persistent residues
5 non-available fraction

NOTE For curves a, b and c see description in text above.

Figure 1 — Temporal changes in extractable/bioavailable fractions, extractable/non-bioavailable fractions and non-extractable/non-bioavailable fractions of a non-polar organic contaminant (modified from [1])

In the scientific research to bioavailability a large number of definitions and concepts are in use, which reflect the discussion in the scientific world. However, for regulatory purposes a more clear and simple approach is necessary. In regulation, organic contaminants are either bioavailable or non-bioavailable. To support decisions, both should be measurable. Therefore, this document follows the approach of Ortega-Calvo et al. (2015)[2] as illustrated in Figure 2. In this approach all defined fractions are measurable as further explained in Clause 4.

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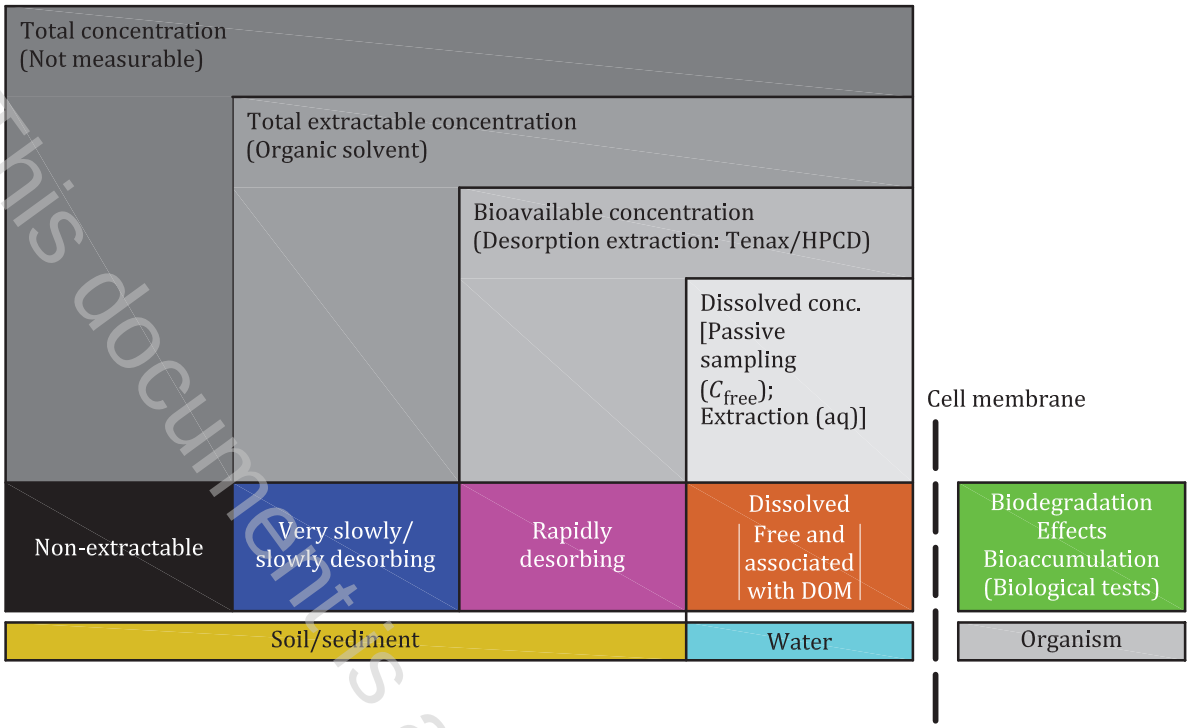


Figure 2 — Measurement of bioavailability of organic chemicals: a simplified scheme for use in regulation [Source: Ortega-Calvo et al. (2015)]

The colour boxes at the left of the biological membrane represent the distribution of pollutant molecules among four classes (non-extractable, very slowly/slowly desorbing, rapidly desorbing and water-dissolved) in soils and sediments. In the scheme in Figure 2, the bioavailable chemical is represented by the rapidly desorbing and dissolved concentrations. The chemical methods able to measure the pollutant present in each specific fraction are given in the grey boxes. The green box to the right of the cell membrane represents the processes that occur within the organism exposed to the pollutant. These biological processes can also serve as the basis for standard methods used for bioavailability measurements.

As presented in Figure 2, the bioavailable fraction can be measured using the method described in this document.

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Soil quality — Environmental availability of non-polar organic compounds — Determination of the potential bioavailable fraction and the non-bioavailable fraction using a strong adsorbent or complexing agent

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1 Scope

This document specifies an extraction method to determine the bioavailable (potential and environmental available) fraction and the non-bioavailable fraction of a contaminant in soil using a "receiver phase" for an organic contaminant with strong sorbing or complexing properties, for example, Tenax®[1)] or cyclodextrin, respectively.

NOTE 1 The bioavailable fraction is defined in ISO 17402 as environmental bioavailability.

The method is applicable for non-polar organic contaminants with an aqueous solubility of <100 mg/l. The method is applicable for soil and soil-like material including (dredged) sediments.

NOTE 2 The method is theoretically applicable to non-polar organic contaminants with an aqueous solubility of 1 000 mg/l. The method has been often applied for compounds with a much lower solubility (K_{ow} > 3) and less for compounds with a higher solubility. The applicability is therefore defined for compounds with an aqueous solubility of <100 mg/l.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11074, *Soil quality — Vocabulary*

ISO 11465, *Soil quality — Determination of dry matter and water content on a mass basis — Gravimetric method*

ISO 14507, *Soil quality — Pretreatment of samples for determination of organic contaminants*

ISO 17402, *Soil quality — Requirements and guidance for the selection and application of methods for the assessment of bioavailability of contaminants in soil and soil materials*

ISO 18512, *Soil quality — Guidance on long and short term storage of soil samples*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11074, ISO 17402 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

1) Tenax® is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

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