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Soil quality — Characterization of soil with respect to human exposure

Qualité du sol — Caractérisation des sols relative à l'exposition des personnes

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15800 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 7, *Soil and site assessment*.

Introduction

Characterizations of soils and sites relative to human exposure are performed all over the world. They are often planned and conducted by consultancy companies and expert organizations. Data from these characterizations are used in the assessment of human exposure. These characterizations are, furthermore, used for decision-making by companies, individuals and local and national authorities as well as for recommendations and regulations issued by national and international authorities.

The assessment of potential human health effects from exposure may be used for:

— classification of contaminated sites;

— recommendations regarding remediation of sites, soils and soil materials, e.g. priority of remediation;

— decisions regarding the future/planned use of contaminated sites;

— decisions regarding the disposal/treatment/reuse of contaminated or remediated soil and/or soil material.

The data needed for evaluations of human exposure are to some extent dependent on the way in which the exposure is assessed, i.e. calculations may be based on scenarios each requiring different data.

The extent of investigations necessary for the assessment of human exposure may vary depending on the level of contamination and the areal use in question. In some cases the assessment of potential human health exposure may be based solely on information regarding the substances present in the soil and their concentrations and the relevant soil parameters. In other cases more detailed information on the availability of the substance will be necessary. This information will depend on the type and concentration of the substance, the relevant soil parameters and the type of exposure relevant for the areal use in question. Furthermore, the sampling method and strategies may depend on the areal use and the possible exposure patterns.

Due to the large expenditure necessary for both private landowners and public funds set aside for the remediation of contaminated land and the general movement of capital and industry/business corporations, International Standards on the characterization of contaminated soil, especially with regard to human health, are in great demand.

International Standards in this complex field will support the creation of a common scientific basis for the exchange of data, development of knowledge and sound commercial evaluation.

Soil quality — Characterization of soil with respect to human exposure

1 Scope

This International Standard gives guidelines on the kind and extent of soil characterization necessary for the evaluation of human exposure to substances that can cause adverse effects.

The possibilities of standardizing the calculations used for the assessment of human exposure are not included in this International Standard.

The information needed for evaluation of human exposure to contaminants leached from soil to surface and/or groundwater or transferred by runoff is not included in this International Standard. Aspects related to radioactivity and pathogens in soil and potential human exposure hereto are also not included in this International Standard.

2 Normative references

The following referenced documents are indispensable for the application 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 10381-1, *Soil quality — Sampling — Part 1: Guidance on the design of sampling programmes*

ISO 10381-5, *Soil quality — Sampling — Part 5: Guidance on investigation of soil contamination of urban and industrial sites*

ISO 11074 (all parts), *Soil quality — Vocabulary*

ISO 15175, *Soil quality — Characterization of soil related to groundwater protection*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 11074 (all parts), ISO 11259:1998 and the following apply.

3.1
bioavailability
degree to which substances present in a soil matrix may be absorbed or metabolized in the human body

NOTE In this context the definition refers to availability in the human body.

3.2
biodegradation
breakdown of a substance or chemical by living organisms, usually bacteria

3.3
contaminant
substance or agent present in the soil as a result of human activity

cf. **pollutant** (3.10)

NOTE There is no assumption in this definition that harm results from the presence of the contaminant.

3.4
data quality objectives
statement of the required detection limits, accuracy, reproducibility and repeatability of the required analytical and other data

NOTE Generic data quality objectives can sometimes be set at national level. Data quality objectives can also embrace an amount of data required for an area of land (or part of a site) to enable sound comparison with generic guidelines or standards or for a site-specific or material-specific estimation of risk.

3.5
exposure
reception of a dose of a substance

3.6
exposure assessment
process of establishing whether, and how much, exposure will occur between a receptor and a contaminated source

3.7
exposure pathway
course a substance takes from a source to a receptor

NOTE Each exposure pathway links a source to a receptor.

3.8
groundwater
any water, except capillary water, beneath the land surface or beneath the bed of any stream, lake reservoir or other body of surface water, whatever may be the geological formation or structure in which such water stands, flows, percolates or otherwise moves

3.9
hazard
inherently dangerous quality of a substance, procedure or event

3.10
pollutant
those substances which due to their properties, amount or concentration cause impacts on (i.e. harm to) the soil functions or soil use

[ISO 11074-1:1996]

3.11
receptor
potentially exposed person

3.12
risk
combination of the probability of occurrence of harm and the severity of that harm

[ISO/IEC Guide 51:1999]

3.13
risk analysis
use of available information to identify hazard and to estimate the risk

3.14
risk assessment
process of risk analysis and risk characterization

3.15
risk characterization
evaluation and conclusion based on the hazard identification and the exposure and effect assessment

3.16
site
defined area, in this context often contaminated by human activities

3.17
site characterization
collection of data providing appropriate information for exposure assessment

3.18
soil
upper layer of the Earth's crust composed of mineral particles, organic matter, water, air and organisms

[ISO 11074-1:1996]

3.19
soil function
function of soil which is significant to man and the environment

[ISO 11074-4:1998]

3.20
source
soil or soil component from which a substance or hazardous agent is released for potential human exposure

3.21
subsoil
material underlying the topsoil and overlying the solid (parent) rock beneath

NOTE All or much of the original rock structure has usually been obliterated by pedogenic processes.

3.22
surface water
lakes, ponds, impounding reservoirs, springs, flowing (streaming) waters, estuaries, wetlands, inlets, canals, oceans within the relevant territorial limits, and all other bodies of water, natural or artificial, inland or coastal, fresh or salt

3.23
topsoil
upper part of a natural soil which is generally dark-coloured and has a higher content of organic substances and nutrient when compared to the subsoil below

[ISO 11074-4:1998]

3.24
trace element
element in low concentration in soil material

NOTE A trace element can be essential at low concentration but harmful at higher concentration.

4 Characterization of soil and sites with respect to human exposure

4.1 Introduction

Characterizations of soils and sites with respect to human exposure are usually performed as a part of a risk assessment.

In this context, a contaminated site is an area defined e.g. by property boundaries and contaminated by past or present human activities. In many countries, contaminated sites are registered publicly as a consequence of specific legislation.

A risk assessment comprises the following elements:

— a hazard identification;

— a dose-response assessment;

— an exposure assessment;

— and, based on the above, a risk characterization.

Risk and exposure assessments are usually performed on the basis of one or more defined scenarios, e.g. in order to obtain general criteria related to the scenario, or on the basis of the data connected with a specific site.

This International Standard includes the element exposure assessment in relation to human exposure.

An exposure assessment is the process by which the intensity, frequency and duration of human exposure to a contaminant are estimated, and it comprises:

— source identification and characterization,

— identification of exposure routes,

— identification of relevant receptors/target groups,

— and based on this: the actual exposure assessment.

Exposure assessments can be carried out in order to assess either the total exposure of a given receptor group (e.g. the population at risk) or the additional exposure from a given source or activity. In this International Standard, only the additional risk from soil contamination is addressed.

For the assessment of possible effects on human health, an analysis of the exposure routes is a prerequisite. For this purpose, the actual and planned use of the site may be included in the assessment, as this may define which exposure routes are of relevance. If a new use is planned, a renewed assessment shall be carried out. Average-, worst- or reasonable-case exposure can be evaluated, and depending on the purpose of the exposure assessment, the data needs can differ for these situations.

If receptors are not directly exposed to a contaminant, exposure assessment needs to consider the various ways by which indirect exposure might occur, and its significance. A contaminant can also undergo transformations through biological, chemical or physical means that might affect its toxicity, availability and mobility. The risk depends on both the concentration of a contaminant and the route of exposure (skin contact, inhalation, ingestion, etc.). For this reason, analysis of the changes that the contaminant undergoes as a result of these transformations and phase transfer processes prior to exposure is an important part of exposure assessment.

Characterization of soil and sites with respect to exposure routes and quantification of the actual exposure is described in 4.2. Characterization of soil and sites with respect to source identification and characterization is described in 5.3, where reference to other relevant International Standards is also made.

4.2 Exposure routes

4.2.1 General

Human exposure from soil contamination may occur through different media.

The following routes of exposure directly from the soil exist:

— soil ingestion;

— dermal contact.

Airborne exposure due to volatilization comprises

— inhalation and ingestion of fugitive dust,

— elevation of outdoor concentrations,

— intrusion of vapours in buildings.

Exposure through the food chain comprises

— consumption of plants, including crops and cultivated plants, wild plants and fungi,

— consumption of animals and animal products, including wild animals.

Exposure routes connected to surface and groundwater are not included in this International Standard. These routes also include exposure due to showering, dishwashing and other domestic use of water, ingestion of fish and of piped water polluted by contaminated soil or groundwater surrounding the pipe. It should be noted that these routes can be very relevant pathways in the overall exposure pattern.

Transfer of contaminants from soil to surface waters is highly site-specific and depends on run-off volume, peak flowrate, soil erodability, slope length and steepness, sorption capacity of the soil, type of vegetation cover, and distance to receiving body. In practice, surface water pollution is usually monitored via direct measurement. With regard to exposure in connection with groundwater, ISO 15175 shall be followed.

The actual exposure routes depend on the site use.

— Playgrounds and private gardens (kitchen and ornamental) can be considered to cause the highest degree of human exposure during use. This use may imply close (skin) contact to the soil, ingestion of soil, ingestion of plants grown in the soil (and of soil on these plants) as well as inhalation of dust and vapours.

— Agricultural zones can be the principal exposure route through the food chain. The size of these areas means that, except when the farmer and his/her family consume part of production, crops are widely distributed to a large population. On the other hand, if the soil is the only source of contamination, the consumption of goods produced in the contaminated area represents only a very small part of those consumed by the population (through dilution with other product sources);

— Parks may be used in ways exposing humans to inhalation of dust and vapours, skin contact with soil/dust and, to a lesser degree than gardens, ingestion of soil;

— Sports facilities mainly give rise to exposure via inhalation of soil/dust and skin contact with soil/dust;

— Consolidated surfaces such as parking lots, roads, etc. give rise to exposure via inhalation of vapours and from accumulation of fine dust;

— Buildings (homes, schools, kindergartens, offices, industry and shops) give rise to exposure via vapours; soil carried into the buildings may cause inhalation and/or ingestion of dust.

— Industry can comprise consolidated and unconsolidated areas, park-like areas and buildings. The information needed for evaluation of human exposure in these types of areas have been listed above.

The actual exposure time can differ between similar site uses, due to differences in climate and actual site use patterns (e.g. number of days per week the site is in use).

An overview of relevant exposure routes for each site use is given in Annex A (informative).

In the following, the characterization of soils with respect to the different exposure routes is described. The uptake patterns and thus the importance of the different exposure routes will vary depending on the properties of the contaminants in question.

4.2.2 Soil ingestion

Soil ingestion by children happens through ingestion of dust, sucking of dirty fingers and by actual eating of soil. Distinction should be made between inadvertent and accidental intake and deliberate long-term persistent behaviour (Pica behaviour). In general Pica behaviour should be regarded as a special case, not necessarily relevant for the actual assessment.

NOTE Some young children go through a short period of exploratory soil ingestion.

Adults mainly ingest soil as dust, e.g. in connection with gardening, and as soil on non-cleaned vegetables and fruit. In the case of the characterization of a specific site, the actual behaviour should be taken into account.

To assess soil ingestion, the contaminant content usually taken into account is that resulting from extraction with strong extractants [this content is known as (pseudo)total for metals]. In addition, the hypothesis of total absorption of the contaminant in the digestive track is often made. A few animal experiments carried out show that this hypothesis is not always relevant, at least for metals. Methods (employing slightly weaker extractants) used for the description of uptake of metals from toys have also been used for this type of assessment. The potential for absorption of a given contaminant can vary with the soil particle size, and information on particle-size distribution may be relevant.

NOTE (Pseudo)total concentration is defined by the actual method of analysis, including the specific extraction method utilized, see 5.5.

4.2.3 Dermal contact

Skin contact with contaminated soil could be caused by dust reaching the skin through atmospheric deposition, by playing or by working with the soil. It should be noted that there is a distinction between skin contact in e.g. a private home and workplace contact, since the latter is usually regulated by health and safety at work. It should be noted that work-related matters are not covered by this International Standard.

For an assessment of this route of exposure, the information needed is the (pseudo)total concentration of each substance in the soil. For calculations of the efficiency of uptake through skin, once the soil particles have reached this surface, the parameters determining the bioavailability may be useful. In evaluation of soil contaminants in connection with skin contact, distinction should be made between contaminants that can be absorbed through the skin and substances potentially causing other effects, such as rashes from hyper-sensitivity.

4.2.4 Inhalation of dust

The actual importance of dust inhalation (and digestion) as an exposure route is connected to the actual site use [e.g. motorcycle scrambling and soccer fields are site uses where dust inhalation (and digestion) can play a major role]. Climatic conditions and vegetation cover also influence the actual exposure.

Calculations pertaining to uptake via dust can be based on general models for dust in air. For a detailed assessment of the uptake of contaminants from inhaled dust, the parameters determining the bioavailability can be useful. The concentration level usually varies with particle size, the smallest particles usually containing the highest concentrations and having the longest exposure times. This should be taken into account if only measurements of the average concentrations are available.