# • SOIL

## Key questions and key findings

**What is the trend in the situation of the agricultural land types in terms of their contamination by risk elements?**

- **Monitored concentrations of risk elements in agricultural soils in Slovakia have been below the limit for the most part. Records showed only increased contents of cadmium and lead in certain fluvisols, especially in lower regions of watercourses.**
- **Risk substances from the first three monitoring cycles (abstraction years of 1993, 1997, and 2002) were assessed under already invalid Decision of the Ministry of Agriculture of the Slovak Republic no. 521/1994 - 540 on highest permissible values of pollutants in the soil. Outcomes of the 3. cycle (abstraction year of 2002) showed that the contents of the majority of risk substances in selected agricultural land types in Slovakia did not exceed the set limit of that time. In case of cadmium and lead, excessive limit values were recorded only in soils situated in higher altitudes, podsols, andosols, which may relate to remote transfer of emissions. Since between the 3. and 4. abstraction cycle (abstraction years of 2002 and 2007) there was a change in legal policies, it has not been possible to carry out comparisons in the contamination by risk substances under the currently valid legal framework.**

**What is the current balance of soil organic carbon (SOC) as one of the key indicators of soil quality?**

- **Currently, due to climatic changes and intensive changes in the use of land, the supplies of organic carbon in the soil has been changing quite rapidly. Based on the outcomes of the monitoring of land in Slovakia it has been shown that the average values of organic carbon within the arable land (AL) horizon of the same soil types are significantly lower that those on permanent grassland (PG), which has been the result of a long-term intensive tilling activities on AL. Mollicfluvisols show the highest SOC values, while pseudogley soils and brunisolic soils show the leat SOC values.**
- **When comparing the SOC situation for the 1. (abstraction year of 1993) and the last 4. (abstraction year of 2007) monitoring cycle, there was a growth in the contents of SOC in all major soil types, including arable land, as well as permanent grassland. The highest growth of SOC on AL has been recorded on mollicfluvisols and fluvisols.**
- **Changes to the SOC contents between the last two monitoring cycles 3 and 4 (abstraction years of 2002 and 2003) have not been so evident as when comparing cycles 1 and 4 (abstraction years of 1993 and 2007). This period clearly shows minimal increment in the soil organic carbon on monitored permanent grasslands. Arable land types in the cases of cambisols and chernozems showed stagnation in SOC and a very slight decline in the SOC contents was shown in pseudogley soils and brunisolic soils. Fluvisols and mollicfluvisols showed statistically significant growth in SOC in the period between the last two cycles.**

**What is the share of the agricultural land types threatened by erosion?**

- **Approximately 39% of total agricultural land size was threatened by water erosion in 2012, while 5.5% was threatened by wind erosion.**
- **Since the end of the 2. monitoring cycle (year 2001) up to the present day, potential water erosion has been on decline. Sizes of the potential wind erosion have not been high and have not significantly changed over the recent years.**
- **When comparing the size of land threatened by potential erosion expressed by erosion categories of the middle to extreme character at the end of the 1st monitoring cycle (the year 1996) compared to the year 2012 this size experienced decline by 183 677 ha for water erosion and by 20 190 ha for wind erosion.**

## Land use

Total size of the Slovak Republic is 4 903 557 ha. In 2012, the share of agricultural land was 49.07% of total land size, while the share of forestland was 41.07%, and the share of non-agricultural and non-forest lands was 9.86%.

**Land Use categories (state to the date 31st December 2012)**

| Land category | Area (ha) | % of total area |
|---|---|---|
| Agricultural land | 2 405 971 | 49.07 |
| Forest land | 2 014 059 | 41.07 |
| Water areas | 94 764 | 1.93 |
| Build-up land | 232 599 | 4.74 |
| Other land | 156 163 | 3.19 |
| **Total area** | **4 903 557** | **100.00** |

Source: GCCA SR

Anthropogenic pressure to use soil for purposes other than its primary production and environmental functions brings about its gradual decrease. Development in the size of the land in Slovakia in 2012 was impacted by **a continuous decline in the size of agricultural and arable land.**

The greatest percentage growth compared to 2000 has been recorded in the category of built-up areas and courtyards by 6.05% (+13 261 ha) that grew at the expense of all other categories, with the exception of forests and water bodies.

Artificial built-up areas within the EU comprise 4.3% of total land cover. As for Slovakia, this area takes up 2.4%, which is the least area size of all the neighbouring countries.

## Monitoring of soils and their quality

Information on state and trend in agricultural soil properties and their degradation may be obtained from the Partial Monitoring System - Soil (PMS-S) carried out by the Soil Science and Conservation Research Institute (SSCRI) and from the Agrochemical soil testing (AST) carried out by Central Controlling and Testing Institute in Agriculture (CCTIA). Information on state and trend in forest soil properties may be obtained from the Partial Monitoring System – Forests (PMS-F) carried out by the National Forest Centre – Forest Research Institute.

### ♦ Soil contamination by hazardous substance

Present situation in the contamination of the analysed land types with extraction carried out in 2007 was first monitored pursuant to annex 2 of Act 220/2004 Coll. on the protection and use of agricultural land and on amendment to Act 245/2003 Coll. on integrated environmental pollution prevention and control and amendments to selected laws as amended, which sets forth the limit values for high-risk elements within the agricultural land. For this reason it is not possible to compare contamination with the previous monitoring cycles there were assessed pursuant to the legislation then valid.

**Limit values of risk elements in the agricultural land types defined on the basis of the soil structure and value of soil reaction as well as the critical value of risk elements within the agricultural soil to plant relationship**

| Risk element | Limit values for risk elements in agricultural soil (in $mg.kg^{-1}$ of dry matter, aqua regia decomposition, Hg total content) | | | Critical values for risk elements as they relate to the agricultural soil and plant (in $mg.kg^{-1}$ of dry matter, in leachate of 1 mol/l amonnium nitrate, F in water leachate) |
|---|---|---|---|---|
| | Sandy, loam-sandy soil | Sand-loamy, loamy soil | Clay-loamy soil, clay | |
| Arsenic (As) | 10 | 25 | 30 | 0.4 |
| Cadmium (Cd) | 0.4 | 0.7 (0.4)* | 1 (0.7)* | 0.1 |
| Cobalt (Co) | 15 | 15 | 20 | - |
| Chromium (Cr) | 50 | 70 | 90 | - |
| Copper (Cu) | 30 | 60 | 70 | 1 |
| Mercury (Hg) | 0.15 | 0.5 | 0.75 | - |
| Nickel (Ni) | 40 | 50 (40)* | 60 (50)* | 1.5 |
| Lead (Pb) | 25 (70)* | 70 | 115 (70)** | 0.1 |
| Selenic (Se) | 0.25 | 0.4 | 0.6 | - |
| Zinc (Zn) | 100 | 150 (100)* | 200 (150)* | 2 |
| Fluorine (F) | 400 | 550 | 600 | 5 |

**Note:** Supplied data apply to samples obtained in arable land types from the upper layer of 0.2 m and air-dried to reach constant weigh, * if pH (KCl) is less than 6, ** if pH (KCl) is less than 5,

Assessed **concentrations of the risk elements (Cd, Pb, Cr, Cu, Zn, Ni, As, Hg)** within agricultural land types of Slovakia have **mostly been under the limit.** Some fluvisols showed increased contents of Cd and Pb, especially in the lower areas of water courses, which points to their frequent transport from more remote areas. Increased contents of Cd have been recorded in some rendzinas. Accumulation of Cd has been favoured by the organic matter and the neutral soil reaction at which this element becomes less dynamic.

The sites that in the past were contaminated (close to industrial facilities and within the geo-chemical anomalies impact area) are contaminated also nowadays, which means that soils have retained this adverse condition over a long time. The example of water-soluble fluoride in the **area of Žiarska basin** points to the fact that after a significant improvement in the contents of fluoride in emissions within that given area especially after 1998 there has been only a slight improvement in the soil. In fact, even at the present time, **values of water-soluble fluoride exceed almost 5 times the valid sanitary limit** (opposite the aluminium factory on pseudogley soils). As for the future, it will be necessary to continue with monitoring of these types of soils.

### ♦ Acidification of soils

Acidification as a process of raising the soil's acidity, represents one of the important processes of chemical soil degradation. The optimum value of soil reaction belongs to the key aspects of soil assessment. Each owner of agricultural land is obliged to implement the appropriate agro-technical measures focused on preserving soil quality and protection against its damage. Although acidification is a reversible process, consequences of acidification within the agro-eco-system are irreversible.

**Development of the soil reaction (pH/$H_2O$) in the soils of Slovakia on the basis of comparing the outcomes of four cycles**

| Major land unit | 1993 | 1997 | 2002 | 2007 |
|---|---|---|---|---|
| Mollicfluvisols AL | 7.29 | 7.24 | 7.03 | 7.08 |
| Fluvisols AL | 7.13 | 6.95 | 6.84 | 6.75 |
| Chernozem AL | 7.28 | 7.31 | 7.22 | 7.14 |
| Brunisolic soil AL | 6.71 | 6.85 | 6.90 | 6.66 |
| Pseudogley soil AL | 6.66 | 6.70 | 6.47 | 6.45 |
| Pseudogley soil PG | 6.31 | 6.24 | 6.13 | 5.88 |
| Rendzinas AL | 7.27 | 7.25 | 7.54 | 7.97 |
| Rendzinas PG | 7.17 | 7.18 | 6.57 | 7.27 |
| Regosols | 6.68 | 6.54 | 6.95 | 6.90 |
| Cambisols AL | 6.56 | 6.42 | 6.18 | 6.24 |
| Cambisols PG | 5.61 | 5.56 | 5.29 | 5.48 |
| Solonchaks and solonetz PG | 8.29 | 7.88 | 8.45 | 8.34 |
| Podsols, rankers, lithomorphic soils PG | 4.21 | 3.93 | 3.88 | 3.77 |

AL – arable land, PG – permanent grassland Source: SSCRI

Outcomes of the partial monitoring system - P have shown **more significant acidification tendencies mainly on cambisols and pseudogley soils** where it is possible to assume, given the limitation of agro-technical measures focusing on optimisation of the soil reaction values, a slow growth of soil reaction on the substrates that are naturally acidic. Acidification trends in soils with soil reaction showing mild acidic values may in the future result in deteriorated sanitary condition of the environment witnessed by the increased penetration of diverse pollutants that include especially heavy metals and aluminium into the food chain.

**Active aluminium** in agricultural soils in Slovakia has been significantly **lower in arable lands as opposed to grassland,** which is the consequence of the relationship between the soil quality and its use. Despite of this, high maximum values have been recorded also on arable land and they are in direct correlation with the lower soil reaction.

### ♦ Salinisation and sodification

The processes of salinisation and sodification have been monitored since 2000 on the built network of 8 stationary monitoring sites of which 6 are situated in the Poddunajská plane. These include mollicfluvisols in different stages of development of salinisation and sodification, along with solonchanks. In the area of the East-Slovakian lowland the monitoring network includes the solonchak in the municipality of Malé Raškovce. Anthropogenic sodification of soil by industrial emissions from aluminium production has been monitored in the vicinity of Žiar nad Hronom.

Process of sodium salts accumulation has been indicated over the period of three monitoring cycle. First of all it addressed over-limit values of total salt contents in all monitored lands. This process has been weak in the soils of Iža and Zemné and the values of total salt contents found in the interval of 0.10 - 0.15% point to the initial stage of salinisation. The sites of Gabčíkovo and Zlatná na Ostrove within the lower horizons recorded a transition into the middle salinisation level with the salts content of 0.15 - 0.35%. Middle level of salinisation was recorded also in the overall soil profile at the site Komárno-Hadovce where however occurred a decline in the overall salts contents for the whole monitored period. The sites of Malé Raškovce, Kamenín, and Žiar nad Hronom showed extreme contents of salts, especially within the 3 rd monitoring cycle, which may qualify them as **solonchaks.** Highest values were recorded mainly within the lower strata of arable land and substrate horizons. This proves that the process of salinisation takes place from the lower horizons up to the soil surface.

**Soil sodification** as a process of binding exchangeable sodium onto the sorption complex of monitored soils in 2012 is comparable to the previous years. Contents of exchangeable sodium within the sorption complex of 5 - 10% indicating a weak sodification was detected within the lower horizons of these sites: Iža, Zemné, Gabčíkovo, Komárno-Hadovce site. **High** (10 - 20%) **to very high** (above 20%) **contents of exchange sodium** have been recorded **at the sites of Zlatná, Malé Raškovce, Kamenín,** as well as within anthropogenicaly salinised soil at the site of **Žiar nad Hronom.** Soil sodification has been defined by soil reaction of pH > 7.3. The recorded values suggest that soil reaction of the majority of the monitored soils and horizons is mid – alkaline (pH 7.3 - 8.5). Only the sites of Kamenín and Žiar nad Hronom have been regularly recording strongly alkaline soil reaction values (pH above 8.5).

## ♦ Organic carbon in the soil

Contents and quality of the soil organic matter (SOM) is the energy basis for a number of biological processes. While it affects the productive function of soil, it also takes part in its extra-productive, mainly ecological functions.

Currently, due to climatic changes and intensive changes in the use of land, the supplies of organic carbon in the soil has been changing quite rapidly. Based on the outcomes of the monitoring of land in Slovakia it has been shown that the average values of organic carbon within the arable land (AL) horizon of the same soil types are significantly lower than those on permanent grassland (PG), This condition has been the result of long-term intensive mineralisation on AL during the ploughing of pastures along with a long-term tilling of the arable land. Mollicfluvisols on arable land show the highest SOC values, while pseudogley soils and brunisolic soils show the leat SOC values.

## ♦ Soil erosion

Potential erosion means possible threat to agricultural land types by processes of water erosion if we do not take into account the soil-protective effect of the vegetation cover. Water erosion (of different intensity) impacts 941 990 ha of agricultural land types in Slovakia.

**Exchange of water erosion categories for the year 2012**

| Erosion categories | Water erosion | |
|---|---|---|
| | Land area in ha | % from Agricultural Land |
| **No erosion or slightly** | 1 463 981 | 60.85 |
| **Medium** | 248 281 | 10.32 |
| **Strong** | 355 955 | 14.79 |
| **Extremely strong** | 337 753 | 14.04 |
| **Total** | **2 405 971** | **100.00** |

Source: SSCRI

Size of agricultural land types potentially impacted by wind erosion is 131 366 ha. These are mainly light granulated soil types with lower content of organic matter that are highly vulnerable to drying (and thus to wind erosion) especially when they are without vegetation cover.

**Exchange of wind erosion categories for the year 2012**

| Erosion categories | Wind erosion | |
|---|---|---|
| | Land area in ha | % from Agricultural Land |
| **No erosion or slightly** | 2 274 605 | 94.54 |
| **Medium** | 55 337 | 2.30 |
| **Strong** | 45 473 | 1.86 |
| **Extremely strong** | 30 556 | 1.27 |
| **Total** | **2 405 971** | **100.00** |

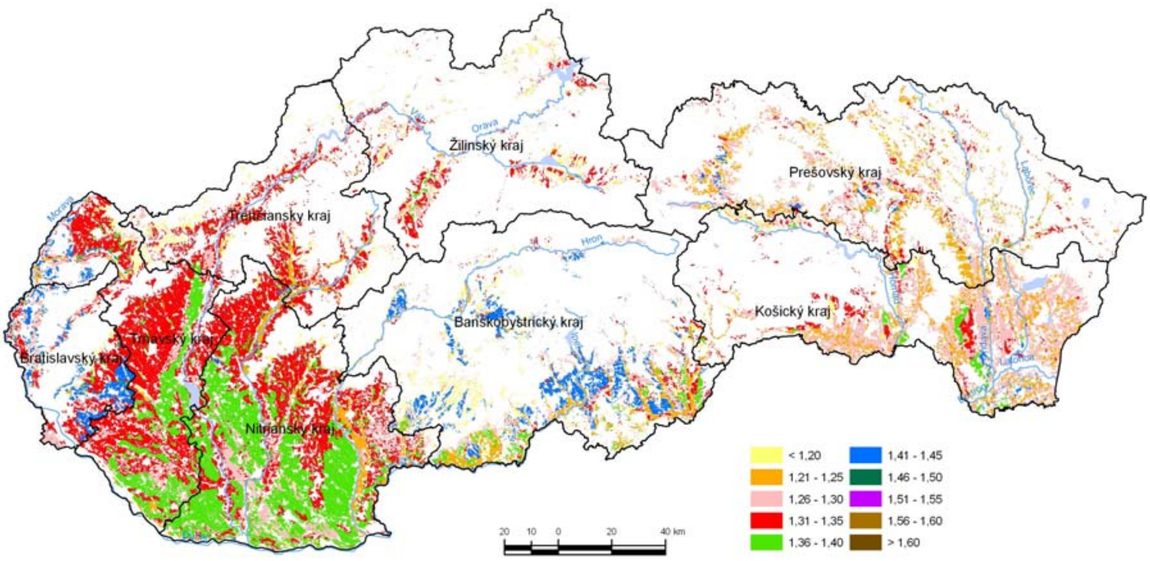
Source: SSCRI

## ♦ Soil compaction

Compaction of agricultural land represents a negative state that has been caused by the increase in volumetric weight. Compaction occurs as a consequence of faulty sowing and fertilizing procedures along with insufficient application of lime, and the incorrect use of agricultural machines. **Limit values of volumetric weigh of compacted soil** for individual soil types are published in **Act 220/2004 Coll.** on protection and use of agricultural land and on amendment to Act 245/2003 Coll. on integrated prevention and pollution control of the environment and on amendment and supplementation of certain laws.

State of the volumetric weigh within the arable land that contains the most part of the root system of plants categorised by the volumetric weigh ($g.cm^{-3}$) is shown by the following map.

**State of the volumetric weigh of the land in the Slovak Republic on the basis of data of the last completed sampling cycle of soil monitoring - arable land**




Source: SSCRI