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MANAGEMENT OF CONTAMINATED SITES IN SLOVAKIA

SLOVENSKÁ AGENTÚRA ŽIVOTNÉHO PROSTREDIA
SLOVAK ENVIRONMENT AGENCY

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SLOVENSKÁ AGENTÚRA ŽIVOTNÉHO PROSTREDIA
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Investment into Your Future!

Education and public awareness as a support in contaminated sites remediation in SR

The project is co-financed by the European Union Cohesion Fund

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MANAGEMENT OF CONTAMINATED SITES IN SLOVAKIA

CONTENT

INTRODUCTION

Contaminated sites in Slovakia represent a serious problem, the systematic solving of which began successfully in 2006 with the launching of the *Systematic Identification of Contaminated sites in the Slovak Republic.* Thanks to this project, which was directed by the Slovak Environment Agency (SEA), approximately 1800 locations were identified containing various chemical substances as a result of long term activities by people. From this figure, about 1200 present a health risk to people and the environment. On the basis of the project's results, an information system of contaminated sites was formed in 2008 and in 2010 the Ministry of the Environment of the Slovak Republic (MESR) presented the government with a strategic document entitled *The State Remediation Programme of Contaminated sites (2010–2015).* The only thing missing relating to this issue was a comprehensive legislative framework and enactment of the principle *polluter pays.* Gradual steps led to revision of the Geological Act in 2009 – Act no. 569/2007 Coll. on Geological Works (Geological Act) as amended, and the Regulation of the MESR no. 51/2008 implementing the Geological Act. In 2011, the Ministry of the Environment of the Slovak Republic managed to enforce the law on "Contaminated sites", Act no. 409/2011 Coll. on certain measures in relation to contaminated sites, and amendments of certain acts whose preparation took almost eight years. After these significant steps had been taken, in the field of contaminated sites, appropriate conditions had finally been set, in order for financial funds to be obtained through the Operational Programme Environment (2007–2013) and the Operational Programme Quality of the Environment (2014–2020).

Running concurrently with the above mentioned activities, the Ministry of the Environment has conducted numerous significant projects which, in terms of the development cycle of environmental politics, have prepared the groundwork for public and political recognition of these issues and led to significant steps being taken towards the removal of contaminated sites. Above all, these concern the following projects:

- Regional Studies of the Environmental Impacts of Contaminated sites in Selected Regions (2008–2010),
- The Upgrade of the Information System of Contaminated sites (2010–2014),
- Education and public awareness as a support in contaminated sites remediation in SR (2012–2015),
- The Atlas of Remediation Methods for Contaminated Sites (2010–2011),
- Investigation of Contaminated sites in Selected Localities in the Slovak Republic (54 locations),
- Monitoring of Contaminated sites in Selected Localities in the Slovak Republic (160 locations),
- Potentially Contaminated sites – a Survey of Selected Localities in the Slovak Republic (87 locations) and
- Remediation Projects of Contaminated sites in 19 Selected Localities.

Members of the public frequently ask questions on what has actually changed since passing the new law on contaminated sites. If somebody expected a miracle overnight then they will be disappointed. The new legislation, above all, has created the conditions for further work in this field and for the smooth acquisition of European grants. This has been one of the first successful 'goals of the match scored' which, according to estimates, will last a minimum of 20 years. And this applies only in the case, that those responsible and the state as a whole, will have sufficient funding for removal of contamination.

What is most important for us, according to the constitution where our rights are to inhabit a healthy environment, is the fact that adoption and implementation of the law represent significant steps towards the gradual elimination of contaminated sites in Slovakia and to environmental improvements, as well as sustainability for future generations.

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LEGISLATION ON ADDRESSING CONTAMINATED SITES IN SLOVAKIA

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The handling of contaminated sites is regulated by the following legal norms in Slovakia:

a) Act No. 409/2011 Coll. on Certain Measures in relation to Contaminated sites, and Amendment of Certain Acts, also known as 'the Contaminated sites Act',
b) Act No. 569/2007 Coll. on Geological Works (the Geological Act) as amended,
c) the Regulation of the Ministry of Environment of the Slovak Republic No. 51/2008 Coll. Implementing the Geological Act.

ACT NO. 409/2011 COLL. ON CERTAIN MEASURES IN RELATION TO CONTAMINATED SITES, AND AMENDMENTS OF CERTAIN ACTS

The 'Contaminated sites Act' was adopted on 21 October 2011 and came into force on 1 January 2012. The Act establishes:

a) persons' rights and responsibilities relating to the identification of contaminated site,
b) the manner for determining of the obliged person in relation to a contaminated site ("the obliged person"),
c) the rights and duties of an originator of a contaminated site (hereinafter only "the originator"), an obliged person and the ministry originator with authority over the activities which led to the contaminated site (hereinafter only "the competent ministry"),,
d) state authorities' competence relating to contaminated site,
e) penalties for breaches of obligations laid down by this Act.

IDENTIFICATION OF A CONTAMINATED SITE

This Act authorises the Ministry of Environment of the Slovak Republic (MESR) to identify contaminated sites, and the Ministry has in turn entrusted the Slovak Environment Agency (SEA) with this function. Identification of contaminated site involves a group of activities, including classification and completion of a contaminated site registration form.

The classification of a contaminated site consists of evaluating their risks and ranking them according to their estimated risk level and the resulting urgency of geological works on them. Classification of contaminated sites comprises three constituent classification categories:

K1: Classifying the risk of the pollution spreading into and via groundwater,
K2: Classifying the risk presented by volatile and toxic substances for the populace,
K3: Classifying the risk of the pollution of surface water.

The final classification K is the sum of the constituent classifications: K = K1 + K2 + K3.

Once classified, contaminated sites are categorised according to their final K value into one of three groups:

1. low-priority contaminated sites – K is less than 35 points
2. medium-priority contaminated sites – K is between 35 and 65 points
3. high-priority contaminated sites – K is more than 65 points

REPORTING SUSPECTED CONTAMINATED SITE

Any person who suspects the existence of a contaminated site is entitled (but not obligated – this is not a duty) to report this to the MESR or a regional environment office. If this report pertains to a contaminated site that is already registered in the Information System of Contaminated sites, the MESR or regional environment office shall inform the person who submitted the report of this and shall not continue with the identification process. A report of the existence of a contaminated site is to be submitted on paper, electronically or orally as a recorded statement. A report template is included in an annexe to the Act. The MESR shall verify that the report fulfils all the established criteria; if it does not, it shall ask the person who submitted the report to correct it. Then the MESR shall take practicable steps to determine whether the report suggests the real possibility of a contaminated site. If the MESR determines, based on the report or otherwise, the existence of a contaminated site, it shall complete a contaminated site registration form and classify the site.

THE MESR'S COURSE OF ACTION AFTER IDENTIFYING A CONTAMINATED SITE

After identifying a contaminated site, the MESR proceeds as follows:

a) immediately registers the site into the Information System of Contaminated sites,
b) sends a report of the contaminated site's identification to the land register,
c) within 15 days of the site's registration in the land register, sends a report of the contaminated site's identification to the owner of the real estate, the occupant (if the owner is not currently the occupant), or the custodian of the property where the contaminated site is located, as well as the governing municipality.

WHO IS OBLIGED PERSON FOR A CONTAMINATED SITE?

A contaminated site is the liability of:

a) the originator of the contaminated site,
b) a designated obliged person,
c) or the state, represented by the corresponding ministry.

THE ORIGINATOR OF CONTAMINATED SITE

The originator is anyone whose activity brings about contaminated site. The originator is immediately obliged for contaminated site by operation of law; their liability does not need to be established by a decision of the regional environment office. The Act frees the originator of liability for contaminated site in the following two cases:

a) if the state has undertaken to remediate the contaminated site on the basis of a contract concluded before this Act came into force or on the basis of a decision of the government of the Slovak Republic, or
b) if the contaminated site is the result of lawful waste disposal.

THE OBLIGED PERSON

If the originator of the contaminated site has died or ceased to exist, the regional environment office shall designate the originator's legal successor as the person liable for the contamination. For the purposes of this Act, heirs and persons designated in separate statutes (e. g. a recipient of restitution) are not considered the originator's legal successors. If the originator is unknown or their legal successor cannot be designated as the obliged person, the regional environment office shall designate the owner of the property containing the contaminated site as the obliged person.

The Act stipulates that a person who proves at least one of the following conditions cannot be designated as the obliged person:

a) funds designated for the improvement of the environment in a contract concluded pursuant to § 14, paragraph 1 of Act No. 92/1991 Coll. on the Conditions of Transfer of State Property to Other Persons (the Large-Scale Privatisation Act) have been allocated towards the contaminated site; the allocated funds must be evidenced by documentation of the improvement of the state of the environment,
b) all liabilities for improving the state of the environment relating to the contaminated site have been met pursuant to § 6a and § 15 of the Large-Scale Privatisation Act; this must be evidenced by documentation of the improvement of the state of the environment,
c) the state has undertaken to remediate the contaminated site on the basis of a contract concluded before this Act came into force or on the basis of a decision of the Government of the Slovak Republic, or
d) the contaminated site is the result of lawful waste disposal.

The owner of the property containing the contaminated site cannot be designated as the obliged person if they prove that:
a) they inherited the property and did not continue the activity which led to the contaminated site,
b) after acquiring the property they did not continue the activity which led to the contaminated site, and at the time of acquisition they could not have been aware of the contaminated site, or
c) after acquiring the property they continued the activity which led to the contaminated site, but without causing harm to the bedrock (mineral environment), groundwater, soil or human health.

THE RELEVANT MINISTRY

If the obliged person cannot be determined, the regional environment office shall end the proceedings to determine the obliged person and serve a decision to that effect to the MESR, which shall in turn submit a proposal for the designation of the relevant ministry to the government of the Slovak Republic. The relevant ministry designated by the government shall ensure the fulfilment of the obligations necessary for the elimination of the contaminated site in question.

The relevant ministry for industrial contamination is chiefly the Ministry of Economy of the Slovak Republic, for agricultural contamination (e. g. pesticide disposal sites) it is the Ministry of Agriculture and Rural Development of the Slovak Republic, for military contamination it is the Ministry of Defence of the Slovak Republic and for contamination related to waste storage it is the MESR. If it is not clear which ministry is the relevant one, this is decided by the government of the Slovak Republic.

PROCEEDINGS TO DETERMINE THE OBLIGED PERSON

The proceedings to determine the obliged person are initiated by the regional environment office either:
a) of its own accord or
b) upon the request of the owner, occupant (user) or custodian of the property containing the contaminated site.

The request of the owner, occupant or custodian of the property to initiate proceedings to determine the obliged person must contain:
a) the identification information of the owner, occupant or custodian of the property,
b) the name of the contaminated site according to the contaminated site registration form and
c) the name and code of the cadastral area according to the land registry's records and the names and numerical codes of the municipality, district and region containing the contaminated site.

The regional environment office's decision on the determination of the obliged person must, in addition to the general requirements, contain:
a) the name of the contaminated site according to the contaminated site registration form,

b) the name and code of the cadastral area and the names and numerical codes of the municipality, district and region containing the contaminated site,
c) the deadline for the submission of the work plan
d) and, if there are multiple obliged persons, the extent of each person's liability.

The regional environment office shall deliver its legally effective decision on the determination of the obliged person to the MESR for the purposes of updating the Information System of Contaminated sites.

WHAT IF THERE ARE MULTIPLE ORIGINATORS OR OBLIGED PERSONS?

If there are multiple originators of a single instance of contaminated site, they will each be held obliged, in accordance with this Act, to the extent that they contributed to the contamination.

If the extent to which each person contributed to the contamination cannot be determined, they will be held liable jointly and severally.

If multiple obliged persons are determined for a single instance of the contaminated site who are not owners of the property containing the contaminated site, they will be held liable in accordance with this Act jointly and severally.

If multiple obliged persons are determined for a single instance of contaminated site who are owners of the property containing the contaminated site, they will be held liable in accordance with this Act according to their share in the property.

If multiple obliged persons are determined of which at least one is the owner or co-owner of the property containing the contaminated site and at least one is not the owner or co-owner of the same property, they will be held obliged in accordance with this Act jointly and severally.

THE LIABILITIES OF THE ORIGINATOR, THE OBLIGED PERSON AND THE RELEVANT MINISTRY

The person or body obliged by law or government decision for the contaminated site (the originator, otherwise obliged person or relevant ministry) is obligated to ensure the preparation and implementation of a work plan for the elimination of the contaminated site. This person is also obligated to cover all the costs associated with the preparation and implementation of the work plan.

The Act also provides for cases where the originator is known or the obliged person has been determined, but this person does not meet their legal liability by failing to ensure the preparation and implementation of a work plan. If such a case imminently threatens the life or health of humans or the environment, these activities will be financed by the relevant ministry's public funds. In such a case, however, the originator or otherwise obliged person is not freed of their liabilities, and they are obligated to reimburse the relevant ministry for all allocated funds by no later than one year from the day the decision becomes effective to complete the implementation of the work plan.

RESTRICTIONS ON THE TRANSFER OF PROPERTY AND PROPRIETARY RIGHTS

If a property contains a contaminated site, this does not mean that it cannot be transferred to another person. If the originator or otherwise obliged person is also the owner of the property containing the contaminated site, they may transfer the property to another person, but only after ensuring the completion of an environmental geological survey of the environment relating to the property; the deed of transfer must include the final report of the geological survey.

Any such transfer of property must be reported, and the deed of transfer sent, to the regional environment office by the transferor (the originator or otherwise obliged person). The regional environment office will in turn issue a decision determining the new obliged person.

THE WORK PLAN FOR THE ELIMINATION OF CONTAMINATED SITE

If a contaminated site has been identified and classified, and the person obligated to meet the liabilities pursuant to this Act has been determined, then the primary objective of this Act, the remediation of contaminated site, will commence.

The originator, otherwise obliged person or relevant ministry are obligated to submit, for the regional environment office's approval, a work plan proposal for the elimination of the contaminated site, with one of the following priority levels:

a) high priority, with a specific deadline, depending on the nature of the obliged person or body, of:
    1. originator – one year from the day the Act came into force (i. e. by 1 January 2013),
    2. otherwise obliged person – one year from the day the decision on the determination of the obliged person comes into effect,
    3. relevant ministry – one year from the day the Government of the Slovak Republic determines the relevant ministry.
b) medium priority or low priority, with a specific deadline, depending on the nature of the obliged person or body, of:
    1. originator – five years from the day of the Act's entry into force (i. e. by 1 January 2017),
    2. otherwise obliged person – five years from the day the decision on the determination of the obliged person comes into effect,
    3. relevant ministry – five years from the day the Government of the Slovak Republic determines the relevant ministry.

In justified cases, primarily if the area containing the contaminated site is large, the deadline can be extended accordingly with the agreement of the MESR.

THE CONTENTS OF THE WORK PLAN FOR THE ELIMINATION OF CONTAMINATED SITE

The work plan for the elimination of contaminated site must specify:

a) the schedule and substance of the geological survey of the environment,
b) the schedule and substance of the remediation of the contaminated site,
c) the schedule and substance of the monitoring of geological factors of the environment,
d) the projected costs of the work plan,
e) the requirements stipulated by a separate regulation.

The separate regulation referred to in point e is the Geological Act, specifically the provision relating to the planning of geological tasks, their execution and their evaluation.

The work plan proposal for the elimination of contaminated site must be prepared in accordance with the State Remediation Programme of Contaminated sites and the Water Plan of the Slovak Republic, which includes an agenda of measures for the fulfilment of environmental goals.

THE APPROVAL OF THE WORK PLAN FOR THE ELIMINATION OF CONTAMINATED SITE

The submitted work plan proposal is approved by the regional environment office by a decision pursuant to the Act on Administrative Procedure (Act No. 71/1967 Coll.). Changes to the approved work plan may be made in two cases:

a) If it is determined during the work plan's implementation that a course of action different from the one in the approved work plan is necessary, or the implementation of the work plan incurs excessive costs, the originator, otherwise obliged person or relevant ministry shall request permission from the regional environment office to change the work plan.
b) The originator, otherwise obliged person or relevant ministry are obligated to update the work plan every six years until its implementation is complete, and to take the executed geological works into account while doing so.

The regional environment office must audit the implementation of the approved work plan at least once per year. The legally effective decision to approve a work plan, an updated work plan or a change to a work plan must be immediately sent by the regional environment office to the ministry for the purposes of updating the Information System of Contaminated sites.

COMPLETING THE IMPLEMENTATION OF THE WORK PLAN FOR THE ELIMINATION OF CONTAMINATED SITES

The work plan's implementation is only considered complete when a decision to this effect is issued by the regional environment office, on the basis of an application from the person for whom the plan was approved. With their application for such a decision, the applicant must include:

a) the final report of the remediation of the contaminated site (pursuant to § 16 of the Geological Act),
b) the final report of the monitoring of the geological factors of the environment (pursuant to § 16 paragraph 7 of the Geological Act),
c) a report on the fulfilment of the goals of the geological task, prepared under professional geological supervision.

Note that, according to § 18 paragraph 2 of the Geological Act, final reports accompanied by a risk assessment of contaminated site will be assessed and approved by the MESR, regardless of their source of funds, and within six months of their submission. For this reason, such final reports may only be submitted to the regional environment office after their approval by the Ministry.

STATE AUTHORITIES FOR CONTAMINATED SITES

The state authorities for contaminated sites are:

a) the MESR,
b) the department of environmental conservation of the regional environment office in the given regional seat,
c) the Slovak Environmental Inspectorate.

According to this Act, decisions in administrative procedures are first ruled on by regional environment offices; appeals against a regional environment office's decision go to the MESR for review.

THE SPECIFICS OF THE ADMINISTRATIVE PROCEDURE

Regional environment offices rule on decisions to:

a) determine the person obliged for instances of contaminated sites,
b) approve work plans for the elimination of contaminated sites,
c) complete the implementation of work plans for the elimination of contaminated sites.

The Act stipulates who may participate in the proceedings (aside from their proposer), which may include the following:

a) the municipality whose cadastral area contains the contaminated site,
b) the owner of the property containing the contaminated site, the occupant of the property (if the owner is not its current occupant), or the custodian of the property,

c) the owner of any property that may be impacted by the instance of contaminated sites in question, by the work plan or by its implementation,
d) if it so requests, any association or its constituent parts with legal personality and which has been active for at least one year in the sphere of environmental protection.

The regional environment office shall announce the commencement of the administrative proceedings on its website and its noticeboard for at least 15 days. This announcement must include an invitation for associations with legal personality to apply as participants in the proceedings. The administrative authority shall also request the municipality participating in the proceedings to announce the same information on their noticeboard, as well as on their website or in another locally customary fashion. Any associations with legal personality have the right to participate in the proceedings if they so request in writing. At the work plan approval proceedings, the regional environment office shall also request the positions taken by the relevant authorities, primarily those related to waste management, environmental and landscape protection, and water management.

SANCTIONS

If this Act is violated by a natural person, it is considered a crime, punishable by a fine of between 100 euros and 20,000 euros. If this Act is violated by a legal person or a natural person-cum-entrepreneur, it is considered an administrative offence, punishable by a fine of:

1. between 500 euros and 6,600 euros if:
   a) the owner, occupant or custodian of the property does not allow it to be inspected for the identification of contaminated site,
   b) the entity under inspection does not allow state supervision or fails to provide the necessary documents, clarifications and truthful and complete information related to contaminated sites,
2. between 1,000 euros and 15,000 euros if:
   a) the originator or otherwise obliged person does not ensure the preparation and implementation of a work plan,
   b) the originator or otherwise obliged person does not cover all the costs associated with the preparation and implementation of the work plan,
   c) the originator or otherwise obliged person does not submit a work plan for approval by the established deadline,
   d) the originator or otherwise obliged person does not request approval for a change to the work plan,
   e) the originator or otherwise obliged person fails to update the work plan,
   f) they do not implement the prescribed corrective measures.
3. between 5,000 euros and 33,000 euros if:
   a) the obliged person does not ensure the implementation of the work plan,
   b) a participant in the proceedings to determine the obliged person knowingly provides inaccurate data which may impact the determination of the obliged person,
   c) the originator or otherwise obliged person transfers the property to another person in breach of § 7 or fails to report the property's transfer to the regional environment office.

TRANSITIONAL PROVISIONS AND THE ACT'S ENTRY INTO FORCE

The 'Contaminated sites Act' came into force on 1 January 2012, but many activities related to the identification, investigation and remediation of contaminated sites had already been undertaken before that date. It was therefore necessary for the Act to address this situation in the transitional provisions. If legal relations and acts arose or commenced relating to the identification of contaminated sites or the preparation or implementation of a work plan before 1 January 2012, they were to be completed in accordance with the laws effective thereto. If a contaminated site had already been identified, classified and registered in the Information System of Contaminated sites by the MESR, the authorised organisation, before 1 January 2012, it is considered an identified contaminated site pursuant to this Act.

Some contaminated sites had already been remediated. To prevent any doubts about whether such a contaminated site can still be considered remediated pursuant to this new law, the MESR is authorised to issue a confirmation of the remediation of such a site, if an application therefore is submitted by the originator, obliged person, owner of the property containing the site or the relevant ministry. After issuing the confirmation, the ministry shall update the pertinent data in the Information System of Contaminated sites and the land registry.

The transitional provisions also stipulated that the owner of the property containing the contaminated site is not entitled to be reimbursed by the originator, obliged person or relevant ministry for the costs that they demonstrably incurred through activities prior to 1 January 2012 related to the implementation of a work plan for the elimination of contaminated site.

ACT NO. 569/2007 COLL. ON GEOLOGICAL WORKS (THE GEOLOGICAL ACT) AS AMENDED

The Geological Act defines several terms related to contaminated sites and establishes the procedures to be followed when investigating, monitoring and remediating them.

CONTAMINATED SITES

The Act defines an instance of contaminated sites as an area contaminated by human activity that presents a serious risk to human health or the bedrock, groundwater and soil, except for environmental damage as defined in Act No. 359/2007 Coll. on the Prevention and Remediation of Environmental Damage (§ 3, subclause s of the Geological Act).

Note: Act No. 359/2007 Coll. on the Prevention and Remediation of Environmental Damage and the Amendment of Certain Laws as amended came into force on 1 September 2007. Given that the law defines environmental damage to water and soil, it established, as of its entry into force, a distinction between pre-existing contamination (environmental burdens) and contamination arising after 1 September 2007 (environmental damage). Though the definitions of contaminated site (environmental burden) and environmental damage are not absolutely identical, both of them clearly refer to contamination presenting a risk to human health and the environment. In most cases the two terms are distinguished by their different times of origin; thus in the identification of water or soil contamination, the well-established distinction between 'burden' and 'damage' should not give rise to any legal uncertainty.

POTENTIALLY CONTAMINATED SITE

'Potentially contaminated site' is the status of an area reasonably supposed to contain a contaminated site (§ 3, subclause t).

Bases for a reasonable supposition include sources of contamination (pollution), centres of contamination, indications of contamination and observed manifestations of contamination. These terms are defined in Annexe No. 2 of the 'Contaminated sites Act'.
A source of contamination is a location or area where parts of the environment have been or are exposed to pollutants. Sources of contamination primarily consist of:

a) inappropriately disposed-of waste,
b) inappropriately disposed-of chemicals,
c) industrial operations and premises,
d) agricultural areas,
e) military grounds,
f) components of railway infrastructure – engine houses, railway stations, traction power stations,
g) fuel stations and pipelines,

h) mining and maintenance areas,
i) other operations and areas.

A centre of contamination is a space containing a primary or secondary accumulation of contamination in the bedrock.
Indicators of contamination include:

a) the presence of contamination sources mentioned in the previous paragraph,
b) state or local government records of the contamination of parts of the environment and/or inappropriate handling of pollutants,
c) archival information on contamination acquired through geological works,
d) data from selected environmental databases.

Observed manifestations of contamination include damage to the landscape, e. g. a change in vegetation, dead organisms, odour, the presence of extraneous substances, the presence of oil slicks in wells etc.

GEOLOGICAL WORKS

Geological works that address contaminated sites include:

- geological survey of the environment,
- monitoring the geological factors of the environment,
- the remediation of contaminated sites,
- professional geological supervision.

GEOLOGICAL SURVEY OF THE ENVIRONMENT

Geological survey of the environment is investigation that detects and verifies

1. the geological factors impacting the given environment, including the detection of contamination caused by human activity in the bedrock, groundwater and soil for the purposes of proposing remediation measures,
2. potentially or confirmed contaminated sites, evaluating the area's present and potential risks with regard to its present and future use for the purposes of proposing remediation measures, or
3. the geological conditions for the establishment and operation of an underground disposal site for radioactive waste or other waste.

MESR Regulation No. 51/2008 Coll. Implementing the Geological Act defines the phases of geological survey of the environment as follows:

a) the preliminary survey evaluates geochemical, engineering-geological and hydrogeological conditions, as well as
    1. determining the geological factors impacting the environment,
    2. identifying, verifying and confirming the presence of contamination caused by human activity, potentially contaminated site or confirmed contaminated site,
    3. making a preliminary risk assessment of the impact of contamination caused by human activity or the impact of potentially or confirmed contaminated sites on human health and the environment,
    4. seeking out appropriate rock structures or verifying the appropriateness of underground spaces for the disposal of radioactive and other waste,
    5. proposing monitoring of the environment's geological factors.
b) the comprehensive survey entails:
    1. verifying the identified geological factors and thoroughly studying their impact on the environment,
    2. verifying contamination caused by human activity or contaminated site, determining the degree, extent, spread, trends and variations in contamination caused by human activity or

environmental contamination, and identifying and characterising all pollutants, including their quantitative and qualitative parameters,
3. risk assessment of the impact of contamination caused by human activity or contaminated site on human health and the environment,
4. processing geological data to determine the optimal procedures for eliminating, reducing or limiting the negative impacts of contamination caused by human activity or contaminated site on human health and the environment,
5. processing geological data for the purposes of establishing and operating disposal sites for radioactive and other waste,
6. proposing monitoring of the environment's geological factors.

c) the supplementary survey entails:
1. observing and specifying the environmental impacts of geological factors related to various activities in the area,
2. observing and specifying the hazardous impact of contamination caused by human activity or contaminated site on human health and the environment,
3. acquiring new information on contamination caused by human activity or on contaminated site which was not foreseeable from the data produced by the comprehensive survey.

MONITORING THE GEOLOGICAL FACTORS OF THE ENVIRONMENT

Monitoring the geological factors of the environment consists of the continuous, systematic observation and evaluation of phenomena and parameters within precisely defined spatial limits and time intervals; such monitoring serves to objectively ascertain the characteristics of the geological environment and evaluate changes in it within the monitored area, thus tracking the impact of activities and constructions on the geological environment or the influence of the geological environment on the organic environment, constructions and activities (§ 2, subclause i of the Geological Act).

THE REMEDIATION OF CONTAMINATED SITE

The remediation of contaminated site consists of work performed on the bedrock, groundwater and soil with the goal of eliminating, reducing or limiting contamination to an acceptable risk level in view of the current and future use of the area (§ 3, subclause r of the Geological Act).

Note: § 3, subclause m of the Geological Act defines the term ***remediation of the geological environment*** *as works performed on the bedrock, groundwater and soil which entail special technological methods focused on eliminating, reducing or isolating the impacts of human activity and geodynamic phenomena on the environment. Thus remediation of the geological environment does not pertain to contaminated sites; it pertains instead to the remediation of slope deformation, environmental damage and other negative phenomena and impacts which have originated in the bedrock.*

The remediation of contaminated site refers to (§ 9a of the Geological Regulation):

a) eliminating the root cause of an instance of contaminated site,
b) restricting the geographical and spatial spread of pollutants in the groundwater, soil and bedrock,
c) eliminating or reducing the concentration of pollutants spread via polluted groundwater, soil and rock environments.

PROFESSIONAL GEOLOGICAL SUPERVISION

Professional geological supervision is supervision of the execution of geological works (remediation of the geological environment and remediation of contaminated site) by an independent natural person who is authorised to execute the type of geological works in question (§ 3, subclause u of the Geological Act).

GEOLOGICAL LICENSE

Geological works can only be executed by a natural person-cum-entrepreneur or a legal person that has been granted geological license by the MESR. A list of the legal and natural persons authorised to execute geological works is maintained by the MESR pursuant to § 4, paragraph 1, subclause a of the Geological Act, and it is available at www.enviro.gov.sk in the *section of Geology* or at www.minzp.sk.

The investigation of confirmed and potentially contaminated sites requires geological license for geological survey of the environment. The remediation of contaminated sites requires geological license for the remediation of contaminated sites, and the monitoring of contaminated sites requires geological license for the monitoring of geological factors of the environment.

PROFESSIONALLY QUALIFIED PERSON

To be granted geological license, the applicant must be a professionally competent person. Geological works concerning the investigation of confirmed or potentially contaminated sites require professional competence in geological survey of the environment; geological works concerning the remediation of contaminated site and professional geological supervision of remediation require professional competence in at least one of the following areas:

a) hydrogeological survey,
b) engineering-geological survey,
c) geological survey of the environment.

Geological works concerning the monitoring of contaminated sites requires one of the following professional competences:

a) geological research,
b) geological survey of deposits,
c) hydrogeological survey,
d) engineering-geological survey,
e) geological survey of the environment,
f) geochemical works,
g) geophysical works.

The MESR maintains a list of such professionally competent persons, which is also accessible at the abovementioned MESR websites.

THE PLANNING OF GEOLOGICAL TASKS

Before a geological task (investigation, remediation or monitoring of contaminated site) is carried out, the contractor must prepare a plan for the geological task. The geological task plan must state the goal of the geological task, propose and justify specific types of geological works for its implementation and specify the method and technical procedure that will ensure that they are carried out professionally and safely. As part of the planning process, it must be determined whether the execution of the geological works will affect any interests protected by specific laws, and if so, the plan must propose measures to preserve these interests. Such protected interests include the environment and the landscape, the soil, telecommunications, roads, railway tracks, energy infrastructure, military facilities, heritage sites and many others. The contractor of the geological works shall begin the implementation of the geological task after the geological task plan has been approved by the ordering party. Only in exceptional cases may the execution of the geological task begin before the geological task plan is approved.

SPECIAL REQUIREMENTS OF THE PLAN

According to § 20 of the Geological Regulation, a task plan that is part of a geological survey of the environment to detect and verify a potentially contaminated site is subject to the following special requirements:

a) data on the activities which led to the emergence of the potentially contaminated site,
b) identification and profile of the potential source of the pollutants,
c) identification and profile of the supposed pollutants,
d) data on the character of the bedrock in the zone of aeration and the zone of saturation.

If the task in question is part of a geological survey of the environment to detect and verify a (confirmed) contaminated site, the following special requirements apply to the plan:

a) data on the activities which led to the contamination caused by human activity or contaminated site,
b) identification of the source of the contamination,
c) data on the extent and degree of the environmental contamination,
d) data on the pollutants' direction of spread,
e) a profile of the detected pollutants, including their quantitative and qualitative parameters,
f) data on the character of the bedrock in the zone of aeration and zone of saturation.

If the task in question is part of the remediation of contaminated site, the following special requirements apply to the plan:

a) data on the results of the geological survey of the environment which detected the contaminated site,
b) results of the risk assessment of contaminated site.

PREPARATORY SURVEY

According to § 15, paragraph 4 of the Geological Regulation, the planning of a geological task may be preceded by a preparatory survey. A preparatory survey for the remediation of contaminated site has the following functions:

a) to assess and determine the feasibility of remediating the contaminated site based on the results of the geological survey of the environment,
b) to analyse and propose various methods and technical procedures for the remediation of the contaminated site,
c) to assess the risks of individual approaches to the remediation of the contaminated site,
d) to assess the cost-effectiveness of individual approaches to the remediation of the contaminated site.

THE FINAL REPORT OF A GEOLOGICAL TASK

A geological task that implements geological works is evaluated in a final report. If serious contamination resulting from human activity was detected and verified in the area during the execution of the task, the final report must contain a separate risk assessment of contaminated site (§ 16, paragraph 6 of the Geological Act).

The final report documents the results of the geological task's execution. The requirements of the final report are stated in Annexe No. 1 of the Geological Regulation. Its extent and overall content depend on the aim and purpose of the geological task in accordance with the geological task plan. The final report of the geological task is generally approved by the ordering party, i.e. the financer of the geological works, but final reports which include a risk assessment of contaminated site must be assessed and approved by the MESR, regardless of the geological task's source of funds, within six months of their submission (§ 18, paragraph 2 of the Geological Act).

SPECIAL REQUIREMENTS OF THE FINAL REPORT

If contaminated site is detected and verified in an area during a geological survey of the environment, the final report is subject to the following special requirements, pursuant to § 39, paragraph 4 of the Geological Regulation:

a) a risk assessment of contaminated site,
b) data on the waste's transport of and manner of handling,
c) a proposal to monitor the environment's geological factors specifying the parameters to be tracked.

A final report on a geological survey of the environment during which contaminated site was detected and verified also requires the following supplements:

1. a map of the investigated area and its surroundings marked with a map sheet number,
2. a geological map of the investigated area,
3. geological maps and cross-sections (including maps of the documentation points),
4. summary documentation of wells, mine workings etc., graphs of measurements and pumping tests, and data acquired through sample analysis,
5. a copy of the cadastral map with the contaminated area delineated by a closed geometrical outline and a certificate of title,
6. a map of the water table contours of the maximum and minimum groundwater levels,
7. a map of the contamination in the bedrock's zone of aeration,
8. a map of the contamination in the bedrock's zone of saturation,
9. a map of the groundwater contamination,
10. geodetic measurements of geological workings and constructions.

A final report of the remediation of a contaminated site is subject to the following special requirements:

a) data on the waste's transport and manner of handling,
b) an update to the risk assessment of contaminated site,
c) a proposal to monitor the environment's geological factors specifying the parameters to be tracked.

A final report of the remediation of a contaminated site requires the following supplements:

1. a map of the investigated area and its surroundings marked with a map sheet number,
2. a geological map of the investigated area,
3. geological maps and cross-sections (including maps of the documentation points),
4. summary documentation of wells, mine workings etc., graphs of measurements and pumping tests, and data acquired through sample analysis,
5. a copy of the cadastral map with the polluted area precisely marked and a certificate of title,
6. a map of the water table contours of the maximum and minimum groundwater levels,
7. a map of the contamination in the bedrock's zone of aeration – before remediation began,
8. a map of the contamination in the bedrock's zone of aeration – after the completion of remediation,
9. a map of the contamination in the bedrock's zone of saturation – before remediation began,
10. a map of the contamination in the bedrock's zone of saturation – after the completion of remediation,
11. a map of the groundwater contamination – before remediation began,
12. a map of the groundwater contamination – after the completion of remediation,
13. geodetic measurements of geological workings and constructions.

THE RISK ASSESSMENT OF CONTAMINATED SITE

The risk assessment of contaminated site must include the requirements listed in an annexe to the Geological Regulation. The chapter 'RISK ASSESSMENT OF CONTAMINATED SITE' (RNDr. Želmíra Greifová, MESR) is focused on this issue.

THE INFORMATION SYSTEM OF CONTAMINATED SITES

An amendment to the Geological Act established the Information System of Contaminated sites (ISCS), whose function is to assemble data and provide information about contaminated sites. The ISCS is a part of the government information system. The MESR is its founder, while its operation and maintenance is entrusted to the Slovak Environment Agency.

According to § 46 and the Geological Regulation, the ISCS encompasses:

a) the State Remediation Programme of Contaminated sites (2010–2015) ,
b) the Register of Contaminated sites Documents,
c) the Register of contaminated sites, consisting of:
    1. Section A – comprising records of potential contaminated sites,
    2. Section B – comprising records of contaminated sites,
    3. Section C – comprising records of remediated and reclaimed localities.

In addition to the abovementioned documents and databases, the ISCS also contains all available data concerning contaminated sites in Slovakia. This includes the relevant legislation, strategic documents, final reports, both a register of professional competence (i. e. register of acknowledged specialists competent to undertake geological work) and a register of geological licenses (i. e. register of geologically authorised individuals, entrepreneurs and legal persons)., publications such as the Atlas of Remediation Methods for Contaminated Sites etc. The ISCS is treated in more detail in the chapter 'INFORMATION SYSTEM OF CONTAMINATED SITES – CONNECTING WITH REGISTERS OF PUBLIC ADMINISTRATION' (Ing. Erich Pacola, PhD., SEA).

THE STATE REMEDIATION PROGRAMME OF CONTAMINATED SITES

The State Remediation Programme of Contaminated sites (2010–2015) is the principal strategy and planning document for the issue of contaminated sites. According to Provision § 20a of the Geological Act, it is primarily drafted and maintained by the MESR on the basis of information from the ISCS. The State Remediation Programme of Contaminated sites is approved by the government of the Slovak Republic. The current State Remediation Programme of Contaminated sites for 2010–2015 was approved by the Slovak government via Resolution No. 153 of 3 March 2010, and it is accessible on the MESR website or at www.vlada.gov.sk.

RISK ASSESSMENT OF CONTAMINATED SITES

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DIRECTIVE OF THE MINISTRY OF ENVIRONMENT OF THE SLOVAK REPUBLIC FOR THE PREPARATION OF RISK ASSESSMENT OF CONTAMINATED SITES

According to § 16, paragraph 6 of Act No. 569/2007 Coll. on Geological Works (the Geological Act) as amended, if serious pollution resulting from human activity is detected and verified in an area during the execution of a geological task, its final report must contain a separate risk assessment of contaminated site.

According to § 18, paragraph 2 the Geological Act, the ordering party of the geological works is obligated to submit a final report with a risk assessment of contaminated site for the ministry's approval within one month of its delivery by the contractor of the geological works. The Geological Act also stipulates that the Ministry of Environment of the Slovak Republic shall approve the final report and risk assessment of contaminated site within six months of its submission, without regard to the works' source of financing.

For the purposes of preparing a risk assessment of contaminated site in a unified manner as required by the Geological Act, a document entitled *Method Statement No. 1/2012-7 of 27 January 2012 for the Preparation of Risk Assessment of Contaminated Site* was prepared by the Ministry of Environment, Division of Geology and Natural Resources, in cooperation with representatives of specialised organisations under the Ministry – the Slovak Environment Agency, the State Geological Institute of Dionýz Štúr and the Water Research Institute – as well as representatives of the community of experts in the field.

On 15 February 2012 the Commission for the Assessment and Approval of Final Reports with Risk assessment of contaminated site was established under the Ministry of Environment. The commission's chief role is to ensure the fulfilment of the obligations stipulated by the provisions of the Geological Act and other related generally binding legal acts regarding the approval of the results of geological works.

Between February 2012 and November 2014, 41 final reports were submitted to the commission. More specifically, the reports related to geological survey of the environment and the remediation of contaminated sites, which were predominantly the result of the following activities:

- active or abandoned industrial operations,
- fuelling stations,
- railway operations.

In the process of assessing and approving these final reports, the commission determined that their authors made repeated errors pursuant to Method Statement No. 1/2012-7, resulting from incorrectly or imprecisely defined terms, improper procedures of assessing health or environmental hazards, incorrectly presented or absent indicative or interventional criteria for particular contaminants, absent procedures for the risk assessment arising from mining waste disposal sites or the determination of reference locations, including the establishment of quality criteria for groundwater in the given locations.
For the purposes of updating the method statement, the commission proceeded to draft a new document for the issue in question entitled *the Directive of the Ministry of Environment of the Slovak Republic No. 1/2015-7 of January 28, 2015 for the Risk Assessment of Contaminated Site.*

The directive establishes the general rules of the risk assessment of contaminated site and the basic content and form of such analyses. It is divided into 15 articles and contains 14 specialised annexes. The directive's articles define the content of the individual sections of the risk assessment of contaminated site, and the specialised annexes provide clear instructions – with illustrative examples – on how to prepare each section pursuant to Annexe No. 1 Subclause E of MESR Regulation No. 51/2008 Coll. Implementing the Geological Act as amended.

The directive is intended for investigators who conduct risk assessment of contaminated site and for all entities that use such assessment, including:

- government authorities and organisations within their scope of authority,
- generators and liable persons determined in accordance with § 4 of Act No. 409/2011 Coll. on Certain Measures in Relation to Environmental Burdens, and on the Amendment of Certain Acts to be responsible for the elimination of a contaminated site or for the elimination of a polluted area resulting from the current operation of their enterprise,
- if the liable person could not be determined, the relevant ministry according to § 5, paragraph 7 of Act No. 409/2011 Coll., which is responsible for the fulfilment of the liable person's obligations.

THE SUBJECT AND GOAL OF A RISK ASSESSMENT OF CONTAMINATED SITE

The subject of a risk assessment of contaminated site is contamination in the bedrock, soil, soil air or groundwater which could present a serious threat to human health or the environment.

The risk assessment of contaminated site is based on the principle of caution, which is to say that when evaluating risks resulting from the presence of pollution to human health or the environment, the worst-case exposure scenario is singled out for assessment.

The risk assessment of contaminated site must evaluate its specific circumstances, including the history of the locality (the pollution's estimated time of origin, data on the activities which led to it, identification of the source of the pollutants present, data on legal violations), the natural conditions of the investigated area, the extent and degree of the pollution, the specific pollutants present, their possible channels of spread (exposure routes) and potential exposure receptors affected by the given hazard and the current and planned use of the investigated area.

The goal of a risk assessment of contaminated site is to characterise its existing and potential hazards to human health and the environment, and to propose target values for its remediation based on an assessment of its hazards' magnitude (an evaluation of exposure scenarios).
If a risk assessment of contaminated site is prepared as an updated risk analysis, after the remediation of the contaminated site has already been completed, its goal is to demonstrate that the established remediation objectives have been fulfilled and that any residual contamination of the bedrock and/or groundwater no longer presents any risk to the environment or human health.

PROFESSIONAL QUALIFICATION FOR THE PREPARATION OF RISK ASSESSMENT OF CONTAMINATED SITE

Given that a risk assessment of contaminated site is an integral part of a final report of a geological survey of the environment, this type of geological works can only be directed, coordinated and implemented by a professionally qualified person who has, pursuant to § 9, paragraph 2, subclause e) of Act No. 569/2007 Coll., been granted professional qualification for the geological survey of the environment. This person – the principle investigator – is responsible for the correctness and quality of the geological works and for the comprehensive implementation of the geological survey and the assessment of its results in the final report, including the correctness and quality of the risk assessment of contaminated site.

USE OF RISK ASSESSMENT OF CONTAMINATED SITE

A risk assessment of contaminated site is an essential piece of data for state authorities' approval of established remediation objectives, evaluation of proposed corrective measures, evaluation of the efficacy of corrective measures or their individual stages, evaluation and approval of proposals to monitor geological factors of the environment and assessment of the state of investigated areas on the basis of monitoring data.

A risk assessment of contaminated site can also be prepared and used for other goals, primarily for establishing priorities in addressing contaminated sites in a particular territorial unit, processing data for the planning of protected water resource zones and measures relating to them, evaluating the hazards of a contaminated site whose ownership is being transferred, evaluating the risk of a contaminated site whose use is being changed, processing the data for the prediction and evaluation of the impacts of construction or other activities on the environment etc.

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PROJECTS ADDRESSING CONTAMINATED SITES SUPPORTED BY THE OPERATIONAL PROGRAMME 'ENVIRONMENT' (2007–2013)

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From 2006 to 2008, an inventory of contaminated sites was conducted throughout Slovakia, establishing the number of potentially contaminated sites, confirmed contaminated sites and remediated, reclaimed sites. The 2009 amendment to Act No. 569/2007 Coll. on Geological Works (the Geological Act) as amended incorporated the issue of contaminated sites, at least partially, into Slovak law. In March 2010, the Slovak government adopted a strategic plan for addressing the issue – the State Remediation Programme of Contaminated sites (2010–2015). The overarching legal framework is provided by Act No. 409/2011 Coll. on certain measures in relation to contaminated sites, and on the amendment of certain acts. Coming into force on 1 January 2012, the Act allows the issue of environmental contamination to be addressed comprehensively, a process that is now in its final phase: projects involving the investigation, remediation and monitoring of contaminated sites are underway. Given that this is a very costly affair, especially when remediation work is concerned, the primary sources of finances are currently European Union funds.

OPERATIONAL PROGRAMME 'ENVIRONMENT' (2007–2013)

The Operational Programme 'Environment' (OPE) was the Slovak Republic's programme document for obtaining aid from European Union funds for the environmental sector from 2007 to 2013. The document was prepared by the Ministry of Environment of the Slovak Republic in its capacity as OPE Governing Body, and it was approved by the European Commission on 8 November 2007. In terms of budget, it is the second-largest operational programme in Slovakia, with a total budget of over €2.14 billion.

The overall goal of the OPE is to improve the state of the environment and to use resources frugally by finalising and improving Slovakia's environmental infrastructure in accordance with EU and Slovak regulations and by making the environmental components of sustainable development more efficient. This goal is fulfilled via more specific goals, which correspond to the following priority axes and their operational objectives:

- Priority Axis 1: Integrated Protection and Rational Utilisation of Water Resources,
- Priority Axis 2: Flood Protection,
- Priority Axis 3: Air Protection and Minimisation of the Adverse Effects of Climate Change,
- Priority Axis 4: Waste Management,
- Priority Axis 5: Protection and Regeneration of the Natural Environment and Landscape,
- Priority Axis 6: Technical Assistance,
- Priority Axis 7: Creation of a Flood Warning and Forecasting System.

Contaminated sites falls under Priority Axis 4: Waste Management, Operational Objective 4.4: Addressing the Issue of Contaminated sites, Including its Removal. The specific objective of this priority axis is fulfilled by the implementation of three groups of activities, focused respectively on:

- monitoring and investigation of contaminated sites and producing risk assessment,
- remediation of the high-risk contaminated sites,
- finalisation of the Information System of Contaminated Sites (ISCS).

Within these groups, the following activities can be supported:

Group I: Monitoring and investigation of contaminated sites and producing risk assessment:

A. projects focused on the production of risk assessment, remediation feasibility studies and inspections of contaminated sites,
B. projects focused on the investigation of high-priority potentially contaminated sites,
C. projects focused on thorough and repeated investigation of the high-risk contaminated sites, in line with the established priorities,
D. regional studies of the environmental impacts of contaminated sites,
E. projects focused on the development of monitoring systems for the high-risk contaminated sites, in line with the established priorities.

Group II: Remediation of the high-risk contaminated sites:

A. projects focused on the remediation of contaminated sites that present a major risk to human health and the environment, in line with the established priorities.

Group III: Finalisation of the Information System of Contaminated Sites (ISCS):

A. implementation of the ISCS as a component of the government's information system,
B. preparation of the Atlas of Remediation Methods as a component of the ISCS,
C. projects focused on public relations, public awareness and promotion of activities related to the remediation of contaminated sites.

Between 2007 and 2013, the Ministry of Environment of the SR made four calls for applications for non-repayable grants (NRGs) as part of Priority Axis 4, Operational Objective 4.4: Addressing the issue of contaminated sites, including its removal. A total of 20 projects were supported.

FINANCED AND COMPLETED PROJECTS ADDRESSING ENVIRONMENTAL CONTAMINATION SUPPORTED BY THE OPERATIONAL PROGRAMME 'ENVIRONMENT' (2007–2013)

Among the approved applications for NRGs, three have already been successfully completed. Table 1 shows basic information on the completed projects.

Project no.	Project title	Grant applicant	Total eligible expenditure – drawn (in euros)
1	Regional Studies of the Environmental Impacts of Contaminated sites in Selected Regions	SEA	319,485.75
2	The Atlas of Remediation Methods for Contaminated Sites	SGIDS	113,870.12
3	The Upgrade of the Information System of Contaminated sites	SEA	922,733.88

Tab. 1: Financed and completed projects supported by the OPE (2007–2013)

1. Regional Studies of the Environmental Impacts of Contaminated sites in Selected Regions

Main objective:

- assess the environmental impacts of contaminated sites in Slovakia's individual regions.

Specific objectives:

- develop a unified rubric of methods for regional studies of the impacts of contaminated sites in Slovakia,

- use this rubric to prepare evaluation reports/regional studies for Slovakia's individual administrative regions.

Project duration: October 2008 to July 2010

Risk assessment of contaminated sites has proceeded from a synthesis of the basic risk assessment (criterion K) performed as part of the project *Systematic Identification of Contaminated sites in the Slovak Republic* (2006–2008) and a supplementary risk assessment (criterion R) carried out as part of this project. The risk assessment was accompanied by an evaluation of the relation between the given contaminated site and the soil, nature reserves, functional land use, local economic and social development, and environmental quality. Based on this evaluation, priorities were established for the handling of individual regions, particularly so-called high-priority localities. The risks resulting from their proximity to contaminated sites were then characterised and measures to address them were proposed.

The project included the publication of the booklet *The State of Contaminated Sites in Slovakia* (Fig. 1), which provides a brief summary of the issue of environmental contamination in Europe and Slovakia specifically, realised projects and their outcomes (*The Systematic Identification of Contaminated sites in the Slovak Republic, Regional Studies of the Environmental Impacts of Contaminated sites in Selected Regions*, *the Atlas of Remediation Methods for Contaminated Sites*). *The State of Contaminated Sites in Slovakia* was published in both Slovak and English.

Fig. 1: The booklet *The State of Contaminated Sites in Slovakia*

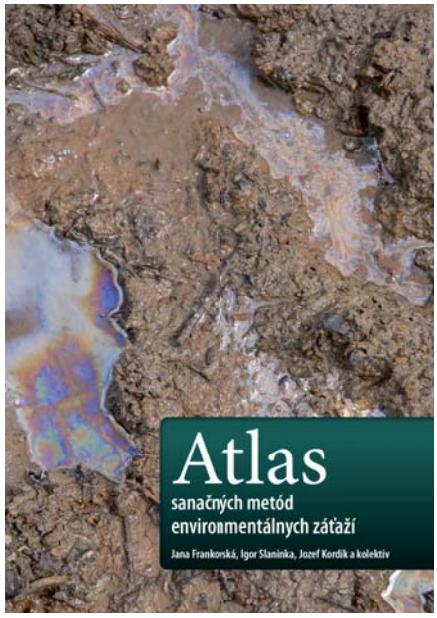

Fig. 2: *The Atlas of Remediation Methods for Contaminated Sites*

2. The Atlas of Remediation Methods for Contaminated Sites

Main objective:

- process the findings on remediation methods for contaminated sites and compile them into an atlas as a part of the Information System of Contaminated sites.

Project duration: December 2008 to November 2010

The publication treats over 80 remediation methods, divided according to type of polluted environment, location of the method's application, and the principle and mechanism behind the method's functioning. There is also a separate overview of various remediation methods' applicability to certain types of pollutants, expected reliability and efficacy, and financial requirements (a rough estimate of the cost of remediation).

The Atlas's (Fig. 2) comprehensive treatment of the topic starts with an introduction summarising the legislation on contaminated sites in Slovakia, the current state of contaminated sites in Slovakia, and the conditions and protocols of remediation measures. The next chapter is devoted to environmental contaminants, which are divided into inorganics (metals and cyanides), organics (aromatic hydrocarbons, phenols, pesticides, chlorinated aliphatic hydrocarbons, polychlorinated biphenyls and other persistent organic compounds), radionuclides, petrochemicals and explosives. The brief overview of remediation methods is divided according to mechanism and principle (natural vs. supported attenuation, physical/chemical vs. biological) and according to selected types of pollutants. The Atlas also includes a separate chapter with an overview of innovative methods, nanotechnologies, and the combination or integration of remediation methods, as well as treating the issue of assessing the costs of investigating and remediating contaminated sites.
The core of the Atlas consists of a chapter profiling various remediation methods, divided into three main subchapters:

- methods for remediating bedrock and solid materials,
- water remediation methods,
- methods of remediating soil air and gases.

Within these categories, remediation approaches are divided into in situ and ex situ methods, as well as biological and physical/chemical methods. Natural (monitored) attenuation is treated individually. Ways of cleaning soil air and gas are divided into biological and physical/chemical remediation methods. A separate subchapter is devoted to nanotechnologies.
The final chapter focuses on findings and experiences with selected remediation methods in Slovakia (34 cases) and the Czech Republic (11 cases), as well as information on the efficacy, costs and time demands of individual remediation projects.

3. The Upgrade of the Information System of Contaminated sites

Main objective:

- the upgrade of the Information System of Contaminated sites, its interconnection with other public information systems,
- carry out an informational and educational campaign in the form of regular informational and instructional trainings.

Project duration: September 2009 to September 2014

This project is understood as the upgrade of the existing Information System of Contaminated Sites (ISCS), the basis of which was created as part of the geological project entitled Systematic Identification of Contaminated sites in the Slovak Republic.

The upgrade of the ISCS entails several related activities:

- finalising the Register of Contaminated sites (RCS) as part of the ISCS,
- finalising the ISCS with a view to the informing the general public on the issue via Enviroportál and EnviroInfo,
- maintaining and updating the ISCS,
- updating the data on liable/obliged persons within the registers' individual parts (RCS Part A (potentially contaminated sites), RCS Part B (contaminated sites), RCS Part C (remediated and reclaimed sites),
- monitoring the collection of data on obliged persons and the consistency of the registers,
- finalising the integration of the ISCS with other operational information systems.

The informational/educational campaign provided up-to-date information on all aspects of the issue of contaminated sites in Slovakia through regular trainings and seminars directed primarily towards:

- state government staff, the Slovak Environmental Inspectorate,
- staff of local governments, particularly regional and municipal governments and the regional environmental offices,
- experts on the issue from other relevant ministries (the Ministry of Defence, the Ministry of Economy, the Ministry of Agriculture and Rural Development, etc.),

- other professionals qualified in the field of environmental contamination,
- owners of contaminated sites.

Over the project's entire duration, 33 seminars and trainings were held in every area of Slovakia. The project was widely propagated via articles published in *Enviromagazín*, as well as presentations of the project at various conferences and trade shows in Slovakia and abroad.

FINANCED AND ONGOING PROJECTS ADDRESSING ENVIRONMENTAL CONTAMINATION SUPPORTED BY THE OPERATIONAL PROGRAMME 'ENVIRONMENT' (2007–2013)

Among the approved applications for NRGs, 17 projects are still in progress. Table 2 shows basic information on the ongoing projects.

Project no.	Project title	Grant applicant	Total eligible expenditure – contracted (in Euros)
1.	Investigation of Contaminated sites in Selected Localities in the Slovak Republic	Ministry of Environment	8,639,552.70
2.	Monitoring of Contaminated sites in Selected Localities in the Slovak Republic	SGIDS	7,985,920.00
3.	Education and public awareness as a support in contaminated sites remediation in SR	SEA	419,716.04
4.	Remediation of Contaminated sites Left by the Soviet Army – Ivachnová	Ministry of Defence	1,353,962.77
5.	Remediation of Contaminated sites Left by the Soviet Army – Lešť main camp	Ministry of Defence	2,369,002.79
6.	Remediation of Contaminated sites Left by the Soviet Army – Lešť garage yards	Ministry of Defence	1,888,264.90
7.	Remediation of Contaminated sites Left by the Soviet Army – Nemšová	Ministry of Defence	1,954,933.82
8.	Remediation of Contaminated sites Left by the Soviet Army – Rimavská Sobota	Ministry of Defence	2,310,742.81
9.	Remediation of Contaminated sites Left by the Soviet Army – Sliač Airport South	Ministry of Defence	2,565,113.86
10.	Remediation of the Contaminated site in Srdce Quarry	Ministry of Environment	12,540,368.77
11.	Remediation of Contaminated sites in Selected Localities of the Trnava Region	Ministry of Environment	5,179,463.62
12.	Remediation of Contaminated sites in Selected Localities of the Nitra Region	Ministry of Environment	6,938,256.96
13.	Remediation of Contaminated sites in Selected Localities of the Trenčín Region	Ministry of Environment	3,119,914.25
14.	Remediation of Contaminated sites in Selected Localities of the Banská Bystrica Region	Ministry of Environment	2,743,996.48
15.	Remediation of Contaminated sites in Selected Localities of the Prešov and Košice Regions	Ministry of Environment	4,441,040.89
16.	Potentially contaminated sites – a Survey of Selected Localities in the Slovak Republic	Ministry of Environment	9,760,350.67
17.	Integration of the Public into the Contaminated Sites Remediation	SEA	239,694.71

Tab. 2: Financed and ongoing projects supported by the OPE (2007–2013)

1. Investigation of Contaminated sites in Selected Localities in the Slovak Republic

Main objective:
- conduct a detailed investigation of potentially contaminated sites and confirmed contaminated sites,
- produce risk assessment and remediation feasibility studies,
- develop monitoring systems for the high-risk contaminated sites.

Specific objectives:
- check and confirm the presence of selected potentially contaminated sites,
- investigate certain high-risk contaminated sites,
- assess the risks and analyse the remediation possibilities of certain contaminated sites.

Project duration: November 2011 to August 2015

The investigation of potentially contaminated sites, confirmed contaminated sites and the preparation of risk assessment of contaminated sites in 54 localities throughout Slovakia will provide detailed data about environmental contamination, including quantitative and qualitative parameters for all contaminants, the trends and variations in pollution over time and space, natural attenuation processes and the comprehensive interpretation of the acquired data. Particular emphasis is placed on precisely delimiting contamination in terms of time and area and evaluating it in detail. Thorough investigation and rigorous risk assessment of contaminated sites are an essential precondition for the selection of the most suitable remediation methods for high-priority localities. The results of the detailed geological investigation will serve as a basis for the preparation of a contaminated site remediation proposal.

2. Monitoring of Contaminated sites in Selected Localities in the Slovak Republic

Main objective:
- design and implement monitoring systems for selected contaminated sites in Slovakia

Project duration: March 2012 to December 2015

The project includes the following activities:
- processing archival materials,
- creating a special-purpose geological information system,
- creating and updating conceptual models,
- a proposal for the creation and updating of a monitoring programme,
- monitoring – collecting samples, field measurements, laboratory work,
- modelling and evaluating the monitoring results.

171 potentially and confirmed contaminated sites throughout Slovakia have been selected for monitoring. The geological investigation is primarily determining the character and properties of the bedrock and the properties, geographical distribution and amount of pollutants.

3. Education and public awareness as a support in contaminated sites remediation in SR

Main objective:
- raise the general public's awareness concerning the issue of addressing contaminated sites, including its remediation.

Specific objective:
- help the public to be better informed about the issue of environmental contamination.

Project duration: June 2012 to May 2015

The project serves to promote and inform experts and the general public about the issue of contaminated sites through various informational, educational and promotional events and activities:
- international conferences, specialised seminars, presentations for owners of contaminated sites, professionally qualified persons and state/local government staff (Fig. 4),

Fig. 3: Publications printed within the project Education and public awareness as a support in contaminated sites remediation in SR

Fig. 4: The participants of the International Conference Contaminated Sites Bratislava 2013

- publication and distribution of promotional (informational) leaflets, publications on contaminated sites in both Slovak and English (Fig. 3),
- the mail-in knowledge competition EnvirOtázniky [EnviroQuestions],
- a documentary on contaminated sites with English subtitles and six short video spots on pollutants.

4. Remediation of Contaminated sites Left by the Soviet Army (six projects)

Main objective:
- remediate selected contaminated sites

Project duration: March 2013 to December 2015

Remediation work is underway in six locations: Ivachnová, Lešť main camp, Lešť garage yards, Nemšová, Rimavská Sobota and Sliač Airport South. The work's goals are to eliminate the root causes

of environmental contamination (sources of pollution), eliminate high-priority contaminants from groundwater and bedrock, halt the spread of contamination and develop a monitoring system for the operation and efficacy of the remediation efforts. The remediation of contaminated sites will fulfil the goals of the State Remediation Programme of Contaminated sites (2010–2015). Completion of the project will improve the quality of life of affected populations and the condition of individual constituents of the environment, above all ground and surface water, soil and bedrock. It will also positively affect neighbouring ecosystems and biodiversity. Areas cleared of contamination can be used for new purposes (e. g. industry, recreation, sports), making the region more attractive to future investment.

5. Remediation of Contaminated sites in Selected Localities in the Slovak Republic (six projects)

Main objective:
- eliminate contaminated sites' negative influence on human health and the natural environment

Specific objective:
- remediate contaminated sites

Project duration: March 2012 to November 2015

Remediation work is underway in 13 locations, divided among six projects throughout Slovakia: Bratislava-Devínska Nová Ves: Srdce Quarry, Jablonica: depo, Voderady: municipal solid waste landfill, Komárno: area used by the Soviet Army, Komárno: Madzagoš, Pukanec: Hampoch sludge landfill, Bánovce nad Bebravou: railway station, Nové Mesto nad Váhom: military area, Ľubietová-Podlipa, Brezno: Slovak Railways Brezno, Plešivec: engine house, Cargo a. s., Krásny Brod: Monastýr landfill – old waste, Stakčín: municipal solid waste landfill with special conditions.
The remediation works will eliminate the contamination of groundwater and bedrock, as well as the negative effects on human health. The project's completion will contribute to the important final phase of systematically addressing contaminated sites: removing them. Compared to other agricultural areas, remediated areas will be more suitable for new industrial or recreational/tourism activities, making the region more attractive to future investment.

6. Potentially contaminated sites – a Survey of Selected Localities in the Slovak Republic

Main objective:
- establish a detailed foundation of data for the remediation of contaminated sites in selected localities in Slovakia

Specific objective:
- check and confirm the presence of selected potentially contaminated sites,
- assess the risks and analyse the remediation possibilities of selected contaminated sites.

Project duration: November 2013 to October 2015

In 87 selected localities, potentially contaminated sites will be subjected to thorough geological analysis with the goal of identifying, checking and confirming the presence of potentially contaminated sites in studied areas; thoroughly studying the state of the groundwater, soil and bedrock in the areas where environmental contamination appears; examining the geographical and spatial extent and degree of contamination; identifying its sources and centres; identifying and characterising all the pollutants including their quantitative and qualitative parameters; assessing the manner and trends of pollution's spread; and producing risk assessment for each studied location as a basis for establishing remediation limits.

7. Integration of the Public into the Contaminated Sites Remediation

Main objective:
- promoting and involving the wider public in activities relating to contaminated sites, including its remediation

Specific objective:
- promote and inform the public about the issue of contaminated sites.

Project duration: September 2014 to August 2015

The project's chief activities consist of:
- an international conference focused on the issue of contaminated sites,
- a specialised course on the appropriate production of risk assessment of contaminated site,
- a training course for university-level instructors and doctoral candidates,
- publication of literature about contaminated sites,
- a course on the investigation and remediation methods for contaminated sites, combining lectures and fieldwork,
- translation of legislative and technical documents related to the contaminated sites issue and the Information System of Contaminated sites into English,
- trainings for teachers (preschool, elementary and secondary) about environmental contamination.

The training activities, the conference, field trips, specialised courses and publications will help to inform the public about addressing environmental contamination. The efforts to inform comprise not only acquainting the public (researchers, instructors, doctoral candidates, students, qualified professionals, teachers) with the issue of contaminated sites/environmental burdens (legislation, the identification of contaminated sites, the investigation and remediation of contaminated sites), but also eliciting feedback in order to update and improve the Register of Contaminated sites, a part of the ISCS, and facilitating the exchange of knowledge and experience in the field via the international conference. Publishing literature on contaminated sites, specialised courses, trainings and educational materials will improve the understanding and awareness of experts and the wider public alike concerning the issue of contaminated sites.

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4. www.opzp.sk
5. www.enviroportal.sk

INFORMATION SYSTEM OF CONTAMINATED SITES – CONNECTING WITH REGISTERS OF PUBLIC ADMINISTRATION

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WHY INFORM ABOUT CONTAMINATED SITES?

It is estimated that there are approximately 2.5 million contaminated sites in Europe. For these sites, contamination may arise from existing ground soils, or indeed from pollution originating in bedrock. For such sites, the danger of pollutants spreading into surrounding areas may be anticipated. It is, therefore, imperative that these sites are thoroughly investigated, a risk assessment being carried out to inform the public concerning the whereabouts of these locations, as well as importantly, providing information regarding current and planned efforts to mitigate harmful effects upon the health of the public and the quality of environment.

Those citizens who wish to purchase land for house building, or plan to buy existing property, should have open access to information regarding whether the ground or property is close to sites where the underground water supply, bedrock or soil quality are not endangered and onto which there is the potential for pollution to spread. Development plans held by local authorities should take into account any hazards, without doubt, of course, the presence of any contaminated site (onwards referred to as CS).

State and public administration bodies, in the sector of process control for environmental protection or the approval of development plans, must have access to information obtained from specialised geological assessment undertaken on contaminated sites. This concerns, primarily, the results of geological surveying of sectors of the environment on CS, expert analysis of CS risks on human health and the environment, information relating to the progress and method of remediation of CS and results from the monitoring of geological factors. In other words, monitoring the extent of pollution both during and after remediation. Only in this case, may representatives of state and public administration bodies be successful in the planning of future precautions to lower risks due to the presence of CS, when redistributing investments for the removal of pollution caused by CS or when controlling remediation work and the reclamation of previously contaminated sites.

WHERE TO FIND INFORMATION ON CONTAMINATED SITES

Information System of Contaminated Sites (onwards 'ISCS ') represents a basic and official platform for records of contaminated sites in Slovakia. Contaminated site is defined as a site, where hazardous substances caused by human activities, poses a significant risk to human health or to the environment, soil and groundwater, except environmental damage. ISCS is a part of the public administration information system according to paragraph 20a, section 1 of the Act no. 569/2007 on geological work (geological law) as amended (onwards referred to as 'Act no. 569/2007').

The basic components of ISCS are stated in regulation of the Slovak Ministry of Environment, no. 51/2008 as amended, which implements the geological law.
They are:

a) A state program of contaminated sites remediation.
b) A register of documents related to contaminated sites.
c) A register of contaminated sites, consisting of:

1. Section A - comprising records of potentially contaminated sites,
2. Section B – comprising records of contaminated sites,
3. Section C – comprising records of remediated and reclaimed localities.

Since 2010, a significant amount of work has been carried out on various of the new ISCS services. They are currently operational and make up an integral part of the information system. The basic applications and content of the ISCS, comprise the following services:

1. An Enviroportal, which serves as the common internet access point designed to provide environmental information and E-services. In terms of a development conception of IS at the Ministry of Environment of The Slovak Republic, for the years 2014 to 2019, it is defined as a second level portal of the Central Government Portal Website: http://enviroportal.sk/environmentalne-temy/vybrane-environmentalne-problemy/environmentalne-zataze/informacny-system-ez

2. A Register of contaminated sites, supporting the content of ISCS . It records the life cycle of CS and all information resulting as a consequence of processes defined by Act no. 409/2011. The register enables the search and subsequent presentation of descriptive information on CS in the form of lists, reports and registration sheets (http://envirozataze.enviroportal.sk/) or information can be displayed in the form of maps and spatial data positioning on these maps (http://envirozataze.enviroportal.sk/Mapa/).

3. An Atlas of remediation methods for contaminated sites, completed in 2011 by the State Geological Institute of Dionýz Štúr. Contains a series of remediation methods for the elimination of contaminated sites and is accessible to the general public in the form of a web application. The application enables the user to search for information according to the type of remediation method and contaminating substance. It interactively connects to remediated localities contained in the Register of contaminated sites, including appropriate methods of remediation applied at the given localities. Website: http://envirozataze.enviroportal.sk/Atlas-sanacnych-metod

4. Under the direction of the Ministry of Environment, Act no. 569/2007 concerns both **a register of professional competence** (i. e. register of acknowledged specialists competent to undertake geological work) **and a register of geological licenses** (i. e. register of geologically authorised individuals, entrepreneurs and legal persons). It concerns indexes of the aforementioned who have the right to perform geological work in the territory of the Slovak Republic and a list of competent specialists complete with their contact details.
Webpages:
http://envirozataze.enviroportal.sk/RegisterPovoleni/GeolFyzOs.aspx
http://envirozataze.enviroportal.sk/RegisterPovoleni/GeolPravOs.aspx
http://envirozataze.enviroportal.sk/RegisterPovoleni/RegisterOdbSposob.aspx

5. An Integrated application interface which accesses, via the ISCS, information held in other data sources consisting of relevant databases and registers of the public administration information system. (onwards referred to as PAIS). This concerns an interface which enables exchange of records between registers of data sources and the ISCS. Mutual communication of the application interface for administration of these records runs in actual time and is independent of the active participation of users.

WHAT MADE US CONNECT TO THE INFORMATION SYSTEM OF PUBLIC ADMINISTRATION

State and public administration workers frequently encounter the problem of duplicate administration of records in various databases and registers, which comprise the source of PAIS records. Those responsible for administering such databases and registers are often forced to enter the same records into different data sources. The updating of such records occurs manually through various application interfaces. Data that has once been entered is typically not updated and thus ends up, after some time, as becoming

outdated and often misleading. It is important to state that records should only be entered once, and that, into data sources legally intended for such administration.

Just as for representatives of state and public administration bodies, individuals when solving day to day situations need records from a variety of information sources which are managed according to the institution or department. Access to the information, however, may be difficult due to the fact that it is held in various, relatively closed systems. If the information is from a record source currently in public use, relevant to information held in other registers, it is to be expected that public access to these records is easily achievable from one access point on the basis of mutual communication between connected systems. This communication, though, must occur independent of the user.

Resolution, therefore, of the above mentioned problems means to introduce principles of IS integration, both technical and in terms of approach. In general, this concept may be understood by those entering information as the joining of parts to make a whole, alternatively as the interconnection of numerous applications which are independent from users. Integrated systems, from the point of view of information technology, refer to the interconnection of "different" worlds that is applications implemented in various technologies. With every new demand for sharing of records from data sources, it should not propose, implement or test anything new. The applicant of information is offered from our data sources a one time created service or application interface implemented on the basis of standardisation.

HOW WE DETERMINED WHICH DATA SOURCES WILL BE INTERCONNECTED AND IN WHICH ORDER

The project of ISCS integration with registers or databases of the Slovak Ministry of Environment (onwards SME) and other government departments was launched in 2010 by undertaking a feasibility study. In view of the extent of the field of data sources and their interface software, in the SME alone (more than 80 applications among 16 organisations), for the purposes of this study 19 registers were chosen, respectively databases, which best fulfilled the criteria for their future interconnection within the ISCS . The basis for the initial choice of databases, included in the study, was mainly content relevance in relation to the issue of assessing existing or potentially contaminated areas. The chosen systems in the feasibility study were analysed for their professional and technical assets, as well as financial matters and in terms of their time consumption. The decision making process for the choice of register to be interconnected with ISCS was undertaken by SWOT analysis. The resulting output of the SWOT analysis produced an order of registers or databases according to preference for their subsequent connection with ISCS.
The aim of SWOT analysis was to determine the current state of registers and their application interfaces, as well as to determine how difficult interconnection was. Individual information systems were analysed and described according to chosen factors of internal and external environments. The internal environment characterised the quality of the contemporary registers or databases and their application interface (relevance, timeliness of records, legislative framework, technical solutions). The external environment identified factors relevant from the point of view of how complex interconnection was for a particular register or database with the Information System of Contaminated Sites (personal requirements, time and financial related difficulties associated with interconnection).

The main internal factors determined by the SWOT analysis were:

1. Legislative support for the operation of record source interconnection,
2. The relevancy of existing legislative support when resolving CS issues,
3. The content relevance of records provided via data sources, from the point of view of addressing CS issues,
4. Condition and timeliness of records provided by data sources,
5. The application architecture which oversees data sources (attribute and spatial data),
6. The existence of a web interface which enables the request for data from data sources also with the help of so called referenceable persistent identifiers,

9. The level of spatial data set processing of the data sources,
10. INSPIRE (inclusion datasets into annexes of INSPIRE directive),
11. The existence of standards, that is, WMS (Web Map Service) or WFS (Web Feature Service) communication interfaces,
12. The existence of accessible information also for the public from data sources,
13. A method for ensuring implementation capacities when changing application interface and its subsequent operation.

The main external factors determined by the SWOT analysis were:

1. The existence of an integration platform (existence of web services),
2. Technological knowledge of the technical operator or administrator of record source content when implementing required changes (technical changes on the existing interface/knowledge in fields of specialised and process operations),
3. The financial demands of the proposed method of interconnection
4. Time related factors of the work for:
   – harmonisation of key codes,
   – identification of reference entities and completion of their identifiers from ISCS and into ISCS,
   – analysis and implementation of web or network services into the application environment of data sources,
   – analysis and implementation of changes into the already existing application which accesses record source data.

REGISTER AND DATABASE CONNECTION WITH ISCS

Based on the results of the feasibility study, a process was launched whose output was the contractual arrangement of technical work for the connection of ISCS with data sources which are administered by the Ministry of Environment and Ministry of Agriculture and Rural Development of the Slovak Republic. The connected systems were arranged into the following groups:

- Records of monitoring systems:
  – Integrated monitoring of pollution sources,
  – Partial monitoring system of geological factors – Subsystem 03, Anthropogenic sediment character of old contaminated sites,
  – Partial monitoring system – Soil,
  – Technical and safety supervision of Slovak water constructions.

- Records of protected areas of the Slovak Republic:
  – State list of specially protected parts of the countryside – protected areas and protected trees section,
  – EU member's network of nature protection areas – NATURA 2000,
  – A register of Ramsar Wetlands, UNESCO heritage sites and Biosphere reservations.

- Records for the support of environmental legislation:
  – Geofond digital archive,
  – Information system for the mining waste management,
  – Information system for the prevention of major industrial accidents,
  – Register of landfill sites.

- Basic spatial register and large scale maps:
  – Digital orthophoto maps of the Slovak Republic and detailed panoramic images of streets and roads of the Slovak Republic (Google Slovakia Ltd.),
  – Digital vector cadastral maps (Geodetic and Cartographic Institute, Bratislava).

INTERGRATED MONITORING OF POLLUTION SOURCES

Its aim is to document and differentiate potential and actual point source pollution on the basis of monitoring ground water which is close to potential polluters (industrial concerns, waste tips, tailings ponds, etc.). Based on conclusions from data, it determines effects on ground water due to the activities of such operators. It comprises data from the monitoring of ground water which, although not regulated, is implemented for internal or other reasons by the company. This has arisen on the basis of the water framework directive 2000/60/ES in order to achieve good water quality before 2015.
Reason and purpose for connection with the ISCS: Monitoring objects, recorded by means of a database, provide supplementary assessment of the chemical status of groundwater in an area or close to an area classified as CS. Experts and the general public may obtain information concerning the exceeding of specific limits by means of chemical indicators for the last five years and the assessed development trend of these indicators.
Webpage of data sources: http://www.vuvh.sk/index.php/sk_SK/rozne/imbzz
Accredited administrator of content: Operators of industrial concerns, landfills, tailing ponds
Technical operators: Water Research Institute, Bratislava

PARTIAL MONITORING SYSTEM OF GEOLOGICAL FACTORS (PMS GF) – SUBSYSTEM 03, ANTHROPOGENIC SEDIMENT CHARACTER OF OLD CONTAMINATED SITES

This is a part of the environmental monitoring system of the Slovak Republic. PMS GF focuses on geological hazards, whether naturally harmful, or anthropogenic geological processes, which threaten the natural environment and thus in the end people.
Reason and purpose for connection with the ISCS: Despite the fact that monitoring of localities using subsystem 03 was stopped in 2011, these monitoring localities and their specific monitoring sites provide a historically significant and additional assessment of the state of ground water (from a chemical perspective) for these areas which are classified as CS. Experts and the general public may obtain information concerning the exceeding of specific limits by means of chemical indicators.
Webpage of data sources: http://dionysos.gssr.sk/cmsgf
Accredited administrator of content: State Geological Institute of Dionýz Štúr, Bratislava
Technical operator: State Geological Institute of Dionýz Štúr, Bratislava

PARTIAL MONITORING SYSTEM – SOIL

This is a part of the environmental monitoring system of the Slovak Republic. Its aim is to monitor agricultural and forest soils. Parameters of these soils are monitored at a time and place which depend upon the fertility and ecology (so called non-production) of soil function. Contamination of soils is also monitored for hazardous substances in terms of their possible entry into the food chain.
Reason and purpose for connection with the ISCS: It is the only system which regularly monitors contamination of agricultural land by hazardous substances. Monitoring sites of agricultural land represents an important complementary source of soil contamination assessment for an area classified as CS. Experts and the general public can obtain information regarding the attributes of soils which have been monitored and evaluated in four previously completed five year cycles.
Webpage of data sources: http://ism.enviroportal.sk/cms_poda/
Content administrator: Soil Science and Conservation Research Institute, Banská Bystrica Regional Office.
Technical operator: Soil Science and Conservation Research Institute, Bratislava and Slovak Environment Agency – DATACENTRE, Banská Bystrica

TECHNICAL AND SAFETY SUPERVISION OF WATER CONSTRUCTIONS

This activity is aimed at ascertaining the relative condition of water constructions whose damage may threaten area flooding and the lives of people and property due to the release of a surge or held water. Operations are undertaken, above all, by observing safety issues and the stability of water constructions, measurement of any deformation, monitoring of seepage water, assessment of output and measurement and by proposals for precautions to ensure removal of any discovered inadequacies.
Reason and purpose for connection with the ISCS: Technical and safety supervision data (onwards TSD) are a part of the Register of categorised water constructions and tailing ponds. This distinguishes water constructions according to their importance and the potential risk of threat to humans and property in adjacent areas. The operation of TSD and informing the public about its operation are the basis for accident avoidance at tailing ponds, which are in most cases classified as CS. Professionals thus may obtain detailed information on the running of the TSD for tailing ponds as well as partly on water constructions.
Webpage of data sources: http://gis.vvb.sk/
Content administrator: Watermanagement Construction, s. e., Bratislava
Technical operator: Watermanagement Construction, s. e., Bratislava

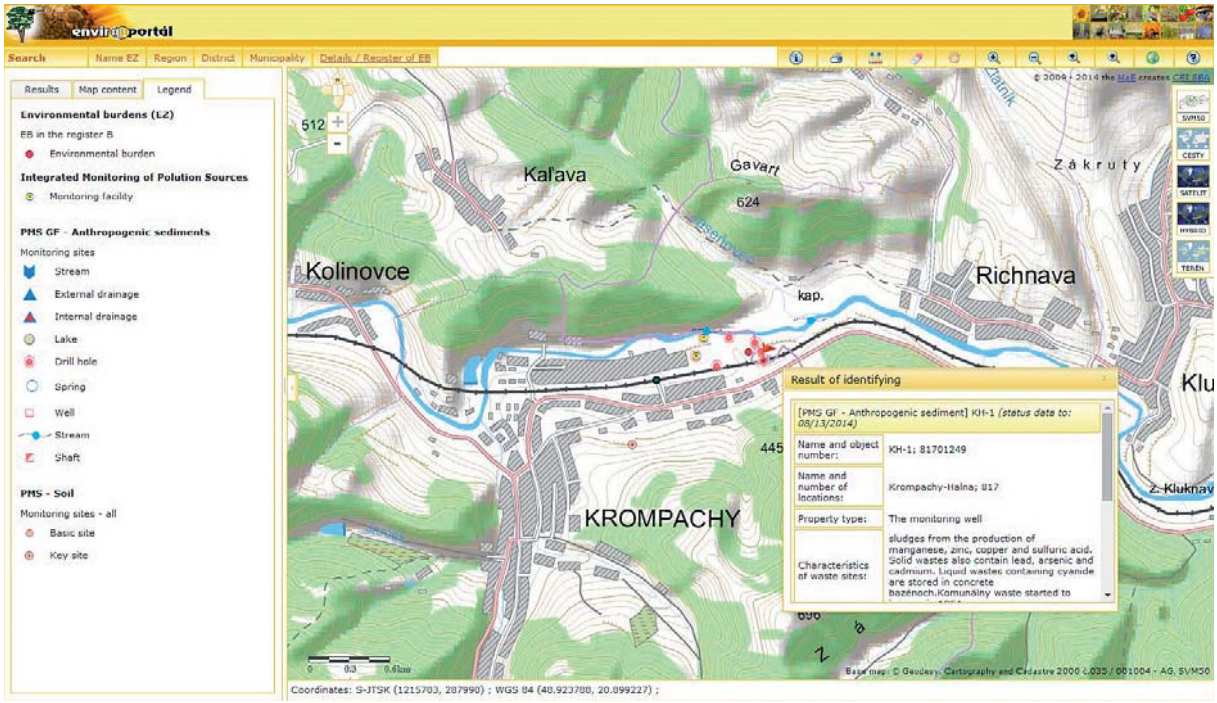

Fig. 5 Monitoring systems close to SN (003)/Krompachy-Halňa, contaminated site

STATE LIST OF SPECIALLY PROTECTED PARTS OF THE COUNTRYSIDE

These are administrative records of protected areas and trees, and their protected zones in the Slovak Republic. Records currently consist of:

- a growing catalogue of protected areas and protected trees, which entered chronologically comprises all basic records concerning them,
- a database of protected areas and protected trees,
- a collection of documents on protected areas and protected trees.

Reason and purpose for connection with the ISCS: Areas classified as being CS may also be included in the category of nationally protected areas as defined by Act no. 543/2002 on nature and landscape protection. In these areas a conflict of interest between two laws occurs. Professionals and the general

public alike may obtain detailed spatial, descriptive and pictorial information on protected areas or trees, as well as access to a digitalised collection of documents.
Webpage of data sources: http://uzemia.enviroportal.sk/, http://stromy.enviroportal.sk/
Administrator of content: The Slovak Museum of Nature Protection and Speleology, Liptovský Mikuláš
Technical operator: The Slovak Environment Agency – DATACENTRE, Banská Bystrica

EU MEMBER'S NETWORK OF NATURE PROTECTION AREAS – NATURA 2000

This guarantees the protection of the rarest and most threatened species of plant, animal and natural biotop which appear in member state countries. By means of species and biotop protection, it ensures preservation of biological diversity in the whole of the European Union. The network consists of two categories of area: Special Protection Areas (onwards SPAs) and Special Areas of Conservation (onwards SACs).
Reason and purpose for connection with the ISCS: Areas classified as CS may also be included in some categories of the network of EU member state protected areas. In this kind of area a conflict of interest between two laws occurs. As of 1.1.2013, according to Act no. 543/2002 as amended, 41 SPAs have been declared by the state conservation body as national protected areas. Implementing European Commission decision no. 2013/735/EU from November 7th, 2013, resulted in the EU accepting 473 SACs from the Slovak national list. According to Act no. 543/2002, the Slovak Republic must within 6 years, through Slovak state conservation, declare these SACs as national protected areas. Professionals and the general public alike shall obtain detailed spatial and descriptive information on biotopes and species, which are the subject of conservation, and the text of the valid legislation whereby protected areas are declared.
Webpage of data sources: http://www.sopsr.sk/natura/index1.php?p=4&lang=sk&sec=20, http://www.sopsr.sk/natura/index1.php?p=4&lang=sk&sec=4
Administrator of content: State Nature Conservancy of the Slovak Republic, Banská Bystrica
Technical operator: State Nature Conservancy of the Slovak Republic, Banská Bystrica

RAMSAR WETLANDS, UNESCO SITES, BIOSPHERE RESERVATIONS

Within the framework of fulfilling the commitments of the Ramsar Convention on Wetlands (signed February 2nd, 1971 in Ramsar, Iran) to which Slovakia became a signatory in 1990, 14 of the most significant Slovak wetland sites gradually were included in the list of international significance. The Caves of Aggtelek Karst and Slovak Karst were included in the list of UNESCO World Cultural and Natural Heritage Sites on the basis of a bilateral Slovak-Hungarian nomination in 1995. This was approved by the World Heritage Committee from December 4th–9th, 1995 in Berlin. The project was subsequently extended to include the Dobšinská Ice Cave by the World Heritage Committee in Cairns from November 27th to December 2nd, 2000.
The following four areas have been recognised in Slovakia as Biosphere reserves without any legal provisions or definitions: the Slovak Karst, Poľana, the East Carpathians and the High Tatras. These are areas which are designated in accordance with the UNESCO Man and Biosphere programme.
Reason and purpose for connection with the ISCS: The above mentioned lists provide additional records about the extent of the borders of the protected areas established on the basis of international conventions.
Administrator of content: State Nature Conservancy of the Slovak Republic, Banská Bystrica
Technical operator: State Nature Conservancy of the Slovak Republic, Banská Bystrica

GEOFOND DIGITAL ARCHIVE

This is a unique collection of archives of geological reports and reviews originating during the course of geological observations in the Slovak Republic. This archive has been developed in accordance with Act no. 503/2007 on archiving and registering and provides bibliographic records of concluding reports, as well as individually scanned concluding reports.
Reason and purpose for connection with the ISCS: Professionals gain, for their work, access to digitalised

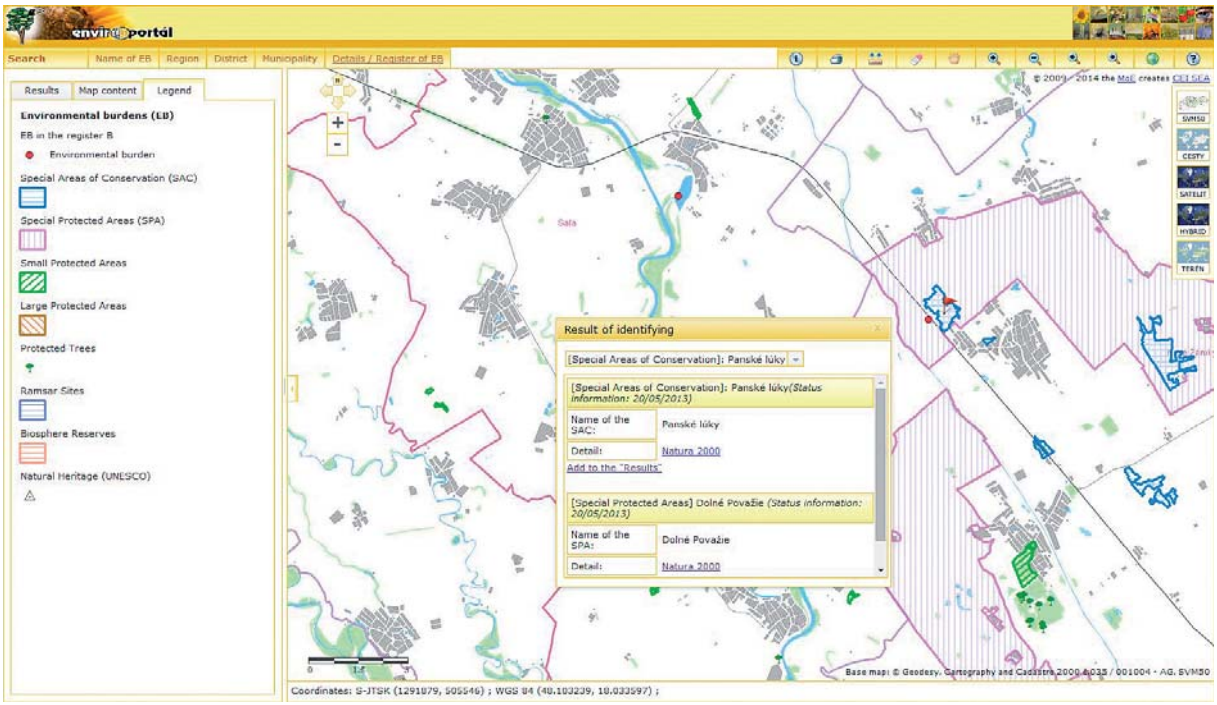

Fig. 6 Environmental burden NZ (037)/Tvrdošovce – landfill site NNO in a Special Protection Area (Dolné Považie) and nearby Panské lúky, a Special Area of Conservation.

texts of summarised reports on geological research of the environment, monitoring and remediation of contaminated sites.
Webpage of data sources: http://www.geology.sk/new/sk/node/39
Administrator of content: State Geological Institute of Dionýz Štúr, Bratislava
Technical operator: State Geological Institute of Dionýz Štúr, Bratislava

INFORMATION SYSTEM FOR THE MINING WASTE MANAGEMENT

This ensures the amassing of data and information on treatment of extracted waste for the requirements of public administration bodies. It informs the public and ensures their participation concerning the authorization of waste disposal from extraction industries, according to Act no. 514/2008 on the management of waste from the extractive industries, and on amendments to certain laws (onwards Act no. 514/2008).
Reason and purpose for connection with the ISCS: An area classified as CS may be a place, or facility, which is intended for the collection or storage of extracted waste in solid, liquid, as a suspension or solution, that is, a waste facility defined according to Act no. 514/2008. Professionals and the general public gain spatial, descriptive, pictorial and text information concerning waste facility directly from data sources of the information system.
Webpage of data sources: http://charon.sazp.sk/Odpady_tp/
Content administrator: Ministry of Environment, Slovak Republic – Geology and natural resources section, Slovak Environment Agency, Banská Bystrica – Section of Environmental Sciences and Project Management (Accredited administrator of content)
Technical operator: Slovak Environment Agency – DATACENTRE, Banská Bystrica

INFORMATION SYSTEM FOR THE PREVENTION OF MAJOR INDUSTRIAL ACCIDENTS

This provides information support for state administration in the field of serious accident prevention according to Act no. 261/2002 on the prevention of serious industrial accidents and on amendments to

certain laws (onwards Act no. 261/2002). It is an important tool for the grouping and exchange of information which is sent on to the EU reference centre for science and technology – the Joint Research Centre.
Reason and purpose for connection with the ISCS: The premises of an operating company, according to Act no. 261/2002, may be polluted directly within the area of the premises and is classified as CS. It is assumed that pollution created by such a company is undertaken by activities of the current operator or those, respectively, by the previous owners. Pollution, however, may also encroach into the actual premises of operation from a CS area which is found in the immediate vicinity by means of ground water flow. From the Information System's records, professionals and the general public alike may obtain spatial information on the position of the company's premises, descriptive information regarding the storing of dangerous substances at the company's premises and safety information for the public who may be affected by a serious industrial accident.
Webpage of data sources: http://enviroportal.sk/environmentalne-temy/starostlivost-o-zp/pzph-prevencia-zavaznych-priemyselnych-havarii/informacny-system-pzph
Content administrator: Ministry of Environment of the Slovak Republic – Environmental Assessment and Management Department, Slovak Environment Agency in Banská Bystrica – Section of Environmental Sciences and Project Management (Accredited administrator of content)
Technical Operator: Slovak Environment Agency – DATACENTRE, Banská Bystrica

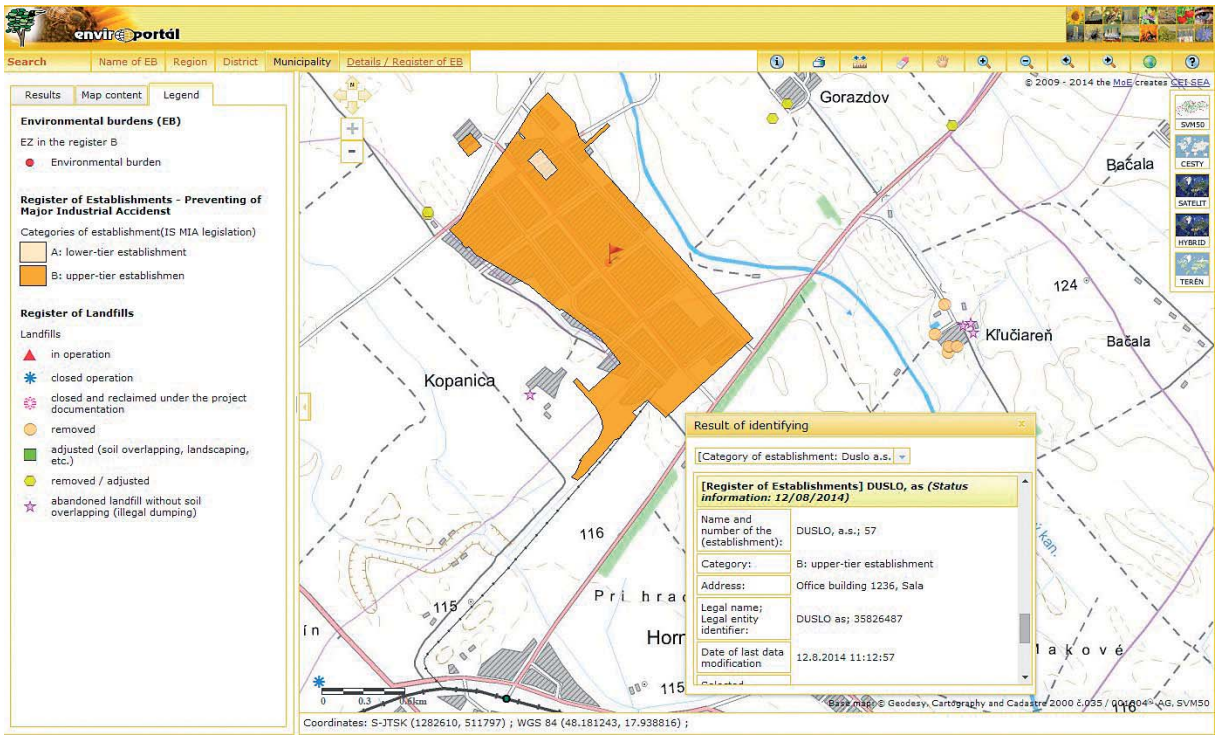

Fig. 7 Company premises of Duslo Ltd., affected by environmental contamination SA (007)/Šaľa – Duslo – manufacturer of rubber chemicals

REGISTER OF LANDFILL SITES

This oversees all registered landfill sites in the Slovak Republic. Intensive work began on it in 1992, in order to cover the whole area of Slovakia, the Slovakian geological office mapped appropriate sites for landfill (Scale 1:50 000). As a part of this project, a register of landfill sites in all districts was generated at 1:10 000 scale. The register was one of the most important sources of data for the systematic identification of CS in Slovakia.
Reason and purpose for connection with the ISCS: An area classified as environmentally contaminated may also be a place where equipment is available for treatment of municipal waste, that is, a place where long term storage on the surface or in the ground takes place. Professionals and the public obtain descriptive information on municipal landfills, especially concerning the character of waste being kept.

Webpage of data sources: http://www.geology.sk/new/sk/sub/ms/geof/skladky
Content administrator: District Environmental Offices of the Slovak Republic
Technical Operator: State Geological Institute of Dionýz Štúr, Bratislava

DIGITAL ORTHOPHOTO MAPS AND PANORAMIC IMAGES OF STREETS AND ROADS OF THE SLOVAK REPUBLIC

Prior to September 2013, users of the Information System of Contaminated Sites were displayed basic (environmental burden) and additional spatial elements (monitored places, tailing ponds, protected areas, landfill sites, disposal sites) only in base map SVM 50 (connected digital vector map). SVM 50 was developed on the basis of maps of the Slovak Republic at 1:50 000 scale. The scale of this map, however, due to the gradual integration and illustration of new spatial elements into the integrated database and register, proved to be insufficient. The identification of mutual spatial relationships (for example relationship of the type "they are monitoring a CS object integrated with the monitored source of pollution?") required the use of greater detailed base maps. One solution has been the integration of Google Maps and Street View by means of open interface Google Maps API, in accordance with Google's licensing policy.

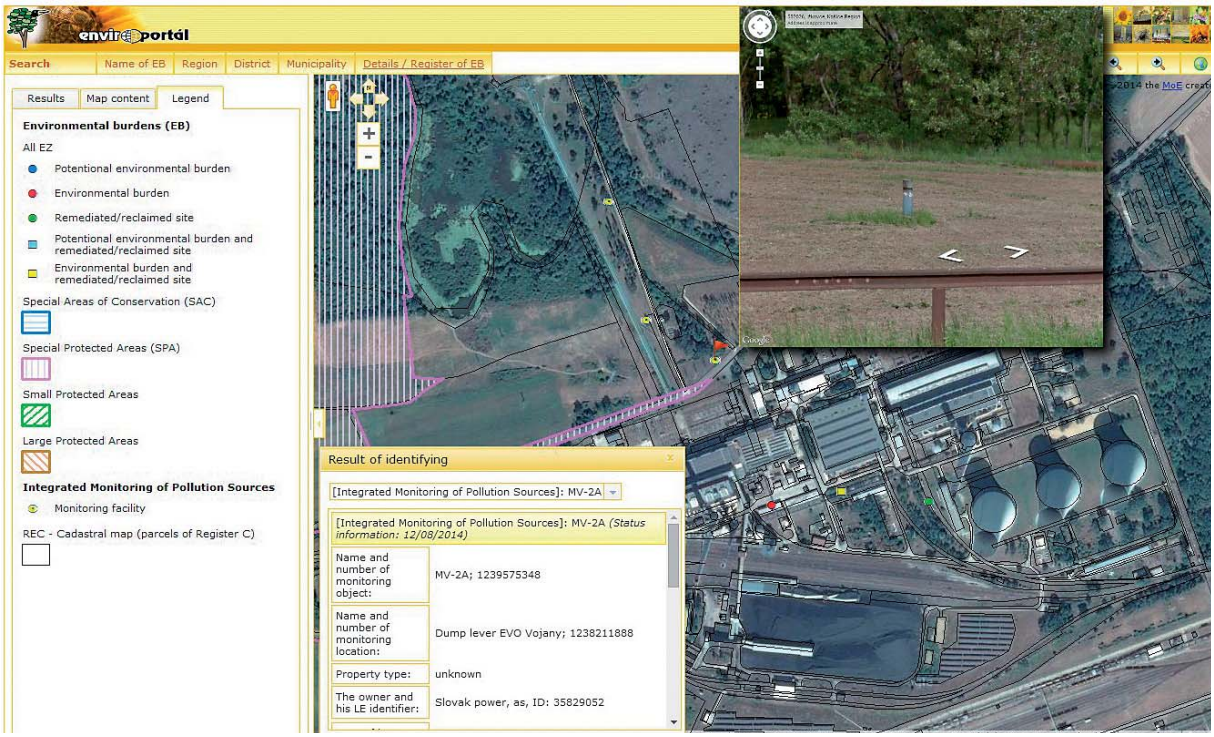

Fig. 8 Monitored object databases MV – 2A Integrated monitoring of pollution sources in the vicinity of contaminated site MI (1989)/Vojany - EVO Vojany – stockpile of inflammables. Identification of monitored object via Google Street View service.

Reason and purpose for connection with the ISCS: Professionals and the general public alike are able to display geographic elements of interest on a level of detail of large scale documentation maps by means of orthophoto images and hybrid maps. The public is also able to review displayed elements from a ground level perspective, that is, street or road level by means of panoramic photographs.

DIGITAL VECTORISED CADASTRAL MAPS

Clearly defined property ownership rights of individuals and legal persons concerning real estate, the rapid gaining and clarification of information relating to ownership rights is being a key pillar of the rule

of law. A basic record and spatial entity of every public administration information system (PAIS) becomes property and its related spatial geometrical boundary. Access to basic spatial data records (Land Register), which provide information on geometrical determination, inventories and descriptions of properties, is an unavoidable prerequisite for the process of mutual exchange of records between public institutions, individuals and organisations. Fulfillment of the above mentioned prerequisites, led to the integration of vector cadastral maps (register C land plots) and maps of unspecific boundary extent (register E land plots) in the ISCS application interface.
Maps were made accessible on the basis of a contractual agreement between the Ministry of Environment and the Geodetic and Cartographic Institute, Bratislava (Contract no. 97–31–13524/2006 on the provision of bulk data by the Land Register, whereby updating of data shall occur yearly. Inventory and descriptive information on ownership rights of property is obtained according to the level of interconnection of the ISCS user interface and Cadastral Portal's which serves as the official access point to Cadastral information of the Slovak Republic.
Reason and purpose for connection with the ISCS: Professionals and the general public are able to identify cadastral areas and specific land plots where environmental contamination may be found or even determine ownership rights of the plot under question. This identification, however, is only of an informative character. The presence of environmental burden, (pollution in bedrock, ground water or ground) in a land plot area or across more land plots, must be verified and confirmed by a geological survey of the environment.

WHAT WAS THE GOAL OF INTEGRATION?

• To avoid duplication of data sources. Each register is responsible only for data whose administration is verified from the point of view of its legislative restrictions.

• To share and present relevant data, from different data sources, in one place. All records related to the problem of dealing with environmental burden were made available directly from the ISCS application interface.

• To improve the database of connected systems. During the process of integration, inconsistency and mistakes in records of participating systems were removed. The used codes were harmonised, an example being the alignment of administrative divisions with Statistical Office regulation č. 597/2002 (September 12th, 2002) which issues statistical codes for counties, districts and villages respectively, as well as an official register of spatial units (REGSU) which is maintained by the Methodology of Filing Department, Slovak Statistical Office.

• To implement processes resulting from Act no. 3/2010. According to this law, administrators of connected registers and databases act as responsible bodies. These must actively participate in development and operational processes of spatial infrastructure. Responsible individuals are obliged to maintain metadata and provide access to datasets and services of spatial data, which have been identified as part of one of the spatial data themes in annexes 1 and 3 of this law. Administrators, therefore, established and began to operate network services (discovery, download and view) which make available spatial datasets, not only in accordance with the demands for connection of data sources with ISCS, but also in accordance with technical guidelines for the implementation of INSPIRE download and view services.

HOW SET GOALS WERE MET

In terms of integration principles, it was introduced system integration on the basis of sharing web or network services. This minimises mutual dependence on existing applications and offers the reuse of already constructed services.

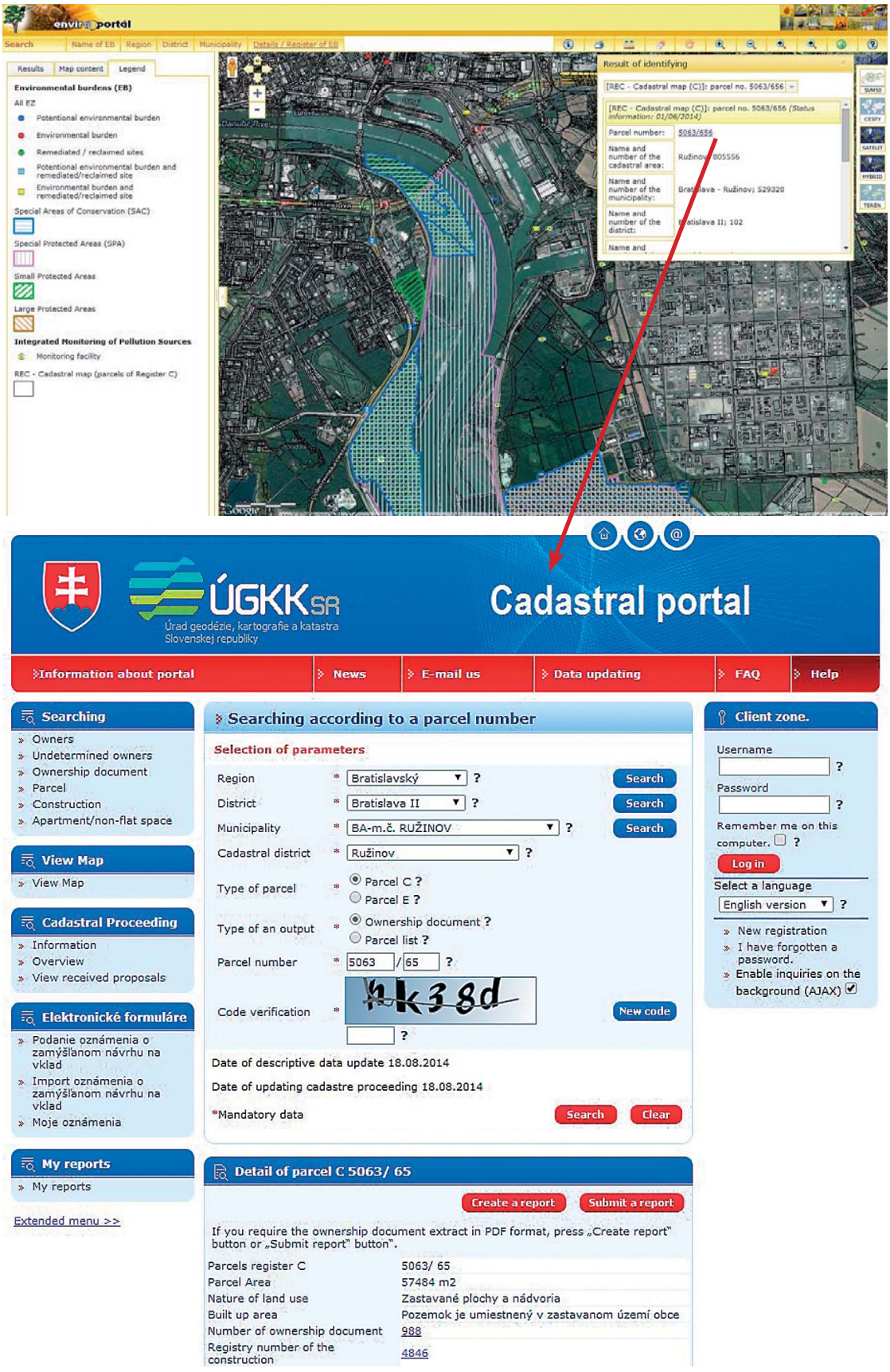

Fig. 9 Identification of land plots affected by contaminated site B2 (013)/Bratislava-Ružinov – Slovnaft – surrounding area of the company. Connection to the Cadastral portal and verification of ownership rights.

All developed services, which enable access to data linked to data sources, are interoperable. When creating services, open technical standards were applied. Web services, that enable access to descriptive attributes of record databases, are in accordance with standards prescribed in document WS-I Basic Profile version 1.1. (WSDL 1.1, SOAP 1.1, XML 1.0, XML Schema 1.1.0). Network services which enable access to spatial datasets are in accordance with Open Geospatial Consortium Web Feature Services Specification 1.1.0 and Web Map Services Specification 1.3.0.

Spatial and attribute data of data sources were made accessible also by means of proprietary ArcGIS map services with the public REST (Representational State Transfer) interface. This map service provides an open and very simple web interface for the hosting service provided by the ArcGIS server. The REST interface presents a hierarchy of sources which are named URL reference. All sources and operational services are easily accessible via a general interface (known as GET and POST methods of HTTP protocol). The ESRI map services with the REST interface are user friendly, scalable and above all often used by mapping clients of the Slovak Ministry of Environment as well as by outside organisations.

The principle of service traceability was introduced via the already existing INSPIRE architectural component. Under the name Metainformation Catalogue, this system is operational for spatial data at a national infrastructure level. Metadata on services have been registered through an on-line metadata catalogue client. The search for metadata records is also possible by means of a discovery service, developed according to OGC Catalogue Services Specification 2.0.2. This service is deployed on national EnviroGeoPortal infrastructure (http://geo.enviroportal.sk/catalog-client/). National metainformation system is constructed in terms of INSPIRE guideline. Its metadata profile is based on ISO 19115, 19139.

Code lists have been derived from data sources. These code lists have been made available to other systems in the form of a shared web service.

The life cycle of the developed architecture (technical specifications, data specifications, implementing architecture, operation) is subject to strict rules which are specified in analytical documentation (functional and non-functional requirements, interface and data specifications, results of functional acceptance tests, the services deployment model in the provider's architecture, operation manual).

The operation of developed components of a technical solution must be guaranteed by organisations throughout the whole period during which they are officially established by guarantors to be administrators or respectively the operators of data sources who are involved in mutual integration (connection).

EXPERIENCE GAINED FROM UNDERTAKEN WORK

The integration of systems, up to the present, belongs among the most difficult projects undertaken within the Slovak Environment Agency (project: completion of an Information System of Contaminated Sites http://www.sazp.sk/public/index/go.php?id=1746). Due to the diversity of systems included in the project, it was necessary to bring together experts, despite the wide variety of addressed domains and utilised technologies. The most difficult part, however, was not the technical realisation of work. Above all, integration required complex organisational arrangement of work. Domain experts had to be involved in the project from each organisation, as well as administrators of existing systems and developers (own employees), but especially from external sources. It was shown that processes which solved integration were not limited only to one section or department connected to the organisation (e.g. department of IT). On the contrary, process solving occurred across the whole organisational structure, that is, through every organisation, which in the end meant the solving of unforeseen events. In spite of this, realisation of the project contributed to the improvement of information exchange between public administration bodies, as well as towards the general public. Development of an application interface will enable easier and more effective implementation of new requirements in the future. (e. g. eGovernment activities).

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TRAINING AND EDUCATION OF THE SPECIALISTS ON THE ELIMINATION OF THE ENVIRONMENTAL CONTAMINATION IN THE COURSE OF ENVIRONMENTAL BIOTECHNOLOGY AT THE SLOVAK TECHNICAL UNIVERSITY IN BRATISLAVA

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ENVIRONMENTAL BIOTECHNOLOGY: EXPECTATIONS, OPPORTUNITIES AND CHALLENGES

Contaminated sites and their decontamination using remediation technologies, above all, applying biological methods, (bioremediation, phytoremediation and mycoremediation), are a part of the subject of Environmental Biotechnology which is taught in the Biotechnology course at the Department of Biochemical Technology, Institute of Biotechnology and Food Science, Faculty of Chemical and Biochemical Technology, Slovak Technical University, Bratislava. This consists of an examined subject based on lectures in the second year of study for the 'inžinier' or master´s degree course (overall at the FCHPT the course lasts 5 years).
Biotechnology is an absorbing and extremely dynamically developing area. Its applications are very wide and the advantages for society are so convincing that, at the present, practically every industrial branch, in some form, makes use of biotechnology. The *Biotechnology* course provides master's graduates with a deep knowledge of biochemistry, microbiology, molecular biology, genetics, biosynthesis and transformations of microorganisms, enzymology, enzyme engineering, bioanalytical methods, immunology and immunochemistry, fermentation, pharmaceutical and *environmental biotechnology.* The relationships between biotechnology and environmental biotechnology are schematically shown in Fig. 10.

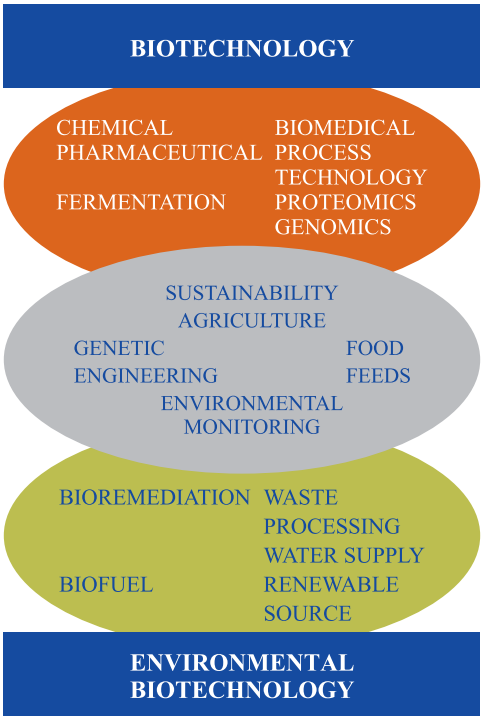

Fig. 10 The relationships and interaction between biotechnology and environmental biotechnology (according to Scragg, 2005).

Graduates of the master's course have appropriate knowledge and qualifications necessary for proving their competence at research institutes across the wide spectrum of the biotechnology industry. This means in areas such as fermentation technology, the development of new medicines, nutrition for people and animals and the protection of the environment. Environmental biotechnology makes use of the natural biodiversity of microorganisms and their metabolic activity for the decontamination of all environmental components: water, soil, sediments and air. The integration of scientific and engineering disciplines, which are required for the undertaking of practical environmental biotechnology, are explained in Fig. 11.

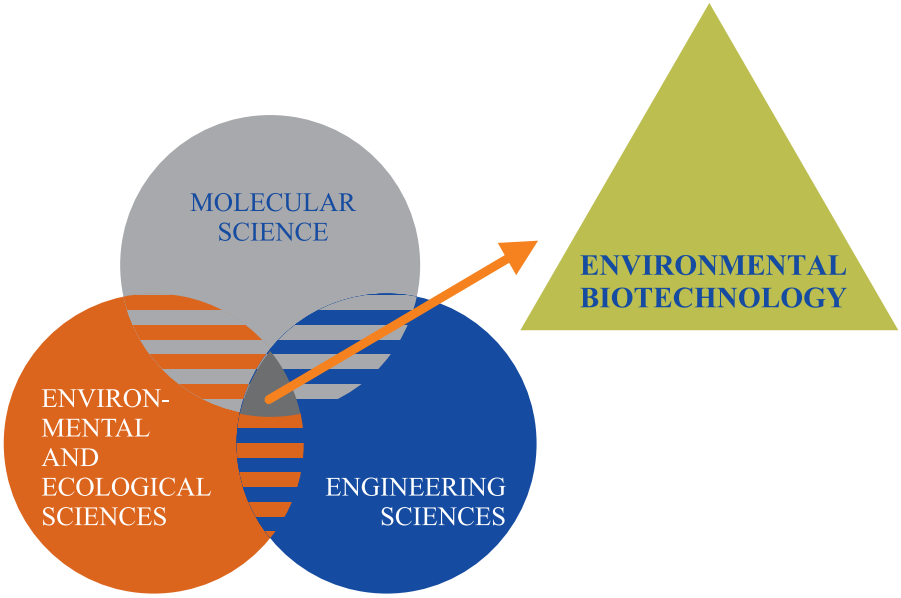

Fig. 11 Integration of scientific and engineering disciplines required for the realisation of practical environmental biotechnology.

The concept of environmental biotechnology consists of environmental monitoring, biodegradation of contaminants, bioremediation technology, technology of sustainable development, waste water treatment plants, biofuels, renewable natural resources, agrobiotechnology and marine biotechnology (Scragg, 2005).
Biocatalysts or enzymes reduce the difficulty of input and energy requirements, and at the same time, represent a minimal burden on the environment when applying bioremediation technologies. Bioremediation may be understood as technology which makes use of biological systems in order to return contaminated environments back to their original state.

Environmental biotechnology utilises the function of micro-organisms in biomining, bioprocessing, as well as their sensitivity towards numerous sources of pollution (heavy metals, herbicides, pesticides and other heterogeneous substances – xenobiotics, for the detection of pollutants (biosensoring).
Apart from making use of bacteria for the break up of anthropogenic organic toxic pollutants (Bioremediation), heavy and toxic metals, as well as organic pollutants may be eliminated by utilising fungi (Mycoremediation), plants (Phytoremediation), their root systems (Rhizoremediation) and algae (Algal Bioremediation).

The subject of Environmental Biotechnology consists of the following:

- **Environmental knowledge**
- **Environmental education**
- **Environmental technology**

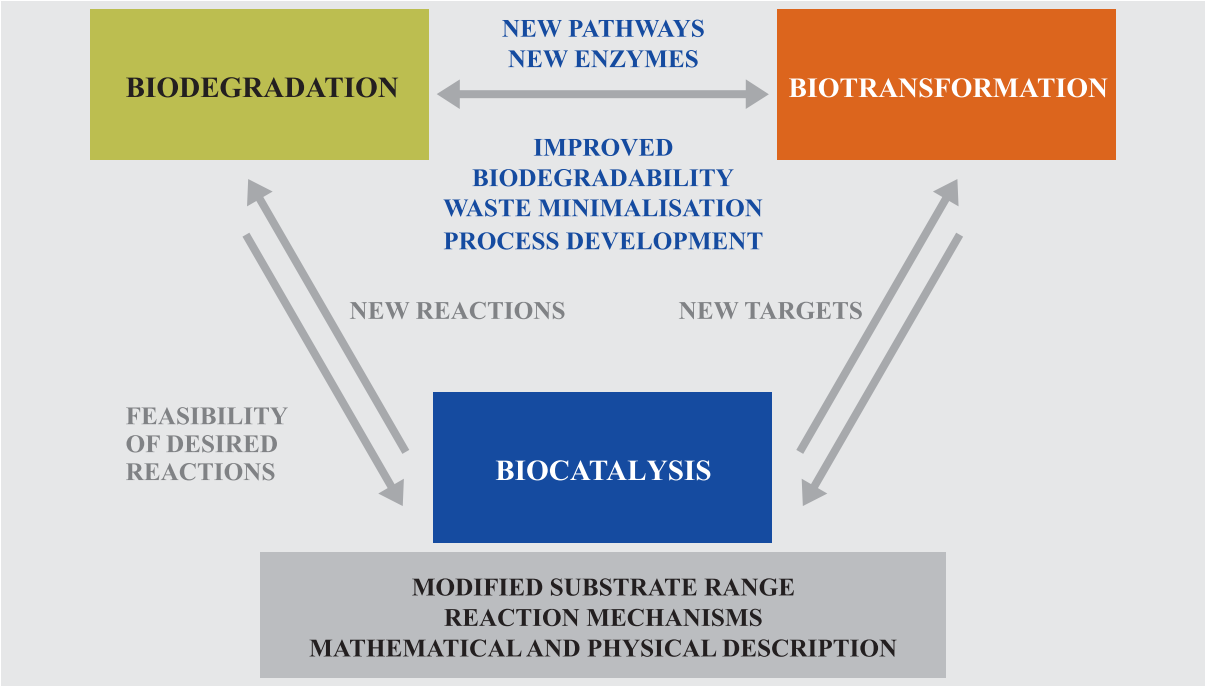

Fig. 12 Mutual dependence of the three main areas of enzyme catalysis (modified according Parales et al., 2002).

Biological processes and especially from them biocatalysis, biotransformation or biodegradation, represent (as well as economically) the main advantage of environmental biotechnologies. All three processes utilise microbial metabolism (Fig. 12). Which of these terms is preferred depends upon the studied process. If the main interest is, for example, degradation of environmental pollutants, biodegradation is relevant. In industry, though, for the manufacture of new products, biotransformation and biocatalysis are more appropriate. For certain situations, however, these interests overlap.

The process of globalisation and anthropogenic activities bring environmental risks ever closer. One effective approach for the elimination of such environmental risks, deriving from contaminated sites (environmental burdens), is bioremediation technology.
A study of the properties of persistent organic pollutants (POPs), their biodegradation, respectively biotransformation, using microorganisms by means of biostimulation and bioaugmentation, is currently being undertaken in the environmental biotechnology laboratory at the Institute of Biotechnology FCHPT STU. Above all, bacteria isolated from contaminated sediments, which have been adapted to the specific contaminant (in this case, polychlorinated biphenyls – PCBs) and containing a certain gene code required by the enzymes for the break up of pollutants, are being studied. Ultimately, they may be used in bioremediation technologies (Fig. 13).

THE OBJECTIVE OF THE SUBJECT OF ENVIRONMENTAL BIOTECHNOLOGY

To acquire knowledge of the basic principles and technology for the removal of persistent organic substances, (hazardous persistent toxic and bioaccumulative contaminants in the environment), from environmental contamination, especially, using biological approaches making use of the degradation capabilities of micro-organisms, fungi and plants. This refers to bioremediation, mycoremediation and phytoremediation technologies, as well as a combination with physicochemical methods, nanobiotechnology and other innovative technologies. Emphasis is placed on the understanding of basic principles of bioremediation technologies, as well as economic and ecological alternatives of physicochemical approaches, that is, non-combustion technologies – their advantages and limitations. An important component is the characterisation of environmental contamination, familiarisation with

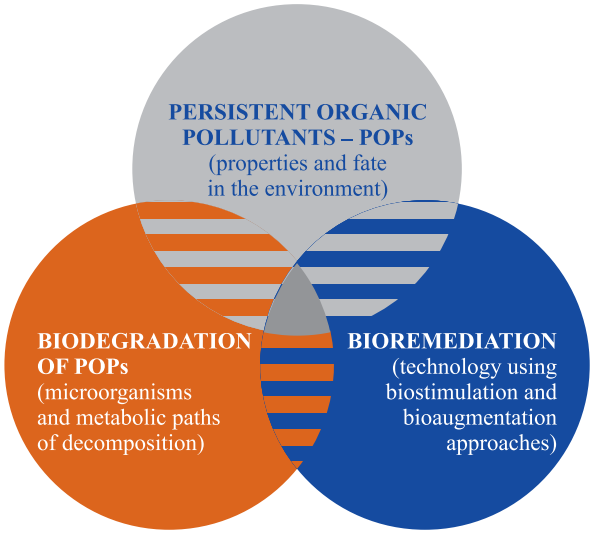

Fig. 13 Utilisation of microorganisms with potential degradation ability for the break down of persistent organic pollutants (POPs) - environmental contaminants

legislation which enables the origin of environmental contamination to be identified and technological procedures for its liquidation as it endangers the health of the population and the environment.

ENVIRONMENTAL BIOTECHNOLOGY SYLLABUS

1. Course Definitions and Basic Concepts
- Environmental Biotechnology
- Sanitation, Remediation, Decontamination
- Environmental Contamination, Legislation
- International Agreements on Hazardous and Toxic Anthropogenic Substances and Environmental Contaminants
- Ecological Disasters

2. Remediation Technologies – Basic classifications
- Combustion Technologies
- Plasma Technologies
- Non-combustion Technologies: Biological and Physico-chemical Methods
- Nanotechnologies for the Environment, Innovative and Integrated Technologies

3. Classification of Remediation Technologies on the basis of criteria
- Reduction of Ecological Risks
- Main Processes used
- Liquidation Mechanism of Harmful Substances
- Location of Release and Liquidation of Pollution
- Type of Polluted Medium – Water, Soil, Air, Sediment

4. Bioremediation
- Biological Remediation Technologies for Organic Pollutants
- Bioremediation using the Degradation Capability of Bacteria
- Assisted bioremediation - Bioaugmentation and Biostimulation approaches
- Natural Attenuation
- Advantages and Disadvantages of Bioremediation
- Risks of Applying Bioremediation Technologies

5. Mycoremediation – Exploiting Fungi for Decontamination
- The Role of Fungi in Preserving Ecological Balance
- Production and Role of Extracellular Enzymes
- Mycorrhizal and Wood-decaying Fungi

Principles of Mycoremediation
Advantages and Disadvantages of Mycoremediation

6. Phytoremediation – Exploiting Plants for Decontamination

Phytodegradation
Phytoextraction
Phytostabilization
Phytovolatilization
Rhizofiltration
Phycoremediation – exploiting algae for decontamination

7. Bioremediation of Metals

Bioextraction
Bioreduction/Biooxidation
Biocrystalization and Biomineralization
Biovolatilization
Phytoremediation

8. In situ Bioremediation – at the source of pollution

Bioventing – Venting and Cleaning of Polluted Air with the Addition of Microorganisms and/or Nutrients
Biosparging – Aeration of Contaminated Ground Water with the Addition of Microorganisms and/or Nutrients

9. Ex situ Bioremediation – outside of the contaminated area

Landfarming
Biopiles
Bioreactors
Biological Waste Water Treatment

10. Decontamination Methods Used in Remediation Technologies

Separation and Concentration Methods
Degradation Methods
Immobilisation and Stabilisation Methods

11. Chemical Methods of Remediation and Associate Technologies

Chemical Extraction
Chemical Oxidation/Reduction – Gas Phase Chemical Reduction, Sodium Reduction Technology
Dehalogenation – Based Catalysed Decomposition, Solvent Electron Technology
Solidification and Stabilisation

12. Physicochemical Remediation Technologies

Combustion
Pyrolysis
Thermal Desorption
Vitrification

13. Genetically Modified Organisms and their use in Remediation Technologies

Legislation
GMO Bacteria
Transgenic Plants

Fig. 14 shows the position and application of environmental biotechnologies in relation to other biotechnologies.

THE ROLE OF BIOTECHNOLOGY IN DEVELOPMENT AND SUSTAINABILITY

The social, environmental and economic benefits of environmental biotechnology go hand in hand and contribute towards sustainable development of societies and principles which were declared in Agenda 21 at the World Summit in Rio de Janeiro in 1992, at the World Summit on Sustainable Development in Johannesburg in 2002 and with principles widely accepted in environmental politics – EIBE 2000 and OECD 2001.

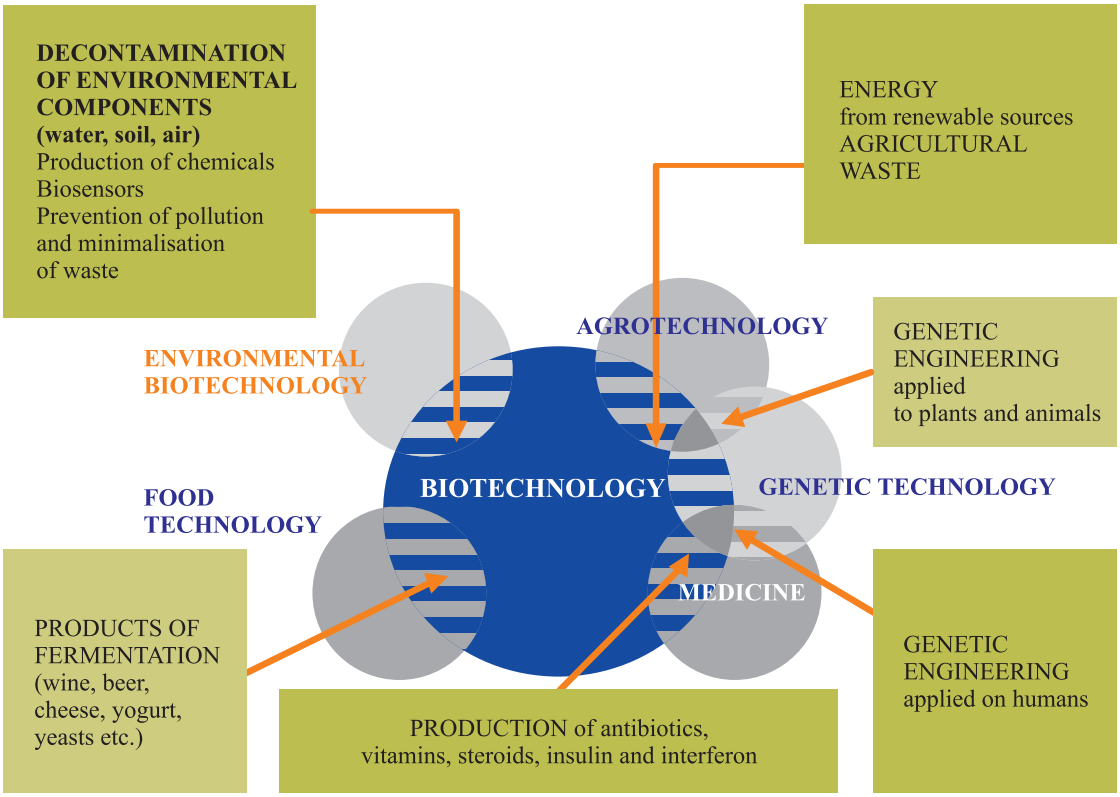

Fig. 14 Applications of biotechnologies in anthropogenic activities of industry, agriculture, medicine, health and environment. (Modified according to Sukumaran Nair 2006 and Gavrilescu 2009).

Supporting areas for biotechnology, significant in science and developmental activities, may be divided in three categories:

- Products for industry (biochemicals, enzymes and reagents for industrial and food processing);
- Energy (fuel from renewable sources);
- Environment (diagnostics of pollution, products to prevent pollution, bioremediation).

SUMMARY – CHALLENGES AND PERSPECTIVES OF BIOTECHNOLOGY

As well as the new environmental challenges which are currently emerging, new technologies for the protection and monitoring of the environment are being developed. New approaches, which make use of potential micro-organisms and plants as ecologically effective and efficient tools for numerous practical applications, are being developed in the following areas:

- enzyme engineering to improve biodegradation,
- evolutionary and genomic approaches towards biodegradation,
- construction of strains to improve biodegradation,
- process engineering to improve biodegradation,
- re-use of treated waste water,
- bio-membrane reactor technology,
- implementation of anaerobic digestion for the treatment of biological waste,
- growth in the use of bio-waste as an alternative and re-usable source of energy,
- development and growth in the exploitation of technological applications for soil remediation and the cleaning up of contaminated locations.

Alongside the wide range of technologies having the potential to reach the goal of sustainable development, biotechnology also plays an important role in food production, the utilisation of renewable energy sources and waste materials, prevention of pollution and bioremediation.

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RESEARCH AND TEACHING ACTIVITIES OF LABORATORY OF ENVIRONMENTAL BIOTECHNOLOGY

associated with studies of biodegradation and bioremediation of POPs, especially polychlorinated biphenyls – PCBs, which present an environmental burden in the surroundings of the former PCB producer Chemko Strážske. Contaminated sediments of the Strážsky canal are a source of contamination of the Laborec River and Zemplínska Šírava water reservoir. Chlorinated phenols have also been studied, mainly pentachlorophenol which was a component of pesticides, as well as being a degradation product deriving from them.

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3. DERCOVÁ K.: Microbial degradation of polychlorinated biphenyls. What are polychlorinated biphenyls? *Odpady* 7 – 8/02: 19 – 20 (2002) (ČR)
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33. DERCOVÁ K: Documentary film *Trashed* – waste as the global problems. *Odpady* 3: 40–41 (2013)
34. DERCOVÁ K.: Principle "polluter pay" for the environmental burdens. *Odpady* 12: 27–29 (2013)
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36. DERCOVÁ K., LÁSZLOVÁ K.: Occurrence of industrial compounds in the environment and their effects on health of human population. *Odpady* 12: 27-30 (2014)

Projects on the theme of biodegradation and bioremediation of POPs:

1. **1992**: Selection of a strain capable of the degradation of polychlorinated biphenyls. (project supported by VUPOP, Bratislava)
2. **1993**: Microbial degradation of polychlorinated biphenyls. (project supported by VUPOP, Bratislava)
3. **1994–96**: Structural determination of the fate of organic compounds in biosystems. (project VEGA, Bratislava)
4. **1994–95**: Assessment of QSAR for predicting fate and effects of the chemicals in the environment. (subproject Subcellular toxicokinetics) (CEU – Commission of the European Union DG-XII/D1, Brussels, Belgium)
5. **1995–96**: Study of enantioselective determination of PCBs after biodegradation by the microorganisms. (bilateral project NATO, LG 940637, Canada-Slovakia)
6. **1999–2001**: Biotechnological aspects of using the microorganisms in food and agricultural industry. (VEGA, project No. 1/6252/99, Bratislava)
7. **2001–2003**: Isolation, selection, and use of the microorganisms for production of the useful metabolites for food industry and agriculture and for detoxification of soil and water environment. (project VEGA, Bratislava)
8. **2004–2006**: Biotechnological use of the microorganisms for biodegradation of persistent organic pollutants (POPs) at decontamination of environment (soil and waters); the effect of POPs as environmental stress factors on microbial cells. (VEGA, project No. 1/1309/04, Bratislava)
9. **2004**: Technology for decontamination of the polychlorinated biphenyls – PCBs. (MŽP SR, project No. 161/2003/6.2)
10. **2007–2009**: Bioremediation of soil contaminated by the degradation products of pesticides of the chlorophenols series: potential use of organomineral complex (OMC), humic acids, and zeolite. (VEGA project No. 1/4357/07)
11. **2008–2009:** Industrial use of PCBs. SAŽP 2009.
12. **2010–2012**: Ecotoxicity, biodegradation, and bioremediation of PCB-contaminated sediments. (VEGA, project No. 1/0399/10)
13. **2012–2014**: Biodegradation and bioremediation of persistent and toxic organic chlorinated priority compounds–pollutants of soils, sediments, and water. (VEGA, project No. 1/0734/12)

POPs, biodegradation and bioremediation of PCP and PCBs in the student's projects (dissertations-doctoral, master's and bachelor's theses); supervisor Assoc. Prof. Katarína Dercová, PhD.; Laboratory of Environmental Biotechnology, Department of Biochemical Technology, Institute of Biotechnology and Food Science, FCHPT STU

Dissertations (PhD theses):

1. Ing. Zuzana Sejáková, PhD.: Biodegradation of persistent organic pollutants: Biodegradation, sorption, and toxicity of chlorophenols (2004–2006)
2. Ing. Marianna Skokanová, PhD.: Effect of humic compounds on biodegradation and bioremediation of chlorinated aromatics in soils (2005–2007)
3. Ing. Tomáš Lobpreis, PhD.: Research and use of passive sampling on monitoring of bioavailability and toxicity of organic contaminants in the environment (2006–2010); dissertation appreciated by Rector STU 2010
4. Ing. Hana Dudášová, PhD.: Ecotoxicity, biodegradation, and identification of microorganisms in sediments contaminated with PCBs (2008–2012); student appreciated as Young Microbiologist 2013
5. Ing. Lucia Lukáčová, PhD.: Ecotoxicity and genotoxicity of sediments contaminated with PCBs (2009–2013)
6. Ing. Slavomíra Zorádová-Murínová, PhD.: Biodegradation of polychlorinated biphenyls and their effect on the cell membrane of bacterial degraders in the presence of inducers (2010–2014)
7. Ing. Katarína Lászlová: Biostimulation and bioaugmentation of sediments contaminated with polychlorinated biphenyls (2013–2016)

Master's theses:

1. Katarína Vozárová: Microbial degradation of polychlorinated biphenyls. 1992.
2. Martin Žúži: Biological degradability of technical greases on the basis of the rapeseed oil.1992.
3. Viera Holecová: Biodegradation of PCBs in liquid media. 1993.
4. Gabriela Lindišová: Microbial degradation of PCBs in soil. 1993.
5. Erika Furčiová: Influence of different soil types on microbial degradation of halogenated compounds. 1994.
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9. Ľubica Šubová: Chemical and photochemical pre-treatment of PCBs and their microbial degradation. 1998.
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11. Zuzana Kyseľová: Biodegradation of pentachlorophenol (PCP) in soil. 2000.
12. Mariola Martišková: Investigation of chlorobenzoates as intermediates and biphenyl as an inductor of PCB biodegradation. 2000.
13. Dáša Salugová: Microbial degradation of chlorinated phenols. 2001.
14. Anna Maľová: Toxicity and biodegradation of chlorinated phenols. 2002.
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2. Ing. Tomáš Lobpreis – 6 months – Department of Biological Sciences, Portsmouth University, United Kingdom, 2006 (Socrates, Foundation SPP, SAIA Program)
3. Ing. Marianna Skokanová – 3 months – Greenwich University, London, United Kingdom, 2008 (SAIA Program)
4. Ing. Hana Dudášová – 3 months – ICT Prague, Czech Republic, 2009 (SAIA Program)

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4. Zuzana Čechová: Biodegradation of PCBs in contaminated soils (Czech Academy of Sciences, Prague, 2007, SAIA Program)
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ACADEMIC EDUCATION AND RESEARCH IN THE FIELD OF CONTAMINATED SITES IN SLOVAKIA

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Contamination of the environment as a result of natural geological processes and anthropogenic activities is a long term area of interest for research and academic organisations in Slovakia. Despite the fact that the concept of an *environmental burden* was precisely defined in 2009, the topic of contaminated areas has been accompanied by numerous scientific projects and academic education since the beginning of the 1990s. Issues of environmental contamination have for a long time been considered at a scientific and educational level by various faculties at Slovakia universities (Comenius University in Bratislava, The Slovak Technical University in Bratislava, The Matej Bel University in Banská Bystrica, The Technical University in Košice) and at the Scientific Institutes of the Slovak Academy of Science (Institute of Geotechnics, Košice, Geological Institute, Banská Bystrica, Institute of Chemistry SAS, Bratislava). Tasks of a specialised and scientific character, focusing upon contamination of the environment in relation to contaminated sites, are also dealt with at numerous departments of the State Geological Institute of Dionýz Štúr in Bratislava or in Spišská Nova Ves, or the Water Research Institute in Bratislava. Orientation of individual scientific teams is very diverse, whereby it extensively reflects the diversity of scientific questions being presented by such issues of environmental contamination. Individual scientific organisations and universities focus upon topics which, to a varying extent, extend into the field of environmental contamination.

RESEARCH PROJECTS IN THE FIELD OF CONTAMINATED SITES IN SLOVAKIA

Research in the field of environmental burden, which is undertaken at the workplace of the Faculty of Natural Sciences, Comenius University in Bratislava, deals with a wide spectrum of particular problems as well as complex scientific questions. In general, it may be said that focus predominates in issues of mining and its processes that influence the environment, including inappropriate waste management of mines and their processes, as well as the study of contamination of individual environmental components in the field of environmental contamination. The advantage of the Faculty of Natural Sciences at the Comenius University in Bratislava, is that the wide scale of scientific disciplines with which the Faculty concentrates, enables a comprehensive approach to issues of environmental contamination whereby the main sphere of scientific activities are divided into the following topics:

1 exploration of localities and assessment of contamination sources, transport and accumulation of contaminants in the environment,
2 legislation and methodological approaches,
3 remediation measures and innovative technologies for environmental decontamination.

The Faculty of Natural Sciences at the Comenius University has, from the 1990s, been solely or partially responsible for resolving a large quantity of projects focusing on issues of environmental contamination. As an example of one of these pilot model projects, in 1996–1998, the *Assessment of the ecological capacity of the Žiar basin,* under the auspices of the Slovak Environmental Agency was undertaken to determine the extent of this extremely exposed area's capacity to withstand local industrial activities. The project assessed extensive chemical pollution in the area, as well as documentation and plans for potential regional development, creation and realisation of revitalisation programs. Those responsible for such projects were the Ecological and Veterinary Laboratory, EL Ltd., Spišská Nova Ves (professional guarantees RNDr. Jaroslav Vozár and RNDr. Štefan Méres) in co-operation with the Faculty of Natural Sciences, Comenius University in Bratislava and the Slovak Academy of Sciences (SAS).

Mining and processing of metallic or non-metallic raw materials is associated with environmental pollution and especially the production of anthropogenic waste. From a historic perspective, Slovakia is well known for its high number of mined ore deposits which, however, only produced a small volume of mining waste in the form of tailings or slag heaps. Due to the advent of new and effective ore processing methods (flotation), huge amounts of mining waste has been produced, especially flotation slurry deposited in tailings ponds. Assessment of the risks of active and enclosed tailings ponds, as well as mining waste concentrated in dumps and waste heaps which represent an environmental burden, has not been comprehensively undertaken. Studies of the environmental influence of tailings on environment quality, above all, represent only a partial examination (geotechnical, geophysical) together with the determination of mineral phases and chemical composition of deposited materials from ore processing, or combustion of coal.

The first pioneering project to determine the negative impact of mining on the environment was a project supported by the Ministry of Education, Slovak Republic named *A complex model of environmental effects derived from ore mining in given standard areas in the Slovak Republic (*prof. Vladimír Šucha, 1996) which was undertaken by the Faculty of Natural Sciences, Comenius University in Bratislava. During the subsequent period, in two projects undertaken by the Faculty, locations affected by acidic mining effluent had applied methods of technological passive purification (constructed wetlands) under aerobic and anaerobic conditions (Scientific-technical project, Ministry of Education, *Liquidation of acidic effluent and immobilization of toxic elements,* 1998 – 99, construction, operation and monitoring of a pilot purification plant for acidic mining effluent in Šobov. In Smolník, a project in co-operation with Aquipour Ltd., Bratislava and Knight Piésold, Denver, Colorado was undertaken. The subsequent outcome of this included mutual consultations with external contributor professor Thomas Wildeman, Colorado school of Mines, an expert on the application of constructed wetlands for the purification of acidic mine affluent (Slovak-American project: *Passive treatment of acid mine drainage at Smolnik Mine, Slovakia* (1999 – 2000), financed by EcoLinks and Knight Piésold Denver). On the basis of the successful completion of these two projects, and their inclusion in academic publications and at international conferences, co-operation with the University of Greifsvald in Germany was undertaken. The outcome of this has been laboratory and location confirmed purification of effluent contaminated by Al, Cu, Cr, Ni and other metals, at Van Chang in Vietnam (Slovak-German-Vietnamese project entitled *Environmental impact of industrial waste in Nam Dinh county, Vietnam*, 2000 – 2003). Results deriving from the project undertaken in Šobove and Smolník are included in the monograph *Atlas of remediation methods for contaminated sites* (Frankovská et al., 2010).

On the basis of the above mentioned projects, two follow up projects were carried out: PECOMINES *Inventory, regulation and environmental impact of mining waste in Pre-accession countries* and MVTS EU/JRC/Tal/SR *Physicochemical properties of mining waste in Slovakia and its influence on the environment.* These projects included, from 2001 – 2003 research focusing on determining and describing sources of contamination in Smolník and their subsequent monitoring, as well as quantification and the determination of the means of pollutant movement and accumulation of potentially toxic elements in the catchment area of the Smolník stream and Hnilec River. During the project, selected toxic elements were monitored in water, suspensions, river sediments, solid mining waste (slag heaps, tailings ponds) and in soils. A significant result of the project was the qualitative and quantitative assessment of contaminant movement (mainly As, Cu, Fe, Zn and Pb), bonded to oxyhydroxides of iron in the form of an aqueos suspensions, which represent the main environmental problem appearing at the Smolník location and the cause of the mentioned water course contamination.

A pilot study – interdisciplinary study of tailings ponds (model example Pezinok tailings pond) was undertaken among those tasks included in applied research by the Ministry of Education, Slovak Republic, no. AV/901/2002 *Estimation of the risks of contamination surrounding Sb, Au & S deposits in Pezinok and proposals for remediation: toxicity As and Sb, acidification.* In view of the speed of oxidation and the quantity of unchanged sulphides present in the flotation slurry, the tailings ponds will present a significant environmental burden for many years. On the basis of the project's outcome, it has

been shown that a complex study on the issues of mining waste, deposited in heaps and in tailings ponds, is required.

Connected to the above mentioned study, the Minister of Education launched a scientific project focusing on selected tailings ponds after digging for Sb ore, (APVV-0268-06 *Assessment of the influence of mining activities in the surroundings of Slovak antimony deposits with remediation proposals,* project supervisor, professor Martin Chovan), whereby the Ministry of Environment had full access to all project results. Detailed inter-disciplinary research into deposited flotation slurries, mining waste and contaminated environmental mediums (air, waters, stream sediments) was carried out at selected abandoned antimony deposits. (Pernek, Dúbrava, Medzibrod, Čučma, Poproč). Experimental and locational results of research determined the extent of contamination of the mentioned environmental mediums including primary and secondary sources of pollution at relevant environmentally contaminated locations. The outcome of the project resulted in integrated research between mineralogical, geochemical, hydrogeological and botanical components. One stage of the project has been completed with successful confirmation of laboratory experiments focusing on purification of contaminated effluent using zero-valent iron (ZVI).

Detailed research from 2009 – 2012 was undertaken on examples of tailings ponds in Rudňany and Slovinky within the project, MŠ SR APVV-VMSP-P-0115-09, entitled *Methodological approach for a complex audit of tailings ponds containing waste after ore mining.* This was undertaken by Ecological Laboratory EL Ltd., Spišská Nová Ves and The Faculty of Natural Sciences, Comenius University in Bratislava. On the basis of this research, a guideline proposal was developed to comprehensively assess tailings ponds, which takes into account the latest scientific approaches when determining constituent material of tailings ponds.

The topic of environmental contamination, regarding abandoned copper mines in Central Slovakia, (Ľubietová, Špania Dolina, Staré Hory) has for a long period been considered by the Matej Bel University in Banská Bystrica in co-operation with the Slovak Academy of Sciences (Geological Institute) in Banská Bystrica. Many topics, such as, the speciation of toxic metals (As, Sb) in landscape components, the environmental study of contamination of landscape components by heavy metals and their remediation and opportunities for the use of natural sorbents in order to protect the environment in the vicinity of former mineworks, are subjects for further APVV a VEGA projects (for example, APVV-0663-10 *The study of mine landscapes contaminated by toxic elements at selected copper deposits and the possibilities for their remediation, 2011 – 2013*, project supervisor prof. Peter Andráš, and APVV-51-015605 *Defining possibilities for landscape recovery in the vicinity of Ľubietova, on the basis of a study of the distribution of heavy metals and toxic elements in landscape components*, project supervisor, professor Peter Andráš).

Defining contamination of ground and surface water is part of a vast number of projects focusing on environmental contamination being undertaken in Slovakia. Specially focused research tasks present projects and objectives carried out at the Water Research Institute in Bratislava. The following projects may be cited as examples: *Products and intermediates of organic substance degradation in an aqueos environment* (1995 – 2000, research supervisor, RNDr. Miroslav Holubec, CSc.) project RVT 27 – 34 *Research into the influence of anthropogenic factors in aqueos systems* (research supervisor, RNDr. Miroslav Holubec, CSc.) and its partial role in 07 *The influence of diffuse sources of pollution on the quality of water* undertaken from 1999 – 2002 or the purposeful role of the Water Research Institute's no. 6413 *The influence of pollution sources and the vulnerability of ground and surface waters due to agricultural chemicals in relation to the implementation of EU guidelines,* from 2007 (project supervisor, RNDr. Anna Patschová-Hornáčková).

Specific problems of environmental contamination are presented by atmospheric deposits. From 2011 – 2014, at the Institute of Geotechnics (SAS in Košice), a project aimed at studying environmental components of specifically affected areas, above all, to define and quantify atmospheric deposits in the central Spiš and Košice areas and a study of lake sediments at the Ružín reservoir were carried out

(VEGA 2/0187/11 project – *Study of heavy metals, harmful mineral substances and their deposits in selected locations of the environment in areas of mining and metallurgic industries of Eastern Slovakia*, project supervisor, Ing. Jozef Hančuľák, PhD.). During the project, the true extent of the burden on the mentioned areas was studied by quantifying the mass flow of contaminants from the monitoring of atmospheric deposits. On the basis of the study of solid atmospheric deposits, it is possible to determine their mobility and the resulting risk presented to other environmental components.

From the perspective of environmental contamination research, waste ponds of fly ash represent an important issue due to the deposits of these specific antropogenic materials containing high levels of arsenic. The Faculty of Natural Sciences (Comenius University in Bratislava) has undertaken a number of scientific projects to define the nature of contaminated sites at the Poša a Zemianske Kostoľany tailings ponds (for example VEGA 1/1034/11 *The binding of contaminants to solid phase fly ashes – geochemistry, mineralogy, environmental impacts* project supervisor, RNDr. Ľubomír Jurkovič, PhD.). In the case of environmental contamination in Zemianske Kostoľany, a unique system of buried fly ash (extremely high in below-ground arsenic) has resulted as a result of an industrial accident at the site in 1965. Both the soil and buried fly ash contain high concentrations of arsenic which is present mainly in the finest fractions of samples. Arsenic binds the aggregates of nanoparticles formed by amorphous aluminosilicate glass. In view of the character of land use in the area of the environmental contamination, findings are important concerning the relatively low extractability of arsenic from the solid matrix compared to a significant proportion of released arsenic in the case of bioleaching by microscopic fungi (*Aspergillus niger).* The study of bioleaching processes and the identification of species diversity of contaminated soils with focus on microscopic filamentous fungi and bacteria, is the actual content of VEGA 1/0321/14 project *Geochemical conditions for the application of autochthonous species of microorganisms in remediation processes of bioleaching for arsenic contaminated soils (pilot locality Zemianske Kostoľany),* project supervisor, RNDr. Ľubomír Jurkovič, PhD.

An inseperable component of scientific focus in many workplaces concerns research aimed at the development and testing of various remediation precautions as well as innovative technologies applicable for decontamination procedures of the environment. Due to the complexity of this topic, solutions require broader research teams and co-operation between academic institutions and the private sector, or even with renowned international institutions. Projects concerning proposals for numerous passive remediation precautions were mentioned in the previous text. These projects were undertaken in co-operation with various organisations (for example, the Joint Research Centre, Ispra, Italy) and foreign universities (e.g. Friedrich Schiller University, Jena, Albert Ludwig University of Freiburg, VŠB – Technical University of Ostrava, and others.). At the Faculty of Natural Sciences in Bratislava, project APVV-0344-11 *PILOTTREAT* is currently ongoing – *Pilot project aimed at remediation of mining effluent at selected abandoned Sb deposits* (project supervisor Mgr. Peter Šottník, PhD.) in co-operation with EL Ltd. Spišská Nová Ves. The aim of this project in field conditions is to verify the binding method of contaminants to secondary mineral phases resulting from the application of Fe^0, define the extent of reduction of contamination spread at the chosen location by application of a sediment tank and to experimentally verify the effectiveness of the controlled formation of stabilised secondary mineral phases binding monitored contaminants. The final outcome of the project will be to propose a final remediation solution for the contaminated location.

Scientific studies focusing on innovative remediation technologies have been undertaken for some time at the Institution of Geotechnics SAS in Košice. From 2011 – 2014, for example, project APVV WATRIP – *Development of advanced technologies for the removal of inorganic pollutants from water* (project supervisor Ing. Miroslava Václavíková, PhD.). This considered the selective elimination of specific cations and anions/oxyanions from mining and industrial effluent and the selective acquiring of metals in a form suitable for reuse in practice. The outcome of this project represented a significant contribution to the development of waste-free, respectively, environmentally suitable purification of industrial effluent. At the present time, a new international project is being worked upon, NATO SECWATER – *Research into safe technologies for the detection and removal of contaminants from water* (project

supervisor, Ing. Miroslava Václavíková, PhD.), which contains development material and methods for sensoring and detection of heavy metals, pathogens, (bacteria, viruses), organic materials (TCE, detergents, halogen compounds), pharmaceutical, pesticides and other toxic components present in water and the environment. As part of the project, a strategic proposal for decontamination and remediation of contaminated water is being worked upon.

An important material-technological project, dealing with topics associated with environmental contamination, is currently the multidisciplined project *WaSClean – Cleaning up water and soil – freeing from mixed contaminants,* which is coordinated by the Institute of Geotechnics, SAS in Košice (project manager, Ing. Miroslava Václavíková, PhD). The project is being undertaken under the auspices of the *seventh framework programme for research and technological development* of the European Union (7RP) from 2013 – 2017. It will be carried out by a consortium of experts at an international scientific level in the fields of environmental management, geochemistry, nanotechnology, (geo)microbiology, environmental engineering, material research, as well as physical, colloidal, and analytical chemistry (Institute of Geotechnics, SAS, University of Brighton, UK, Aristotle University of Thessaloniki, Greece, Nazarbayev University, Kazakhstan). Members of the consortium are also representatives of some small and medium sized businesses (Environcentrum Ltd. Košice, MAST Carbon International Ltd., Basingstoke, United Kingdom, Hermes s. a., Oraiokastro, Greece, Ekodor SK, Astana, Kazakhstan) whereby the smooth transfer of studied knowledge put into practice is expected. The project is very wide ranging; scientific objectives include the research and development of new materials and technologies for remediation of contaminated water and soils, the development of a pilot plant for production of nanoparticles based on Fe and Cu, the study of sorption processes for removal of contaminants, preparation of biogenic materials for the removal of heavy metals from water, biodegradation of organic pollutants and degradation of non-biodegradable pollutants using electrochemical processes. The main outcome of the project will be to integrate individual approaches into a sequential remediation process for the removal of diverse contaminants from the environment.

ACADEMIC EDUCATION IN THE FIELD OF CONTAMINATED SITES IN SLOVAKIA

Academic education dealing with issues of environmental contamination is represented in accredited courses of technical and natural sciences at bachelor, masters and doctoral levels of study at the previous mentioned universities. Varying kinds of individual courses have gradually evolved into the present form, however, a highly specialised course dealing only with problems of environmental contamination in Slovakia is missing. From the natural sciences point of view, environmental contamination is mainly dealt with by natural sciences faculties (Faculty of Natural Sciences, Comenius University in Bratislava, Faculty of Natural Sciences UMB Banská Bystrica, Faculty of Mining, Ecology, Management and Geotechnology TU Berg Košice), studies at masters level spanning technological areas are covered by curricula at the Faculty of Chemical and Food Technology STU in Bratislava (further information may be obtained from the contribution TRAINING AND EDUCATION OF THE SPECIALISTS ON THE ELIMINATION OF THE ENVIRONMENTAL CONTAMINATION IN THE COURSE OF ENVIRONMENTAL BIOTECHNOLOGY AT THE SLOVAK TECHNICAL UNIVERSITY IN BRATISLAVA (Assoc. Prof. Katarína Dercová, PhD.).

The most comprehensive study of various scientific subdisciplines required for the objective assessment of contaminated sites is ongoing at the Faculty of Natural Sciences, Comenius University in Bratislava. The study of environmental contamination takes place in the form of options at bachelor's level in *Geology and the Environmental Sciences* and in a newly accredited course *Bio-geology and Geology and land use.* Two masters courses, connected to the bachelors, in which teaching of specific subjects focusing on environmental contamination are undertaken are *Geology,* within which *Applied and Environmental Geophysics, Engeneering Geology and Hydrogeology, Economic Geology* and *Mineralogy and Petrology* are taught and the *Protection and Land Use* course, within which features the subject of *Environmental Geochemistry.* In the case of the geological course, it enables graduates the ability to interpret knowledge on geological structures of studied localities, as well as on potential geogenic sources of contaminants in relation to the presence of ore deposits in the considered area. The aim of the courses is to enable graduates the ability to assess the environmental risks of mining and processing of ore as well as anthropogenic contaminated components of the environment, to define hydrogeological and engineering-geological conditions of environmental contamination and separately judge the environmental and economic consequences of environmental contamination and the exploitation of raw materials for the development of a region using geoinformation systems. After graduation at the Faculty of Natural Sciences of Comenius University, graduates, having taken the mentioned subjects, are able to apply standard research methods to contaminated sites as well as diverse analytical procedures to identify the scale and character of environmental contamination. Efforts made at this level of academic education are directed to graduate ability – to individually solve research tasks connected to the objective verification of the characteristics of environmental contamination in accordance with current legislation and using the most modern analytical and field techniques of geological work.

Contaminated sites issues are partially considered, as well as related optional subjects being taught, at the Faculty of Natural Sciences (Matej Bel University in Banská Bystrica) and at the Faculty of Mining, Ecology, Management and Geotechnology (TU Berg Košice). At the UMB Banská Bystrica, for example, a bachelors course of *Environmental Management* is taught which acts as the precursor for two masters courses – *Geology* (course title – *Applied Geology*) and *Environmental Management.*

The current trend of active education and technical support of students, when concluding scientific work, requires modern technical facilities and laboratories at universities as well as the most up to date equipment for field work and research. In the case of issues of contaminated sites, it is necessary for the assessment of potential environmental contamination and to devise suitable remediation methods, not only to find out the overall pollutant content in waste and contaminated substrates, but also to define mineral phases in waste and forms of bound contaminants in primary and secondary mineral phases. It is also important to determine the proportion of soluble and mobilizable fractions of contaminating

potentially toxic elements. For these objectives, various experimental methods are used, including evaluation of the mobility of contaminants by means of static and dynamic extraction experiments and modern mineralogical and chemical analysis for the study of solid phases and solutions. Modern equipment using top of the range instruments for the purposes of scientific projects and teaching (especially at doctoral level of study) is represented at chosen universities *Centres of excellence.* In the case of the Faculty of Natural Sciences, Comenius University in Bratislavaand the Institute of Chemistry SAS, it applied to project APVV-VVCE-0033-07 *Research-education centre of excellence for solid phase research aimed at nanomaterials, environmental mineralogy and material technology – Centre of excellence APVV-SOLIPHA* (project supervisor prof. Martin Chovan). This major and exceedingly well equipped centre of excellence was finished recently on the basis of project ITMS: 26220120064 *Centre of excellence for integrated research of the Earth's geospheres* (2010 – 2013) as a partnership between the Geological Institute SAS in Bratislava and in Banská Bystrica, the Institute of Geotechnics SAS in Košice and the Technical University in Zvolen.

A component of educational activities relating to issues of environmental contamination was a recent major project of the European Social Fund (ESF) – JPD 3 2005/1-052 *Quality improvement of specialist preparation in the field of environmental risks of waste from the extraction industry* (project supervisor, Mgr. Peter Šottník, PhD.) which was undertaken at the Faculty of Natural Sciences, Comenius University in Bratislava, from 2006 to 2009. During this project, all knowledge, outcomes and contacts obtained from long-term scientific work in this field were applied and five specialist workshops (67 delivered presentations) and 15 educational programmes (e-learning courses, field studies, project teaching) took place. Altogether, 423 participants took part including scientists, civil servants, employers and management in the private sector and bachelor, masters and doctoral students from across Slovakia. The results gained from this project were applied in the UNDP PS 2009/15 educational project *Preparation and conducting of Study tour – learning from the Slovak experience in environmental management and remediation of priority mine sites.* (Faculty of Natural Sciences, Comenius University in Bratislava, project supervisor Mgr. Peter Šottník, PhD.), whereby lectures and field trips took place that focused on mining burdens for representatives of universities and mining companies from Montenegro, Serbia, Macedonia, Albania and Kosovo.

Department of Economic Geology (Faculty of Natural Sciences, Comenius University) from 2012 – 2015, organised a two week summer course as a part of the *ADVANCEG* project – *Advanced Environmental Geology* (financed by the Erasmus IP program, project supervisor Doc. Peter Uhlík, PhD.) for university students participating in the project. Every year approximately 40 students took part from all three study levels of education and 15 lecturers – teachers from universities in the Czech Republic, Romania, Poland, Hungry, Germany, Portugal, Spain and Slovakia. The main themes considered gradually changed and included: Environmental Raw Materials (*ADVANCEG 1* 2012 in Banská Štiavnica), Influence of Ore-mining on the Environment (*ADVANCEG 2* 2013 in Spišska Nová Ves) and Remediation Technologies (*ADVANCEG 3* 2014 in Košice). For all three years, lectures dealt with exploration and remediation issues of environmental contamination and as a part of field trips, participants paid visits to numerous of these sites (Poproč, Rudňany, Smolník, Šobov and Merník). Participation in the summer course for the students counted as a subject within their course and they could gain credits or marks based on a test result and participation in field studies and laboratory work.

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ENVIRONMENTAL EDUCATION OF CONTAMINATED SITES ISSUES AT THE SLOVAK ENVIRONMENT AGENCY

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Key words: teacher, pupils, competition, environmental education and awareness, contaminated sites

The Slovak Environment Agency (SEA), from June 2012, has been the executor of the *Education and public awareness as a support in contaminated sites remediation in SR* project. This is co-financed by the Cohesion fund of the EU within the framework of the Operational Programme Environment. The project is planned to continue until May 2015.

The main aim of the project is to increase awareness of the general public when dealing with problems of contaminated sites, including its remediation. Featuring among its main activities are two international conferences, five expert seminars for professionals, a day of final presentations of the project, the issuing of information leaflets for the general public and professionals alike in two different languages (Slovak and English), preparation of a 30 minute documentary film, 6 short video clips on pollutants, arranging a fair in 2013 of environmental education programmes (ŠIŠKA), realisation of school competitions on the environment – EnvirOtázniky (EnviroQuestions) in 2013/2014, implementation of a new school programme 'Enviróza' (Envirosis) including the issuing of worksheets for schools and other activities dedicated to the issues of contaminated sites.

FAIR OF ENVIRONMENTAL EDUCATION PROGRAMMES – ŠIŠKA

ŠIŠKA is a three day event for people with a passion for environmental education (EE) which is created and carried out by these individuals. They meet at the beginning of every school year to inspire one another, as well as encourage each other in their work.

The **16th yearly meeting** took place in the Veporsky hills, in a place called Látky-Prašivá and over **140 coordinators of environmental education** took part. They came from schools, state and non-governmental organisations. The main theme of the event covered **contaminated sites.** During the course of three days, almost 40 presentations, a field trip and two social evenings took place. Participants also witnessed the symbolic beginning of the new SEA school programme, called **Enviróza** and together brought it to life (Fig. 15).

The second day of the fair continued with lectures which highlighted a wide range of environmental education in schools and national parks, as well as in state, non-governmental and business sectors. At the same time, prizes were handed over in the ProEnviro and 'Oči na stopkách' (Eyes wide open) school contests. The afternoon field trip, keeping within the central theme of this year, was an excursion of participants to a local regulated landfill site (Fig. 16). In re-cultivated parts of the site, they could view a district drainage channel, ventilation shafts or monitoring wells, and in the operational part of the site, examine its composition and smell the rotting rubbish.

After the outdoor trip and evening meal the participants again met up, this time with celebratory expectations. Prizes were received by those schools which left the smallest ecological footprint in their category and for teachers successful in the Hour with Eco-footprint competition. A Culturally uplifting experience was provided by the tones of the Fujara and Heligonka – traditional Slovak musical instruments. The participants, later on, created together the symbol of the event, a cone, made out of waste materials. Squashed plastic bottles represented the cone seeds within which were hidden various

enviro-educational tasks or activities. Through fulfilment of these, everybody gained some knowledge and of course, had fun. Entertainment in the evening hours was complete in the form of the 'ŠIŠKA' or Cone song which participants sang accompanied by guitar, drums and some rattle instruments.

Fig. 15 RNDr. Vlasta Jánová, PhD., Director General of the Directorate for Geology and Natural Resources of the Ministry of Environment of the Slovak Republic and Ing. Martin Lakanda, Director of the Section of Environmental Sciences and Project Management of SEA, in an unusual style, launch a new school programme of SEA by the name of Enviróza. The programme logo was initially cut up into little pieces then blown among fair participants which symbolises the spreading of information about contaminated sites.

The last day of the fair did not fall behind those of previous events. Presentations of specific EE activities performed by teachers took place as well as practical demonstrations how to produce numerous useful objects from waste materials.

ENVIRONMENTAL SCHOOL COMPETITION ENVIROTÁZNIKY

This concerns a national based competition for pupils in the 2nd level of primary school.
Its aim is to increase pupil's interest in natural science issues and environmental concerns before they decide on their future studies at high school. At the same time, it is supposed to contribute to an increase of environmental awareness, knowledge of sustainable development and involvement of pupils in environmental issues – whether at home, school or in their region.

The competition takes place on line at www.envirotazniky.sk. Pupils are registered by their teacher and their answers are recorded directly on the portal in response sheets. The most successful candidates win valuable prizes.

The school competitions comprise **60 questions** on chosen topics. All questions are concealed, with a choice of correct answers. Every correct answer carries 1 point, whereby the maximum number of achievable points is 60. Pupils, when answering questions, are able to utilise any accessible information source including the internet. In so doing, they learn to work with a variety of information, as well as levels of quality.

The **9th year** of school competitions, which was launched in February 2014, focused on problems of contaminated sites. The 60 questions were distributed among the following categories:

1. Contaminated sites
2. The Enviróza school programme
3. Types of contaminated sites
4. Soil and bedrock

Fig. 16 The field trip to a landfill site was led by Ing. Jaromír Helma, PhD of SEA (in the middle), who is also the expert responsible for the Enviróza project.

5. Water
6. Human health

Before the competition deadline in April 2014, a total of 882 pupils from 162 primary schools responded to the competitions questions. The most successful pupils were from Eastern Slovakia (Fig. 17) occupying the top three positions:

1. **Róbert Karpiel,** Church Associated School, Duchnovičova 24, Humenné
2. **Simona Tomková**, Primary School, Budovateľská 9, Snina
3. **Chiara Frandoferová,** Church Associated School, Duchnovičova 24, Humenné

The winner got 57 points and received sports goods as the prize – worth 400 Euros. Pupils who came from second to tenth place were collectively awarded prizes of value 660 Euros. Every pupil who gained 50 or more points was sent a certificate for successfully taking part in the competition.

Further information can be found on the School's Competition webpage: www.envirotazniky.sk

METHODOLOGICAL DAYS FOR TEACHERS

With the aim of schools familiarising themselves with the Enviróza programme, its objectives and methodology, similarly with issues of contaminated sites in general, lasting from January to March 2014, 10 methodological days for teachers took place. Due to co-operation between various state educational and cultural organisations (Methodological-Teacher Training Centres, Free Time Activity Centres and Centres of Culture), these meetings were able to take place at different locations across Slovakia. Altogether, 224 teachers got involved in Enviróza, who tried out several prepared activities

Fig. 17 Róbert Karpiel (centre) winner of EnvirOtázniky and the other awarded students from the Church Associated School in Humenné.

given on worksheets both for pupils and students (Fig. 19). They gained an expert's interpretation on the current condition of contaminated sites in Slovakia. Apart from useful information they received a SEA bundle of publications dedicated towards environmental education.

INFORMATION COMPETITIONS

Apart from the primary goal to map selected contaminated sites, within the Enviróza school programme, players also had the opportunity to enter associate competitions. Three such competitions were launched in the 2013/2014 school year: **Photo-burden, Infoška** and **Sci-fi**, which all have the common objective to inform about issues of contaminated sites and contribute towards increasing awareness concerning the risks as well as importance of this issue.

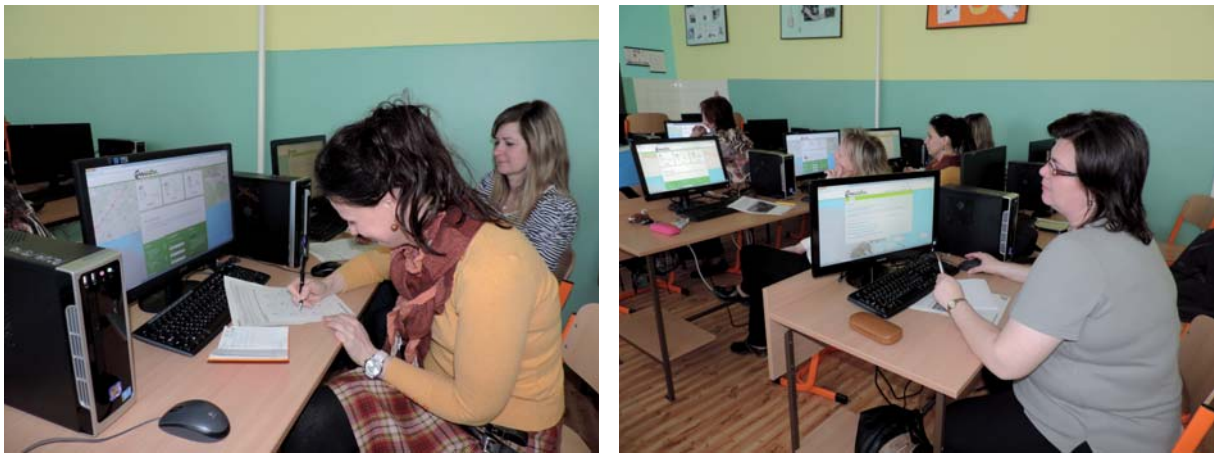

Fig. 18 Photo taken at the Methodological days undertaken in co-operation between the Poprad town municipality and Komenský street Primary School/Nursery School.

All associate competitions took place in terms of rules, topics and schedule according to the announced round. Entry contributions, as well as the documenting of individual competitions, are presented in the public section of the portal called Informuj. From a total of 71 registered schools, 19 play groups actively took part in the competition.

Photo-burden is competition on the best picture on a given theme. Two rounds of the competition occurred during the 2013/2014 school year (autumn and spring) based on the theme *Shocking Enviróza* and *Inhabitants of Enviróza*. In the first round, 22 photographs from 12 picture takers were entered and in the second round 23 picture takers forwarded a total of 43 photographs (Fig. 19 and 20). Photograph assessment took place initially by means of public voting on the competition's website, as well as via so called new media methods, i.e. in the form of a Facebook 'Like' which enabled the general public, similarly, the chance to cast a vote.

Fig. 19 Jury award Photoburden (1st round) – Pavol Fať un from the Tajkáči playgroup (Primary school/Nursery school, Tajovský street 2764/17, Poprad).

Fig. 20. (Non)Culture photographed by Vladimir Šoffa from the Enviropositive playgroup (Technical High School, Komenský 2, Košice – Old town) entered in the first round of Photoburden within the theme Shocking Enviróza.

Infoška is a competition on the best information activity. During the 2013/2014 school year, the competition ran for the whole year. Five informational activities from three playgroups were entered in the competition. Informational activities consisted, for example, of the creation of notice boards in places in the school, a lecture given to pupils and teachers of the school and a presentation together with the showing of a filmed video for younger pupils whose aim was to encourage them to get involved in Enviróza in the next school year. All mentioned activities were wide ranging and were aimed at various age categories as well as interest groups.

Sci-fi is a competition on the best science-fiction story. During the 2013/2014 school year, one round took place on the theme "I have a dream" – a world without contaminated sites. In total, 35 sci-fi stories from 36 authors and 15 playgroups were entered. Story assessment occurred at first by means of public voting on the competition's website as well as in the form of Facebook likes, the aim being to engage the general public.

PROMOTION AND PUBLICITY

Information on the Enviróza school programme and its associate competitions attracted the public's attention through:

- **press releases –** issued to mark the launch of the school programme (1 ×) and associate competition judging (3 ×);

- **articles –** in printed magazines (Enviromagazín – 3/2013, 2/2014, 3/2014, News Banská Bystrica – 14/2013), in proceedings of conferences (Conference Contaminated Sites 2014 Štrbské Pleso, Enviro-i-Fórum) and on websites and portals (www.sazp.sk, www.enviroportal.sk, www.enviroza.sk, www.ekostopa.sk, www.envirotazniky.sk and snaturou2000.sk).

During selected conferences and seminars, a 20 minute presentation of the Enviróza programme was also shown:

- **Conference of Environmental and Ethical Education, Ekotopfilm,** October 7th, 2013, Bratislava
- **International Conference Contaminated Sites,** April 23rd–25th, Štrbské Pleso
- **Seminar for state administration in the field of contaminated sites,** May 13th, 2014, Bratislava
- **Enviro-i-Fórum,** June 24th–25th, 2014, Zvolen

WASTE HAS ITS OWN STYLE!

A mixture of materials and colours. A mountain of discarded objects and food. A rotting smell spreading everywhere. Most people would describe a landfill site as a place that frightens away rather than attracts. Ladislav Bíro (SEV Dropie – Dropie Environmental Education Centre), who sees things differently, definitely doesn't belong to one of the former. "I gladly go to a landfill site where I find inspiration and plenty of nice things" he commented during a visit to a municipal landfill site as part of the ŠIŠKA event. What was expressed was also carried out. It isn't an accident that worn out bicycle tyres interested him. Into thrown out boxes they go, as a look of satisfaction due to the acquired "possession" manifests upon his face.

Tyres from the landfill site got a second chance during the fair. As part of a workshop, under the supervision of Ladislav Bíro, others tried their hand similarly with rubbish. Cut here, press there, attach the buckle, that is, the toothed wheel of the bicycle pedal…. as if by magic, a stylish belt is made. The tread design of the tyre gives it an air of originality – suitable for any occasion. This original idea attracted a lot of attention from the fair's participants. Maybe because, at that moment, they started to see waste in a different light.

Fig. 21, 22 and 23 The materials from the landfill site got a second chance from Ladislav Biro

THE ENVIRÓZA SCHOOL PROGRAMME – A SUCCESSFUL EXAMPLE OF INVOLVING THE PUBLIC IN ADDRESSING CONTAMINATED SITES IN SLOVAKIA

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Keywords: school programme, game, environmental education, contaminated sites (CS), environmental burdens

Enviróza (Envirosis) is a school programme and outdoor game designed to gather and spread information on contaminated sites in Slovakia.

Intended for primary and secondary schools, the programme is implemented through the website **www.enviroza.sk** (Fig. 25). The participants (teachers and pupils) ***seek out*** and ***identify*** contaminated sites, publish their data online and ***score points*** for doing so. Through accompanying competitions, they also ***inform*** the public about this issue.

Enviróza is categorised as a citizen science programme; its **practical role** is to update information about selected contaminated sites registered in the Information system of Contaminated Sites (ISCS) and to identify new sites (known as "school-identified sites") that display signs of serious contamination. The information gathered by the participants is further processed by Slovak Environment Agency (SEA) staff, integrated into the ISCS and thus made available to state authorities as well as the professional and lay public.

Enviróza's **educational goal** is for participants to gain information about existing contaminated sites and the state of their own environment based on first-hand observations in the field. In the process, pupils and students develop their skills at orientation with maps and navigational tools; they learn to work with information, use information/communication technology and work as a team, as well as think critically and express their own opinions. The programme provides the teacher with an experiential learning tool for environmental education and incorporating the issue of contaminated sites into lessons of many other school subjects. The materials include a teacher's handbook and worksheets with 50 activities, but the chief teaching aid is the programme website itself.

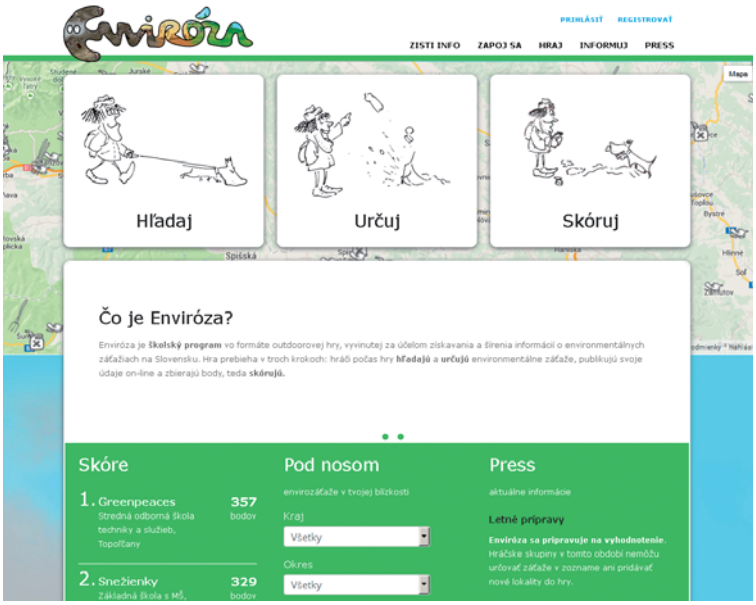

Fig. 24 Homepage of the school programme Enviróza website

Enviróza is part of the project *Education and public awareness as a support in contaminated sites remediation in the Slovak Republic*, which is financed by the EU Cohesion Fund as part of the Operational Programme 'Environment' (2007–2013). The programme was launched at the start of the 2013/2014 school year, under the auspices of the **Ministry of Environment of the Slovak Republic**. In its first year, **71 schools** from across Slovakia registered in the programme.

HOW IS ENVIRÓZA PLAYED?

The programme (game) consists of three core phases and a fourth, supplementary one:

1. **Seek** – selecting contaminated sites from a list and locating them via map, GPS or smartphone,
2. **Identify** – registering data on environmental burden right in the field via ID form,
3. **Score** – publishing data on environmental burden online and collecting points,
4. **Inform** – informing people about contaminated sites through the accompanying Photo-burden, Infoška and Sci-Fi competitions.

WHAT ARE THE RULES?

1. Participants from a given school comprise a **team**, which is registered and led by their teacher. Each team can have an unlimited number of players, including pupils or students of any age. Each school can only have a single team in the game.
2. A team can seek and identify any environmental burden in the list. They collect points even if the contaminated site has already been identified by another team.
3. Teams can also seek out new cases of environmental contamination that are not in the list but fulfil the specified criteria.
4. The publication of information by individual team members on the public area of the website must be approved by the teacher.
5. If a team infringes copyright or violates the code of ethics, they will be eliminated from the game.

LIST OF CONTAMINATED SITES

Using the Information system of Contaminated Sites (ISCS), a list of **501 contaminated sites** distributed throughout Slovakia has been created for the purposes of the programme (game). Safety was the chief selection criterion, which eliminated certain groups and classes of sites completely. The final list consisted of 192 sites from Register A (potentially contaminated sites), 22 from Register B (confirmed contaminated sites) and 214 from Register C (remediated, reclaimed contaminated sites), as well as 50 categorized as both A and C, and 23 categorized as both B and C.

The sites in the list are schematically divided into the following **classes and types**, each marked with its own icon (Fig. 25):

Classes
1. Landfill sites
2. Dunghills
3. Petrol stations
4. Industry and mineral extraction

Types
1. Conventional
2. Mystery
3. Unidentified
4. Series
5. School-identified

Every environmental burden in the list has a **point value** (determined according to pre-established criteria) and **clues** as to its location (map, coordinates) and identification (identification form). Teams can also look for **"new"** (school-identified) **contamination sites** not on the list, thus becoming co-creators of the game itself.

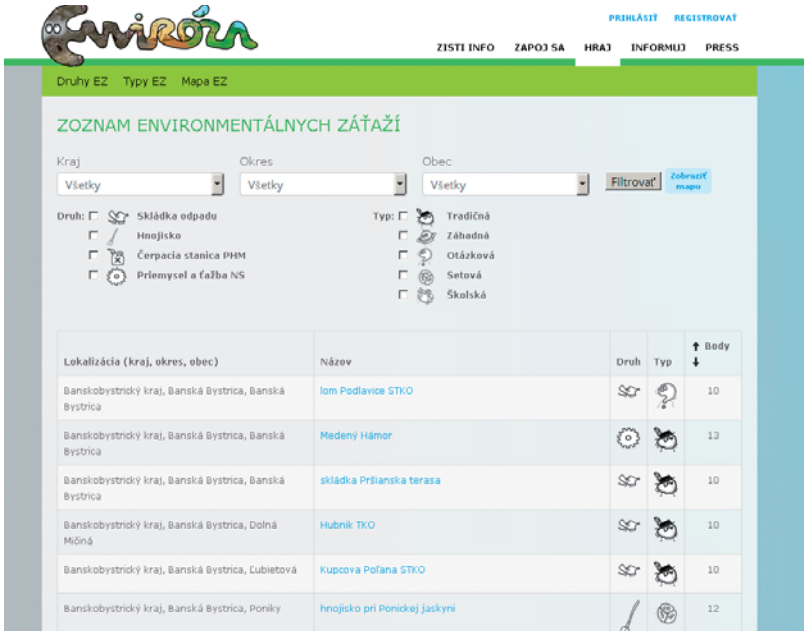

Fig. 25 The list of contaminated sites included in the programme can be filtered according to location, class, type and point value.

HOW TO JOIN IN?

Teachers (or club leaders) can register their school in the Enviróza programme and establish a team by filling out the **online registration form** at www.enviroza.sk. Registration does not obligate the school to take part in any activities or pay any fees!

After successfully registering, the teacher will be sent (via post at their school's address) the **programme materials**: the teacher's handbook, worksheets for primary and secondary schools, and an informational poster.

PROGRAMME DIDACTICS

The Enviróza programme is a source of information and topics for incorporating the issue of contaminated sites into the teaching of various school subjects, including **mathematics**, **information technology**, **biology**, **chemistry**, **Slovak**, **art** and **civics**.

Through its four phases – 1. **Seek**, 2. **Identify**, 3. **Score** and 4. **Inform** – and set of **worksheets**, students can develop and strengthen a range of **competences**, including:

- taking interest in the natural world and events within it,
- actively shaping and protecting the environment,
- acquiring information on the environment and its components through first-hand observations in the field,
- understanding the environmental factors that influence our lives,
- actively taking part in public affairs,
- working with maps and orientation,
- using information/communication technology and media,
- working with information, reading comprehension and using acquired information,
- understanding graphs, diagrams and charts,
- creativity, critical thinking and expressing their own opinion,
- written expression,
- self-actualisation and self-presentation,
- cooperation.

The programme provides a venue for **experience learning** outside the classroom and the implementation of varied educational

- **methods** – problem- and project-based learning, written assignments and work with texts, hands-on learning, research methods,
- **forms** – the use of information/communication technology, group learning, hikes and field trips.

The teacher has cost-free access to printed and electronic publications, including

- **the teacher's handbook** – a companion to implementing the programme's core phases,
- **worksheets for primary and secondary schools** – featuring 50 activities for pupils and students, divided into five subject areas: Contaminated sites; Classes of Contaminated sites; Water, Soil and Bedrock; Human Health,
- **informational poster** – providing basic information about the school programme.

WHAT'S THE POINT?

Through active participation in the Enviróza school programme, pupils and students help to address the issue of contaminated sites in Slovakia in the following ways:

- The **information** they collect by seeking out and identifying contaminated sites is further processed and utilised by SEA staff and state authorities.
- The **identification (ID) forms** are linked to concrete contamination sites/contaminated sites in the Information system of Contaminated Sites (ISCS, http://envirozataze.enviroportal.sk/), and thus made available to the professional and lay public.
- They can point out ***new* sites** not yet listed in the ISCS and become their annotators, helping to identify as-yet-unrecorded cases of contaminated sites in Slovakia.
- As part of the **informational competitions**, they help to spread information and raise public awareness about the issue of CS. This preventive action contributes not only to environmental conservation but possibly also to the participants' own health.

RESULTS OF THE FIRST YEAR

Enviróza was launched at the start of the 2013/2014 school year, during which **71 schools** and **440 participants** (teachers, pupils and students) took part in the programme. Together the teams mapped **120 contaminated sites**, of which 95 were from the ISCS and 25 were school-identified (Fig. 26). The team that identified the most cases (36) was **Snežienky** [The Snowdrops] from the Primary School and Kindergarten in Komenského ulica 587/15, Poprad.
The most school-identified sites (6) were contributed by the team **Krúžok – Dobrovoľník – „Anjel"** [The Angel Volunteer Club] from the Secondary Vocational School in Jarmočná 108, Stará Ľubovňa.

Fig. 26 A total of 25 new sites were added by schools. After they were mapped, field inspection and evaluation of the school-identified sites for the purposes of their classification in the ISCS was carried out by Ing. Jaromír Helma, PhD. (SEA) in July and August 2014.

Enviróza's first year included three associated informational competitions, to which participants submitted a total of **105 entries**. They competed not only for individual awards and the appreciation of the expert jury and the public, but also for extra points for their team.

Unified by the theme *Shocking Enviróza*, the first round of the **Photo-burden** photography competition was won in the popular vote portion (with 67 votes) by Ivana Štefkovičová from the Greenpeaces team with the photograph "Príroda sa nezaprie" [Nature Can't Deny Its Nature], while the jury prize went to an untitled photograph by Pavol Faťun from the Tajkáči team. The competition's second round, centring on the theme *Inhabitants of Enviróza* was won by Petra Adamkovičová (Greenpeaces) with "Aj starý dom môže zakvitnúť" [Even an Old House Can Bloom] (1,058 votes) and Kristína Bujňáková (Krúžok – Dobrovoľník – „Anjel") with "Vtáky v tŕní" [The Thorn Birds] in the vote and jury portions, respectively.

Sci-Fi, the competition for best science-fiction story on the theme *I Have a Dream: A World Without Contaminated sites*, also featured a popular vote prize and a jury prize. The former was won by Paulína Čupková (Snežienky) with "Vianočný príbeh" [A Christmas Story], the latter by Miriam Gajdošová (Rtím) with "Projekt TZ (tektonický zlom)" [Project TZ (Tectonic Fault)]. **Infoška**, the competition for best informational activity, was won by the team Ochrancovia [The Conservationists] with their "Motivačné video" [Motivational Video], aimed at "infecting" their younger schoolmates with Enviróza. All the competition entries are presented at www.enviroza.sk/informuj.

The final scores and **rankings** of the teams were determined by the total number of points acquired by mapping contaminated sites and through the accompanying competitions:

Rank	Team	School	Score
1	**Greenpeaces**	Stredná odborná škola techniky a služieb, Tovarnícka 1609,Topoľčany	357
2	**Snežienky**	Základná škola s MŠ, Komenského ulica 587/15, Poprad	329
3 (tie)	**Krúžok – Dobrovoľník – „Anjel"**	Stredná odborná škola, Jarmočná 108, Stará Ľubovňa	152
3 (tie)	**Tajkáči**	Základná škola s MŠ, Tajovského ulica 2764/17, Poprad	152

The teams that placed first, second and third were rewarded with a class **field trip** to an environmental contamination site. Every participant received a T-shirt with the Enviróza logo as a small gift. Organised by the Banská Bystrica company MEEN, in cooperation with members of the *Awareness* project team, the all-day field trips were made in September and October 2014.

Field Trip 1
Location: Novoveská Huta + Levoča
Date and time: 17. 9. 2014
Participants: Krúžok – Dobrovoľník – „Anjel" and Tajkáči (third place)
Number of participants: 22 (including teachers and guides from the SEA)
Schedule summary:
Morning – a tour of the gypsum mine in Novoveská Huta (safety training and descent into the mine, an example of a potentially CS site).
Afternoon – a tour of the Levoča urban conservation area (a UNESCO World Heritage Site since 2009) with an expert guide, including a visit to the Church of St James, which features an altar by Master Paul of Levoča.

Field Trip 2
Location: Žiar nad Hronom + Špania Dolina
Date and time: 22. 9. 2014
Participants: Snežienky (second place)
Number of participants: 44
Schedule summary:
Morning – a tour of the Závod SNP factory in Žiar nad Hronom with expert commentary by ZSNP staff, including the Kalové pole ZSNP tailing pond (an example of an CS site resulting from long-term aluminium production; categorised in Registers B and C of the ISCS).
Afternoon – a tour of Špania Dolina (the folk architecture conservation area and the mining-themed nature trail) with a local expert guide.

Field Trip 3
Location: Komárno + Dropie
Date and time: 2. 10. 2014
Participants: Greenpeaces (first place)
Number of participants: 45
Schedule summary:
Morning – a tour of the Old and New Fortress in Komárno (an area used by the Soviet Army, categorised in Registers B and C of the ISCS).
Afternoon – a tour of the Dropie Environmental Education Centre accompanied by expert SEA staff.

Every active team (those that submitted at least one ID form or competition entry) was **thanked** for their help in addressing the issue of contaminated sites in Slovakia. The rankings of the remaining teams and mapping data, as well as a final report on the programme's first year are available at www.enviroza.sk.
Enviróza is continuing in its second year during the 2014/2015 school year.

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