



LIFE Project Number
LIFE10 ENV/SK/086

FINAL Report
Covering the project activities from 01/09/2011 to 31/08/2016

Reporting Date
30/11/2016

**The impact of geological environment on health status of residents
of the Slovak Republic (GEOHEALTH)**

Project Data

Project location	Slovak Republic (whole territory)
Project start date:	01/09/2011
Project end date:	31/08/2015 Extension date: 31/08/2016
Total Project duration (in months)	60 months (including Extension of 12 months)
Total budget	418,112 €
Total eligible budget	416,612 €
EU contribution:	207,273 €
(%) of total costs	49.75
(%) of eligible costs	49.57

Beneficiary Data

Name Beneficiary	State geological Institute of Dionýz Štúr
Contact person	Mr Stanislav Rapant
Postal address	Mlynská dolina, 1, 817 04, Bratislava, Slovak Republic (SK)
Visit address	Mlynská dolina, 1, 817 04, Bratislava, Slovak Republic (SK)
Telephone	++421-2-59375213
Fax:	++421-2-54771940
E-mail	stanislav.rapant@geology.sk
Project Website	http://www.geology.sk/gеоhealth/

1. List of contents

2. Executive Summary	3
3. Introduction	7
4. Administrative part	8
4.1 Description of the management system	8
4.2 Evaluation of the management system	10
5. Technical part	11
5.1 Technical progress, per task	11
5.2 Dissemination actions	24
5.2.1 Objectives	24
5.2.2 Dissemination: overview per activity	24
5.3 Evaluation of Project Implementation	29
5.4 Analysis of long-term benefits	32
6. Comments on the financial report	35
6.1 Summary of Costs Incurred	35
6.2 Accounting system	37
6.3 Partnership arrangements (not relevant)	37
6.4 Auditor's report/declaration	37
6.5 Summary of costs per action	37
7. Annexes	
7.1 Administrative annexes	
7.1.1 Members of Steering Committee	
7.2 Technical annexes	
7.2.1 List of abbreviations	
7.2.2 List of short reports	
7.2.3 Legislative proposal/guideline	
7.3 Dissemination annexes	
7.3.1 Layman's reports	
7.3.2 After-LIFE Communication Plan	
7.3.3 List of other dissemination annexes	
7.3.3.1 Monographs	
7.3.3.2 Books of Abstracts	
7.3.3.3 Scientific articles in International magazines/Conference books	
7.3.3.4 National publications	
7.3.3.5 Propagation posters	
7.3.3.6 Media work	
7.3.3.7 Lists of participants (meetings, workshop, conference, seminars)	
7.3.3.8 Presentations, posters	
7.3.3.9 Photo documentation	
7.3.3.10 E-mail communication with WHO	
7.4 Final table of indicators	
8. Financial report and annexes	
8.1 Law 553/2003 of Coll. on remuneration of employees working in public bodies	
8.2 Additional clarification of the financial costs - Personnel	
8.3 Answers to EC letters	
8.4 Financial reporting	
8.5 Auditor's report	
8.6 Auditor's licence	

2. Executive Summary

The main objective of the project was to reduce the negative impact of geological environment on the health status of residents in the Slovak Republic.

The implementation of target objective included several partial goals defined as key project deliverables:

- compilation of data set of environmental indicators (chemical elements/compounds) for groundwater and soil from the whole territory of the Slovak Republic,
- compilation of data set of health indicators for the Slovak Republic (indicators of demographic evolution and health status of residents),
- elaboration of optimized datasets of environmental indicators with the greatest impact on human health and health indicators which are to the greatest extent influenced by geological environment,
- characteristics of the areas with impaired health status of residents in the Slovak Republic due to unfavourable or contaminated geological environment,
- elaboration of environmental-health regionalization of the Slovak Republic,
- elaboration of the proposal of measures to be taken in order to reduce negative impact of geological environment on the health status of residents,
- proposal of limit values for the influential chemical elements/compounds in geological environment (soil and groundwater) at which the health status of Slovak population is the most favourable including recommendations for legislative measures.

Based on the implementation of the project key deliverables through technical actions involved, the following key project outputs were reached:

- identification of the most influential environmental indicators on health status of population in the Slovak Republic and determination of their limit/optimal values at which the health status is the most favourable,
- elaboration of proposal of legislative measures for the most influential environmental indicators,
- dissemination of background information on negative impact of unfavourable geological environment on human health (cause – effect) and proposed measures to reduce this impact among Layman population (website, meetings) as well as scientific audience (technical publications).

The project was implemented within the programme Environment, sub-programme Environment Policy and Governance. All the project objectives were successfully implemented.

Project administration was based on project management and coordination in accordance with the project proposal and LIFE+ rules, including monitoring of the project progress and planning project tasks through monthly organized consultative meetings, annual sessions of the steering committee and regular reporting (reports to EC, annual monitoring reports). During the project implementation we did not face any serious problem in management process. All EC requests and comments were included and explained in the respective project reports (Inception report, Progress reports No. 1, 2, 3, Mid-term report). Our answers and corrections were in all cases fully accepted by the Commission. There was one amendment to the Grant Agreement requested by the coordinating beneficiary and accepted by the EC related to prolongation of the project

duration for 12 months. All project actions were implemented in accordance with the new project timetable.

Technical part of the project consisted in 7 main technical actions, namely:

Action A1: Compilation of data set of environmental indicators,
Action A2: Compilation of data set of health indicators,
Action A3: Elaboration of environmental and health indicators,
Action A4: Linking of environmental and health indicators,
Action A5: Environmental analysis,
Action A6: Elaboration of the proposal of measures,
Action A7: Realization of measures.

The main premise to reach main project objective – identification of the impact of geological environment on human health of Slovak population, was the elaboration of datasets for environmental indicators (EI) and health indicators (HI), their optimization and division according to diversity of geological structure and level of groundwater/soil contamination.

By various statistical methods (mainly artificial neural networks – ANNs) we linked both datasets of EI and HI to determine the impact of geological environment on health status of population. Following environmental indicators (chemical elements) were identified as the most influential on health status of population in the Slovak Republic: Ca and Mg in groundwater and water hardness (Ca + Mg). In the areas with deficit contents of Ca and Mg in geological environment (Crystalline, Paleozoic, Volcanic rocks) shorter life expectancy (about 2 – 4 years) and increased mortality from cardiovascular diseases (CVD), oncological diseases (OD) and diseases of gastrointestinal and respiratory system (GTS, RS) were documented. These diseases represent about 80 – 85% of all causes of deaths of human population in the Slovak Republic.

The impact of contamination of geological environment on health status of Slovak population was studied in the most contaminated areas of the Slovak Republic. We analysed in detail three historical mining areas with highly contaminated geological environment by potentially toxic elements (PTEs): Central Slovak Neovolcanics, Slovak Ore Mts. and Upper Nitra region. The first two regions represent the historical mining areas with ore extraction from the Middle Ages and the third area is a territory characterized by more than 100 year exploitation and combustion (power plant operation) of brown coal with high contents of arsenic and other metals. A total of 138 contaminated and 155 non contaminated municipalities were compared within individual assessed regions by the concentration level of chemical elements/compounds in groundwater and soils (environmental indicators) and health status of the population (health indicators).

Contamination of the studied areas by various PTEs (As, Sb, Pb, Zn, Cu, Cd, Hg and others) has been documented mainly in soils. However, we found no significant impairment in the health of the population living in the areas with higher PTE contamination compared to non contaminated areas. Thus our results do not support the assumption of negative impact of PTEs in geological environment on human health in natural conditions of the Slovak Republic.

Within environmental analysis, environmental-health regionalization was elaborated based on evaluation of quality of groundwater/soil and health status of Slovak population in all 2,883 Slovak municipalities. For each municipality the level of groundwater and soil quality and health status was characterized.

The most important knowledge of the occurrence of chemical elements/compounds in groundwater and soils of the Slovak Republic – the cause and their adverse health effects – was interpreted into a proposal of simple measures in order to point out to potentially negative impacts of the geological environment on the health of population and to provide a simple set of "instructions" of how to eliminate them. The most significant findings were comprehensively processed for all evaluated chemical elements/compounds into specific "cause – effect – measure" catalogue (individual factsheets), which also include a list of the most important sources of information.

Within the realization of measures for reduction of negative impact of geological environment on the health status of residents, proposal of legislative measures was elaborated. We have recommended contents of Ca, Mg and water hardness (Ca + Mg) for further monitoring in groundwater/drinking water. These three parameters were identified within our research as the most influential on human health of residents in the Slovak Republic. We have elaborated final proposal for increasing of limit values of these parameters to two times higher levels than are currently valid as recommended levels within the Slovak guideline for drinking water. We have also disseminated our results and recommendations among Layman public audience in the form of informative meetings organized in 11 municipalities with unfavourable geological environment and impaired health status of residents. The residents were informed about the negative impact of unfavourable geological environment on their health and they were advised how they can eliminate or reduce this impact.

Project outputs were highly disseminated among scientific audience mainly through technical publications of the project including two final monographs (in Slovak and English) and several scientific articles (three of them published in the impacted international magazines). Organized events – international conference and seminars contributed to raising awareness on project results and proposed legislative measures not only among experts and researchers but also among administrative officers from concerned authorities (e.g. Ministry of Environment of the Slovak Republic, Ministry of Health of the Slovak Republic). Project website was regularly updated to provide public as well as scientific audience actual information on project progress. All dissemination materials and related information (e.g. media work, publications, outputs of workshop, conference, seminars etc.) are published on the project website (www.geology.sk/geohealth). Intensive presentation (oral/poster) of project results was made through active participation in a number of international conferences as well as national seminars.

Evaluation of Project Implementation

Within the project we were using an innovative methodology of environmental and health data elaboration and interpretation which has not been applied in similar studies across the EU yet. Among the results achieved following are considered to be the most significant:

- Compilation of national datasets of environmental (groundwater, soil) and health indicators,
- Elaboration of limit values for environmental indicators,
- Compilation of environmental-health regionalization,
- Proposal of measures for reduction of negative impact of geological environment on health status of residents and their dissemination among residents (edification and environmental-health education),
- Publishing of results in international impacted magazines and final project monographs.

Successful project implementation is reflected in high awareness of public as well as scientific community on environmental-health problem, their high interest in project results (e-mail, phone communication) as well as e.g. documented number of participants during organized events (informative meetings, final conference, seminars).

The project **quantitative environmental benefits** are represented by the long-term improvement of health status of about 1 million of residents living in the unfavourable geological environment (with Ca and Mg deficiency in groundwater/drinking water), if proposed measures are applied into practice. These include simple measures to increase consumption of Ca and Mg by other sources (e.g. mineral water, appropriate diet, and vitamin supplements) with effect on local residents as well as legislative measures with effect on drinking water sources on national level. The results achieved in this project are fully relevant for the European environmental policy and legislation (e.g. Environment Action Programme to 2020 (EAP), Health 2020).

Long-term qualitative environmental/social/financial benefits of this project consist in gradual improvement of health status of human population after long-term application of proposed measures into Slovak and EU legislation. The value of human health and human life is priceless. Neither in the EU nor anywhere in the world, any regulations, methodologies or guidelines exist to measure price of life. We consider human diseases and deaths caused by consumption of soft water as so called avoidable causes of deaths.

In case of long-term dissemination of project results to raise public awareness (mainly of those consuming soft water for drinking purposes) there is full assumption to improve health status of population drinking soft water at national level – at least 1% of Slovak population (minimum 10,000 residents) and international level – at least 1 ‰ of EU population (minimum 120,000 inhabitants). From the point of view of long-term qualitative economic benefits, the financial costs saved within the health care will every year multiply exceed project costs.

The continuation of the project dissemination is very important. The project results represent background information for other similar projects to be implemented in the future. Project innovation value consists mainly in application of new innovative mathematical statistical method of data linking – ANNs in environmental-health regionalization of the Slovak Republic, derivation of limit values (based on ANNs) for the most influential chemical elements and parameters in geological environment on health status of population.

Financial part

The total financial costs for the project were in the amount of 384,379.16 €. The eligible costs were in the amount of 382,915.16 €. The project costs incurred were lower compared to the project budget of about 33,736.47 € (i.e. 8.07 %). The total costs within individual cost categories are fully in accordance with the rule of allowed flexibility of 30,000 € and 10 % (cf. Article 15.2 of the Common Provisions). Total costs were significantly lower in case of two categories “Travel” and “Consumables”. In case of “Travel” the costs were not spent due to disapproval of general director for participation on the international conferences. In case of “Consumables” lower costs were associated to substitution of some works, e.g. printing of Conference Books of Abstracts was substituted by electronic format of publishing on USB keys. In addition all posters were printed within the expenses of the coordinating beneficiary (ŠGÚDŠ) and were not sub-contracted externally. The external assistance costs related to the organization of events

(workshop, final conference, seminars) were due to careful public tender lower than expected in the project budget. Financial Statement of the Coordinating Beneficiary is attached to this report specified for all cost categories.

The **audit** of the project financial costs was implemented at the end of the project with detail information provided in the audit report. All financial costs reported in the final report were approved by the auditor. The financial report is in compliance with the LIFE+ Programme Common Provisions, the national legislation and accounting rules.

3. Introduction

The environmental problem addressed by the project was the analysis of impact of diverse geological structure of the Slovak Republic as the source of variable geochemical backgrounds - contents of chemical elements in groundwater/soil that can be favourable or toxic to human health. The geological structure of the Slovak Republic is rather complicated and variable. It is characterized by alteration of rocks with various geneses, ages and therefore various mineralogical/petrographic characteristics. Variable geochemical backgrounds are reflected in the variable chemical composition of groundwater/drinking water and soil.

Our hypothesis to be demonstrated by the project was that various chemical compositions of groundwater/drinking water and soil can have various influences on health status of the resident population.

The methodological solution of targeted environmental problem was based on analysis of environmental and health data at national level, in relation to diversity of geological setting. One of the methods used for data analysis was the calculation of artificial neural networks (ANNs). Based on hypothesis we divided the territory of the Slovak Republic according to variable geological structure into eight main units. Subsequently, we divided our data by chemical composition of groundwater and soil – environmental indicators as well as indicators of health status – health indicators into partial datasets according to the geological units and analysed them through the statistical methods including ANNs. Our hypothesis was confirmed and **expected results** were demonstrated. Based on the project results we can conclude that for human health are the most favourable carbonate geological units and the most unfavourable silicate geological units. From the point of view of chemical contents in groundwater and soil the dominant influence on human health was determined for Ca and Mg in groundwater and water hardness (Ca + Mg). The contents of chemical elements in soils from national point of view (the whole Slovak territory) do not have impact on human health. The reason is global origin of the foodstuffs. Low (deficit) contents of Ca and Mg and water hardness (Ca + Mg) in groundwater/drinking water are reflected in lower life expectancy and increased mortality from cardiovascular diseases (CVD), oncological diseases (OD), diseases of gastrointestinal system (GTS) and diseases of respiratory system (RS). Based on ANN calculations we were able to derive limit values for the contents of chemical elements identified in our research as the most influential on human health. We determined minimum required contents for Ca, Mg and Ca + Mg in drinking water at following concentrations: $\text{Ca} > 50 \text{ mg.l}^{-1}$, $\text{Mg} > 25 \text{ mg.l}^{-1}$ and $(\text{Ca} + \text{Mg}) > 2 \text{ mmol.l}^{-1}$. Our derived limit values are about 2 times higher compared to limits defined within the Slovak guideline for drinking water and within our final recommendation we proposed to increase them.

Environmental benefit of the project consists mainly in determination of causes which lead to impair health status of population in the Slovak Republic (SR). Through the

internet, media work including TV shows, radio sessions, newspaper articles etc. we highlight this environmental-health problem. We have elaborated the set of proposals of measures for Slovak residents how they can reduce or eliminate the negative impact of unfavourable geological environment on their health. The targeted environmental-health problem relates to population living in about 20% of the Slovak territory. Our results are valid for the whole territory of the EU. Therefore in the future it is necessary to widely disseminate our results within the EU countries and act to highlight the necessity of reconsideration of WHO legislation for drinking water quality and importance of including limit values for Ca and Mg in drinking water guideline. This problem obviously relates also to bottled drinking water. In the future it is necessary to act in such a way to guarantee at least minimum required Ca and Mg contents also in bottled water.

The most significant **expected longer term result** is gradual and long term improvement of the health status of population in the Slovak Republic. This project long term benefit can be reached also in the EU countries after application of our results in the EU and WHO legislation.

4. Administrative part

4.1 Description of the management system

The project was implemented in four main phases. During the very first phase all necessary input data – mainly of environmental and health indicators were collected (technical actions A1, A2). The second phase was focused on data elaboration, mainly their division according to diverse geological setting within the territory of the Slovak Republic (A3). During the third phase the collected and elaborated datasets were linked and analysed through the statistical methods, mainly by ANNs (technical actions A4, A5). The final phase of the project included interpretation works to define the most influential chemical elements on human health and to derive their limit values (technical actions A6, A7). The project was managed and coordinated/monitored within the planned actions B1 and B2.

The overall project management and coordination was implemented from the very beginning in accordance with the rules of LIFE+ programme.

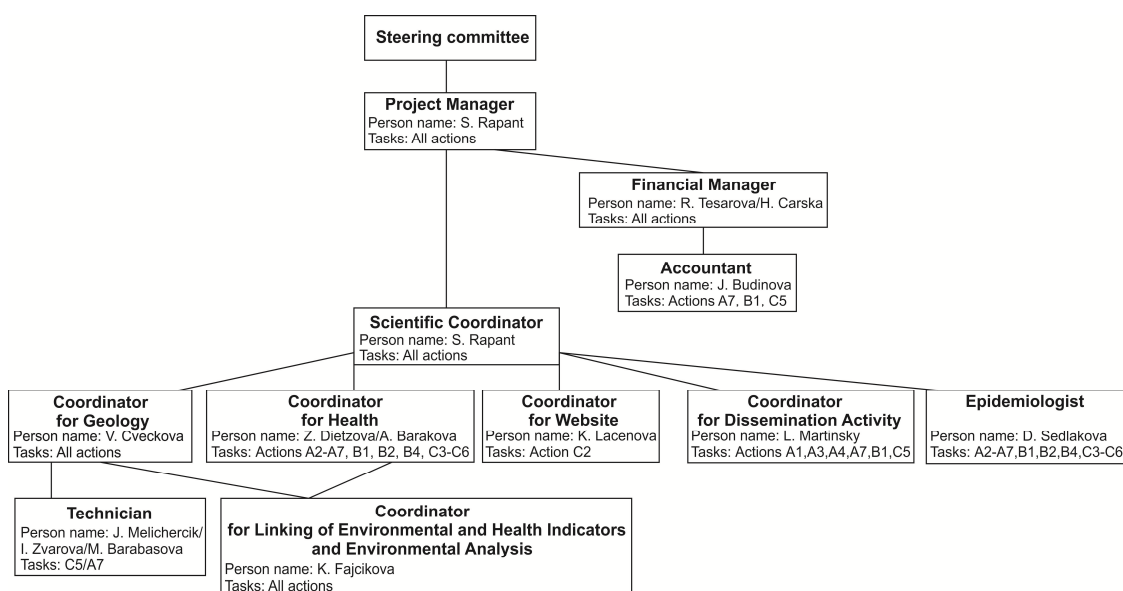
The project management was established on 20/09/2011 in accordance with the project proposal (milestone deadline 30/09/2011, please see the organigramme). Every month consultative meetings participated by members of project team were organized. Consultative meetings dealt with the evaluation of project progress and planning further tasks to be solved during next period. The records from consultative meetings were regularly published on the website of the project. On October 20th 2011 the Steering committee was established in terms of project's plan (project milestone with deadline 30/10/2011). All related authorities including Ministry of Environment of the Slovak Republic, Ministry of Health of the Slovak Republic, Statistical Office of the Slovak Republic, Public Health Authority of the Slovak Republic and State Geological Institute of Dionýz Štúr (coordinating beneficiary) delegated their own representatives (list of members is reported in Annex 7.1.1). The four sessions of the Steering committee were also organized according to planned project schedule. The conclusions and recommendations of the Steering committee were also published at project website. In addition, monitoring report for the project was once a year compiled by the project manager and published at the project website.

The only one substantial change in project team occurred on the position of the financial manager. Due to several reasons during the project implementation (maternity leave,

terminated employment) overall four persons altered this position (Mrs. Renata Tesarova, Mr. Ivan Tamasovic, Mrs. Lubica Sokolikova, and Mrs. Helena Carska). Finally two persons were included in the personnel costs of the project for the position of financial manager, namely Mrs. Renata Tesarova altered by Mrs. Helena Carska.

Due to large amount of works related to compilation and edition of the project final monographs and Layman report, we additionally included in the project team two temporary workers (Mrs. Janka Hrtusova, Mrs. Slavka Zidekova) for assistance to the coordinator for dissemination activity (language correction and text edition). Two persons were also additionally employed for assistance to the project manager and scientific coordinator in the revision process of the two monographs (Mr. Miloslav Khun, Mr. Peter Letanovsky). For a short period we have altered the position of the Coordinator for Health during the implementation of specific subtasks within the action C6 (Mrs. Zuzana Dietzova was altered by Mrs. Anna Barakova). Several persons from the permanent staff of the coordinating beneficiary altered the position of the technician (as planned in the project) according to the project needs.

We provide the organigramme of the project team and project management structure.

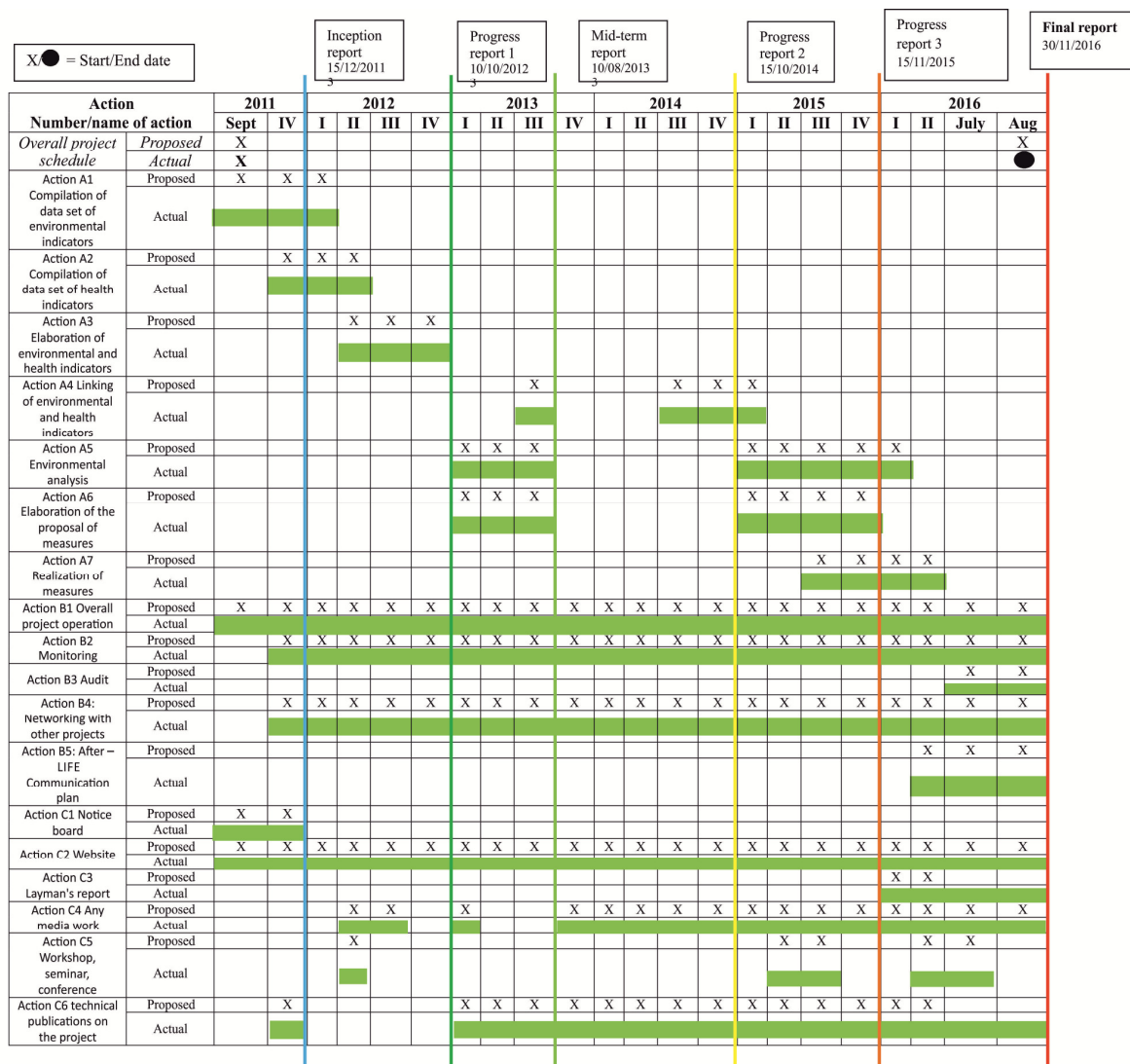


The project progress was regularly reported to the Commission in accordance with the project proposal. Overall 5 reports were sent to the EC including Inception report, Progress report No. 1, 2, Mid-term report and Progress report No. 3, respectively.

There were only few changes in the project implementation according to the previous project proposal, all of them were communicated to the EC and monitoring team. There was one change in the project timetable due to amendment to the Grant Agreement. This change was related to prolongation of the project duration due to about two year delay of public tender necessary for the implementation of the key action A4 – Linking of environmental and health indicators. This public tender referred to mathematical-statistical data environmental and health data analysis through calculations of artificial neural networks and fuzzy cluster analysis. We have elaborated request of amendment to a grant agreement for project prolongation for 12 months. After final approval of amendment to grant agreement by EC (dated 25/03/2015) the project duration was extended by 12 months and works on the project were implemented according to the new project timetable.

The overall project progress including project reports (with reporting dates) is illustrated in Gantt chart below. The After-LIFE Communication Plan was compiled within the action B5 as project milestone in accordance with the project schedule (dated to proposed deadline 10/08/2016) and it is attached as Annex 7.3.2 to this report. Audit (project milestone with deadline 30/11/2016) was realized in accordance with the LIFE rules and project timetable. The auditor's report is attached as Annex 8.5.

The project end defined as milestone was successfully reached in deadline of 31/08/2016.



Note: proposed deadlines correspond to modified timetable in accordance with the amendment to a grant agreement

4.2 Evaluation of the management system

The scientific project staff comprised three key project members (permanent staff) who communicated with each other on daily basis, implemented solutions for the problems encountered operatively and on regular basis made plan for further works (Mr. S. Rapant – project manager and scientific coordinator, Mrs. V. Cveckova – coordinator for geology and Mrs. K. Fajcikova – coordinator for linking of environmental and health indicators, coordinator for environmental analysis). The other project team members were invited to

participate in consultative meetings (organized monthly) according to actual problems and tasks to be solved.

The project was implemented only by coordinating beneficiary without any partner. During the project management process we did not face any serious problem that could affect negatively the project implementation. The communication with the Commission and Monitoring team was always very correct. All recommendations and remarks of the Commission were appropriate and valid for the successful project implementation within the rules of LIFE+ programme. All comments, recommendations and requested explanations were included in the respective project reports and they were fully accepted by the Commission.

Similarly, the external project monitor (Mr. Svoboda) was always supportive and helpful and we highly appreciated the comments and advices he readily provided us during the whole period of the project implementation.

5. Technical part

Coordinating beneficiary ŠGÚDŠ as the only one beneficiary organization of this project was responsible for the implementation of all technical actions.

The outcome indicators of the project are summarized in the final table of outcome indicators attached as Annex 7.4. The main indicators of project impact including mainly dissemination activities (website, publications, education, training activities) are also reported (status at the beginning, at the end and five years beyond the project end) in LIFE Indicators database (web tool).

5.1. Technical progress, per task

Seven main technical actions were implemented during the project to reach the main project objective and partial goals:

Action A1: Compilation of data set of environmental indicators,
Action A2: Compilation of data set of health indicators,
Action A3: Elaboration of environmental and health indicators,
Action A4: Linking of environmental and health indicators,
Action A5: Environmental analysis,
Action A6: Elaboration of the proposal of measures,
Action A7: Realization of measures.

For each action all planned deliverables and milestones were successfully fulfilled in accordance with the project proposal and additional modifications in the project timetable defined in the amendment to a grant agreement. The list of abbreviations used is attached as Annex 7.2.1. The significant outputs of respective technical actions were reported in the form of short reports. The list of short reports (some of them defined as project deliverables) is attached as Annex 7.2.2. These reports are included as outcome indicators in the final table of outcome indicators (Part 3 – Awareness raising and communication) attached as Annex 7.4.

Action A1: Compilation of data set of environmental indicators

Within this action, datasets of environmental indicators for groundwater (more than 20,000 samples) and soils (more than 10,000 samples) were planned to be compiled.

The implementation of this action was managed by Coordinator for Geology supervised by the Scientific Coordinator.

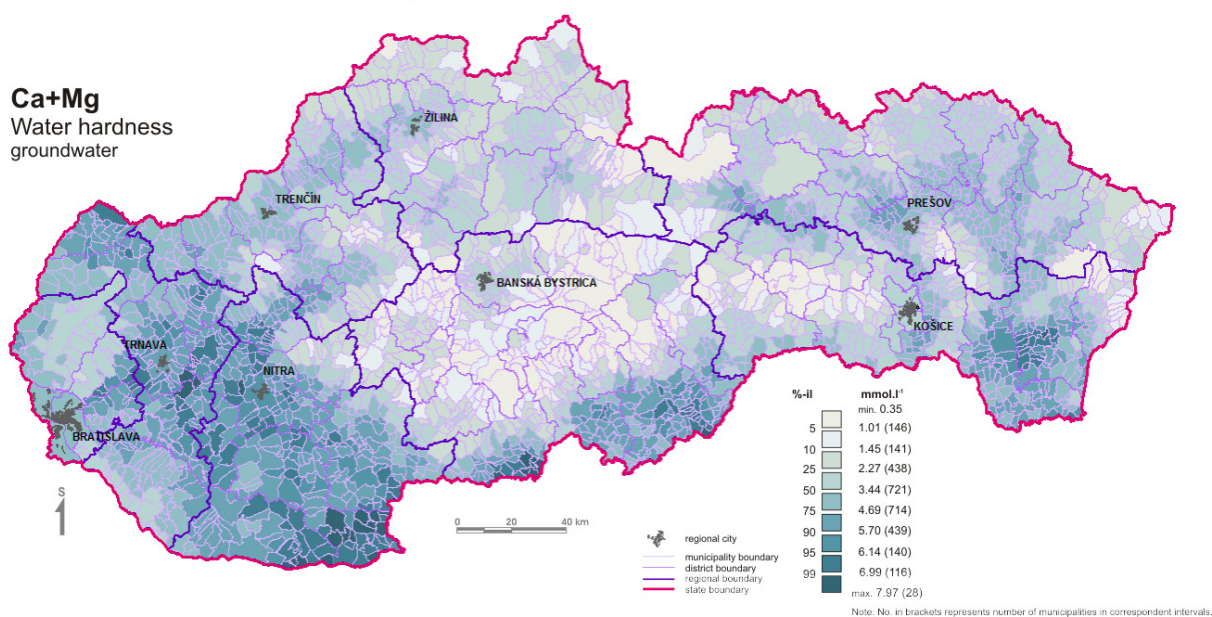
Final datasets included 20,344 chemical analyses of groundwater (34 chemical elements/parameters) and 10,738 chemical analyses of soils (33 chemical elements/parameters) covering the whole territory of the Slovak Republic (over 5,500,000 of inhabitants). They were elaborated in numeric as well as map form for Slovak administrative units (municipalities, districts) and published on the project website. This action was completed without any problems encountered and without any modifications in accordance with the time schedule. The related deliverable “Dataset of environmental indicators in numeric and map form” was finalized 20/05/2012 (deliverable deadline 30/05/2012) and 2 associated milestones “Purchase of 2 PC” and “Completion of excerption of environmental data” were finalized 10/01/2012 (milestone deadline 15/12/2011) and 15/01/2012 (milestone deadline 30/01/2012), respectively. The project objectives were successfully fulfilled.

The background methodology is described in more detail in project final publications – monograph in Slovak and English which are attached to this final report as Annex 7.3.3.1a and Annex 7.3.3.1b, respectively.

The compiled datasets and maps of environmental indicators provide information on average contents of chemical elements/compounds in groundwater and soil at municipal level across the whole territory of the Slovak Republic. They represent useful background information for further environmental, ecological and health studies. Map form of dataset is illustrated on figure below on case of water hardness.

The 2 datasets of environmental indicators (table form, map form) represented output indicator specified in initial output indicator table as “Others – datasets (tables, maps)”. This output indicator was successfully fulfilled and attached in Annex within the Progress report No. 1. It is included also as outcome indicator in table of final outcome indicators (Part 2 – Concrete actions) attached to this report as Annex 7.4.

Water hardness distribution in groundwater of the Slovak Republic - municipalities



Action A2: Compilation of data set of health indicators

Within this action dataset of health indicators was compiled. Existing datasets of 30 health indicators were extended of about 25 health indicators, mainly those characterizing cardiovascular and oncological diseases, including data standardization.

The implementation of this action was managed by Coordinator for Health supervised by the Scientific Coordinator.

The final dataset of health indicators was in accordance with the project schedule elaborated in map as well as table form (database). On the website of the project 30 selected health indicators are presented because of space limitation due to huge amount of data. The results with description of methodology of data excerption and elaboration were reported in more detail in the final Slovak monograph (Annex 7.3.3.1a). Summary information is reviewed in the final English monograph (Annex 7.3.3.1b).

This action was completed without any problems encountered and without any modifications in timetable. The planned objectives and outputs were successfully fulfilled. The related deliverable “Dataset of health indicators in numeric and map form” was finalized on 20/04/2012 (deliverable deadline 30/04/2012) and the associated milestone “Completion of excerption of medical data” was finalized on 20/02/2012 (milestone deadline 28/02/2012).

The compiled datasets and maps of health indicators provide information on the most significant indicators of health status of Slovak population at municipal level, across the whole Slovak territory. These data are very useful for characteristics of the health status including demographic growth and mortality data for various causes of deaths. They can be used for further ecological-health researches in various regions of the Slovak Republic or similar studies. Map form of dataset is illustrated on figure below on case of relative mortality for diseases of circulatory system (CVDs).

2 datasets of health indicators (table form, map form) represented output indicator specified in initial output indicator table as “Others – datasets (tables, maps)”. This output indicator was successfully fulfilled and attached in Annex within the Progress report No. 1. It is included also as outcome indicator in table of final outcome indicators (Part 2 – Concrete actions) attached to this report as Annex 7.4.

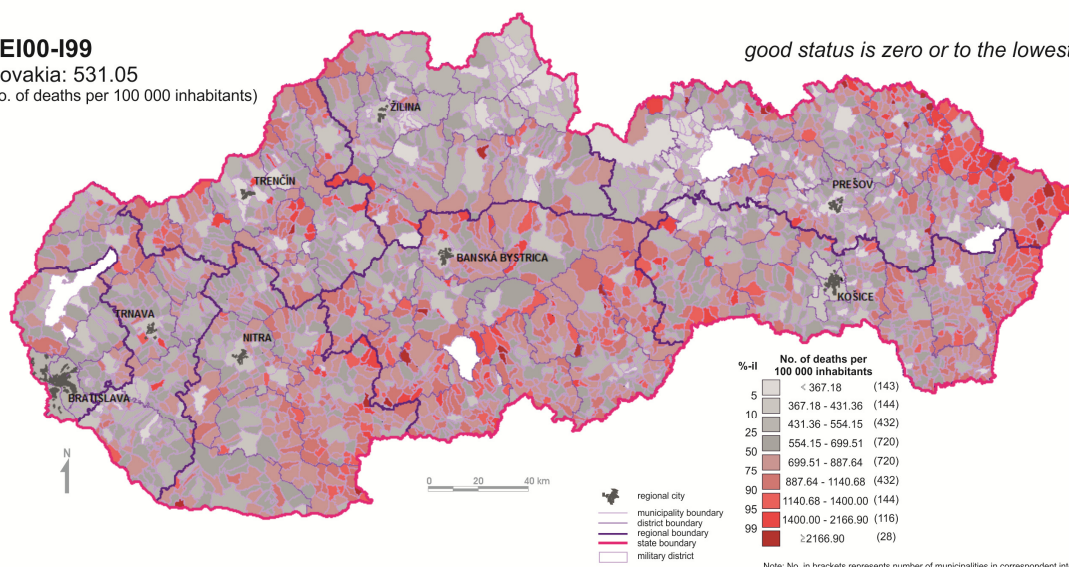
Deaths per 100 000 inhabitants - diseases of circulatory system

REI00-I99

Slovakia: 531.05

(No. of deaths per 100 000 inhabitants)

good status is zero or to the lowest number



Action A3: Elaboration of environmental and health indicators

This action includes division of datasets of environmental and health indicators compiled for the whole Slovak territory according to geological environment and especially for selected contaminated sites.

The implementation of this action was coordinated by the Coordinator for Linking of Environmental and Health Indicators supervised by the Scientific Coordinator. Project had in plan delineation of 7 basic geological units and 5 – 6 contaminated areas of the Slovak Republic. Finally we have realized the division of both datasets in 8 geological units and 3 contaminated and 3 non contaminated areas. The territory of the Slovak Republic has been categorized into following eight geological units: 1. Paleozoic metamorphic rocks, 2. Granitoides and crystalline complexes, 3. Carbonatic rocks of Mesozoic complexes and basal Paleogene, 4. Carbonates of Mesozoic complexes and Paleogene Klippen Belt, 5. Paleogene Flysch, 6. Neogene volcanics, 7. Neogene sediments, 8. Quarternary sediments.

In addition we have delineated 3 contaminated and 3 neighbouring non contaminated areas (instead of 5 – 6 only contaminated areas) that are similar from the geological as well as socioeconomic aspect within:

1. Slovak Ore Mts. (geogenic contaminated area due to historical mining activities),
2. Central Slovak neogene volcanics (geogenic contaminated area due to historical mining activities),
3. Upper Nitra region (anthropogenic contamination due to combustion of brown coal).

This modification of our approach of data elaboration enabled us to compare the health status of residents living in contaminated and non contaminated areas.

The results of this action were published on the project website. More detail information is reported in the final project monographs (Annex 7.3.3.1a, Annex 7.3.3.1b). This action was completed without any delays in accordance with the project schedule and no problems were encountered during its implementation. The planned objectives were successfully fulfilled.

The related deliverable “Datasets of environmental and health indicators divided according to geological environment and contaminated areas in numeric form” was finalized 25/11/2012 (deliverable deadline 30/11/2012). There was 1 associated milestone “Organization of workshop with international participation and agreement on methods of data elaboration” which was organized on 31/05 – 01/06/2012 (milestone deadline 30/05/2012) and it is described in chapter 5.2.2 “Dissemination: overview per activity”.

All partial datasets of environmental and health indicators elaborated according to geological setting and level of environmental contamination (groundwater, soil) provided input data for further statistical analysis of relationship between geological environment and human health performed within action A4.

Action A4: Linking of environmental and health indicators

Within this action we linked the datasets of environmental and health indicators compiled and elaborated within the previous actions A1, A2 and A3.

We used three main procedures of data analysis:

1. Comparison of EI and HI datasets according to diverse geological structure,
2. Correlation analysis (Pearson and Spearman correlations),
3. Method of artificial neural networks/fuzzy cluster analysis.

The implementation of this action was coordinated by the Coordinator for Linking of Environmental and Health Indicators supervised by the Scientific Coordinator. Specific statistical works – ANNs and fuzzy cluster analysis were performed by a subcontractor selected through the public tender.

This action was delayed for about two years compared to project timetable due to problems with public tender for selection of subcontractor for calculation of neural network and fuzzy cluster analysis. Due to this problem we were not able to reach planned timetable and we have elaborated request of amendment to grant agreement for project prolongation by 12 months. After final approval of amendment to grant agreement by EC (dated on 25/03/2015) we have successfully implemented all objectives and reached all planned outputs within this action in accordance with modified time schedule.

This action consisted in processing millions of partial calculations with several thousands of outputs.

To assess the health status of the Slovak population in connection with the environment through above mentioned methods of statistical analysis, the final optimized dataset of 43 health indicators, assumed to have the most significant correlation with the geological component of the environment, was elaborated (the planned output was dataset of 40 – 45 health indicators). In addition, datasets of environmental indicators compiled within the action A1 were optimized according to recommendations reported during the International Workshop “Environmental and Health Indicators of the Slovak Republic” (please see the chapter 5.2.2 for more details). The final optimized datasets included 43 health indicators and 32 EI for groundwater and 28 EI for soils.

The results of calculations represented input data information for further environmental analysis: identification of the most favourable and unfavourable geological environment to human health, definition of the most influential chemical elements on human health and derivation of their limit values at which the health status of population is the most favourable. They were subsequently evaluated, interpreted and reported in the form of short reports within the following action A5.

Due to huge amount of data only the most significant partial calculations were published on the project website including the examples of ANN calculations for groundwater and soil, reporting the influence of environmental indicators on health indicators, order of 15 environmental indicators with the highest influence on selected groups of health indicators and limit/optimal contents of 10 the most influential environmental indicators in relation to evaluated health indicators according to geological structure.

In addition, two short reports dealing with the most significant results of the ANN calculations were elaborated:

- „Chemical composition of groundwater and relative mortality for cardiovascular diseases“ (dated on 15/09/2014, attached in paper format to Progress report No. 2, attached to this report in electronic format as Annex 7.2.2a),
- “Impact of chemical composition of groundwater/drinking water on health status of inhabitants of the Slovak Republic and proposal of limit values for influential elements” (dated on 22/03/2016, attached as Annex 7.2.2b to this report).

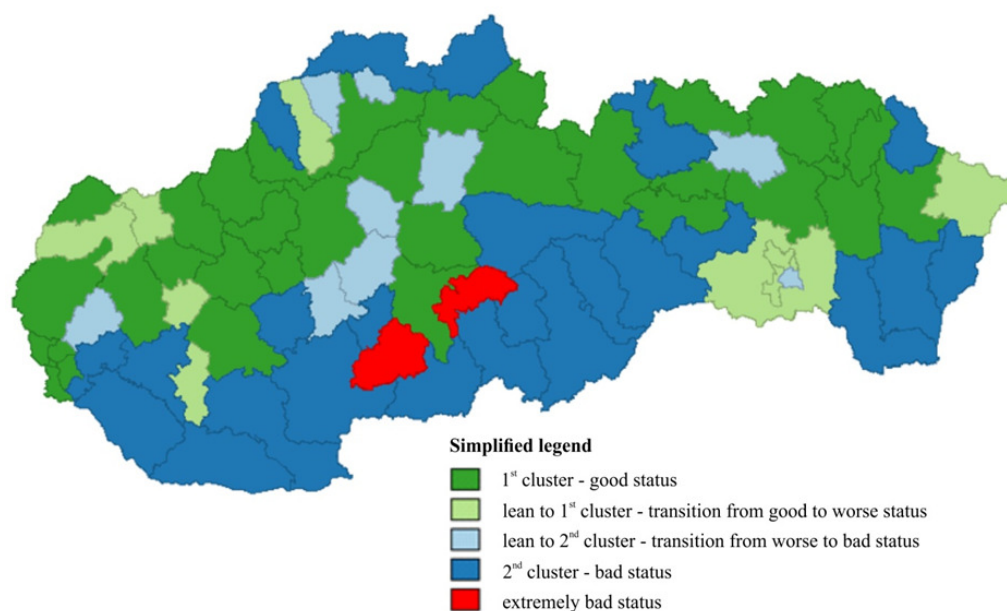
Based on fuzzy cluster analysis used to compare health data in individual Slovak districts and municipalities we determined those municipalities and districts in the Slovak Republic with the most impaired health status of residents. The results were reported within this action and published on the project website in the form of two short reports “Evaluation of the health status of population in the Slovak Republic according to districts – Fuzzy cluster analysis” and “Evaluation of the health status of population in the Slovak Republic according to municipalities – Fuzzy cluster analysis” (dated on 02/01/2016, attached to this report as Annexes 7.2.2c, d). Due to a large amount of data elaborated these reports are available only in Slovak. The main output is reported in English within the Layman’s report (please see Annex 7.3.1b).

The main conclusion of fuzzy cluster data analysis was division of the territory of the Slovak Republic in two parts: the northern part characterized with better health status and the southern part characterized with worse health status of the Slovak population. In general, more favourable health status (lower mortality level) has been observed in bigger cities/municipalities compared to those smaller ones with lower number of inhabitants. Based on the evaluation of health indicators characterizing mortality from selected causes of deaths, two districts with the most unfavourable health status of residents were defined – Krupina and Detva – both laying on silicate geological bedrock (illustrated on figure below). The methodology and results of statistical calculations were interpreted in more detail within the Action A5 (subtask 4 - Delineation and characteristic of areas with unfavourable health status) and reported in the final monograph (Annex 7.3.3.1a).

The related deliverable “Optimized datasets of environmental indicators and health indicators in text form – tables” was finalized on 20/05/2013 (deliverable deadline 30/05/2013). There were three associated milestones to this action: “Selection of subcontractor for calculation of neural network and fuzzy cluster analysis” (finalized on 10/07/2014, deadline 30/08/2012), “Linking of datasets on environmental and health indicators” (finalized at deadline 30/03/2015) and “Organization of workshop with international participation and agreement on methods of data elaboration” (for more detail please see chapter 5.2.2 “Dissemination: overview per activity”).

All the project outputs were successfully reached.

Health status of Slovak population as fuzzy cluster analysis of 36 indicators of mortality from selected causes of deaths - DISTRICTS



Action A5: Environmental analysis

Within this action, we solved four main technical scientific tasks, key tasks for the whole project, based on the results of the statistical analysis of EI and HI datasets, mainly neural network calculations. These tasks represented also project deliverables:

1. Evaluation of the impact of variability of geological environment on health status of population,
2. Definition of limit values for the influential environmental indicators,
3. Environmental-health regionalization of the Slovak Republic,
4. Delineation and characteristic of areas with unfavourable health status.

The implementation of this action was coordinated by the Coordinator for Linking of Environmental and Health Indicators supervised by the Scientific Coordinator. This action was directly linked to the results of the previous action A4. Due to the delay of public tender for statistical calculations (explained in action 4) this action was implemented with delay of one year compared to the project proposal but in accordance with the modified timetable according to the amendment to a grant agreement. The results of this action were regularly published on the project website. They were also reported in the form of several short reports and technical papers (scientific articles in current content magazines, please see the chapter 5.2.2) as well as in the final project monographs (Annex 7.3.3.1a, Annex 7.3.3.1b). The most significant outputs were summarized in the following reports (considered as outcome indicators):

- “The evaluation of impact of geological environment on health status of residents of the Slovak Republic“ (dated on 17/07/2013, attached in paper format in Mid-term report, attached to this report in electronic format as Annex 7.2.2e),
- “Contaminated sites and their impact on health status of residents” (dated on 27/01/2014, attached as Annex 7.2.2f to this report),
- “Elaboration of limit values for environmental indicators” (dated on 22/09/2015, attached as Annex 7.2.2.g to this report),
- “Chemical composition of groundwater and relative mortality for oncological diseases” (dated on 30/10/2015, attached to Progress report No. 3, attached to this report in electronic format as Annex 7.2.2h),
- “Evaluation of the impact of geological environment on health status of residents of the Slovak Republic- Soils” (PhD. thesis dated on 20/09/2016, attached to this report in shortened paper version as Annex 7.2.2i and as Annex 7.2.2j in full version in electronic format).

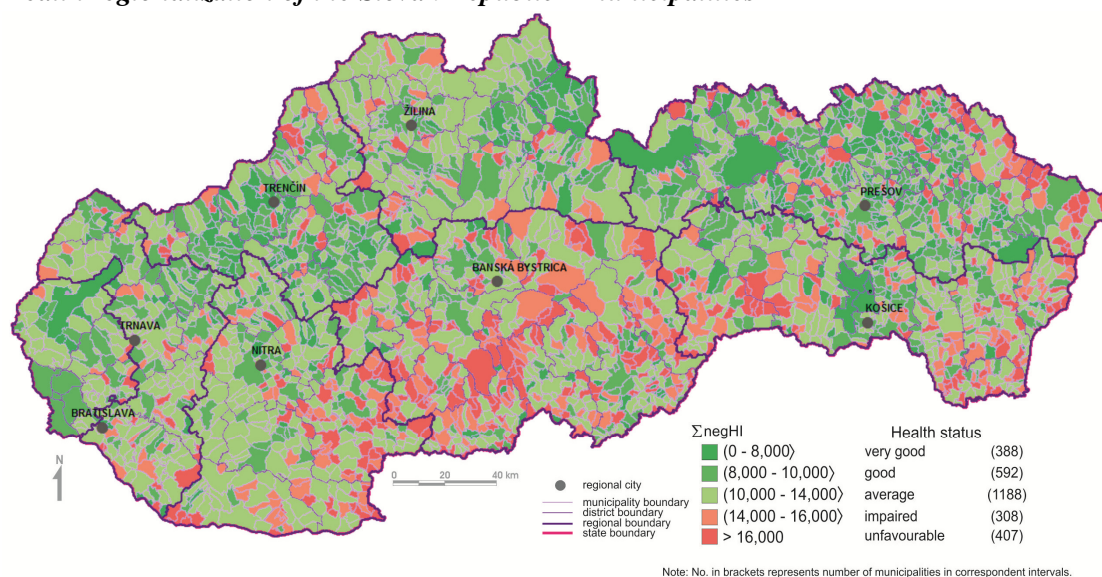
The most significant results and conclusion of this action can be summarized as follows:

1. The health status of residents living in contaminated historical mining areas with increased contents of potentially toxic elements like As, Sb, Cu, Pb, Zn, Hg and Co is not impaired compared to adjacent non contaminated areas.
2. The limit values calculated for the most influential environmental indicators on human health through ANNs were reviewed taken into account not only mathematical approach but also other known aspects (e.g. potential negative effect on sensory water properties, technological aspects, optimal levels without any adverse health effects, significance of exposure of Slovak residents to individual geological compartments – groundwater, soil). After considering all potential aspects and revision of calculated limit values we have identified Ca, Mg and Ca + Mg in groundwater as the most influential environmental indicators on human health in the Slovak Republic, including life expectancy, potential years of lost life, cardiovascular and oncological diseases and diseases of gastrointestinal and respiratory system. The background of

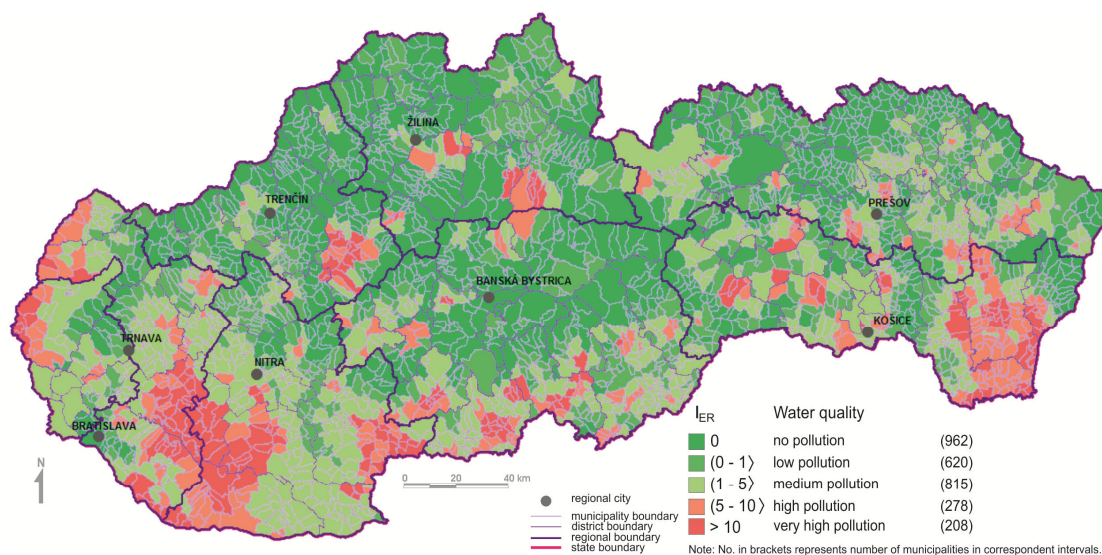
applied methodology is in more detail reported in the final monographs (Annex 7.3.3.1a, Annex 7.3.3.1b). This output represented basis for the final proposal of limit values to be applied within legislative framework (Action A7).

3. Environmental-health regionalization of the Slovak Republic providing information on quality level of the environment (groundwater, soil) and health status of population was elaborated at municipal level. The methodology is in more detail described in the final monographs (Annex 7.3.3.1a, Annex 7.3.3.1.b). Each inhabitant of the Slovak Republic can find the information for respective municipality where he/she lives. The results are available also on the project website. The results visualized in map form are illustrated on figures below.

Health regionalization of the Slovak Republic – municipalities



Environmental regionalization of the Slovak Republic – municipalities, GROUNDWATER



Evaluated chemical elements and their limit values (limit value Government regulation No. 496/2010 of Coll.)

parameter	TDS	NO ₂	NO ₃	Cl	SO ₄	As	F	Cd	Cu	Cr	Pb	Hg	Se	NH ₄	Al	Mn	Zn	Fe	Na	Sb	COD _{Mn}
limit (mg.l ⁻¹)	1,000	0.5	50	250	250	0.01	1.5	0.005	2	0.05	0.01	0.001	0.01	0.5	0.2	0.05	3	0.2	200	0.005	3

4. Based on the results of fuzzy cluster analysis we delineated and characterized areas of the Slovak Republic – districts and municipalities with the most unfavourable health

status of population in table as map form. The most significant output of this subtask was published in the final monograph (Annex 7.3.3.1a). Partial results were reported within the action A4 and respective short reports.

The list of associated deliverables together with the date of their finalization is reviewed in table below:

Name of the Deliverable	Deadline	Final date
Assessment of impact of geological environment on health status of inhabitants – short report	30/07/2013	17/07/2013
Elaboration of limit values for environmental indicators, tables	31/01/2016	22/09/2015
Compilation of environmental-health regionalization of the Slovak Republic (maps, tables, short text)	30/08/2015	30/08/2015
Delineation and characteristics of areas with unfavourable health status of inhabitants, maps, tables, short text	30/03/2016	02/01/2016

There was one associated milestone to this action “Selection of subcontractor for calculation of neural network and fuzzy cluster analysis” finalized on 10/07/2014 (milestone deadline 30/08/2012).

All planned objectives and project outputs were successfully fulfilled. The results of this action were preferably published in the form of short reports (e.g. not only as tables or maps) to provide comprehensive overview of the achieved outputs, including background information, methodology, interpretation of results in tables, maps... All five short reports published within this action were included as outcome indicators in table of final outcome indicators (Part 2 – Concrete actions) attached to this report as Annex 7.4.

Action A6: Elaboration of the proposal of measures

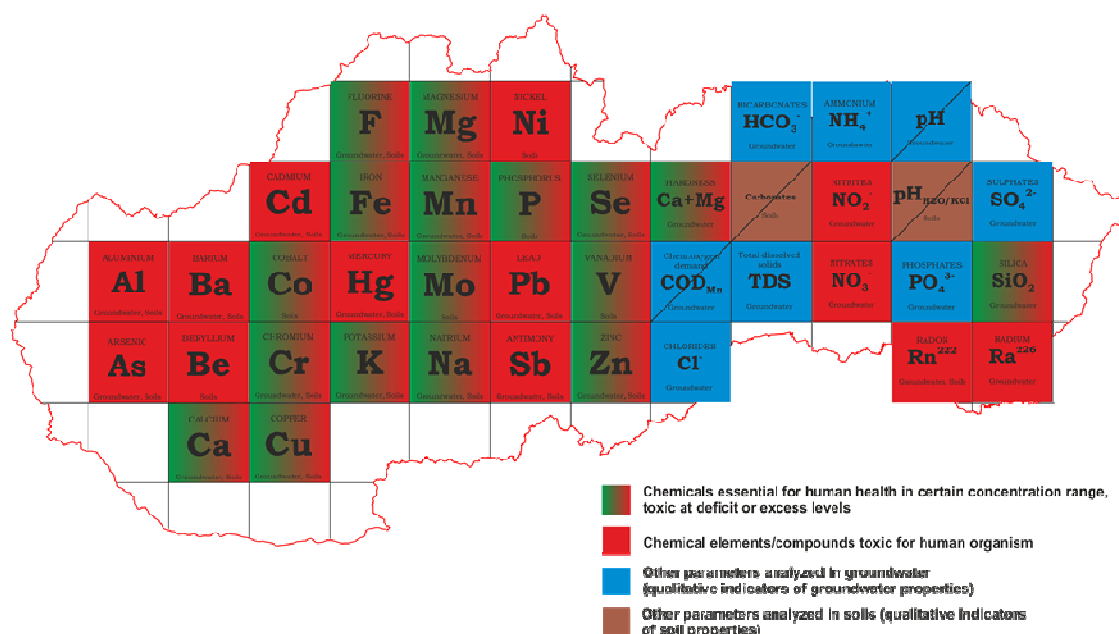
This action consists of elaboration of summarizing factsheets of proposal of measures to reduce or eliminate negative impact of geological environment on health status of residents in the Slovak Republic.

Its implementation was managed by the Coordinator for Geology supervised by the Scientific Coordinator.

Two main groups of evaluated environmental indicators were identified: chemicals essential for humans in certain concentration range (with negative health effects at deficit or excess concentrations) and chemicals toxic for human organism (please see figure below).

The factsheets present summarizing information for each of evaluated environmental indicators (in groundwater/soil) from the point of view of:

- Toxic effects on human organism (due to excess or deficit) and minimal risk levels,
- Concentration levels in geological environment of the Slovak Republic (groundwater and soils) and the source of their origin (natural/anthropogenic sources).
- Proposal of simple measures to prevent/reduce negative health effect of chemical element in case of its deficit or excess in the geological environment (groundwater, soil).



The methodology of data elaboration was reported in the final project monographs (Annex 7.3.3.1a, b).

Individual factsheets have the form of small brochures (double side A4 form that can be folded in a small brochure) that provide all above mentioned information on each environmental indicator in summary way. They are based on excerpted scientific information but interpreted in way easy to understand and easy to be disseminated among public. They represent a good information source mainly for Layman population but also for scientific audience from different fields of research (e.g. public health).

All factsheets (total number 36) are free available on the project website and they were also included as attachment in the final Slovak monograph (Annex 7.3.3.1a) and examples are included in English monograph (Annex 7.3.3.1b). The project deliverable associated to this action “Proposal of measures for reduction of negative impact of geological environment on health status of residents, text report and factsheet” was successfully finalized on 19/10/2015 (deliverable deadline 30/12/2015). Due to huge amount of excerpted data we did not compile

a special short report but we published the outputs on the project results in graphic form (map) and scheduled individual factsheets according to evaluated environmental indicators and tables to provide easy understandable review of achieved results to public. The text summarizing methodology of factsheet compilation was included as separate chapter in both final monographs (Annex 7.3.3.1a, 7.3.3.1b).

This action was implemented in accordance to the modified project timetable and all objectives were successfully fulfilled.

Action A7: Realization of measures

This action included following subtasks:

1. Edification and environmental-health education,
2. Elaboration of proposal of legislative measures.

Its implementation was managed by the Coordinator for Dissemination supervised by the Scientific Coordinator.

1. We organized 11 informative meetings in 11 municipalities with the most unfavourable geological environment (Crystalline, Paleozoic and Neovolcanics) and impaired health status of residents. During these meetings residents were explained through oral presentations and discussion which risks can be posed by the geological environment and how to avoid them in their everyday life. We distributed copies of propagation posters to participants (in total 11 posters were specifically compiled for individual municipalities, attached as Annex 7.3.3.5 to this report, in paper format A4, in electronic format A0). They were considered as output/outcome indicators within category “publications” and included also in the final table of outcome indicators (please see Annex 7.4). Oral presentations are attached to this report as Annex 7.3.3.8a. During the meetings participants were provided with small refreshment and they were given propagation materials (including T-shirts, eco bags) with logo LIFE+ and project acronym/website. In addition, edification and environmental-health education was implemented through the internet (publication of project results on the website) and subsequent question-answer communication with public mainly through e-mail or phone. Photo documentation from the meetings was published on the website and partially also in Layman’s report and is attached in electronic format as Annex 7.3.3.9a. To this subtask one milestone was associated “Organization of at least 10 informative meetings for public” considered also as output indicator (included in table of initial output indicators). Due to two years delay of action A4 (Linking of environmental and health indicators) and timeline problems related to final interpretation of calculations, we decided to organize these meetings during spring 2016. We have informed the Commission about the prolongation of deadline in Progress report No. 3 (milestone deadline 30/10/2015). This subtask – organization of meetings was successfully fulfilled on 30/06/2016. The outcome indicator is included also in table of final outcome indicators in Annex 7.4 (Part 2 – Concrete actions, Training activities). Overall number of residents participated in the meetings was about 400 (391 officially signed). The lists of participants with signatures are attached as Annex 7.3.3.7a to this report. Not all of participants were willing to give us their signature in the participant list due to various subjective reasons (personal/ethical).
2. Within the proposal of legislative measures the proposal of limit values for the influential chemical elements/parameters in groundwater was elaborated. In case of soils, we were not able to propose limit values for any of the evaluated chemical elements based on the achieved results (in more detail described in report attached as Annex 7.2.2j). The main reason is that the input of chemical elements from soils to humans occurs mainly through the food chain. Currently, the foodstuffs are of global origin and do not reflect local chemical composition of the soils where people live. We elaborated proposal of limit values for the most influential chemical parameters in groundwater – Ca, Mg and water hardness (Ca + Mg). The methodology is described in more detail in the final monographs (Annex 7.3.3.1a, 7.3.3.1b). The contents of Ca, Mg and water hardness show significant positive correlation with the life expectancy and high negative correlation with the mortality from the main causes of deaths in

Slovakia, including CVD, OD, GTS and RS. In simplified words, we can conclude that lifetime of humans (life expectancy) prolongs while mortality from CVD, OD, GTS and RS decreases at increased Ca and Mg contents in groundwater/drinking water.

The proposal of limit values for the most influential environmental indicators on human health in drinking and bottled water is following:

Parameter	Recommended values	
	Drinking water for public supply	Bottled drinking water
Ca + Mg	2 – 5 mmol.l ⁻¹	2.5 – 5 mmol.l ⁻¹
Ca	50 – 180 mg.l ⁻¹	60 – 180 mg.l ⁻¹
Mg	25 – 50 mg.l ⁻¹	30 – 60 mg.l ⁻¹

New proposed limit values for Ca + Mg, Ca and Mg are approximately two times higher than recommended values for these parameters defined in the Slovak guideline for drinking water and therefore our final recommendation is to increase them at proposed levels. “Proposal of list of environmental and health indicators and limit values of environmental indicators for implementation into Slovak legislatives, tables, factsheet” as project deliverable associated to this action was successfully implemented on 01/02/2016 (deliverable deadline 10/02/2016) and published in the final project monographs (Annex 7.3.3.1a, Annex 7.3.3.1b). The final legislative proposal (guideline, in Slovak) is attached to this report as Annex 7.2.3.

Following accompanying actions were implemented to manage and monitor the project progress:

Action B1: Overall project operation,

Action B2: Monitoring,

Action B3: Audit,

Action B4: Networking with other projects,

Action B5: After – LIFE Communication plan.

The overall project operation (Action B1) was managed and coordinated fully in accordance with the project proposal and LIFE+ rules, including monitoring of the project progress and planning project tasks through monthly organized consultative meetings, annual sessions of the steering committee and regular reporting (reports to EC, annual monitoring reports). Project monitoring (Action B2) was basically focused on regular control and evaluation of each project action with results published regularly in the form of monitoring reports. The audit of the project (Action B3) was implemented at the end of the project in accordance with the LIFE+ rules. More details are provided in chapter 6.4 and related annexes. Networking with other project (Action B4) represented very important action for presentation of achieved results among scientific communities. The implementation of this action is described in more detail under dissemination actions in Chapter 5.2.2. After – LIFE Communication plan (Action B5) was completed before the end of the project in accordance with the LIFE+ rules (Annex 7.3.2). After-life actions will be focused mainly on the continuous huge dissemination of the achieved results among public as well as scientific audience.

5.2 Dissemination actions

5.2.1 Objectives

The project results, reporting the relationship between the impaired health status of Slovak population (higher mortality from CVD, OD, GTS, RS, lower life expectancy) and deficiency of Ca and Mg in groundwater/drinking water due to unfavourable (silicate) geological environment, represent level of basic research and are of society-wide importance. They cannot be measured directly and the achieved outputs can be from the quantitative point of view estimated only indirectly. On the other hand, they are of very high significance for the improvement of health status of population in the Slovak Republic as well as in other EU countries. Therefore the objective of the dissemination plan set out in the project proposal was the very wide dissemination of the project results and outputs at national as well as international level among public and scientific audience (e.g. representatives of public health authorities, epidemiologists, experts in environmental sciences, medical geochemistry, water management etc.). This wide dissemination represents in this project a unique and very effective tool to raise awareness, knowledge and transfer of achieved findings on this environmental-health problem leading to higher concern of related authorities in implementation of proposed measures into legislative. The outputs of dissemination activities represent in the overall project concept the quantifiable indicators. They are summarized in final table of outcome indicators attached to this report as Annex 7.4. The overall number of project presentations performed at national/international forums includes 37 oral presentations and 6 poster presentations. Their list is attached as Annex 7.3.3.8 to this report and full versions are attached due to their large amount in electronic format (as ppt. files) as Annexes 7.3.3.8a – 7.3.3.8j. The photo documentation of dissemination activities is attached in electronic format as Annex 7.3.3.9a – 7.3.3.9j).

All planned dissemination activities were successfully implemented according to the project plan. The only unfulfilled output was that we did not realized planned dissemination of final results by their presentation in the central office of WHO for Europe in Bonn (the general director did not give us approval for the travel). We informed the Commission about this problem in regular project progress reporting. In addition we did not organize final press conference at the end of the project (again due to the decision of general director to disapprove this event). Beside these small problems we successfully reached the objectives of dissemination plan.

All dissemination outputs including scientific articles, short reports, propagation materials, presentations, final monographs etc. were visibly marked with the LIFE+ logo and when possible also acknowledgment to the financial support by the LIFE+ programme was given.

The dissemination activities will be carried out also after the project end and are specified in After-LIFE Communication Plan (Annex 7.3.2).

5.2.2 Dissemination: overview per activity

All dissemination activities were implemented by project team of the coordinating beneficiary (ŠGÚDŠ).

Action C1: Notice board

Two notice boards about the project with the logo LIFE+ and project logo were displayed at strategic places in accordance with the project plan. One notice board was placed in the premises of ŠGÚDŠ and one was place in the premises of Open-Air Mining Museum in

Banská Štiavnica. The number of visitors of Mining Museum in Banská Štiavnica is according to the number of sold tickets estimated to about 30,000 – 40,000 per year and the number of visitors of ŠGÚDŠ is regularly about several hundred per year.

This action - “Notice boards displaying” was completed as project significant indicator of progress (deliverable) on 30/11/2011 fully in accordance with the project plan (deadline 01/12/2011). They are included in final table of outcome indicators (Part 3 – Awareness raising and communication) attached to this report as Annex 7.4.

The notice board erection is documented within the photo documentation in electronic format (Annex 7.3.3.9b).

Action C2: Website

The website implementation – one of the project deliverables – was started with a little delay of 20 days (on 20/12/2011) compared to the project plan (deadline 01/12/2011). At present the project website is fully in operation. All relevant information and outputs related to the project implementation were published and updated on the website, including administrative part, implementation of technical actions as well as dissemination activities. The planned number of visitors per month (considered as output indicator) was set to 100 (overall 6,000 unique visits were planned for the whole project duration). The total number of website views up to the project end (31/08/2016) was 18,852 and up to the final reporting (30/11/2016) was 19,605. We remind that the permanent staff of the coordinating beneficiary (ŠGÚDŠ) was excluded from the visitor counting and repeated views from the same PC were also not registered (only unique visits were counted). Website visits per months are included as outcome indicators in the final table of outcome indicators (Part 3 – Awareness raising and communication) attached as Annex 7.4.

We can conclude that this output indicator was successfully fulfilled during the entire period of the project implementation and the higher number of visitors reflected big interest of public but also scientific audience in this project. We have noticed a big feedback mainly from the public audience (Slovak residents) which was reflected in e-mail or phone questioning about the project progress, achieved results and the proposed measures elaborated within the Action A6 and A7.

Action C3: Layman’s report

By the end of the project, Layman’s report in Slovak language (150 copies) and English language (150 copies) was published in printed version (20/08/2016). Layman’s report in electronic format was published on the project website on 20/07/2016. The proposed deadline for the Layman’s report as project deliverable was 30/05/2016. This action was implemented with a delay of about 3 months due to problems with public tender for arrangement of publication printing. The hardcopies of the Layman’s report in both languages are attached to this final report as Annex 7.3.1a (Slovak version) and 7.3.1b (English version). The length of the Layman’s report is larger than normally recommended 5 – 10 pages (26 pages) due to huge amount of project qualitative/quantitative outputs which are illustrated, including supporting figures, tables, photographs etc. Layman’s reports will be distributed among public audience also within the implementation of the After-LIFE Communication Plan (please see Annex 7.3.2).

Publication of Layman’s report is specified as output/outcome indicator and is included in the final table of outcome indicators (Part 3 – Awareness raising and communication) attached as Annex 7.4.

Action C4: Any media work

The objective of this action was intense widespread propagation of project results to layman and professional audience and to rise up general interest in objectives and achievement of project results. Within the project two press conferences held in the Ministry of the Environment (project start/project end) were planned (considered also as output indicators of the project). The press release planned at the very beginning of the project was realized and fulfilled as project milestone (on 20/08/2011) in accordance with the project schedule (milestone deadline 30/09/2011). Due to the problems with the approval of realization of the final press conference by the general director of ŠGÚDŠ this event was not organized. However we can conclude that except of this failure the objective of this action was successfully reached by other activities.

During the dissemination activities related to media work we had very positive feedback and reactions on publicized information about the project. The project website raised general interest of media into implemented topic (relationship between geological environment and human health) and thus they contacted us regularly to make interviews, TV or Radio reportages. We persistently faced the problem with the approval of general director of ŠGÚDŠ to make interviews, reportages or newspaper articles. Nevertheless, the final number of various reportages was slightly exceeded. Overall, we made 1 press conference (Annex 7.3.3.6a, attached also in paper format), 4 articles in national press (Annexes 7.3.3.6b – 7.3.3.6e, attached also in paper format), 1 article in local press (Annex 7.3.3.6f attached also in paper format), 10 internet articles (published on the project website online, attached in paper format in previous project reports), 3 TV reportage (1 in national TV JOJ, 2 in national TV MARKÍZA, available online) and 3 Radio reportages (1 in local radio Medzibodrožie, Trebišov, 1 in national radio LUMEN, 1 in national radio FUN, available online) during the project implementation. Within the category of internet articles 5 Newsletters (attached in Annexes 7.3.3.6g – 7.3.3.6j) presenting the project objectives and partial results were published during the project and attached within regular project reporting. We have several representatives of public as well as scientific audience which have subscribed to be given the information about the project through the project website - section Newsletter.

Media work was specified as output/outcome indicator and the final numbers of realized works is summarized in the final table of outcome indicators (Part 3 – Awareness raising and communication) attached as Annex 7.4.

All media works were regularly published on the project website and reported to the Commission within the project reports. They are listed in Annex 7.3.3.6 and attached to this final report in electronic form in Annexes 7.3.3.6a – 7.3.3.6o. TV and radio reportages and internet articles are available only on the project website (TV and radio archives are available only online without possibility to make downloads).

Action C5: Workshop, seminar, conferences

We have organized one workshop, two seminars and one conference in accordance with the project proposal. These events were considered as output indicators of the project and they are included in the final table of outcome indicators (Part 3, session “Workshops, seminars and conferences” attached as Annex 7.4. The presentations and posters reporting project results during these events were regularly published on the project website. The list of presentations is included in Annex 7.3.3.8 and full versions are attached to this report in electronic format as Annex 7.3.3.8b – 7.3.3.8e.

Workshop with the international participation was held during 31/05 – 01/06/2012 in Bratislava, Slovak Republic in the premises of ŠGÚDŠ (milestone deadline 30/05/2012).

The total number of participants was 22. During the workshop the most significant environmental and health indicators were selected and methods of their elaboration were discussed. The output of scientific discussion during this workshop was the definition of the final dataset of environmental and health indicators and approval of artificial neural networks (ANNs) as appropriate method for data linking. This output was directly linked to the implementation of actions A3 and A4. The results of workshop including final recommendations and oral presentations were published on the project website. We attach the list of participants with the signatures as Annex 7.3.3.7b. Photo documentation of this event is attached as Annex 7.3.3.9c to this final report.

International conference SEGH2015 “The link between environment and health” was organized on 22 – 26 June 2015 (milestone of the project with deadline 30/06/2015) under the auspices of Ministry of Environment of the Slovak Republic and the Society for Environmental Geochemistry and health (SEGH). We welcomed 102 delegates from over 25 countries including 61 foreign participants that actively joined the conference. We attach the list of participants with the signatures as Annex 7.3.3.7c. The conference website was implemented to disseminate the event and project objectives (<http://www.geology.sk/geohealth/segh-conference-2015/>). We have actively disseminated project results during the conference in the form of keynote lecture and posters. The conference was supported also by a member of ASTRALE team – Mrs. Lucie Trokanova who presented short speech about the LIFE+ programme during the conference and chaired the desk of propagation materials for LIFE+ programme as well. Photo documentation of this event is attached as Annex 7.3.3.9d to this final report. During the conference participants were provided with refreshment and they were given propagation materials (including T-shirts, eco bags, badges, USB-keys with Conference Books of Abstract) with logo LIFE+ and logo of the project.

We organized two **seminars** where the most significant project results were presented in the form of oral presentations.

Seminar “Geohealth” for Slovak participants was organized on 27/04/2016 in the premises of ŠGÚDŠ (milestone deadline 30/05/2016) and it was participated mainly by experts but also e.g. students from the field of public health, epidemiology, medicine, medical geochemistry (Slovak Medical University in Bratislava, Regional Public Health Authorities, Slovak University of Technology, Faculty of Natural Sciences, Comenius University, etc.). Total number of participants was 102.

We were co-organizers of the international Seminar “Drought and Water Scarcity” on 17 – 18/05/2016. The cooperation with Water Research Institute (VÚVH) led to wider dissemination of the project results among higher number of experts and officers from the field of water quality, water treatment and water management. ŠGÚDŠ as coordinating beneficiary of this project was responsible for arrangement of special session “Water and Health” where the project results were also presented. Total number of participants was 141 Slovak participants and 15 foreign participants. This seminar represented milestone “Organization of propagation seminar for administrative officers” with deadline 30/06/2016.

Both organized seminars were attended by administrative officers from the most concerned authorities, mainly the Ministry of Environment of the Slovak Republic and the Ministry of Health.

We attach the list of participants with the signatures for Seminar “GEOHEALTH” as Annex 7.3.3.7d and Seminar “Drought and Water Scarcity” as Annex 7.3.3.7e. Photo

documentation of the Seminar “GEOHEALTH is attached as Annex 7.3.3.9e to this final report.

This action was successfully implemented and all planned events were organized according to the project proposal.

Action C6: Technical publications of the project

The project results were published in various forms of publications, including 2 monographs in Slovak/English (Annex 7.3.3.1a/7.3.3.1b), 2 books of abstracts from organized conference/seminar in Slovak/English (Annex 7.3.3.2a/7.3.3.2b), 3 scientific articles in English published in international impacted magazines (Annexes 7.3.3.3a, b, c), 2 scientific articles in English published in international non impacted magazines (Annexes 7.3.3.3d, e), 12 abstracts in English published in Books of Abstracts from the international conferences participated by the members of project staff (Annexes 7.3.3.3.f – 7.3.3.3.p, for more detail please see Action B4 Networking with other project), 4 scientific articles published in Slovak magazines/Book of Proceedings (Annexes 7.3.3.4a – 7.3.3.4d), 7 short papers published in Slovak in Books of Abstracts from Slovak seminars (Annexes 7.3.3.4e – 7.3.3.4j).

Technical publications of the project were included in output/outcome indicators and they are summarized in the final table of outcome indicators (Part 3, Publications) attached as Annex 7.4 to this report. We can conclude that all planned activities related to technical publications of the project were successfully implemented with higher number of the publications as we planned in the project proposal (as well as within output indicators).

All scientific articles and papers were published regularly on the project website. The two monographs (Slovak and English) were published only in the printed form. They were officially distributed to all concerned organizations and authorities as well as libraries. Following institutions were provided the hardcopy of both monographs: Slovak National Library, University Library in Bratislava, Central Archive of Geodetic and Cartographic Institute in Bratislava, Ministry of Environment of the Slovak Republic – minister; state secretaries; Directorate for environment policy, EU and international affairs; Directorate for climate change and air protection; Directorate for water; Directorate for geology and natural resources (geology department, environmental geology department, department of state geological administration); Directorate for nature, biodiversity and landscape protection, Library of the Ministry of Environment of the Slovak Republic; Libraries of State Geological Institute of Dionýz Štúr in Bratislava, Košice, Spišská Nová Ves and Banská Bystrica. Both monographs will be distributed among scientific audience (in case of interest also public audience) within the implementation of the After-LIFE Communication Plan (please see Annex 7.3.2).

Within this action there was one deliverable defined – “Publishing of results in international impacted magazines – publications”. We have successfully fulfilled this deliverable in the proposed deadline of 30/03/2015.

Action B4: Networking with other projects

During the project implementation we did not find any related project dealing with similar environmental-health issue – linking of environmental and health indicators to assess the impact of geological environment on health status of inhabitants. The project GEOHEALTH was highly innovative in the field of medical geology and for this reason we were not able to create networking group of the project. We regularly informed the Commission within project reports about the related problems encountered within this action.

We contacted various scientific and expert groups and institutions from the related fields of research (e.g. US EPA, WHO, National Institute of Public Health in Czech Republic, Dallas University in Texas, WHO Centre for Environment and Health, Slovak Regional Public Health Authorities, National Health Information Centre in Slovakia, Charles University in Prague, etc.) and discussed with them scientific background of this project mainly through e-mail communication as well as during the conferences and similar events. Two members of project staff presented the project objectives during the European meeting (of 27 EU countries) organized by WHO Regional Office for Europe (29–30/10/2012, Bonn, Germany) dedicated to formation of European Environment and Health Information System (ENHIS). Unfortunately we did not participate the second planned travel to this destination (please see chapter 5.2.1 for more explanation) during which we planned to present the project final results.

The project team members actively participated in five international conferences organized by scientific associations such as Medical Geology (9th ISEG 2012, Aveiro, Portugal) and Society for Environmental Geochemistry and Health (29th International conference SEGH 2013, Toulouse, France; 30th International conference SEGH 2014, Newcastle upon Tyne, UK; 32nd International conference SEGH 2016, Brussels, Belgium; ISEH2016, ISEG2016 and Geoinformatics 2016, Galway, Ireland).

We presented project results through 14 scientific presentations and 7 poster presentations. Our huge dissemination of the project results led to successful organization of the annual international SEGH conference as final project conference (for more detail please see Action C5) with participation of more than 60 foreign scientists from different interdisciplinary fields of research (environmental geochemistry, public health, epidemiology, analytical chemistry, medical geology etc.).

In addition we presented the project results to Slovak scientific audience during national conferences/seminars (37 presentations, 6 posters).

The oral presentations and posters reporting project results during the international events were regularly published on the project website. Due to their large amount their list is included in Annex 7.3.3.8 and full versions are attached to this report in electronic format as Annex 7.3.3.8f – 7.3.3.8i. Photo documentation of these events is attached also in electronic format in Annexes 7.3.3.9f – 7.3.3.9i.

We plan to realize travel to WHO centre in Bonn, Germany during Spring 2017 within the project LIFE FOR KRUPINA (LIFE2 ENV/SK/094) where we would like to present the results of both projects.

Although we were not able to network with any concrete project we consider this action to be fulfilled through intensive communication with experts and scientists (mainly through the e-mail) from countries inside/outside EU as well as from the Slovak Republic and active dissemination of project results and awareness raising among international scientific audience (participation in five international conferences).

5.3 Evaluation of Project Implementation

Within the project we were using an innovative methodology of environmental and health data elaboration and interpretation for the implementation of respective actions. This methodology has not been applied in similar studies across the EU yet. The new methodology was applied in the implementation of following project tasks: compilation of datasets of environmental and health indicators, elaboration of the environmental-health regionalization of the Slovak republic and linking of EI and HI through calculations of ANNs.

When processing and calculating the environmental indicators we adopted a method of geochemical data processing and representation of environmental indicators so that they can be united with the health indicators. Therefore, we had transformed the environmental indicators into a form compatible with the health indicators, which represented an administrative unit of the Slovak Republic – a municipality or a district. Calculations of environmental indicators represented a determination of the average concentration value (based on inverse distance interpolation method) of an element/parameter in groundwater (34 chemical elements/parameters) and soils (33 chemical elements/parameters) for each Slovak municipality (2,883 municipalities in total), presented in numeric (table) as well as map form. In this way, we obtained the background information on chemical composition of groundwater and soil across the whole Slovak territory, necessary for elaboration of environmental regionalization of the Slovak Republic at municipal level. Statistical data on demographic growth and health status of Slovak population were transformed in the form of health indicators as average values for Slovak municipalities and districts as well as national average. These health data represented background information for health regionalization of the Slovak Republic at municipal level.

Based on linking of EI and HI we were able to search for relationship between geological environment and health status of population. The most innovative was the method of ANNs through which we defined the most influential chemical elements on human health in Slovakia; we determined limit values for individual chemical elements/compounds at which the health status of Slovak population is the most favourable and the lifetime is the longest. In table below we review the main project objectives/deliverables/milestones and the achieved project results.

Task (action)	Foreseen in the revised proposal	Achieved	Evaluation
Dataset of environmental indicators (A1)	> 30,000 chemical analyses of groundwater/soil	31,082 analyses	fulfilled
Dataset of health indicators (A2)	40 – 45 HIs	43 HIs	fulfilled
Dataset of environmental and health indicators divided according to geological environment and contaminated areas (A3)	13 – 14 sets	14 sets	fulfilled
Assessment of impact of geological environment on health status of inhabitants (A5)	1 short report	1 short report	fulfilled
Elaboration of limit values for environmental indicators (A5)	1 short report	1 short report	fulfilled
Delineation and characterization of areas with unfavourable health status of inhabitants (A4, A5)	1 short report	2 short reports	fulfilled
Compilation of environmental-health regionalization (A5)	1 short report	1 short report	fulfilled
Proposal of measures for reduction of negative impact of geological environment on health status of residents (A6)	Set of factsheets for environmental indicators	36 factsheets	fulfilled
Publishing of results in international impacted magazines (C6)	3 publications	3 publications	fulfilled

Technical publication of project – monograph (in Slovak) and brochure (in English), (C6)	1 monograph/1 brochure	2 monographs	fulfilled
Organization of international workshop (A3, A4)	1 workshop	1 workshop	fulfilled
Organization of seminar (for Slovak participants/administrative officers), (C5)	2 seminars	2 seminars	fulfilled
Organization of international conference (C5)	1 conference	1 conference	fulfilled
Organization of at least 10 informative meetings for public (A7)	10 meetings	11 meetings	fulfilled
Press conference at the end of the project (C4)	1 press conference	no press conference	unfulfilled

The information included in the table clearly documents that all significant project outputs were successfully fulfilled, in some cases even exceeded. For example, the application of ANNs for environmental and health data linking was successfully implemented. This unconventional method was key technique for determination of the most influential chemical elements in groundwater and soils on human health of the Slovak population and derivation of their limit values (minimum required, maximum acceptable, optimal range). The results (qualitative, quantitative) achieved have been immediately **visible**. However, their incorporation into national and even EU legislation is very long process. The following improvement of the health status influenced by long-term use of drinking water with non deficit Ca and Mg contents will become apparent only after a certain time period (several years). Therefore we presented the project results at organized events (conference, seminars) as well as international scientific forum (active participation in 5 conferences) through a series of oral and poster presentations to raise awareness on project objective and achieved results – low mineralized drinking water with deficit contents of Ca and Mg are unfavourable for the human health. We communicate this statement to the EC through e-mail with our comments on the currently discussed WHO concepts for a review of the drinking water parameters (the review of Annex I parameters of the Drinking Water Directive 98/83/EC). We recommended considering the project results documenting the significance of Ca and Mg drinking water contents and water hardness levels (Ca + Mg). This e-mail communication with WHO is attached as Annex 7.3.3.10.

The **project amendment** – prolongation by 12 months led to successful implementation of the key actions (A4, A5, A7). If the amendment had not been agreed upon we would not be able to reach the project objectives in accordance to the project proposed timetable.

We find the **dissemination** of project results to public as well as scientific audience effective and successfully implemented. After overcoming a certain barrier – initial scepticism mainly among “medical audience” (epidemiologists, public health workers etc.) linked to innovativeness and new methods applied into medical-geochemical practice in this project, the huge dissemination and communication/discussion with experts finally led to general acceptance of the project results. This fact was demonstrated by the successful organization of the project final conference (SEGH 2015) with participation of about 60 foreign experts from various fields of research (for more detail please see chapter 5.2.2, action C5) and their very positive reactions on project outputs. The implemented environmental-health problem was the object of concern of public audience and thus we were often contacted by media to make reportages. Due to

certain problems with communication with general director of ŠGÚDŠ and approvals for make interviews (for more detail please see chapter 5.2.2) we successfully reached the planned project outputs. We had very good communication also with Layman public. Many persons found information on the project results on the website or they were informed through media (TV, radio) and contacted us through the e-mail or phone with questions related mainly to possible measures to eliminate negative impact of geological environment on their health status. We have trained several hundreds of residents living in the municipalities with the unfavourable geological environment and impaired health status during the organized informative meetings (for more detail please see chapter 5.1, action A7) how to reduce the adverse health effects associated to deficit Ca and Mg contents in their drinking water (e.g. by increased consumption of mineral/bottle water with higher Ca and Mg contents). Based on the huge presentation of the project results we can finally conclude the project impact in 4 levels (as reported regularly in the project reports):

1. Community of professionals / experts,
2. Media,
3. Administrative organs,
4. Inhabitants, mayors of municipalities.

Within the project also educational activities were implemented. Project team members trained hundreds of students with emphasis mainly on the new methodology used for environmental-health data elaboration, including:

- Secondary school - Medical High school, University of Pavol Jozef Šafárik, Košice (subject “Hygiene of the Environment”, lecturer Z. Dietzová),
- University (higher education) – Comenius University Bratislava (division of environmental geochemistry, subject – “Environmental Geochemistry 2”, lecturer S. Rapant, K. Fajčíková).

These educational activities were considered as output indicators and are specified as outcome indicators in final table of outcome indicators in Annex 7.4.

In addition, the project team members (S. Rapant, K. Fajčíková) were leaders of 2 Diploma thesis and 1 PhD thesis (for more detail please see chapter 5.1, action A5) focused on the issue solved within the project (relationship between environmental and health data).

5.4 Analysis of long-term benefits

1. Environmental benefits

The project **quantitative environmental benefits** are represented by the long-term improvement of health status of residents in the Slovak Republic if proposed measures are applied into practice, including simple measures to increase consumption of Ca and Mg by other sources (e.g. mineral water, appropriate diet, and vitamin supplements) with effect on local residents and legislative measures with effect on drinking water sources on national level. This process as discussed in the chapter 5.3 will become apparent only after a certain time period (several years), mainly due to long-term legislative procedures and acceptance of proposed changes in limit values. Based on the project results we demonstrated that low mineralized groundwater/drinking water with deficit Ca and Mg contents are for human health unfavourable. This fact was demonstrated on sample of 5.5 million of inhabitants across the whole Slovak territory. The proposed measures to reduce/eliminate the negative impact of unfavourable geological environment relates to

about 1 million of residents living in the unfavourable geological environment reflecting in Ca and Mg deficiency in groundwater/drinking water.

The results achieved in this project are fully relevant for the European environmental policy and legislation. They are directly applicable in main strategic EU documents dealing with the environment and human health, namely: 1. “Environment Action Programme to 2020 (EAP)” and 2. “Health 2020”.

Within the 7th EAP the third key action covers the issue of the human health: “Healthy environment for healthy people”. The important part of this key action is the improvement of legislation relating to drinking water. The environment impacts health through many factors including inadequate water quality.

Within “Health 2020” the policy framework aims to support actions across government and society to: “significantly improve the health and well-being of populations...”. Good health status of population brings benefits to all sectors and the entire society. The supply of population by “safe” drinking water is one of the most important health determinants. The results objectives are therefore fully applicable the above mentioned strategic EU documents.

2. Long-term benefits and sustainability

Long-term qualitative environmental benefits of this project consist in gradual and long-term improvement of health status of human population after the application of proposed measures into Slovak and EU legislation. The value of human health and human life is priceless. Neither in the EU nor anywhere in the world, any regulations, methodologies or guidelines exist to measure price of life. We consider human diseases and deaths caused by consumption of soft water as so called avoidable causes of deaths. This is an environmental factor – character of geological background namely silicate rock environment that is associated with the formation of soft water. Of course it is senseless and impossible to move the residents from such unfavourable geological environment. We simply need to eliminate this environmental factor in adequate way to provide residents at least minimum required contents of these essential elements to human organism (within the food chain).

About 20–25 % of the Slovak territory as well as the EU territory is built of silicate geological environment. In Slovakia about 1 million inhabitants and in the EU about 60 millions of inhabitants are impacted in relation to consumption of drinking water deficient in Ca and Mg contents. In case the project results will be disseminated enough to raise public awareness (mainly of those consuming soft water for drinking purposes) there is full assumption to improve health status of population drinking soft water at national level – at least 1% of Slovak population (minimum 10,000 residents) and international level – at least 1 ‰ of EU population (minimum 120,000 inhabitants). Special case is the issue of the consumption of bottled drinking water which is often deficient in Ca and Mg (except of the water for babies) and need of legislative measures to be applied also in this field.

From the point of view of long-term qualitative economic benefits, the financial costs saved within the health care by application of proposed measures into practice, will every year multiply exceed project costs.

We find long-term qualitative social benefits in everyday application of project results (proposed measures) into practice. When a human is healthy, he/she is happier and can live and work full life.

We find also important to arrange the continuation of the project actions, mainly in two levels:

- Gradual but long-term incorporation of the project results into national as well as EU legislation process,
- Compilation of new project „Elimination of negative impact of low mineralized drinking water on human health in the Slovak Republic“. The project will aim to improve health status of inhabitants by increasing of Ca and Mg drinking water contents (water sources used for public supply) at required levels through development and application of prototype for water re-carbonization.

The continuation of these actions is included in the After-LIFE Communication Plan (Annex 7.3.2).

3. Replicability, demonstration, transferability, cooperation

The project result dissemination led to raised awareness and **transfer of knowledge** and new findings among experts and scientific communities. Main project topic – searching for the impact of geological environment on human health by linking of environmental and health data through new innovative method of ANNs was the object of high concern. At present, project results were used for preparatory works and included in one project proposal submitted within the programme HORIZON 2020. The team members of the project GEOHEALTH were invited to cooperate on this project. The **transferability and cooperation** of the project results is highly affected by the needed running costs for similar projects and available grant programmes and funding.

4. Best Practice lessons

The **best practice lessons** related to this project were represented mainly by direct edification and environmental-health education of local residents. The organized informative meetings in the selected municipalities with the unfavourable geological environment and impaired health status led to direct communication with local people and discussion their problems. Once people are well informed and in easy way explained that the geological environment can have negative impact on their health and how they can reduce or avoid potential health risks there is very high presumption that they will apply the proposed measures in their every-day life successfully.

Another approach used within this project was active presentation and discussion of the results at national as well as international forums which enabled us to give feedback from other experts and researchers and thus review our methodology and applied procedures in way to increase its quality and effectivity. The result of this approach is e.g. publication of three scientific papers in impacted international magazines which are highly appreciated among the scientific community.

We find the used strategy of project result dissemination and training activities appropriate in relation to overall project objective and concept. This strategy could be adjusted in way to cover higher amount of inhabitants to be informed (e.g. more meetings to be organized etc.).

5. Innovation and demonstration value

Project **innovation value** consists in the following issues:

- Compilation of national datasets of environmental indicators (chemical analyses of groundwater and soils) and health indicators (statistical data on demographic growth and mortality from selected causes of deaths) in numeric and map form. We are not aware of any similar datasets of national significance.
- Application of new innovative mathematical statistical method of data linking – ANNs in environmental-health regionalization of the Slovak Republic.
- Derivation of limit values (based on ANNs) for the most influential chemical elements and parameters in geological environment on health status of population.

6. Long term indicators of the project success

Long-term indicator of the project success is gradual and long-term improvement of health status of residents which can be monitored based on future statistical data on health status, mainly mortality from CVD, OD, GTS and RS. These diagnoses represent the decisive causes of deaths not only in the Slovak Republic but also across the entire EU.

6. Comments on the financial report

6.1. Summary of Costs Incurred

The total financial costs for the project were in the amount of 384,379.16 €. The eligible costs were in the amount of 382,915.16 €. According to individual cost categories the budget according to the grant agreement was slightly modified and exceeded in case of “Personnel” and “Other costs” but fully in accordance with the rule of allowed flexibility of 30,000 € and 10% (cf. Article 15.2 of the Common Provisions).

Personnel costs were exceeded from two main reasons:

- Change in Slovak legislation: From 01/01/2013 based on law 461/2003 of Coll. on social insurance and amendment to the Act. No. 580/2003 on health insurance the salaries of external employees (temporary work agreement) are burdened with levies related to social and health insurance in total amount of 24.8%. It means that total personnel costs for these employees increased by 24.8%. These are the reasons of higher daily rates for temporary staff in comparison with project proposal.
- We had to employ for short period additional external workers for assistance to works that were planned within the project but not specially included in the project budget (as separate category of works). These works included reviews of the final project monographs (by two independent reviewers), language correction and text edition of the final monographs before final printing. Due to huge amount of works we had to employ additional staff to assist Project manager/Scientific coordinator and Coordinator for dissemination activity during the preparation, edition and revision of the final monographs.

The total personnel costs for the permanent staff are 174,900.78 € and the contribution of the beneficiary is 193,877.04 €. The 2% rule is thus fully respected.

The costs included into the category of “Other costs” were slightly exceeded (in amount of 738 €) due to slightly higher conference fees for participation in the international conferences as it was planned in the project budget.

In addition, we made changes in the items financed within the category of “Consumables”. Compared to the proposed items we made purchase of project stamp and we realized two payments for publishing of scientific articles in the international magazines. These changes were not substantial and the total costs planned for this category was not exceeded. Project stamp (cost of 16.9 €) was required for better identification of all financial materials, invoices etc. related to the project. In case of publishing fees we made one payment (in amount of 41.32 €/50 USD) for publishing of logo LIFE+ in the acknowledgment in paper “Historical Mining Areas and Their Influence on Human Health” (attached in electronic format to this report as Annex 7.3.3.3e). The editorial board of the magazine European Journal for Biomedical Informatics required this payment for logo publishing. We made also payment of

publishing fee (in amount of 386.85 €/500 USD) for article “Linking of Environmental and Health Indicators by Neural Networks: Case of breast cancer mortality, Slovak Republic” published in Open Journal of Geology (attached in electronic format to this report as Annex 7.3.3.3.d).

During the last monitoring visit to the project GEOHEALTH as well as project LIFE FOR KRUPINA (19/07/2016) we informed the monitor Mr. Svoboda about the problems encountered with free publishing of papers in the impacted magazines. Majority of the scientific magazines require some fees for publishing. We were given approval by the Commission in the respective EC letter (Ref. Ares(2016)4171931 – 05/08/2016) but we are aware that this letter was officially addressed within the project LIFE FOR KRUPINA not specially for the project GEOHEALTH. However, before the payment realization we communicate by e-mail with monitor Mr. Svoboda if we can make this payment and we were given positive answer of eligibility of this cost within the project budget.

In table below we provide a summary of the incurred project costs according to the categories within the project budget.

Additional comments to financial issues - Personnel

We apologize for the mistake in the No. of “Law 553/2013 of Coll. on remuneration of employees working in public bodies” which should be Law No. 553/2003 of Coll. We attach this Law in the Annex 8.1 to this report. We provide explanation of exceedance of salaries in case of two project staff members, Mr. Rapant and Mrs. Fajčíková for better clarification in Annex 8.2. Answers to the EC comments and recommendations stated in EC letters addressed after the monitoring visit and submission of the Progress report No. 3 (Ref. Ares(2016)788996 – 15/02/2016, Ref. Ares(2016)4171931 – 05/08/2016) are attached as Annex 8.3.

PROJECT COSTS INCURRED			
Cost category	Budget according to the grant agreement*	Costs incurred within the project duration	%**
1. Personnel	192,162	203,130.10	105.71
2. Travel	32,300	19,281.50	59.70
3. External assistance	123,500	108,316.8	87.71
4. Durables: total <u>non-depreciated</u> cost	0	0	0
- <i>Infrastructure sub-tot.</i>	0	0	0
- <i>Equipment sub-tot.</i>	3,000	2928	97.6
- <i>Prototypes sub-tot.</i>			
5. Consumables	32,450	17,430.47	53.71
6. Other costs	7,500	8,238.38	109.85
7. Overheads	27,200	25,050.29	92.10
TOTAL	418,112	384,375.53	91.93

*) If the Commission has officially approved a budget modification indicate the breakdown of the revised budget. Otherwise this should be the budget in the original grant agreement.

***) Calculate the percentages by budget lines: e.g. the % of the budgeted personnel costs that were actually incurred

Financial annexes including signed “Standard Payment Request and Beneficiary's Certificate”, “Consolidated Cost Statement for the Project” and “Financial Statement of the Coordinating Beneficiary” are attached in paper as well as electronic format to this final report as Annexes 8.4.

6.2. Accounting system

Beneficiary implemented a special accounting system SW GARIS of the State Geological Institute. Accountancy centre (No. 750) was set up for the project. Accounting system included well separated Analytical accounts and follows accounting rules of governmental institution.

The project manager approved the invoices (costs) and instructed the Economic Director that the payment was approved. Payment was done by the economist of finance department.

In case of cost selected under public procurement principles, the procedure was implemented according to national legislation – Public Procurement Act.

Timesheets were completed electronically – MS Excel and also archived signed in paper format.

Time registration system of employees was made electronically on a daily basis in GARIS System. A monthly sheet served as a basis for salary calculation.

The beneficiary requested suppliers to issue invoices with a clear reference to the LIFE+ project (project code and acronym). In case this was not possible, a beneficiary stamped the invoice with a code and project acronym (project stamp).

6.3. Partnership arrangements

State Geological Institute of Dionýz Štúr (ŠGÚDŠ) was the only beneficiary organization (coordinating beneficiary) of this project without any associated beneficiaries.

6.4. Auditor's report/declaration

The project audit was performed by the external auditor TAX-AUDIT Slovensko®, spol. s r. o, established in Kapitulská 14, 917 01 Trnava, Slovak Republic.

Audit was included among the project milestones and it was realized within the action B3 in accordance with the project proposed timetable. The auditor's report was made in accordance with the rules of the Common Provisions and it is included with the financial report as Annex 8.5. The auditor's licence is attached to the Final report as Annex 8.6. The auditor stated that the financial report is in compliance with the LIFE+ Programme Common Provisions, the national legislation and accounting rules.

6.5 Summary of costs per action

The table below presents an allocation of the costs incurred per action. Generally, we did not face any big discrepancies between the costs per action set out in the project proposal and incurred project costs.

Major discrepancy is documented in case of action A7 “Realization of measures” with total costs incurred within the project of about 30,000 € lower (37,594.11 €), compared to the project budget proposal (69,870 €).

The related costs categories with reduced total costs were following: “Travel” costs lower of about 3,500 €, “External Assistance” costs were not spent (7,500 €), “Consumables” costs lower of about 16,000 € and “Other costs” lower of about 4,800 €. Travel costs were reduced due to effective organization of works related to the organization of informative meetings (they were grouped in to blocks of 3 – 5 meetings and thus expenses e.g. for fuel or accommodation were reduced). The costs for “External Assistance” were reduced mainly due to reduction of printing costs by printing of Conference Books of Abstracts preferably in electronic format (USB keys), realization of printing of posters at the expenses of the coordinating beneficiary (ŠGÚDŠ), etc. Total costs for “Consumables” and “Other costs” were reduced compared to the project proposal mainly due to careful selection of sub-contractor for works/assistance through public tender (e.g. refreshment for organized events, purchase of propagation materials).

Action number	Short name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.b Equipment	6. Consumables	7. Other costs	TOTAL
A1	Compilation of data set of environmental indicators	10,842.00	0.00	0.00	2,928.00	0.00	0.00	13,770.00
A2	Compilation of data set of health indicators	6,617.11	124.89	0.00	0.00	0.00	0.00	6,742.00
A3	Elaboration of environmental and health indicators	17,486.00	0.00	0.00	0.00	0.00	0.00	17,486.00
A4	Linking of environmental and health indicators	27,106.00	0.00	67,300.00	0.00	0.00	0.00	94,406.00
A5	Environmental analysis	25,232.00	0.00	14,000.00	0.00	0.00	0.00	39,232.00
A6	Elaboration of the proposal of measures	19,112.00	0.00	0.00	0.00	0.00	0.00	19,112.00
A7	Realization of measures	24,850.00	2,449.84	0.00	0.00	7,582.27	2,712.00	37,594.11
B1	Overall project operation	16,920.00	575.99	0.00	0.00	1,755.44	0.00	19,251.43
B2	Monitoring	6,380.00	0.00	0.00	0.00	0.00	0.00	6,380.00
B3	Audit	0.00	0.00	5,580.00	0.00	0.00	0.00	5,580.00
B4	Networking with other projects	5,591.64	15,571.51	0.00	0.00	0.00	5,526.38	26,689.53
B5	After – LIFE Communication plan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	Notice board	501.00	0.00	1,995.60	0.00	0.00	0.00	2,496.60
C2	Website	810.00	0.00	6,950.00	0.00	0.00	0.00	7,760.00
C3	Layman's report	3,103.00	0.00	0.00	0.00	0.00	0.00	3,103.00
C4	Any media work	1,003.00	0.00	0.00	0.00	0.00	0.00	1,003.00
C5	Workshop, seminar, conference	19,304.62	559.27	1,915.20	0.00	7,655.91	0.00	29,435.00

C6	Technical publications on the project	18,271.73	0.00	10,576.00	0.00	436.85	0.00	29,284.58
Over-heads								
	TOTAL	203,130.10	19,281.50	108,316.80	2,928.00	17,430.47	8,238.38	€359,325.25