# Questionnaire

## Summary of the main activities of a research institute of the Slovak Academy of Sciences

*Period: January 1, 2012 - December 31, 2015*


*Bratislava, August 2016*

# Contents

# *1. Basic information on the institute:*

## 1.1. Legal name and address

**Institute of Hydrology Slovak Academy of Sciences**
**Dúbravská cesta 9, 841 04 Bratislava, Slovakia**

**Previous address till 1 April 2016**
**Račianska ulica 75, 831 02 Bratislava, Slovakia**

## 1.2. URL of the institute web site

**http://www.uh.sav.sk**
**http://www.ih.sav.sk**

## 1.3. Executive body of the institute and its composition

| Directoriat | Name | Age | Years in the position |
|---|---|---|---|
| **Director** | Vlasta Štekauerová, RNDr., DrSc. | 65 († 2013) | 01/2012-05/2012 |
| **Director** | Pavla Pekárová, RNDr., DrSc. | 58 | 06/2012-12/2015 |
| **Deputy director** | Yvetta Velísková, Ing., PhD. | 51 | 01/2012-05/2012 |
| **Deputy director** | Pavol Miklánek, RNDr., PhD. | 61 | 06/2012-12/2015 |
| **Scientific secretary** | Renáta Dulovičová, Ing. | 52 | 01/2012-09/2012 |
| **Scientific secretary** | Peter Šurda, Ing., PhD. | 34 | 10/2012-12/2015 |

## 1.4. Head of the Scientific Board

Pavol Miklánek – until June 2012
Yvetta Velísková – since June 2012

## 1.5. Basic information on the research personnel

### 1.5.1. Number of employees with university degrees (PhD students included) engaged in research projects, their full time equivalent work capacity (FTE) in 2012, 2013, 2014, 2015, and average number of employees in the assessment period

| | 2012 | | 2013 | | 2014 | | 2015 | | total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | number | FTE | number | FTE | number | FTE | number | FTE | number | averaged number per year | averaged FTE |
| **Number of employees with university degrees** | 29.0 | 26.600 | 29.0 | 25.030 | 30.0 | 25.030 | 29.0 | 25.500 | **117.0** | **29.3** | **25.540** |
| **Number of PhD students** | 4.0 | 3.840 | 4.0 | 3.630 | 5.0 | 4.550 | 5.0 | 4.510 | **18.0** | **4.5** | **4.133** |
| **Total number** | 33.0 | 30.440 | 33.0 | 28.660 | 35.0 | 29.580 | 34.0 | 30.010 | **135.0** | **33.8** | **29.673** |

### 1.5.2. Institute units/departments and their FTE employees with university degrees engaged in research and development

| **Research staff** | 2012 | | 2013 | | 2014 | | 2015 | | average | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | FTE | No. | FTE | No. | FTE | No. | FTE | No. | FTE |
| **Institute in whole** | 29.000 | 26.600 | 29.000 | 25.030 | 30.000 | 25.030 | 29.000 | 25.500 | **29.3** | **25.540** |
| **Department of soil hydrology** | 10 | 8.46 | 9 | 7.60 | | | | | **9.5** | **8.030** |
| **Department of mountain hydrology** | 8 | 8.09 | 9 | 7.85 | | | | | **8.5** | **7.970** |
| **Department of surface stream water and groundwater interactions** | 7 | 6.05 | 6 | 5.58 | | | | | **6.5** | **5.815** |
| **Department of lowland hydrology** | 4 | 4.00 | 5 | 5.00 | | | | | **4.5** | **4.500** |
| **Department of surface water hydrology** | | | | | 14.0 | 12.680 | 13.0 | 12.160 | **13.5** | **12.420** |
| **Department of subsurface water hydrology** | | | | | 16.0 | 12.350 | 16.0 | 13.340 | **16.0** | **12.845** |

## 1.6. Basic information on the funding of the institute

### Institutional salary budget and others salary budget

| Salary budget | 2012 | 2013 | 2014 | 2015 | average |
|---|---|---|---|---|---|
| **Institutional Salary budget** *[thousands of EUR]* | 392.000 | 398.000 | 388.000 | 399.000 | **394.250** |
| **Other Salary budget** *[thousands of EUR]* | 68.000 | 86.000 | 110.000 | 54.000 | **79.500** |

## 1.7. Mission Statement of the Institute as presented in the Foundation Charter

Institute of Hydrology Slovak Academy of Sciences is a scientific research institution which conducts a comprehensive research and teaching in the field of environmental science and water management to improve and disseminate knowledge on the circulation and quality of water in the nature. The activity of the Institute is focused on:

- water balance components and their changes in catchments;
- transport processes of water and dissolved matters in the atmosphere–plant canopy–soil water–groundwater system with special focus on the subsurface water formation and its quality;
- flow of surface water, groundwater and transported substances;
- impact of human activities on hydrological processes, including processes of surface and subsurface water pollution;
- changes in hydrological regime of surface and subsurface waters caused by expected climatic changes;
- solving problems connected with environmental management, ecology, utilization and protection of environment, hydrogeology, pedology
- solving problems connected with water constructions and their impact on the environment, hydromelioracy, hydrotechnical applications, water modifications, flood protection, water morphology, integrated water management, water planning and water resources protection;
- solving problems connected with landscape engineering, plants and soil protection and with securing water supply during drought seasons.

The Institute provides consultancy and expertise services related to its main activity.

The Institute performs PhD study in accordance to valid legal regulations.

Results of the research conducted at the Institute are published in periodic and other publications such as monographs, proceedings of scientific conferences and other meetings to disseminate the obtained knowledge and provide the information to specialists and other interested bodies.

The Institute publishes two journals – Journal of Hydrology and Hydromechanics which has an international scope and Acta Hydrologica Slovaca which is nationally focused.

## 1.8. Summary of R&D activity pursued by the institute during the assessment period in both national and international contexts

Since its establishment, the mission of the Institute of Hydrology is the acquirement and transfer of new scientific knowledge in the fields of hydrology, hydrodynamics and water hydraulics to water management practise in Slovakia. The Institute elaborates methodologies and manuals to provide the society with powerful tools to solve urgent and perspective water-related problems using the contemporary scientific knowledge. Simulation models are designed and used in analyses and predictions of water dynamics and quality. Special attention is paid to building databases of input data characterizing the regions of Slovakia. These activities are continuous.

The activity of the Institute in the assessment period was focused on research of water resources formation and evolution. Cooperation with other countries, especially the neighbouring ones, with which we share the common river basins or similar geographic - hydrological runoff formation conditions (Poland, Hungary, Czech Republic, Austria, Germany) was supported.

The assessment period (from 2012 to 2015) can be characterized by a number of important changes:

- New executive body of the Institute was formed in June 2012.
- The recommendations of the previous assessment in November 2012 were elaborated and implemented by the new leadership. The Institute was restructured by the end of 2013. Two relatively equal departments were constituted out of previous four personally unbalanced departments:

    1. ***Department of surface water hydrology (OHPV),***
       which includes the *Experimental Hydrological Base (EHZ)* in Liptovský Mikuláš,
    2. ***Department of subsurface water hydrology (OHPPV),***
       which includes the *Research Hydrological Base (VHZ)* in Michalovce.

- The two departments were established to promote tighter cooperation and communication among researchers with similar research interests and allow them better focus on common goals. The departments represent two teams. Experimental bases have autonomous position in the teams.
- Our work is based on field research, and we have the opportunity to use the results measured at our experimental sites located near Liptovský Mikuláš and Michalovce. "*Centre of Excellence for Integrated River Basin Management in Changing Environmental Conditions*" (ITMS 26220120062) was built from the Structural Funds of the European Union (SF). The Centre was completed by another SF project "*Completion of Infrastructure of Hydrological Research Stations*". Both projects focused on the experimental bases. The modern infrastructure which was built during the projects improves the availability of conducting the up-to-date experimental work, and attracts foreign young researchers and experts to visit our Institute for short or long-term training and research purposes.
- In Bratislava, for the first time in its 60-years history, the Institute acquired its own seat as an owner of part of the building at Dúbravská cesta 9 in 2015. Sufficient room for offices and laboratories was thus obtained. While this is a very promising change for the future, the performance of the staff in the second half of 2015 was affected by preparative activities related to the move of the Institute. The Institute is now equipped with a new high-quality communication network and servers. New furniture for executives and new workbenches for all employees were purchased from our own resources.
- Our own resources were also used to repair the coating and build the security measures of the buildings of the experimental bases in Liptovský Mikuláš and Michalovce.
- Our experimental research is based on field experiments. Because the researchers need to go to the field, the Institute self-financed purchase of two new cars suitable for easy terrain driving (one in 2014, the second in 2015). We were not successful to finance a mobile laboratory vehicle from any project. Despite the necessity of transportation of people and equipment to and in the field, funding rules considered such vehicles as ineligible costs.
- Education of PhD students is one of the priorities of the Institute. Since the institutes of the Slovak Academy of Sciences are not universities, they are not eligible to provide an independent PhD education. Yet, the Institute managed to contribute to education of PhD students during the entire assessment period as an external teaching institution affiliated with the PhD programs of the Slovak University of Technology. PhD programs at the universities change relatively frequently. Consequently, also the affiliated external teaching institutions have to be re-accredited. The Institute re-accredited in September 2015 and obtained the licence to provide the PhD education for the next period until 2020.
- We have strived to publish the results of our research in high quality CCC journals. However, publication in national journals is also necessary to transmit the new knowledge to domestic hydrological non-scientific community.
- Journal of Hydrology and Hydromechanics published by the Institute significantly improved in the assessment period. It has become one of the best journals published at Slovak Academy of Sciences (SAS) according the WOS ranking. It is the only SAS journal ranked

in the second quartile among all journals published worldwide in its field. Journal of Hydrology and Hydromechanics ranks 39 out of 85 in category Water Resources in the 2015 Thomson Reuters Journal Citation Report/Science Edition. Journal's impact factor increased from 0.6 to 1.4 which is a good value in hydrological sciences where only a few top journals have impact factors higher than 2.

- The assessment period was characterized by arrival of younger generation of research leaders that overtook the leading positions in the projects, scientific board and the overall management of the Institute. Nine staff members acquired higher qualification degree during four years of the assessment period.
- New web page of the Institute was constructed. Young colleagues built the Facebook page for promotion of the Institute to general public.
- Extension of research results dissemination to general public by other media (public discussions, newspapers, radio, and TV sessions) will remain an important activity for the future. Expertise and advisory activities will be extended, too.

Our research has been supported by various international and national agencies and funding schemes including the FP7, Structural funds of the EU, UNESCO, IAEA, EUREKA, Slovak Research and Development Agency (APVV) and Scientific grant agency of the Ministry of Education of the Slovak Republic and Slovak Academy of Sciences (VEGA).

***Summary of R&D activity of the Department of surface water hydrology (OHPV)***

Team: Velísková, Kostka, Holko, Miklánek, Pekárová, Halmová, Bačová Mitková, Danko, Schügerl, Dulovičová, Kováčová, Hlavčo, (PhD. Students: Pramuk, Dušek, Sočuvka, Krajčí, 4 technicians; Koczka Bara - maternity leave)

The main research tasks solved during the period 2012–2015 at the Department of surface water hydrology (formerly Department of mountain hydrology and Department of surface stream water and groundwater interactions) were linked with scope of its research focus, such as study of basic hydrological processes in the natural environment taking into account anthropogenic activities and global changes, eco-hydrological problems - particularly the issues of stream water quality, study of surface water flow, impact on groundwater flow, and groundwater-surface water interactions. Monitoring, field and laboratory experiments, mathematical and numerical modelling were employed to reach the research objectives.

Researchers of the Department participated in two FP7 EU projects in period 2013–2015. One project was focused on investigating technological means for tracking pollution in remote rivers using the sensor network technology („Detection of watercourse contamination in developing countries using sensor networks"). The task of our researchers was to develop tools for localizing the source of pollution on rivers and serve as experts for river hydraulics and pollution spreading in natural rivers. The developed software tool allows to localize the pollution source which could be kilometres away. This is done by using mathematical, statistical and hydraulic relationships between the available data from the sensors. Testing of the tool was conducted in Slovakia, Poland, and Colombia.

Second FP7 EU project (2012-2014) was related to evaluation of uncertainty in hydrological modelling ("Estimation of Uncertainty in Rainfall Runoff Modelling, Korea, Poland, and Slovakia"). New calibration method for hydrological model parameters was developed. Application of the method considerably improved prediction of flood risks.

Department employees have also participated in research activities of International Hydrological Programme (IHP) of UNESCO in frame of project European Network of Experimental and Representative Basins (ERB), which has very closely cooperated with the IHP UNESCO project Flow Regimes from International Experimental and Network Data (EUROFRIEND). Our colleague RNDr. Holko, PhD. was the international coordinator of the ERB in 2008-2012.

The Danube River represents key basin in the European space from the hydrological point of view. This was reflected by another UNESCO project "Managing water as a shared

responsibility across geographical & social boundaries – Regional cooperation of Danube Countries“, in which the researches from the Department hold the leading position.

Floods have always been a problem from various aspects. Floods as one of extreme hydrological situation and water management problems have been coming into focus more acutely in the last years. Study and analysis of flood regime in the Danube River basin in the period from the first observations until the present time has been an objective of the fourth UNESCO project “Flood regime of rivers in the Danube river basin“. The project was coordinated by researchers from the Department. Partial results were summarized in the monograph Pekárová et al. (2014): Flood marks along the Danube River between Passau and Bratislava. They show that annual discharges of the Danube River remain approximately the same, but the frequency of floods increases. On the other hand, durations of the floods decrease. This is linked with increasing speed (or slope) of rising and falling limbs of hydrographs (flood-waves). These results were confirmed also by research activities carried out in the APVV project “Identification of changes in hydrological regime of rivers in the Danube River basin“. Database of historical floods and droughts in Slovakia territory was created in the project. The most significant contribution of the project is the identification of historical floods on the Danube in Bratislava since the year 1000 and identification of the historical levels of the Danube in Bratislava since 1501. Incorporation of historical floods into the measured series of peakflow discharges significantly improves the estimation of the design values of *N*-year discharges.

Another APVV project coordinated at the Department (“Quantification of input data influence on correctness of outputs of dispersion simulation models for surface water“) aimed at finding answers to questions related to the use of available dispersion modelling tools in Slovakia which could be fully used in the implementation of Water Framework Directive (WFD 2000/60/ES). The abilities, shortcomings, strong and weak points of the current approaches to deal with water quality problems in surface water streams were examined. All aspects were solved with the main focus on hydrodynamic approach of mixing (dispersion) of carried substances (pollution) in surface water streams. Project results also offered solutions for the elimination of uncertainty in determining the values of dispersion characteristics and recommendations for the use of an appropriate dispersion model depending on the complexity and scale of the area of interest, characteristics of the source of pollution, etc. Project results also show the possibility of using 1D and 2D simulation models in practical applications. For example, they contribute to the elaboration of the problems of mixing zones, which is a new feature in our water legislation (Government Regulation of Slovak Republic no. 270/2010 Z.z., § 3 – Mixing zone). Results of the project were summarised in monograph Velisková et al. (2014): Dispersion in surface streams – measurements and modelling.

Researchers of the Department participated also in the APVV project „Multivariable frequency analysis of hydrological extremes for water resources planning and design“, in which correct description of hydrologic extremes was searched for by the use of multidimensional characteristics (e.g. joint study of the flood peak, volume and duration). The structure and dependence properties of such entities were studied (both theoretically and hydrologically at site and regionally) by copulas. The development of hydrologically acceptable copula-based multivariate probability distributions was performed. These new models can be used to supply water resources specialists with a new type of design information which was not available generally so far and in Slovakia it was totally absent.

One of the newest research activities supported by the APVV is the project “New possibilities of use of drainage canal systems with taking into account the protection and use of a landscape“. Scientists from the Water Research Institute, Slovak University of Technology and Institute of Landscape Ecology SAS cooperate in the project as well.

Problems of surface water bodies quality were studied also in the VEGA project „Evaluation of water formations' quality in small basin extent - hydrodynamic approach performance“. Series of tracer experiments to determine the longitudinal and transverse dispersion coefficient in different flow conditions were carried out. They provided a unique data base which allowed to eliminate partly the uncertainty in establishing these characteristics. Evaluation of water quality trends and prediction of transport of potential contamination in stream water were linked with

evaluation of their immediate environment by the hydrodynamic approach (interaction between surface water and groundwater and surroundings). Part of the upper Hron river threatened by a chemical factory and area with drinking water resources in the Danubian lowland were evaluated.

Water temperature is an important water quality characteristic. In accordance with the requirements of the Water Framework Directive - EU WFD (WFD, 2000), water temperature like other physico-chemical water quality parameters enters into the assessment of the ecological status of the surface waters. According to the WFD it was necessary to establish the limits of the water temperature for different surface water bodies in Slovakia, but especially for small mountain rivers where measurements of water temperature are absent. We have established our own monitoring of water temperature in the mountain catchments of the Jalovecký creek and the Belá river within the project „Sensitivity of the river water temperature of the Slovak rivers to hydrologic extremes and climate variability“ (VEGA). The Morava river was initially selected as a lowland river. The data were used in the development of methodology for determination of the limit values of the classification scheme for the water temperature in different types of surface water bodies in Slovakia.

Impact of extreme hydrological events on hydrological regime in the Slovak part of the Danube river basin is an objective of research activities carried out in the VEGA project “Identification of changes in hydrological regime of streams and mutual relation of extreme hydrologic events in complex river system of the Danube basin“. The theme provides ample opportunities for hydrological research. The infrastructure built within the projects of Centre of Excellence (supported by the Research & Development Operational Programme funded by the ERDF) allowed to study the groundwater-surface water interaction in more details. Improved knowledge and skills obtained in the VEGA project “Analysis of sediment impact rate on interaction between surface water and groundwater with implementation of progressive measurement methods“ can be used in water management practice for estimation of erosion control effectiveness in the Myjava river basin for which we provided the expert measurements and report.

Researchers of the Department actively participated in two Centres of Excellence, namely “Centre of excellence for the integrated river basin management in changing environmental conditions” CEIMP (2010–2013) and “Infrastructure completion of hydrological research station” DIHYS (2012–2014).

### *Experimental Hydrological Base in Liptovský Mikuláš (EHZ)*

Team: Kostka, Holko, Danko, Krajčí, Hlavčo

The main research tasks solved in the assessment period focused on the basic hydrological processes in mountain catchments. Our long-term research activities are mainly connected with the Jalovecký creek catchment which was selected in the mid-1980’ as a representative of hydrological processes in the highest part of the Western Carpathians. We studied formation and interaction of the basic water balance components, spatial and regime characteristics of the hydrological cycle elements. Namely, runoff characteristics including extreme discharges, spatial distribution of snow, precipitation and evapotranspiration (including its components) in the basin and quantification of the soil water content and groundwater recharge were the subject of the research.

International Atomic Energy Agency (IAEA) funded projects “The Role of Snow in Hydrological Cycle of the Upper Vah River Basin, Slovakia” (2010–2015) and “Basin–scale recharge estimation in the upper Váh river basin, Slovakia” (2010–2013). Extended monitoring of isotopic composition of soil water and precipitation in the Jalovecký creek catchment at the weekly time step was performed. Additional data was provided by sampling of springs for chloride analyses in the upper Váh river catchment. Measurements of hydraulic conductivity of soils in the mountain and foothill parts of the Jalovecký creek catchment were performed as well. The data revealed that hydraulic conductivity in the mountain part of the catchment is on average

significantly higher than in the foothill part of the catchment (although it has higher variability). Thus, rainfall infiltration into mountain soils is faster. Measured characteristics of snow cover enabled validation of MODIS satellite images for mountain catchments. The isotopic composition of water in the Jalovecký creek catchment related to snow accumulation and melt was evaluated. Evaluation of the long–term data on isotopic composition of precipitation in Slovakia allowed construction of the map of annual $\delta^{18}O$ in precipitation. The analysis of stable isotopes of oxygen and hydrogen in water samples from intensive sampling has enabled to answer some methodological issues of the use of tracers. Significant variability in the isotopic composition of snow and snowmelt water was found. A big difference between the isotopic composition of snow and snowmelt water was confirmed. Catchment runoff at the beginning of the snowmelt was almost entirely made up of water presented in the basin before the start of snowmelt, i.e. not by the snowmelt water. Maximum contribution of snowmelt water to catchment runoff during seasonal (spring) runoff maximum was about 60%. Stable isotopes of oxygen and hydrogen provide a realistic point data on groundwater recharge. Realistic basin-scale groundwater recharge estimation was obtained by chloride which was the first application of this method in Slovakia.

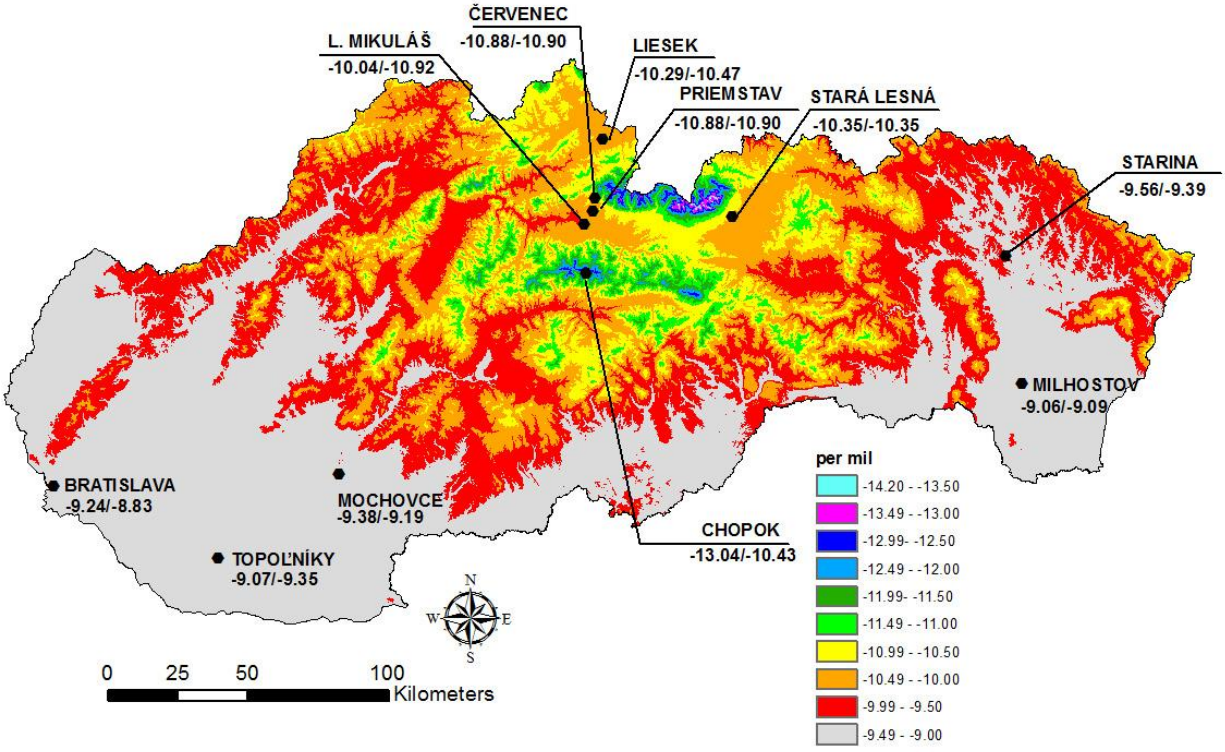


Fig. Map of spatial distribution of mean annual $\delta^{18}O$ in precipitation in Slovakia; the first number under the name of a station represents the value [in ‰] extracted from the map, the second number is the measured value.

The experimental base is the long term participant in the UNESCO International Hydrological Programme through project “European Network of Experimental and Representative Basins” ERB (2013–2021). Part of the research activities was also devoted to the FP7 project “Estimation of Uncertainty in Rainfall Runoff Modelling, Korea, Poland, Slovakia” (2012–2014).

Two VEGA projects, “Quantification of snow contribution to runoff formation and groundwater recharge” (2011–2014) and “Experimental research of overland flow generation in small catchments” (2015–2018) were solved at the base. New method of snow line altitude estimation using data from remote sensing was developed. The method was tested in the upper Váh river basin using the MODIS satellite data. It can also be used for the estimation of snow covered area as well as cloudiness elimination from the satellite images.

Monitoring of spatial distribution of precipitation in the mountain catchment of the Jalovecký creek showed that runoff events observed at catchment outlet are rarely generated by rains which hit only part of the catchment. Measurements of transpiration of the spruce forest at the upper forest line indicated that the amount of water used by the forest in dry summer was comparable with the amount of precipitation fallen during the same season (June to September).

Measured data were used in spatially distributed hydrological modelling to improve the knowledge on hydrological cycle in mountains (water balance, evapotranspiration, snow cover accumulation and melt, runoff formation) and its response to changed climatic or landuse characteristics (e.g. deforestation).

***Summary of R&D activity of the Department of subsurface water hydrology (OHPPV)***

Team (2012–2015): Brezianská, Čelková, Gomboš, Hlaváčiková, Kandra, Lichner, Majerčák, Nagy, Novák, Orfánus, Pavelková, Rodný, Stojkovová, Štekauerová, Šurda, Šútor, Tall, Vitková, PhD. student - Zvala, 3 technicians; Vasiľová - maternity leave

Department of Subsurface Water Hydrology (formerly Department of Soil Hydrology and Department of Lowland Hydrology) focused on generating information on the processes of water, solutes and energy transport in the soil to quantify the characteristics of these processes and create generalization patterns of water and energy transport. The aim was to obtain a set of tools for diagnostic and prediction of water regime influenced by climate change and anthropogenic factors. Thirty automatic stations for monitoring of groundwater tables, soil water content, precipitation amount and soil temperature were installed on the territory of Slovakia. This network covers the most important research areas of the Department. The process of improving and modernisation of field and laboratory equipment supported by the Structural funds of EU started and is planned to be successfully completed within two years.

Employees of the Department participated in several international projects and projects of national granting schemes.

1. *First theme of the research focused on extension of knowledge base about physical and hydrophysical characteristics of soils, influence of biological factors which determine the transfer of water in soil and new methods of its interpretation.*

Project APVV-0139-10 “Spatial interpretation of soil hydrophysical characteristics in relation to their hydrological regime” was focused on regular monitoring of soil moisture and groundwater table in selected catchments. Valuable data which were obtained allow the analysis of the dry and wet periods in the past, but can also be used as a basis for the development of pro futuro predictions. Spatial database of soil hydrophysical characteristics (particle-size distribution, mean particle density and bulk density, humus content, organic carbon content, water retention curve and saturated hydraulic conductivity) was created in the project. The database is open to the public as a web service at http://fzki.uniag.sk/hydrophysics/.

The VEGA project 2/0083/11 “Quantification of the water movement processes in the aeration zone considering optimal development of vegetative cover in different ecosystems” synthesized water storage data in the unsaturated soil zone of the Rye Island region obtained during the monitoring which was established, processed and interpreted for the assessment of optimum water supply of ecosystems. Impact of periods without precipitation was analysed. Water supply in the aeration zone of soil was quantified from soil moisture monitoring and actual evapotranspiration (Eta) calculated by the HYDRUS-ET model for sites located on the Rye Island. It was documented that differently defined period without precipitation is substantial in the dynamics of soil water at monitored sites and it is an essential condition for the formation of soil drought.

Project VEGA 2/0054/14 “The impact of biological soil crust and microtopography on infiltration and flow of water in sandy soil” quantified the impact of soil biological crust in different stages of

development/succession on infiltration and flow of water in sandy soil and its hydrophysical characteristics. Vegetation succession in the different phases affects properties and flow of water in sandy soils. The sequence of changes of certain soil properties and the penetration depth of infiltrating water may be different from the order of sequence of succession stages. The values of soil hydraulic conductivity were very similar in areas featuring the beginning phase of succession, while the soil hydraulic conductivity at the stand with the highest density and variation of vegetation species was on average six times higher.

The significant result of project VEGA 2/0073/11 "Infiltration and flow of water in soil as influenced by biological factors and soil moisture" was that the "hockey-stick-like" relationships of the cumulative infiltration *I* of water against the square root of time *t* (SQRT t) were found in soils covered with biological soil crusts. We estimated two different water sorptivities from this relationship. Water sorptivity *Swh* for water repellent state of the crust was estimated from the slope of *I = f(SQRT t)* relationship for a short time of infiltration (the straight line representing the less steep part of the hockey-stick). Water sorptivity *Sww* for nearly wettable state of the crust was estimated from the slope of *I = f(SQRT t)* relationship for a longer time of infiltration (the straight line representing the steeper part of the hockey-stick). The water repellency cessation time (WRCT) was estimated from the point of intersection of the two straight lines representing the *I = f(SQRT t)* relationships for hydrophobic and nearly wettable states of the crust. The new method allows a more precise estimation of water infiltration into soils covered with biological soil crust.

Bilateral project APVV SK-CZ-0192-11 "Hydraulic conductivity of soils and its spatio-temporal variability" resulted in proposal and tests of innovative solution of minidisc infiltrometer (Model S - Decagon Devices, Pullman, WA) measurement automation. This infiltrometer is often used in *in situ* determination of soil hydrophysical characteristics. Two-step software solution based on digital recording and subsequent evaluation of infiltration experiment was developed. The Java application creates image sequences or photo files in a defined time step and gives the information on a change of the water level in the storage tank of the measurement device. The data are then analysed with the algorithm integrating image analysis and particle tracking principle.

The ultimate goal of project VEGA 2/0040/12 "Complex mathematical simulation of the water, heat energy and chemical substances motion in agricultural and forest biotopes, with emphasis upon extreme situations" was to create a complex and compact external tool (model LOCAL) for identification and quantification of the critical water regimes in the soil-plant system, consisting of mathematical simulation models itself, programs for preparation of the input data and software for graphical presentation of output variables which are the results of numerical simulation of water, chemicals and heat movement processes. In the first stage subprograms for identifying drought were implemented and tested for selected years. Then, the complex model LOCAL was finished, debugged and calibrated. The model allows determination of the conditions of extreme moisture regime of soil profile in agricultural and forest stands.

2. *Second theme of the research dealt with quantification of water and energy transport in non-homogeneous forest soils with high content of skeleton, strong organic layer on the soil surface and a significant slope of the soil surface.*

Project VEGA 2/0167/12 "Influence of superposed organic soil horizons on hydrological processes" provided new classification of soil texture based not only on textural composition of the fine-earth (sand, silt, clay) but also on the volumetric content of organic matter at different decomposition levels. Application of both the older and the innovative classifications when characterizing the wetland soil texture in Jurský Šúr demonstrated practical and theoretical significance for the soil geography. In case of the wetland soil – located in the national nature-reservation – there are six textural districts which are conceptually the same according to both classifications. The innovative classification however enabled to earmark two separate humolitic and histic districts. That allowed documentation of gradual mineralization of the peat soils after its partial dewatering in 1943. If building of constructions and dewatering in border areas of the nature reservation continues, the existence of the reservation will certainly be endangered.

During the research supported by the VEGA project 2/0152/15 "Forest soils, their degradation and hydrological consequences" it was found out that calculation of hydraulic conductivity $K_{(-2}$

$_{cm)}$ according to Zhang (1997) may cause apparent correlation of $K_{(-2\ cm)}$ with antecedent soil water content which is the artificial effect of sorptivity parameter in the equation on steady infiltration stage. This was theoretically anticipated by Vandervaere et al. (1997). This "pseudocorrelation" has disappeared after adopting Minasny and McBratney (2000) approaches in calculation of $K_{(-2\ cm)}$. The use of water vapour adsorption data for correction of soil water retention curves and wilting point estimated in pressure chambers was developed as a method useful for non-homogeneous soils.
Project VEGA 2/0021/10 "Hydrological processes in soils with high content of stones influenced by land use changes" proposed the method of quantitative determination of the impact of stones (rock fragments) in the soil matrix on the distribution of soil moisture and on the course of soil water content during the season, using mathematical simulation model. Comparison of soil moisture course in the soil with rock fragments and a homogeneous soil without rock fragments showed that rock fragments can substantially decrease soil water retention capacity and hydraulic conductivity. Stony soils have a lower water retention capacity due to presence of nearly non-porous rock fragments (when comparing with the porosity of the soil matrix). Therefore, rainfall infiltrates faster into the stony soils that has an impact on runoff and possibly also flood formation.

The main result of the VEGA project 2/0032/13 "The effect of rock fragments and vegetation on retention and movement of water in soil" was the method of determination of the saturated hydraulic conductivity of a stony soil and its dependence on the relative content of rock fragments (stoniness), shape, position and distribution of rock fragments in the soil matrix. Direct measurement of the influence of shape and position of rock fragments on hydraulic conductivity in stony soils is difficult or may be nearly impossible in practice. Therefore, it was decided to use a numerical model which provides a unique opportunity to evaluate the effects of different factors on the saturated hydraulic conductivity of stony soils. The assessment method was based on a numerical equivalent of Darcy's classical experiment. The numerical experiment simulated the steady-state flow through virtual soil samples of 1 $m^3$ volume. Spatial distribution of pressure heads, water contents and water fluxes explained the influence of different shapes (spheres, ellipsoidal and triangular rock fragments) and distributions (regular or irregular) of rock fragments in stony soil samples on their transport properties. Furthermore, regression relationships between the relative effective saturated hydraulic conductivities and soil stoniness for particular shape and distribution of rock fragments were derived. Results of the steady-state water flow simulations indicated that the relative saturated hydraulic conductivities do not depend on the hydraulic properties of the soil matrix, but on soil stoniness. The influence of particular shape, distribution or position of rock fragments is smaller.

3. *Third theme of the research was aimed at development of amelioration (in the context of climate change and effects of anthropogenic factors) of soil processes, functions and selected soil physical characteristics which determine among others hydrostatic and hydrodynamic soil water behaviour.*

The goal of the project APVV-0512-12 "Analysis of nitrous oxide emissions from agriculturally used soils and proposal of measures for their reduction" was to establish the research of $N_2O$ emissions from agriculturally used soils of Slovakia through continuous direct measurements which were absent in the country. Reduction potential of $N_2O$ emissions was quantified through the application of biochar in the soil and management of nitrogen inputs without negative impact on crop yields and soil quality. This however results in the long-term effects of biochar application on porosity, retention and soil hydraulic conductivity. Our aim as project participant was to quantify the impact of biochar on soil hydraulic conductivity, determine the influence of biochar on soil water retention curve and quantify the effect of biochar on the dynamics of soil water under field conditions.

Laboratory measurements of hydrophysical characteristics of soil samples containing biochar which were prepared in laboratory conditions were conducted in the ongoing VEGA project 2/0013/15 "Biochar impact on transport and retention of water in agricultural soil". We focused on the course of water retention curve in the interval of saturation - field capacity hydrolimits. The laboratory experiments required the reconstruction of existing and manufacturing of new components of laboratory equipment. Laboratory data were compared with the characteristics

obtained in the experimental research on agricultural land with large spatial and temporal variability of soil hydrophysical characteristics caused mainly by agrotechnical interventions.

***Research hydrological base in Michalovce (VHZ)***

Team: Gomboš, Pavelková, Tall, Kandra, Vasiľová - maternity leave

Research on VHZ was conducted under national projects of basic and applied research VEGA and APVV and international applied research projects Eureka.

Our basic research activities were conducted under the VEGA project 2/0142/12 "Water regime in heavy soils of depression lowland areas" (2012- 2015). The Research hydrological base was principal investigator in the project. Project results present significant benefit in the field of water supply prediction in heavy soils of the Eastern Slovak Lowland under extremely dry growing season conditions. A method based on the numerical experiment in extremely dry growing season developed in the project represents a significant progress in the examined research area. Research results will bring important benefits to practical applications in the design of adaptation measures eliminating the negative effects of heavy rains in the dry season.

VHZ participated also in the VEGA project 2/0040/12 "Complex mathematical simulation of the water, heat energy and chemical substances motion in agricultural and forest biotopes, with emphasis upon extreme situations". A model allowing determination of the extreme conditions of moisture regime of soil profile in agricultural and forest stands was developed.

The APVV-0163-11 project "Analyses of soil properties and landscape development for non-regularly overflowed areas" quantified changes in water supply in the soil profile after flooding of the research area. The VHZ acted as cooperating institution.

VHZ participated in two international application projects supported by the EUREKA program in 2010–2012 and 2012–2017 ("The monitoring of selected parameters of porous materials through the use of EIS method in a wide range of applications"). The VHZ is responsible for the assessment of methods of spectral analysis in electrical impedance measurements of volumetric moisture of soil environment. Principal investigator is from the Czech Republic, other participants are from Switzerland, Italy, Belgium, Bulgaria, Lithuania and Philippines.

VHZ also solved bilateral project APVV SK-CZ-0169-11 "Peculiarity of heavy soils retention curves and its impact on the water regime analysis". The project provided quantification of differences in retention curves of heavy soils in case of neglecting volume changes and the impact of these differences on the results of numerical simulations of the unsaturated zone of heavy soils.

VHZ managed two projects financed by the EU Structural Funds during the assessment period, namely the "Centre of excellence for the integrated river basin management in changing environmental conditions" CEIMP
http://www.uh.sav.sk/Portals/10/Documents/CentreOfExcellence/CEIMP_EN_2016.JPG?ver=2016-03-30-213324-433
and the "Infrastructure completion of hydrological research station" DIHYS
http://www.uh.sav.sk/Portals/10/Documents/CentreOfExcellence/DIHYS_EN_2016.JPG?ver=2016-03-30-213353-200

# 2. Partial indicators of main activities:

## 2.1. Research output

### 2.1.1. Principal types of research output of the institute:

basic research/applied research **80/20**;
international/regional **30/70**
(ratios in percentage)

### 2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications listed for the assessment period should not exceed the average number of employees with university degrees engaged in research projects. The principal research outputs (max. 5, including Digital Object Identifier - DOI) should be underlined

1. BAČOVÁ-MITKOVÁ, Veronika - HALMOVÁ, Dana. Joint modeling of flood peak discharges, volume and duration: a case study of the Danube River in Bratislava. In *Journal of Hydrology and Hydromechanics*, 2014, vol. 62, no. 3, p. 186 - 196. (1.231 - IF2013). (2014 - WOS, SCOPUS). ISSN 0042-790X.
2. CZACHOR, H. - HALLETT, P.D. - LICHNER, Ľubomír - JOZEFACIUK, G. Pore shape and organic compounds drive major changes in the hydrological characteristics of agricultural soils. In *European Journal of Soil Science*, 2013, vol. 64, no. 3, pp. 334–344. (2.651 - IF2012). (2013 - Current Contents). ISSN 1351-0754.
3. CZACHOR, Henryk - CHARYTANOWICZ, M. - GONET, S. - NIEWCZAS, J. - JOZEFACIUK, G. - LICHNER, Ľubomír. Impact of long-term mineral and organic fertilizer application on the water stability, wettability and porosity of aggregates obtained from two loamy soils. In *EUROPEAN JOURNAL OF SOIL SCIENCE*, 2015, vol. 66, no. 3, pp. 577-588. (2.649 - IF2014). (2015 - Current Contents).
4. FENDEKOVÁ, Miriam - PEKÁROVÁ, Pavla - FENDEK, Marián - PEKÁR, Ján - ŠKODA, Peter. Global drivers effect in multi-annual variability of runoff. In *Journal of Hydrology and Hydromechanics*, 2014, vol. 62, no. 3, p. 169 - 176. (1.231 - IF2013). (2014 - WOS, SCOPUS). ISSN 0042-790X.
5. HALMOVÁ, Dana - PEKÁROVÁ, Pavla - OLBŘÍMEK, O. - MIKLÁNEK, Pavol - PEKÁR, Ján. Precipitation Regime and Temporal Changes in the Central Danubian Lowland Region. In *Advances in Meteorology*, 2015, pp. 15830-15830 - dx.doi.org/10.1155/2014/715830. (0.946 - IF2014). (2015 - Current Contents).
6. HLAVÁČIKOVÁ, Hana - HOLKO, Ladislav - NOVÁK, Viliam. On the role of rock fragments and initial soil water content in the potential subsurface runoff formation. In *Journal of Hydrology and Hydromechanics*, 2015, vol. 63, no. 1, p. 71-81. (1.486 - IF2014). (2015 - WOS, SCOPUS). ISSN 0042-790X.
7. **HLAVÁČIKOVÁ, Hana - NOVÁK, Viliam. A relatively simple scaling method for describing the unsaturated hydraulic functions of stony soils. In *Journal of Plant Nutrition and Soil Science*, 2014, vol. 177, issue 4, p. 560-565. (1.663 - IF2013). (2014 - Current Contents). ISSN 1436-8730. DOI: 10.1002/jpln.201300524.**
8. HLAVÁČIKOVÁ, Hana - NOVÁK, Viliam. Comparison of daily potential evapotranspiration calculated by two procedures based on Penman-Monteith type equation. In *Journal of Hydrology and Hydromechanics*, 2013, vol. 61 no. 2, pp. 173- 176. (0.653 - IF2012). (2013 - SCOPUS, WOS). ISSN 0042-790X.
9. HOLKO, Ladislav - DÓŠA, Michal - MICHALKO, J. - KOSTKA, Zdeňek - ŠANDA, M. Isotopes of oxygen-18 and deuterium in precipitation in Slovakia. In *Journal of Hydrology and Hydromechanics*, 2012, vol. 60, no. 4, p. 265–276. (0.340- IF2011). (2012 - SCOPUS, WOS). ISSN 0042-790X. DOI - 10.2478/v10098-012-0023-2

10. HOLKO, Ladislav. Syringe life and memory effects in isotopic analyses performed by liquid water isotopic analysers – a case study for natural waters from central Europe. In *Isotopes in Environmental and Health Studies*, 2015, vol., pp. (0.964 - IF2014). (2015 - Current Contents). ISSN 1025-6016.

**11. KOCZKA BARA, Márta - VELÍSKOVÁ, Yvetta - DULOVIČOVÁ, Renáta - SCHÜGERL, Radoslav. Influence of surface water level fluctuation and riverbed sediment deposits on groundwater regime. In *Journal of Hydrology and Hydromechanics*, 2014, vol. 62, no. 3, p. 177 - 185. (1.231 - IF2013). (2014 - WOS, SCOPUS). ISSN 0042-790X. DOI- 10.2478/johh-2014-0030**

12. KOVÁČOVÁ, Viera - VELÍSKOVÁ, Yvetta. The risk of the soil salinization of the eastern part of Žitný ostrov. In *Journal of Hydrology and Hydromechanics*, 2012, vol. 60, no. 1, p. 57-63. (0.340 - IF2011). (2012 - SCOPUS, WOS). ISSN 0042-790X.

**13. KRAJČÍ, Pavel - HOLKO, Ladislav - PERDIGAO, Rui A. P. - PARAJKA, Juraj. Estimation of regional snowline elevation (RSLE) from MODIS images for seasonally snow covered mountain basins. L. Holko, R. Perdigao, J. Parajka. In *Journal of Hydrology*, 2014, vol. 519, part B, p. 1769–1778. (2.693 - IF2013). (2014 - Current Contents). ISSN 0022-1694, DOI: 10.1016/j.jhydrol.2014.08.064.**

14. LICHNER, Ľubomír - CAPULIAK, J. - ZHUKOVA, Natalia - HOLKO, Ladislav - CZACHOR, Henryk - KOLLÁR, Jozef. Pines influence hydrophysical parameters and water flow in a sandy soil. In Biologia: journal of the Slovak Academy of Sciences, 2013, vol. 68, no. 6, p. 1104-1108. (0.506 - IF2012). (2013 - Current Contents). ISSN 0006-3088.

**15. LICHNER, Ľubomír - HALLETT, P.D. - DRONGOVÁ, Z. - CZACHOR, H. - KOVÁČIK, Ľubomír - MATAIX-SOLERA, Jorge - HOMOLÁK, Marián. Algae influence the hydrophysical parameters of a sandy soil. In *CATENA*, 2013, vol.108, p.58-68. (1.881 - IF2012). (2013 - Current Contents). ISSN 0341-8162. DOI: 10.1016/j.catena.2012.02.016**

16. LICHNER, Ľubomír - HOLKO, Ladislav - ZHUKOVA, N. - SCHACHT, K. - RAJKAI, K. - FODOR, N. - SÁNDOR, R. Plants and biological soil crust influence the hydrophysical parameters and water flow in an aeolian sandy soil. In *Journal of Hydrology and Hydromechanics*, 2012, vol. 60, no. 4, p. 309-318. (0.340 - IF2011). (2012 - SCOPUS, WOS). ISSN 0042-790X.

17. NAGY, Viliam - MILICS, G. - SMUK, N. - KOVÁCS, A. J. - BALLA, I. - JOLÁNKAI, M. - DEÁKVÁRI, J. - SZALAY, K. D. - FENYVESI, L. - ŠTEKAUEROVÁ, Vlasta - WILHELM, Z. - RAJKAI, K. - NÉMETH, T. - NEMÉNYI, M. Continuous field soil moisture content mapping by means of apparent electrical conductivity (ECa) measurement. In *Journal of Hydrology and Hydromechanics*, 2013, vol. 61, no. 4, p. 305-312. (0.653 - IF2012). (2013 - SCOPUS, WOS). ISSN 0042-790X.

18. NOVÁK, Viliam - KŇAVA, Karol. The influence of stoniness and canopy properties on soil water content distribution: Simulation of water movement in forest stony soil. In *European Journal of Forest Research*, 2012, vol. 131, issue 6, pp. 1727-1735. (1.982 - IF2011). (2012 - Current Contents). ISSN 1612-4669.

19. ONDERKA, Milan - BANZHAF, S. - SCHEYTT, T. - KREIN, A. Seepage velocities derived from thermal records using wavelet analysis. In *Journal of hydrology*, 2012, vol. 479, no., p. 64-74. (2.656 - IF2011). (2012 - Current Contents). ISSN 0022-1694. <http://dx.doi.org/10.1016/j.jhydrol.2012.11.022, How to Cite or Link Using DOI>.

20. ONDERKA, Milan - WREDE, S. - RODNÝ, Marek - PFISTER, L. - HOFFMANN, L. - KREIN, A. Hydrogeologic and landscape controls of dissolved inorganic nitrogen (DIN) and dissolved silica (DSi) fluxes in heterogeneous catchments. In *Journal of Hydrology*, 2012, vol. 450-451, no. 1, p. 36-47. (2.656 - IF2011). (2012 - Current Contents). ISSN 0022-1694.

21. ORFÁNUS, Tomáš - DLAPA, Pavel - FODOR, N. - RAJKAI, K. - SANDOR, A. - NOVÁKOVÁ, K. How severe and subcritical water repellency determines the seasonal infiltration in natural and cultivated sandy soils. In *Soil & Tillage Research*, 2014, vol. 135, no. 1, pp. 49-59. (2.575 - IF2013). (2014 - Current Contents). ISSN 0167-1987.

22. PARAJKA, Juraj - HOLKO, Ladislav - KOSTKA, Zdeňek - BLÖSCHL, G. MODIS snow cover mapping accuracy in a small mountain catchment – comparison between open and forest sites. In *Hydrology and Earth System Sciences*, 2012, vol. 16, pp. 2365–2377. (3.148 - IF2011). (2012 - Current Contents). ISSN 1027-5606.

23. **PEKÁROVÁ, Pavla - HALMOVÁ, Dana - BAČOVÁ-MITKOVÁ, Veronika - MIKLÁNEK, Pavol - PEKÁR, Ján - ŠKODA, Peter. Historic flood marks and flood frequency analysis of the Danube River at Bratislava, Slovakia. In *Journal of Hydrology and Hydromechanics*, 2013, vol. 61,**

**no. 4, p. 326-333. (0.653 - IF2012). (2013 - SCOPUS, WOS). ISSN 0042-790X. DOI- 10.2478/johh-2013-0041.**

24. PEKÁROVÁ, Pavla - SVOBODA, Aleš - MIKLÁNEK, Pavol - ŠKODA, Peter - HALMOVÁ, Dana - PEKÁR, Ján. Estimating flash flood peak discharge in Gidra and Parná basin: case study for the 7–8 June 2011 flood. In *Journal of Hydrology and Hydromechanics*, 2012, vol. 60, no. 3, p. 206–216. (0.340 - IF2011). (2012 - SCOPUS, WOS). ISSN 0042-790X.

25. PENNA, D. - AHMAD, M. - BIRKS, S. J. - BOUCHAOU, L. - BRENČIČ, M. - BUTT, S. - HOLKO, Ladislav - JEELANI, G. - MARTINEZ, D. E. MELIKADZE, G. - SHANLEY, J. B. - SOKRATOV, S. - STADNYK, T. - SUGIMOTO, A. - VREČA, P. A new method of snowmelt sampling for water stable isotopes. In *Hydrological Processes*, 2014, vol. 28, issue 22, p. 5637–5644. (2.696 - IF2013). (2014 - Current Contents). ISSN 0885-6087.

26. PFISTER, L. - WETZEL, C.E. - MARTINEZ-CARRERAS, N. - IFFLY, J. F. - KLAUS, J. - HOLKO, Ladislav - MCDONNELL, J. J. Examination of aerial diatom flushing across watersheds in Luxembourg, Oregon and Slovakia for tracing episodic hydrological connectivity. In *Journal of Hydrology and Hydromechanics*, 2015, vol. 63, no. 3, p. 235–245. (1.486 - IF2014). (2015 - WOS, SCOPUS). ISSN 0042-790X.

27. RODNÝ, Marek - LICHNER, Ľubomír - SCHACHT, K. - HOLKO, Ladislav. Depth-dependent heterogeneity of water flow in sandy soil under grass. In Biologia: journal of the Slovak Academy of Sciences, 2015, vol. 70, no. 11, p. 1462—1467. (0.827 - IF2014). (2015 - Current Contents). ISSN 0006-3088.

28. SCHACHT, K. - CHEN, Y. - TARCHITZKY, J. - LICHNER, Ľubomír - MARSCHNER, B. Impact of treated wastewater irrigation on water repellency of Mediterranean soils. In *Irrigation Science*, 2014, vol. 32 no. 5, pp. 369–378. (2.843 - IF2013). (2014 - Current Contents). ISSN 0342-7188.

29. ŠURDA, Peter - LICHNER, Ľubomír - NAGY, Viliam - KOLLÁR, Jozef - IOVINO, Massimo - HOREL, Ágota. Effects of vegetation at different succession stages on soil properties and water flow in sandy soil. In Biologia: journal of the Slovak Academy of Sciences, 2015, vol. 70, no. 11, p. 1474-1479. (0.827 - IF2014). (2015 - Current Contents). ISSN 0006-3088.

### 2.1.3 List of monographs/books published abroad

AAA01 NOVÁK, Viliam. *Evapotranspiration in the Soil-Plant-Atmosphere System - Progress in Soil Science*. Dordrecht: Springer, 2012. 253 s. ISBN 978-94-007-3839-3.

AAA02 VELÍSKOVÁ, Yvetta - SOKÁČ, M. - HALAJ, Peter. *Disperzia v povrchových tokoch – meranie a modelovanie* [Dispersion in surface streams- measuring and modelling]. Brno: ARDEC, 2014. 118 s. ISBN 978-80-86020-80-8.

### 2.1.4. List of monographs/books published in Slovakia

AAB01 PEKÁROVÁ, Pavla - MIKLÁNEK, Pavol - MELO, Marián - HALMOVÁ, Dana - PEKÁR, Ján - BAČOVÁ-MITKOVÁ, Veronika. *Flood marks along the Danube River between Passau and Bratislava*. Bratislava: Veda, 2014. ISBN 978-80–224-1408-1.

AAB02 REHÁK, Štefan - BÁREK, V. - JURÍK, Ľ. - ČISTÝ, M. - IGAZ, Dušan - ADAM, Štefan - LAPIN, Milan - SKALOVÁ, Jana - ALENA, J. - FEKETE, V. - ŠÚTOR, Július - JOBBÁGY, J. *Zavlažovanie poľných plodín, zeleniny a ovocných sadov* [Irrigation of field crops, vegetables and orchards]. 1. vyd. Bratislava: Veda, 2015. 640 s. ISBN 978-80–224-1429-6.

AAB03 SKALOVÁ, Jana - KOTOROVÁ, Dana - IGAZ, Dušan - GOMBOŠ, Milan - NOVÁKOVÁ, K. *Regionalizácia pedotransferových funkcií vlhkostných retenčných kriviek pôd Slovenska* [Regionaliation of the soil water retention curves of Slovakia using pedotransfer functions]. Bratislava: Slovenská technická univerzita v Bratrislave, 2015. 143 s. ISBN 978-80–227-4455-3.

AAB04 ŠÚTOR, Július - MAJERČÁK, Juraj - ŠURDA, Peter. *Voda v zóne aerácie pôd Žitného ostrova* [Water in the soil aeration zone of the Rye Island]. Bratislava: Veda, 2014. 188 s. ISBN 978-80–224-1368-4.

### 2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items

- The monograph by NOVÁK, Viliam: Evapotranspiration in the Soil-Plant-Atmosphere System - Progress in Soil Science (by Springer, 2012. 253 p. ISBN 978-94-007-3839-3) has a total of 14,266 chapter downloads on Springer Link. This means that the book was one of the top 50% most downloaded books in the Springer eBook Collection in 2015.
- The database was created of mean daily discharge and maximum annual discharge of the river Danube from 23 riparian stations for the period since 1931. Other database was compiled of the mean daily discharges of significant rivers in the Danube river basin. These databases are made accessible for the consortium partners of the UNESCO project Flood regime of rivers in the Danube river basin.
  MIKLÁNEK, Pavol - PEKÁROVÁ, Pavla - PRAMUK, Branislav - HALMOVÁ, Dana. High flows regime analysis along the Danube. P. Pekárová, B. Pramuk, D. Halmová. In Proceedins Danube Conference 2014 - Bridging the sciences - crossing borders: XXVI CONFERENCE OF THE DANUBIAN COUNTRIES ON HYDROLOGICAL FORECASTING AND HYDROLOGICAL BASES OF WATER MANAGEMENT [elektronic source]. - Deggendorf: Institute of Technology, 2014, pp. 19-22.
  PEKÁROVÁ, Pavla - MIKLÁNEK, Pavol - PEKÁR, Ján. Increase of flood water levels on the middle Danube. In Proceedings of the International Association of Hydrological Sciences: Hydrological Sciences and Water Security: Past, Present and Future, PIAHS, Volume 366. - WALLINGFORD: INT ASSOC HYDROLOGICAL SCIENCES, INST OF HYDROLOGY, 2015, pp. 145-146. (2015 - WOS). ISBN 978-1-907161-44-5. ISSN 0144-7815.
- The measurements were processed from the network of soil moisture measuring stations in Slovakia, which was built from the Structural funds.
  TALL, Andrej - VITKOVÁ, Justína. Automatická monitorovacia sada pre vlhkosť a teplotu pôdy, zrážky a HPV (popis a vyhodnotenie monitoringu za obdobie august 2014 – júl 2015): Interná správa ÚH SAV [Automatic monitoring set for moisture and temperature of soil, precipitation and groundwater level measurements (description and evaluation of monitoring for the period from August 2014 to July 2015)]. Michalovce: ÚH SAV, 2015. 96 s.
- The database was created of hydrological and meteorological measurements in the high mountain basin of Jalovecký creek.
- The lysimetric station near Michalovce was set into operation in 2015 and data are collected regularly.
- The NLN-Danube model was prepared and calibrated, which serves for forecast of the flood wave movement along the Slovak part of the Danube between Devín and Štúrovo. Model was used to forecast the peak discharge and flood wave transformation of the July 2013 flood of the Danube.

### 2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad, incl. revenues

None

### 2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia, incl. revenues

None

## 2.1.8. Table of research outputs (as in annual reports).

| Scientific publications | 2012 | | | 2013 | | | 2014 | | | 2015 | | | total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | No. / FTE | No. / salary budget | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
| **Scientific monographs and monographic studies in journals and proceedings published abroad** *(AAA, ABA)* | 1.0 | 0.033 | 0.003 | 0.0 | 0.000 | 0.000 | 1.0 | 0.033 | 0.003 | 0.0 | 0.000 | 0.000 | **2.0** | **0.5** | **0.017** | **0.001** |
| **Scientific monographs and monographic studies in journals and proceedings published in Slovakia** *(AAB, ABB)* | 0.0 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 2.0 | 0.067 | 0.005 | 2.0 | 0.066 | 0.005 | **4.0** | **1.0** | **0.033** | **0.003** |
| **Chapters in scientific monographs published abroad** *(ABC)* | 2.0 | 0.065 | 0.005 | 0.0 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | **2.0** | **0.5** | **0.017** | **0.001** |
| **Chapters in scientific monographs published in Slovakia** *(ABD)* | 0.0 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | 0.0 | 0.000 | 0.000 | **0.0** | **0.0** | **0.000** | **0.000** |
| **Scientific papers published in journals registered in Current Contents Connect** *(ADCA, ADCB, ADDA, ADDB)* | 6.0 | 0.196 | 0.015 | 5.0 | 0.172 | 0.013 | 8.0 | 0.266 | 0.021 | 8.0 | 0.262 | 0.020 | **27.0** | **6.8** | **0.225** | **0.017** |
| **Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS** *(ADMA, ADMB, ADNA, ADNB)* | 4.0 | 0.131 | 0.010 | 9.0 | 0.310 | 0.023 | 10.0 | 0.333 | 0.026 | 4.0 | 0.131 | 0.010 | **27.0** | **6.8** | **0.225** | **0.017** |
| **Scientific papers published in other foreign journals (not listed above)** *(ADEA, ADEB)* | 12.0 | 0.392 | 0.031 | 9.0 | 0.310 | 0.023 | 10.0 | 0.333 | 0.026 | 15.0 | 0.492 | 0.038 | **46.0** | **11.5** | **0.383** | **0.029** |
| **Scientific papers published in other domestic journals (not listed above)** *(ADFA, ADFB)* | 30.0 | 0.980 | 0.077 | 33.0 | 1.137 | 0.083 | 44.0 | 1.465 | 0.113 | 25.0 | 0.820 | 0.063 | **132.0** | **33.0** | **1.099** | **0.084** |
| **Scientific papers published in foreign peer-reviewed proceedings** *(AEC, AECA)* | 13.0 | 0.425 | 0.033 | 19.0 | 0.654 | 0.048 | 22.0 | 0.733 | 0.057 | 10.0 | 0.328 | 0.025 | **64.0** | **16.0** | **0.533** | **0.041** |
| **Scientific papers published in domestic peer-reviewed proceedings** *(AED, AEDA)* | 25.0 | 0.817 | 0.064 | 19.0 | 0.654 | 0.048 | 14.0 | 0.466 | 0.036 | 13.0 | 0.426 | 0.033 | **71.0** | **17.8** | **0.591** | **0.045** |
| **Published papers (full text) from foreign and international scientific conferences** *(AFA, AFC, AFBA, AFDA)* | 5.0 | 0.163 | 0.013 | 5.0 | 0.172 | 0.013 | 13.0 | 0.433 | 0.034 | 9.0 | 0.295 | 0.023 | **32.0** | **8.0** | **0.266** | **0.020** |
| **Published papers (full text) from domestic scientific conferences** *(AFB, AFD, AFBB, AFDB)* | 20.0 | 0.654 | 0.051 | 0.0 | 0.000 | 0.000 | 3.0 | 0.100 | 0.008 | 14.0 | 0.459 | 0.035 | **37.0** | **9.3** | **0.308** | **0.023** |

- **Supplementary information and/or comments on the scientific outputs of the institute.**

The list of CCC journals in which the authors from the Institute publish, has changed significantly since the last assessment. Our researchers published more in acknowledged international journals. Except journals registered in CCC or SCOPUS, 18 scientific papers were published in foreign peer-reviewed proceedings indexed in WOS, and/or SCOPUS databases.

The period 2010 – 2014 was affected by formation of the Centres of excellence established with the help of the EU Structural Funds. The researchers were overloaded by administration related to selection of the equipment, its acquisition in tenders, arranging the necessary licenses for installation of the equipment on private lands, transport to field, installation itself and establishment of the network of stations.

In addition, preparations for the movement of the Institute in Bratislava from the Račianska street to the Dúbravská cesta street started in 2015. It was necessary to prepare the laboratories, classify the documents for archiving and manage the disposal of unnecessary equipment which was not to be moved. It was also necessary to prepare the new communication networks (computers, IP telephones), select and self-financed purchase of the necessary hardware.

Despite these circumstances, all the running projects were successfully finished and the main results were published in peer-reviewed journals.

## 2.2. Responses to the research outputs (citations, etc.)

### 2.2.1. Table with citations per annum.

*Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.*

| Citations, reviews | 2011 | | 2012 | | 2013 | | 2014 | | total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | number | No. / FTE | number | No. / FTE | number | No. / FTE | number | No. / FTE | number | averaged number per year | av. No. / FTE |
| **Citations in Web of Science Core Collection (1.1, 2.1)** | 125.0 | 4.085 | 154.0 | 5.305 | 199.0 | 6.627 | 249.0 | 8.164 | **727.0** | **181.8** | **6.050** |
| **Citations in SCOPUS (1.2, 2.2) if not listed above** | 64.0 | 2.092 | 21.0 | 0.723 | 30.0 | 0.999 | 22.0 | 0.721 | **137.0** | **34.3** | **1.140** |
| **Citations in other citation indexes and databases (not listed above) (3.2,4.2,9,10)** | 0.0 | 0.000 | 0.0 | 0.000 | 0.0 | 0.000 | 0.0 | 0.000 | **0.0** | **0.0** | **0.000** |
| **Other citations (not listed above) (3, 4, 3.1, 4.1)** | 419.0 | 13.693 | 225.0 | 7.751 | 148.0 | 4.928 | 125.0 | 4.098 | **917.0** | **229.3** | **7.631** |
| **Reviews (5,6)** | | 0.000 | | 0.000 | | 0.000 | | 0.000 | **0.0** | | |

### 2.2.2. List of 10 most-cited publications, with number of citations, in the assessment period (2011–2014).

1. PEKÁROVÁ, Pavla - MIKLÁNEK, Pavol - PEKÁR, Ján. Spatial and temporal runoff oscillation analysis of the main rivers of the world during the 19th–20th centuries. In *Journal of Hydrology*, 2003, vol. 274, no. 1, pp. 62-79. ISSN 0022-1694. **(24 total, 22 WOS, 1 SCOPUS)**
2. ONDERKA, Milan - PEKÁROVÁ, Pavla. Retrieval of suspended particulate matter concentrations in the Danube River from Landsat ETM data. In *Science of the Total Environment*, 2008, vol. 397, no. 1-3, pp. 238–243. (2.182 - IF2007). (2008 - Current Contents). ISSN 0048-9697. **(18 total, 17 WOS, 1 SCOPUS)**
3. CZACHOR, H. - DOERR, Stefan H. - LICHNER, Ľubomír. Water retention of repellent and subcritical repellent soils: New insights from model and experimental investigations. In *Journal of hydrology*, 2010, vol. 380, issue 1–2, pp. 104-111. (2.433 - IF2009). (2010 - Current Contents, Current Contents). ISSN 0022-1694. **(18 total, 16 WOS, 2 SCOPUS)**
4. NOVÁK, Viliam - ŠIMUNEK, J. - GENUCHTEN, Martinis Th. van. Infiltration of water into soil with cracks. In *Journal of Irrigation and Drainage Engineering*, 2000, vol. 126, no.1, pp. 41-47. ISSN 0733-9437**. (18 total, 15 WOS, 2 SCOPUS)**
5. LICHNER, Ľubomír - HOLKO, Ladislav - ZHUKOVA, N. - SCHACHT, K. - RAJKAI, K. - FODOR, N. - SÁNDOR, R. Plants and biological soil crust influence the hydrophysical parameters and water flow in an aeolian sandy soil. In *Journal of Hydrology and*

*Hydromechanics*, 2012, vol. 60, no. 4, pp. 309-318. (0.340 - IF2011). (2012 - SCOPUS, WOS). ISSN 0042-790X **(13 total, 12 WOS)**

6. BAČA, Peter. Hysteresis effect in suspended sediment concentration in the Rybarik basin. In *Hydrological Sciences Journal: International Association of Hydrological Sciences.Association Internationale des Sciences Hydrologiques*, 2008, vol. 53, no. 1, pp. 224–235. (1.604 - IF2007). (2008 - Current Contents). ISSN 0262-6667. **(11 total, 11 WOS)**
7. LICHNER, Ľubomír - DLAPA, Pavel - DOERR, Stefan H. - MATAIX-SOLERA, J. Evaluation of different clay minerals as additives for soil water repellency alleviation. In *Applied Clay Science*, 2006, vol. 31, issues 3-4, pp. 238–248. (1.324 - IF2005). (2006 - Current Contents). ISSN 0169-1317. **(10 total, 10 WOS)**
8. PEKÁROVÁ, Pavla - ONDERKA, Milan - PEKÁR, Ján - RONČÁK, Peter - MIKLÁNEK, Pavol. Prediction of water quality in the Danube River under extreme hydrological and temperature conditions. In *Journal of Hydrology and Hydromechanics*, 2009, vol. 57, no. 1, pp. 3-15. (2009 - SCOPUS). ISSN 0042-790X. **(14 total, 9 WOS, 2 SCOPUS**)
9. HOLKO, Ladislav - ŠKVARENINA, Jaroslav - KOSTKA, Zdeňek - FRIČ, M. - STAROŇ, J. Impact of spruce forest on rainfall interception and seasonal snow cover evolution in the Western Tatra Mountains, Slovakia. In *Biologia: journal of the Slovak Academy of Science*, 2009, vol. 64, no. 3, pp. 594-599. (0.406 - IF2008). (2009 - Current Contents, WOS, SCOPUS). ISSN 0006-3088. (**13 total, 8 WOS, 3 SCOPUS)**
10. MAJERČÁK, Juraj - NOVÁK, Viliam. *GLOBAL, one-dimensional variable saturated flow model, including root water uptake, evapotranspiration structure, corn yield, interception of precipitations and winter regime calculation*. Bratislava: Institute of Hydrology, 1994. 75 p. **(32 total, 1 WOS )**

### 2.2.3. List of most-cited authors from the Institute (at most 10 % of the research employees with university degree engaged in research projects) and their number of citations in the assessment period (2011– 2014).

| | | | |
|---|---|---|---|
| RNDr. Pavla Pekárová, DrSc.: | 251 citations | (WOS - 131, | SCOPUS - 23) |
| Ing. Viliam Novák, DrSc.: | 230 citations | (WOS - 94 | SCOPUS - 21) |
| RNDr. Ladislav Holko, PhD.: | 196 citations | (WOS - 98 | SCOPUS - 17) |
| Ing. Ľubomír Lichner, DrSc.: | 180 citations | (WOS - 148 | SCOPUS - 10) |

- **Supplementary information and/or comments on responses to the scientific output of the institute.**

The publication of results in high quality journals is reflected in higher citation impact of the studies.

## 2.3. Research status of the institute in international and national contexts

- **International/European position of the institute**

**2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items.**

The international collaboration of the Institute is based on both multilateral and bilateral collaborations. The multilateral collaboration was developed within the International Hydrological Programme of UNESCO (IHP UNESCO) and the International Atomic Energy Agency.

Dominating role in Institute`s bilateral international cooperation have the long–term co-operations with institutions in Poland, Hungary, Russia, Austria and the Czech Republic. The Institute is active in many projects in Europe and outside it. Colleagues from Europe are visiting us mainly on the occasion of regular scientific meetings. International Poster Day organized annually by the Institute is popular in Central Europe. Conference "The influence of anthropogenic activity on water regime of the territory" was organized simultaneously with Slovak – Czech – Polish seminar Physics of Soil Water in 2015. In 2012-2013 the Institute cooperated intensively with Columbia University New York through the Columbia University Seminars. The Institute was co-organising biennial conferences ERB (European Network of Experimental and Representative Basins) of the IHP UNESCO. The Institute of Agrophysics PAN in Lublin and IH SAS are cooperating in the framework of Centre of Excellence lead by IA PAN.

1. The good position of the institute in the process hydrology, and particularly in tracer hydrology was reflected in the collaboration with the International Atomic Energy Agency (IAEA). Our experts participated in coordinated research projects "Combined Hydrograph and Isotopic Baseflow Separation for the Upper Vah Catchment Vulnerability Assessment" (IAEA CRP F3.30.15, 2004–2009), "The Role of Snow in Hydrological Cycle of the Upper Vah River Basin" (IAEA CRP F3.20.06, 2010–2013), and "Basin-scale recharge estimation in the upper Váh river basin" (IAEA 15997/R0, 2010–2012). Dr. Holko gave lectures in courses on tracer hydrology organized by the IAEA in Georgia, Sierra Leone and Tajikistan in 2013 and in Malawi in 2014.
2. The National Committee of the International Hydrological Programme of UNESCO (IHP UNESCO) is affiliated to the Institute. The International Hydrological Programme of UNESCO is one of five intergovernmental scientific programmes of UNESCO. Slovakia as a member country of UNESCO has to contribute to the aims of the programme. Historically, since the establishment of the programme, the Institute of Hydrology SAS was designated as a focal point (National Committee) of the programme. Participation in the programme helps to develop the international collaborations and the international position of the Institute. Besides the administrative coordination of the whole programme in Slovakia, several projects of the Programme are running at the Institute.
   The Institute is the national representative for the IHP UNESCO Cross-Cutting Programme Component Flow Regimes from International Experimental and Network Data (FRIEND). FRIEND is a worldwide project operated on large scale regions. Practically all European countries are participating in the EUROFRIEND group and the Institute is an active member of the Steering Committee.
3. The Institute acts as a national representative for the IHP UNESCO Regional cooperation of Danube Countries. The cooperation between 18 participating countries (from Germany downstream the Danube to Moldova and Ukraine) formulates basin-wide research projects of common interest and organizes regular bi-annual scientific conferences. During the assessment period, the co-operation was developed under themes Managing water as a shared responsibility across geographical & social boundaries (Regional cooperation of Danube Countries, IHP UNESCO FA 2.4, 2008–

2013), and Improve scientific basis for hydrology and water sciences for preparation and response to extreme hydrological events (Regional cooperation of Danube Countries, IHP UNESCO FA 1.5, 2014–2021). The Regional co-operation is a very important tool for understanding the hydrological regimes and processes of our region. The Institute represents Slovakia in the steering committee of the co-operation.

4. The Institute conducts international co-ordination of the project 9 of the Regional Collaboration of the Danube Countries entitled Flood Regimes of Rivers in the Danube River Basin. We have initiated and developed the project proposal which was adopted by all 18 participating countries. The topic of floods is one of the most important and hot themes in hydrology discussed also in connection to climate change impact. The origin of significant floods (not the local ones) results from large scale processes and its analysis has to be based on the regional co-operation. The Institute thus plays a leading role in the second largest European river basin, i.e. the Danube river basin.
5. In Austria, the Institute collaborates with University of Natural Resources and Life Sciences (BOKU) in Vienna through the project "Root uptake modelling with field scale parameters assessment". As part of the ongoing cooperation a new project was accepted in the 2015 bilateral call Slovakia - Austria. The project entitled SK-AT 2015-0018 "The Impact of biophysical and environmental factors on the differences between measured and calculated evapotranspiration totals" will start in 2016.
6. The Institute also collaborates with several Hungarian universities and with institutes of the Hungarian Academy of Sciences (HAS). Common project with Eötvös Loránd University, Budapest was focused on data analysis of soil and groundwater regime in lowland areas of Slovakia and Hungary. Project "Assessment of soil water regime in the context of ensuring the moisture needs for vegetation" was managed in cooperation with University of West Hungary, Sopron. Memorandum of Understanding with Szent István University Institute of Crop Production signed in 2015 confirms the future scientific cooperation with the main goal to enhance hydrological properties of crop site to improve yielding ability in the Carpathian Basin. Main research partners of the Institute from HAS are Agricultural Institute, Centre for Agricultural Research in Martonvásár, and Centre for Regional Studies of HAS in Pécs.
7. The Institute has a fruitful cooperation with Polish scientific institutes since many years. Former common research projects, e.g. „ Evaluation of surface soil moisture from satellite and ground-based measurements” with the Institute of Agrophysics PAS in Lublin dealt with the climate change issues related to evaluation of water storage in soil from ground and SMOS (Soil Moisture Ocean Salinity) satellite measurements. Since 2015 the Institute cooperates also with European Regional Centre for Ecohydrology of Polish Academy of Sciences. The aim of cooperation is to assess how the revitalization of urban areas by proper utilization of the soil-plant-atmosphere system can influence local climate and water quality in urban areas via the effects on water, radiation and heat balances.
8. IH SAS has a kibg-term cooperation with Water Problems Institute of the Russian Academy of Sciences, Moscow. Last common project was focused on evaluation methods of catchment water balance components.
9. Traditional partners are Czech University of Life Sciences in Prague (Department of Water Resources and Department of Soil Science and Soil Protection), and Institute of Hydrodynamics of the Academy of Sciences of the Czech Republic.
10. Memorandum of Understanding with University of Palermo, Department of Agricultural and Forestry Sciences was signed in 2015. The memorandum supports future research focused on impact of water-repellent top-layer of soil on water flow and evaporation.

### 2.3.2. List of international conferences (co)organised by the institute.

2012

1. Green Water - 11th ALPS ADRIA Conference, 2012, Smolenice, 168 participants, 26.3-31.03.2012
2. 20th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012

2013

3. Conference “State of art in Hydrological Research”, held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre SAS, Smolenice castle, 23.–25. 9. 2013
4. Conference “River basin and flood risk management”, Bratislava, Hotel Družba, 120 participants, 11.–13. 12. 2013

2014

5. Hydrology of small basins 2014, Praha, 100 participants, 22.04.–24.04.2014
6. Workshop of the project KORANET2, Bratislava, 20 participants, 01.05.-03.05.2014
7. Workshop of the project Goldfish, Bratislava, 15 participants, 08.09.-12.09.2014
8. Workshop Flood regime of rivers in the Danube Basin, Deggendorf, 15 participants, 25.09.2014
9. 21th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 150 participants, 13.11.2014

2015

10. Joint Event of Science with international participation River Basin and Flood Risk Management 2015 and Hydrological Days 2015, hotel Družba, 135 participants, 06.10.-09.10.2015
11. 22th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 130 participants, 12.11.2015
12. 9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory“; 2-4.6.2015, Zemplínska šírava – Kamenec resort, and 19th Slovak-Czech-Polish Scientific Seminar “Physics of Soil Water”; Zemplínska šírava, 3.6.2015

### 2.3.3. List of edited proceedings from international scientific conferences.

1. Pollution and Water Resources, Columbia University Seminar Proceedings: Impact of Anthropogenic Activity and Climate Changes on the Environment of Central Europe and USA. Volume XLI., 2012. (Eds.: J. Halasi-Kun; V. Štekauerová, I. Fodor, V. Nagy, R. Lo Pinto). Bratislava IH SAS, and Pécs: HAS, 2012. 390 pp. ISBN 978-963-9899-59-9.
2. 20st International Poster Day and Institute of Hydrology Open Day: Proceedings of peer-reviewed contributions. Transport of Water, Chemicals and Energy in the Soil-Plant-Atmosphere System. Čelková A. (ed.). Bratislava: Slovak Academy of Sciences, Institute of Hydrology and Geophysical Institute, 2012. 858 pp. ISBN 978-80-89139-28-6.
3. State of art in Hydrological Research: proceedings of peer-reviewed contributions from conference held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS. Eds.: A. Čelková, Reviewers: M. Gomboš, H. Hlaváčiková, L. Holko, Z. Kostka, Ľ. Lichner, P. Miklánek, V. Novák, P.

Šurda, M. Rodný, Y. Velísková. Bratislava: IH SAS, and SVH, 2013. 345 pp. ISBN 978–80–89139–30–9.

4. 21st International Poster Day and Institute of Hydrology Open Day: Proceedings of peer-reviewed contributions. Transport of Water, Chemicals and Energy in the Soil-Plant-Atmosphere System. Čelková A. (ed.). Reviewers: V. Bačová-Mitková, M. Gomboš, D. Halmová, D. Igaz, V. Novák, T. Orfánus, J. Skalová, R. Schügerl, A. Tall, Y. Velísková. Bratislava, IH SAS, 2014. 432 pp. ISBN 978 - 80 - 89139 - 30 - 0.
5. 22nd International Poster Day and Institute of Hydrology Open Day: Proceedings of peer-reviewed contributions Transport of water, chemicals and energy in the soil-plant-atmosphere system. Čelková A. (ed.). Reviewers: Bačová-Mitková Veronika, Gomboš Milan, Holko Ladislav, Nejedlík Pavol, Orfánus Tomáš, Podhorský Dušan Skalová Jana, Stojkovová Dagmar, Tall Andrej. Bratislava: IH SAS, 2015. 353 pp. ISBN 978-80-89139-36-1.
6. Influence of anthropogenic activities on water regime of lowland territory, Proceedings of peer-reviewed contributions. D. Pavelková,i M. Gomboš, A. Tall. (Eds.) Bratislava; Michalovce: IH SAS: Research hydrological base, 2015. ISBN 978 – 80 – 89139 – 35 - 4.

### 2.3.4. List of journals edited/published by the institute:

#### 2.3.4.1. WOS (IF of journals in each year of the assessment period)

*Journal of Hydrology and Hydromechanics*; jointly published by the Institute of Hydrology, Slovak Academy of Sciences, Bratislava and Institute for Hydrodynamics, Academy of Sciences Czech Republic, Prague

Rank 39 out of 85 in category Water Resources in the 2015 Thomson Reuters Journal Citation Report/Science Edition

*IMPACT FACTOR 2012*: 0.653

*IMPACT FACTOR 2013*: 1.231

*IMPACT FACTOR 2014*: 1.486

*IMPACT FACTOR 2015*: 1.469

#### 2.3.4.2. SCOPUS

*none*

#### 2.3.4.3. other databases

*Acta Hydrologica Slovaca;* journal is published two times per year and distribution of the journal is free of charge.

Abstracting & Indexing:

- Electronic Journals Library
- Staats- und Universitätsbibliothek Hamburg - Bibliothekssystem Universität Hamburg
- Universitätsbibliothek Leipzig - Bibliothekssystem
- E- International Journals of Academic & Scientific Research (EIJASR) by Texila American University
- Journals for Free

#### 2.3.4.4. not included in databases

none

- **National position of the institute**

### 2.3.5. List of selected projects of national importance

Selected projects of national importance are described in categories APVV and VEGA.

### 2.3.6. Projects of the Slovak Research and Development Agency (APVV)

Institute of Hydrology SAS is steadily successful in obtaining and elaboration of the APVV projects. In the assessment period it was engaged in 10 APVV projects, 7 of which were finalised. The Institute was principal investigator in three projects. Collaborating institutions included:

- Slovak University of Technology, Bratislava, Civil Engineering Faculty
- Slovak University of Agriculture, Nitra, Faculty of Horticulture and Landscape Engineering
- Comenius University, Bratislava, Faculty of mathematics, physics and informatics
- Prešov University, Prešov
- Slovak Hydrometeorological Institute, Bratislava
- National Agricultural and Food Center – Research Institute of Soil Science and Protection, Bratislava
- National Agricultural and Food Center – Research Institute of Agroecology, Michalovce
- Institute of Landscape Ecology SAS, Bratislava, branch Nitra.

Two of the APVV projects were the bilateral projects with the Czech Republic and one project was in the EU projects co-financing scheme. List of all APVV projects is given in Table 2.4.4. The main results of the APVV projects finalised in the assessment period are given below:

**Title of the project: Hydrological regime changes identification of rivers in the Danube River basin**

Project registration number: APVV-0015-10

Duration of the project: 1. 07. 2011 - 31. 12. 2014

Principal investigator: RNDr. Pavla Pekárová, DrSc.

We focused on finding data and creation of the database of historical floods and droughts in Slovakia. Particular attention was paid to historical flooding on the Danube river in Bratislava. The most significant project result is the identification of historical floods on the Danube in Bratislava since the year 1000 and identification of the historical levels of the Danube in Bratislava since 1501. Incorporation of historical floods into the measured series of peakflows significantly improves the design values of the N-year flows. In particular, the estimation of flows with very long return periods (*500-1000*-year flows) can result in big mistakes when using simple statistical methods. Therefore, we used special statistical procedures for incorporation of historical floods into the series of maximum annual flows. The design values were then estimated by regionalization methods. Next, we focused on mapping the largest known historical flood in Slovakia which occurred in August 1813. We searched and described the preserved flood marks in the Vah, Hron, Hnilec and Poprad river basins in Slovakia and in the Vistula river basin in Poland. Based on historical records and flood marks of the water level we estimated the peakflows during the catastrophic flood of August 1813. These data were incorporated into the estimation of design floods for selected stations in the Váh (Liptovský Mikuláš), Poprad (Chmeľnica) and Hron (Banská Bystrica) river basins. The rivers and stations were chosen in such a way that the measured maximum annual flow Qmax was the least affected by anthropogenic changes in the basin. All obtained results have application in water management practice not only in Slovakia, but also in the entire Danube river basin.

**Title of the project: Quantification of input data influence on correctness of outputs of dispersion simulation models for surface water**

Project registration number: APVV-0274-10

Duration of the project: 1. 07. 2011 - 31. 12. 2014

Principal investigator: Ing. Yvetta Velísková, PhD.

The aim of the project was to find the answers to questions related to the use of available dispersion modelling tools in Slovakia which could be fully employed in the implementation of Water Framework Directive (WFD 2000/60/ES). This objective was fully met. We evaluated the abilities, shortcomings, strong- and weak points of the current approaches used to deal with water quality problems in surface streams. All aspects were solved with a focus on hydrodynamic approach of mixing (dispersion) of carried substances (pollution) in surface streams. Project results offer solutions for possible problems, such as the elimination of uncertainty in determining the values of dispersion characteristics, recommendations for the use of an appropriate dispersion model depending on the complexity and scale of the area of interest, characteristics of the source of pollution, etc. Project results also show the possibility of using 1D and 2D simulation models in practical applications. For example, they contribute to the elaboration of the problems of mixing zones, which is a new feature in our water legislation (Government regulation of Slovak Republic no. 270/2010 Z.z., § 3 – Mixing zone). We also created a unique database of experimental data. The database contains all data from series of field measurements and tracer experiments on various types of surface streams during the project. The database was used to determine the basic dispersion characteristics of variant types of streams and flow conditions on them, and as the data source for testing of simulation models.

**Title of the project: Spatial interpretation of soil hydrophysical characteristics in relation to their hydrological regime**

Project registration number: APVV-0139-10

Duration of the project: 1. 07. 2011 - 31. 12. 2014

Principal investigator: Ing. Justína Vitková, PhD.

Weather extremes in the form of long-term periods of dry days without precipitation or vice versa with flood events, draw the attention of experts in the area of soil water regime. Soil moisture in the active layer of the soil profile has the greatest impact on the crop quality and quantity and ultimately also on the harvest. Regular monitoring of soil moisture and groundwater tables provided valuable data that served in the analysis of the dry and wet periods in the past, but can also form the basis for the development of future predictions. The data are an integral part of the parameterization, verification and validation of mathematical simulation models of the soil water regime and of addressing specific tasks related to the soil water regime.

Methodology for detecting missing data for days without the soil moisture and ground water table measurements was developed. The methodology uses genetic algorithms and can also be used to predict the soil moisture and groundwater table in the future.

One of the project objectives was to create spatial database of soil hydrophysical characteristics (size distribution, mean particle density and bulk density, humus content, organic carbon content, water retention curve and saturated hydraulic conductivity) which is open to the public as a web service at http://fzki.uniag.sk/hydrophysics/. The database provides a comprehensive overview of the soil profile at selected locations and represents a significant help for scientists and professionals.

**Title of the project: Multivariable frequency analysis of hydrological extremes for water resources planning and design**

Project coordinator: Slovak University of Technology, Bratislava, Civil Engineering faculty

Project registration number: APVV-0496-10

Duration of the project: 1. 07. 2011 - 31. 12. 2014

Investigator: Ing. Dana Halmová, PhD.

Hydrological extremes used in water resources planning and design were usually described by one dimensional characteristics in the past (e.g. l00-year discharge). However, the extremes result from complex hydrological and meteorological events and their correct description should use multidimensional characteristics (e.g. joint study of the flood peak, volume and duration), which are interrelated and may be mutually correlated. The structure and dependence properties of such entities were studied (both theoretically and hydrologically at site and regionally) by copulas. Within a simulation modelling framework, the combination problem adequate of rainfall-runoff models and rainfall generators was proposed and used to generate long series of flows for the study of properties of multivariate hydrologic extremes. The development of hydrologically acceptable copula- based multivariate probability distributions was performed. These new models can be used to supply water resources specialists with a new type of design information which was not available generally so far and in Slovakia it was totally absent.

**Title of the project: Hydraulic conductivity of soils and its spatio-temporal variability**

Project coordinator: Institute of Hydrology SAS & Department of Water Resources, Czech University of Life Sciences, Prague

Project registration number: SK-CZ-0192-11

Duration of the project: 01.01.2012 - 31. 12. 2013

Investigator: Ing. Peter Šurda, PhD.

Variability of unsaturated hydraulic conductivity $K_{(-2cm)}$ and the index of water repellency (R) in the horizontal and vertical planes were evaluated. The measurements were made at the site Mláky II at Sekule in south-western Slovakia in the pine stand with relatively homogeneous soil biological crust (SBC) and fallen needles. Measurements in the horizontal plane were conducted on the raw surface of the soil with SBC. Measured $K_{(-2cm)}$ values were relatively homogeneous. Spatially greater incidence of needles directly under the trees affected the results. The $K_{(-2cm)}$ values were higher under the foliage of pine trees, where the incidence of needles was higher. Measurement in the vertical plane was carried out in a soil pit. The $K_{(-2cm)}$ values were measured every 10 cm. We assumed that the value of $K_{(-2cm)}$ would rise with depth and the value of R would decline. This was confirmed by the measurements. However, the water repellency effect was lost at the depth of 40 cm. The decrease in the values of $K_{(-2cm)}$ and increase in R can be relatively reliably described by the relationship $y = 7.10^{-7} .x^{3,0165}$ wherein the depth is x and y is $K_{(-2cm)}$, respectively $y = 4095.x^{-2.47}$, where x is depth and y is R. It can be concluded that variability in the vertical direction is greater than in the horizontal direction.

**Title of the project: Peculiarity of heavy soils retention curves and its impact on the water regime analysis**

Project coordinator: Institute of Hydrology SAS & Research Institute for Soil and Water Conservation, Deputy Branch: Brno

Project registration number: SK-CZ-0169-11

Duration of the project: 01.01.2012 - 31. 12. 2013

Investigator: Ing. Branislav Kandra, PhD.

Methodology for measurement of the retention curves of heavy or extremely heavy soils was clarified. We used the ISO standard 11274: 1998 method (Soil quality. Determination of the water retention characteristics), the methods of a ring test of laboratories (1st FSCC Soil Physical Ring Test 2009, FutMon Protocol on how to measure retention curve) and current practice of measuring retention. Measured data were created databases for numerical simulation of soil water regime. Our measurements were extended to other sites with heavy soils in the Czech Republic. We made mutual comparison and quantification of the differences of soil retention properties resulting from the comparison of retention curves obtained with and without neglecting volume changes during the measurement. High correlation between examined parameters of soil samples was proven.

**Title of the project: Analyses of soil properties and landscape development for non-regularly overflown areas**

Project coordinator: National Agricultural and Food Centre (NPPC)

Project registration number: APVV-0163-11

Duration of the project: 1. 07. 2012 - 31. 12. 2015

Investigator: Ing. Dana Pavelková, PhD.

The project was aimed at analysis of soil environment properties after polder overflow by quantification of physical, chemical and biological indicators of soil, impact of area overflowing on water storage in soil, prediction of the overflown area by mathematical simulation, determination of the overflown area effects on grass-ecosystems composition and analysis of actual use of service area and prediction of its further development in the context of its non-regular overflowing. The polder saturation in year 2010 resulted in negative change of physical soil properties which improved in the next years. Chemical soil properties were influenced moderately. More negative changes of soil parameters were determined for heavier soils. Thus, each overflowing of the polder may cause deterioration of soil fertility. Low to middle soil micro-organisms diversity was observed with no-significant differences. Climate change should not significantly change hydrological regime of polder for evaluated time horizons. Production parameters of perennial grass stands corresponded to extensity of its cultivation and utilization. The share of grasses decreased in years after polder overflowing while the share of fabaceaeous and other herbs increased. Meadows overgrowing, pastures and spreading of invasion plant sorts threaten the rare biological, landscape and function polder biodiversity. Extensive use of polder area between its overflowing is favourable for maintenance of its natural, protectionist and landscape aesthetic values. The most important result of the project is the detailed analysis of changes in basic soil indicators, agro-ecosystems, soil water storage, landscape elements and scenarios predicting further possible of development of polder Beša area.

### 2.3.7. Projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA)

Ten VEGA projects were finalised in the assessment period. The Institute is engaged in 9 VEGA projects each year on average. About half of the projects are joint projects with the universities. Main results of the projects finalised during the assessment period are as follows:

2012

**Title of the project: Hydrological processes in soils with high content of stones influenced by the land use changes**
Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0021/10
Duration of the project: 1. 1. 2010 - 31. 12. 2012
Principal investigator: Ing. Viliam Novák, DrSc.
Achieved result: Mountainous forest soils as well as majority of agricultural soils of Slovakia contain a large number of rock fragments (particle diameter > 2 mm) which influence soil properties. Data characterizing hydraulic properties of these soils usually describe only the fine soil fraction properties. New methods were developed to quantitatively describe soil water movement in stony soils and evaluate effective hydrophysical characteristics by means of a simulation model. Properties of evaporating surface (plant canopy) also play an important role in formation of soil water movement and retention. Methodology and results of the study of rock fragments (stoniness) and canopy properties effect on soil water content profiles and soil water dynamics during the season were presented. Dense canopies decrease infiltration, stones decrease retention capacity and soil hydraulic conductivity.

2013

**Title of the project: Infiltration and flow of water in soil as influenced by biological factors and soil moisture**
Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0073/11
Duration of the project: 1. 1. 2011 - 31. 12. 2013
Principal investigator: Ing. Ľubomír Lichner, DrSc.
Achieved result: The “hockey-stick-like” relationship of the cumulative infiltration *I* of water against the square root of time *t* was found in a soil covered with biological soil crust (BSC).,Therefore, we estimated two different water sorptivities from this relationship. The water sorptivity *Swh* for hydrophobic state of the crust was estimated from the slope of relationship for a short time of infiltration (the straight line representing the less steep part of hockey-stick). The water sorptivity *Sww* for nearly wettable state of the crust was estimated from the slope of relationship for a longer time of infiltration (the straight line representing the steeper part of hockey-stick). The water repellency cessation time (WRCT) was estimated from the point of intersection of the two straight lines representing the relationships for hydrophobic and nearly wettable states of the crust (Lichner et al., CATENA, 108, 2013, 58–68). The new method enables more precise estimation of infiltration of water into soils covered with BSC.

2014

**Title of the project: Sensitivity of the river water temperature of the Slovak rivers to hydrologic extremes and climate variability**
Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0010/11
Duration of the project: 1. 1. 2011 - 31. 12. 2014
Principal investigator: RNDr. Pavla Pekárová, DrSc.
Achieved result: Water temperature is an important water quality characteristic. Water temperature - like other physico-chemical water quality parameters - enters into the assessment of the ecological status of the surface waters in accordance with the requirements of the Water Framework Directive - EU WFD (WFD, 2000). According to the WFD it is necessary to establish the limits of the water temperature for different surface water bodies in Slovakia. Measurements of water temperature in the small mountain rivers

of Slovakia are not conducted. Therefore, we established monitoring of water temperature in the mountain streams of the Jalovecký creek and the Belá river. The Morava river was initially selected as a lowland river. Methodology for determination of the limit values of the classification scheme for the water temperature for different types of surface water bodies in the Slovakia was developed on the basis of three years of continuous water temperature measurements at different altitudes of the monitored streams.

**Title of the project: Quantification of the water movement processes in the soil aeration zone considering optimal development of vegetative cover in different ecosystems**

Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0083/11
Duration of the project: 1. 1. 2011 - 31. 12. 2014
Principal investigator: RNDr. Vlasta Štekauerová, DrSc., since 2013 – Ing. Peter Šurda, PhD.
Achieved result: The main objective of the project was to determine the criteria for optimal water supply of various ecosystems and analysis of the risk caused by the duration of extreme events (droughts). Continuous monitoring of soil moisture at four sites of the Rye Island was used to develop a method of calculation of the rate of water resources decrease in different ecosystems, A new method of soil moisture interpolation based on data-driven models was developed as well. Long time series of soil moisture data obtained by the monitoring provide unique input data into the existing mathematical models simulating soil water regime.

**Title of the project: Quantification of snow contribution to runoff formation and groundwater recharge**

Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0042/11
Duration of the project: 1. 1. 2011 - 31. 12. 2014
Principal investigator: RNDr. Zdeněk Kostka, PhD.
Achieved result: Analysis of stable isotopes of oxygen and hydrogen in water samples collected in the snow-rich winter 2012 showed significant variability in isotopic composition of snow cover and snowmelt water. It also confirmed big differences between the isotopic composition of snow cover and snowmelt water. Therefore, the isotopic composition of snowmelt water (difficult to obtain) should be used in determination of the impact of snow in hydrological cycle instead of the isotopic composition of snow cover (obtained more easily). Calculation of the contribution of snowmelt water to basin runoff indicated that at the beginning of the snowmelt season, the catchment runoff was almost entirely made up of water which was stored in the catchment before the beginning of the snowmelt. Maximum contribution of snowmelt to catchment runoff during the main phase of the snowmelt was about 60 %. Although there is significant flow variability during the snowmelt period, the sampling showed that only two samples per day were needed for an acceptable characterization of the variability in isotopic composition of streamflow.

**Title of the project: Influence of superposed organic soil horizons on hydrological processes**

Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0167/12
Duration of the project: 1. 1. 2012 - 31. 12. 2014
Principal investigator: RNDr. Tomáš Orfánus, PhD.
Achieved result: Infiltration into meadow and fallow (cultivated) sandy soils was evaluated after several prolonged rainy and dry spells during the years 2005–2011. For comparison, the perfectly wettable bare sediment of similar origin and texture was taken as a reference

material. The results indicate that cultivation (mainly liming) of the fallow soil alleviated the water repellency to its subcritical level. Notwithstanding, the cultivation has not substantially increased water infiltration properties confirming the hypothesis that subcritical water repellency may still retard water infiltration. Some stability of wetting patterns observed in the meadow and fallow soils resulted in only insignificant increase of k(–20mm) during the rainy periods.

**Title of the project: Evaluation of water formations' quality in small basin extent - hydrodynamic approach performance**
Number and title of VEGA committee: 6 - VEGA commission for civil engineering (building industries, transport and geodesy) and environmental engineering, including mining, metallurgy and water management sciences)
Project registration number: 2/0123/11
Duration of the project: 1. 1. 2011 - 31. 12. 2014
Principal investigator: Ing. Yvetta Velísková, PhD.
Achieved result: The project produced two important results. The level of knowledge about processes and characteristics describing the transport of pollution in surface streams was enhanced. Series of tracer experiments to determine the longitudinal and transverse dispersion coefficient in different flow conditions carried out in the project allowed creation of a unique data base. We partially managed to eliminate the uncertainty in establishing these characteristics. Evaluation of water quality trends and prediction of transport of potential contamination in water stream were linked with evaluation of their immediate environment by the hydrodynamic approach (interaction between the surface water, groundwater and the surrounding environment).

2015

**Title of the project: Complex mathematical simulation of the water, heat energy and chemical substances motion in agricultural and forest biotops, with emphasis upon extreme situations**
Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0040/12
Duration of the project: 1. 1. 2012 - 31. 12. 2015
Principal investigator: RNDr. Juraj Majerčák, PhD.
Achieved result: Local monitoring of the areal unit in the Nitra river basin was carried out to obtain the inputs on soil moisture and hydrophysical characteristics of the given area. We evaluated the share of individual soil texture classes in the Nitra river basin on the basis of map records and comparison with the soil samples taken from the 111 selected sites. The sites were chosen according to the percentage representation of individual soil texture classes. We modelled critical states of water in the soil profile and studied the response of plant cover. The simulation was based on the measured data from the studied locations and the results were compared with the real condition of the monitored soil-plant systems. We developed compact expert tools for identification of critical water regimes soil-plant system consisting of simulation models, databases and special-purpose measuring means were created.

**Title of the project: The effect of rock fragments and vegetation on retention and movement of water in soil**
Number and title of VEGA committee: 2 - VEGA commission for Earth and Space sciences, environmental sciences (including earth resources)
Project registration number: 2/0032/13
Duration of the project: 1. 1. 2013 - 31. 12. 2015
Principal investigator: Ing. Viliam Novák, DrSc.
Achieved result: Rock fragments (gravel, stones, and cobbles) as a part of stony mountainous soils can strongly influence soil water transport and catchment runoff formation. Although they are abundant in many catchments, their properties are still not well understood. Modelling results showed that the presence of rock fragments with low

water retention in stony soil with moderate or high stoniness can cause the soil water storage decrease by 16–31%. Reduced retention capacity of stony soils resulted in faster water outflow from the stony soil profile. This result shows that the presence of quick lateral water flow at hillslope (especially at the soil and bedrock interface) can be caused on the one hand by preferential paths involved in many natural soils as presented in many publications. On the other hand, presence of rock fragments can speed up the quick response of stony soil outflow to the rainfall even more.

**Title of the project: Water regime of heavy soils in depression areas of lowlands**
Number and title of VEGA committee: 6 - VEGA commission for civil engineering (building industries, transport and geodesy) and environmental engineering, including mining, metallurgy and water management sciences)
Project registration number: 2/0142/12
Duration of the project: 1. 1. 2012 - 31. 12. 2015
Principal investigator: Ing. Milan Gomboš, PhD.
Achieved result: Water regime of heavy soils in lowland depressions is determined mainly by the position of groundwater level (GWL) under the ground and current evapotranspiration. GWL impact on water storage in unsaturated soil profile and thus on evapotraspiration is different throughout the depression. For that reason, a unique calculation method was proposed to quantify the part of the groundwater participating in the current evapotranspiration. The method provided quantification of water transfer from the GWL to unsaturated soil and from the unsaturated soil by evapotranspiration to the atmosphere. The method is based on a numerical experiment. The experiment examined the impact of GWL position on the current evapotranspiration $E_{ta}$ during the period of an extreme drought. Mathematical model HYDRUS was used in the experiment. and function $E_{ta}$=f(GWL) was obtained as the result of the experiment.

### 2.3.8. Projects of SAS Centres of Excellence

*None*

### 2.3.9. National projects supported by EU Structural Funds

***1. Centre of excellence for the integrated water regime management in the changing environment"***

http://www.uh.sav.sk/en-gb/Research/Centre-of-Excellence
Applicant: Institute of Hydrology SAS
Partner 1: Slovak University of Agriculture in Nitra
Partner 2: Technical university in Zvolen
Realisation: 10 / 2010 – 06 / 2013
Sites of realisation: Michalovce, Hollého 42
Liptovský Mikuláš, Ondrašovská 16
Nitra, Trieda Andreja Hlinku 2
Nitra, Hospodárska 7
Zvolen, T. G. Masaryka 24

The main project objective was to create centre of excellence for integrated management of river basins in the area of water management under the climate change. The main results of the project are:

- Continual monitoring of soil water storage, water flow and meteorological and climatic elements was established at selected sites.
- Devices for acquiring basic physical, chemical and hydrophysical characteristics of soils, physical and chemical properties of water, meteorological and climatic characteristics, characteristics of the vegetation cover and topographical data from the river basins were obtained.

- Software and hardware equipment for the research centre to simulate soil moisture regime, groundwater level regime, water balance in the catchments and analytical expression of input data into simulation models were acquired.

***2. Project DIHYS: „Infrastructure completion of hydrological research stations“***

http://www.uh.sav.sk/en-gb/Research/Centre-of-Excellence
Applicant: Institute of Hydrology Slovak Academy of Sciences
Period of project implementation: 11 / 2012 – 11 / 2014
Cost of obtained instruments: 2 924 647, 01 EUR
Number of obtained instruments: 52
Place of project realization: Liptovský Mikuláš, Ondrašovská 16
Michalovce, Hollého 42
Petrovce nad Laborcom

The infrastructure of technical equipment was completed for hydrological research stations of the Institute located in Michalovce and Liptovský Mikuláš. The infrastructure and technical equipment will serve in complex monitoring of hydrological processes in the lowland and mountain areas. The project significantly improved the quality and variety of instrumentation as well as of research infrastructure by acquiring 52 instruments. Some of instruments, software and equipment are rare within the European research scope.

**2.3.10. List of journals (published only in the Slovak language) edited/published by the institute:**

**2.3.10.1. WOS (IF of journals in each year of the assessment period)**

None

**2.3.10.2. SCOPUS**

None

**2.3.10.3. Other databases**

None

**2.3.10.4. Not included in databases**

None

- **Position of individual researchers in an international context**

**2.3.11. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter**

2012

1. Lichner, L., Hallett, P.D., Drongová, Z., Czachor, H., Kovacik, L.: Biohydrology - it has its uses. EGU 2012 General Assembly, Wien
2. Lichner, L., Hallett, P.D., Drongová, Z., Czachor, H., Kovacik, L.: Vegetation impact on the hydrology of an aeolian sandy soil. Kongres Eurosoil 2012, Bari
3. Lichner, L., Drongová, Z., Kováčik, L., Rajkai, K., Fodor, N., Sándor, R., Orfánus, T.: Plants and biological crust influence the hydrophysical parameters of a sandy soil. Conference on "Hydropedology", Leipzig
4. Holko, L.: The role of snow in hydrological cycle, an example from Slovakia., 2012, University of Ljubljana, Slovenia

5. Rodný, M., Nagy, V., Štekauerová, V. Application of the optimization multialgorithm in the soil water regime diagnostic process. 11th ALPS-ADRIA SCIENTIFIC WORKSHOP 2012, Smolenice, Slovakia
6. Majerčák, J. Subprograms for Identification of Extreme Water Regime Situations in Mathematical Simulation Model. Ecology - interdisciplinary science and practice - international conference, 25.10.2012, Sofia
7. Orfánus, T.: Ecohydrological research at the Institute of Hydrology SAS. The present time and the future. European Regional Centre for Ecohydrology Lodz, 2012, Poland
8. Orfánus, T.: Is the soil water repellency an ecohydrological issue? European Regional Centre for Ecohydrology Lodz, 2012, Poland

2013

9. Novák, V.: Seasonal transpiration and biomass production, International Conference Agrophysics, Institute of Agrophysics, Lublin, Poland
10. Holko, L.: invited presentations (as a lector) at National Training Course on Basic Isotope Hydrology, Ministry of Water Resources, Freetown, Sierra Leone – invitation of International Atomic Energy Agency (IAEA); presentations were not published as contributions.
11. Holko, L.: Hydropower Engineering and Ecology, Academy of Sciences, Institute of Water Issues, Dušanbe, Republic of Tajikistan; – invitation of International Atomic Energy Agency (IAEA); presentations were not published as contributions.
12. Holko, L.: Using Isotope Techniques to Assess Water Resources and Evaluate of their Hydrogeological Conditions,Hydropower Engineering and Ecology, Installation of Laser Water Isotope Analyser, Academy of Sciences, Institute of Water Issues, Dušanbe, Republic of Tajikistan; – invitation of International Atomic Energy Agency (IAEA); presentations were not published as contributions.
13. Holko, L.: invited presentations (as a lector) at National Training Course on the Application of Isotope Techniques and Related Field Work and Data Interpretation in Water Resources Assessment and Management, Institute of Geophysics, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia; – invitation of International Atomic Energy Agency (IAEA); presentations were not published as contributions.
14. Velísková, Y. et al.: Interaction of surface and groundwater in the Danube Lowland, conference on "Security of drinking water supply - a challenge for the Danube Region", Bratislava, Slovakia

2014

15. Holko, L.: Hydrological effects of the large-scale windfall in the highest part of the Carpathians. Symposium on —Land Use Change Impacts on Floods, Vienna, Austria.
16. Miklánek, P.: Development of Danube cooperation in the field of hydrology, XXVI Conference of the Danubian Countries on Hydrological Forecasting and Hydrological Bases of Water Management, Institute of Technology, Deggendorf, Germany.
17. Holko, L.: invited presentations (as a lector) at Practical Workshop on Designing and Sampling Demonstration. Ministry of Irrigation and Water Development, Lilongwe, Malawi; – invitation of International Atomic Energy Agency (IAEA); presentations were not published as contributions.

2015

18. Velísková, Y., Dulovičová, R., Dušek, P.: Quality of groundwater at Vrakuňa junction surroundings (Žitný ostrov, Slovakia), konferencia 14th ALPS ALPS-ADRIA SCIENTIFIC WORKSHOP, Neum Bosnia-Herzegovina.
19. Miklánek, P., Pekárová, P.: Long term climate variability/ climate change and long hydrological regimes of rivers in the Danube River basin. Expert Meeting V4+Romania and Bulgaria on „Integrated river basin management and protection of water resources Ministry of Environment of SR, 29. 04. 2015, Bratislava.

20. Velísková, Y.: Influence of surface stream silting on interactions with surrounding groundwater, International conference on „Water resources protection“ within the EU Danube Strategy, priority area 4 „Water quality“, water Research Institute and ministry of Environment of SR, Bratislava.
21. Pekárová, P., Miklánek, P.: Analysis of selected flash floods in Slovakia. Conference on “Flash floods – Reasons, development, implications, warning and lessons learned”, within the Strategy AV21 programme, Praha, 2.12. 2015.
22. Nagy, V.: Correlation between soil moisture and changing climatic conditions. Soil moisture as a renewable energy resource. Conference on "Smart agriculture and the impacts of climate change", University of Debrecen, 10.9.2015.
23. Novák, V.: Influence of forests and forest skeleton soils on basin runoff, seminar of HYDROFOR project (Slovak-Ukrainian EU project Partnership without borders) "Management of forest and flood danger in the Vydranka basin", Medzilaborce, 24.–26.6.2015.

### 2.3.12. List of researchers who served as members of the organising and/or programme committees

**1. BAČOVÁ MITKOVÁ V.**

*Conference “State of art in Hydrological Research”, held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, 23.–25. 9. 2013, Congress centre of SAS, Smolenice, 23.–25. 9. 2013*

**2. ČELKOVÁ, A.**

*20th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*Conference “State of art in Hydrological Research”, held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*21th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 150 participants, 13.11.-13.11.2014*

*22th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2015, IH SAS Bratislava, 130 participants, 12.11.2015*

**3. GOMBOŠ, M.**

*Conference “State of art in Hydrological Research”, held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory“;Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar “Physics of Soil Water”; Zemplínska šírava, 3.6.2015*

**4. HALMOVÁ, D.**

*Joint Event of Science with international participation River Basin and Flood Risk Management 2015 and Hydrological Days, Bratislava, 06.10.-09.10.2015*

**5. HOLKO, L.**

*14th Biennial Conference ERB 2012, September 17–20, 2012, St. Petersburg, Russia*

*Hydrology of small basins 2014, Praha, 100 participants, 22.04.–24.04.2014*

*15th Biennial Conference ERB 2014, September 9-13, 2014, Coimbra, Portugal*

**6. KANDRA, B.**

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory“, Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar “Physics of Soil Water”; Zemplínska šírava, 3.6.2015*

**7. LICHNER, Ľ.**

*20th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*Biohydrology 2013; Landau, Germany*

*Hydrology of small basins 2014, Praha, 22.04.–24.04.2014*

**8. MAJERČÁK, J.**

*20th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory“;Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar “Physics of Soil Water”; Zemplínska šírava, 3.6.2015*

**9. MIKLÁNEK, P.**

*14th Biennial Conference ERB 2012, September 17–20, 2012, St. Petersburg, Russia*

*20th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 15.11.-15.11.2012*

*Conference “State of art in Hydrological Research”, held on the occasion of 60$^{th}$ anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*Conference “River basin and flood risk management”, Bratislava, 11.–13. 12. 2013*

*21th International Poster Day “Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 150 participants, 13.11.-13.11.2014*

*26th Conference of Young Hydrologists, Bratislava, 6.11.2014*

*Workshop of the project KORANET2, Bratislava & Smolenice, 01.05.-03.05.2014*

*Hydrology of small basins 2014, Praha, 22.04.–24.04.2014*

*Int. Conf. Catchment processes in regional hydrology: Confronting experiments and modeling in Carpathian drainage basins; Bratislava & Sopron, 27 October 2014*

*27th Conference of Young Hydrologists, Bratislava, 5.11.2015*

*Joint Event of Science with international participation River Basin and Flood Risk Management 2015 and Hydrological Days, Bratislava, 06.10.-09.10.2015*

**10. NAGY, V.**

*XI. Alps-Adria Scientific workshop; 26-31 March 2012, Smolenice, Slovakia*

*XII. Alps-Adria Scientific workshop; 18th – 23rd March 2013, Opatija, Croatia*

*XIII. Alps-Adria Scientific workshop; 28th April – 3rd May 2014, Villach, Ossiacher See, Austria*

*XIV. Alps-Adria Scientific workshop; Neum, Bosna-Herzegovina*

**11. NOVÁK, V.**

*20th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*Hydrology of small basins 2014, Praha, 100 participants, 22.04.–24.04.2014*

*Joint Event of Science with international participation River Basin and Flood Risk Management 2015 and Hydrological Days, Bratislava, 06.10.-09.10.2015*

**12. ORFÁNUS, T.**

*21th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 150 participants, 13.11.-13.11.2014*

*22th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2015, IH SAS Bratislava, 130 participants, 12.11.2015*

**13. PAVELKOVÁ, D.**

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory"; Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar "Physics of Soil Water"; Zemplínska šírava, 3.6.2015*

**14. PEKÁROVÁ, P.**

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*Hydrology of small basins 2014, Praha, 22.04.–24.04.2014*

*Meeting of Project 7: Regionalisation of the annual maximum runoff, XXVI Conference of the Danubian Countries, Degenndorf, 2014*

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory"; Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar "Physics of Soil Water"; Zemplínska šírava, 3.6.2015*

**15. PRAMUK, B.**

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

**16. RODNÝ, M.**

*20th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

**17. STOJKOVOVÁ, D.**

*22th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2015, IH SAS Bratislava, 130 participants, 12.11.2015*

**18. ŠURDA, P.**

*20th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*21th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 150 participants, 13.11.2014*

*22th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2015, IH SAS Bratislava, 130 participants, 12.11.2015*

**19. TALL, A.**

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory"; Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar "Physics of Soil Water"; Zemplínska šírava, 3.6.2015*

**20. ŠTEKAUEROVÁ, V.**

*XI. Alps-Adria Scientific workshop; Smolenice, Slovakia, 26-31 March, 2012*

*XII. Alps-Adria Scientific workshop; Opatija, Croatia, 18th – 23rd March 2013*

*XIII. Alps-Adria Scientific workshop; Villach, Ossiacher See, Austria, 28th April – 3rd May 2014*

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

**21. VELÍSKOVÁ, Y.**

*20th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.-15.11.2012*

*Conference "State of art in Hydrological Research", held on the occasion of 60th anniversary of the Institute of Hydrology and the 60th anniversary of the SAS, Congress Centre of SAS, Smolenice, 23.–25. 9. 2013*

*Workshop of the project Goldfish, Bratislava, 15 participants, 08.09.-12.09.2014*

*9th International Scientific Conference „Influence of anthropogenic activities on water regime of lowland territory"; Zemplínska šírava –Kamenec resort, 2-4.6.2015*

*19th Slovak-Czech-Polish Scientific Seminar "Physics of Soil Water"; Zemplínska šírava, 3.6.2015*

*Joint Event of Science with international participation River Basin and Flood Risk Management 2015 and Hydrological Days, Bratislava, 06.10.-09.10.2015*

**22. VITKOVÁ, J.**

*20th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2012, IH SAS Bratislava, 145 participants, 15.11.2012*

*21th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2014, IH SAS Bratislava, 150 participants, 13.11.2014*

*22th International Poster Day "Transport of water, chemicals and energy in the soil – plant – atmosphere system, 2015, IH SAS Bratislava, 130 participants, 12.11.2015*

- **Position of individual researchers in a national context**

**2.3.13. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter**

2012

1. Gomboš, M.: Impact of EU Structural Funds on development of the basic hydrologic research in Eastern-Slovakian Lowland area, conference „XVI. District water days in Michalovce“, 29. – 30. April 2012
2. Holko, L.: Runoff formation research in small basins – how does the flood originate? Conference: Water management in Slovakia, its state and perspective. 11.-12. 12. 2012, Štrba.
3. Pekárová, P: History of floods in Slovakia. Conference: Water management in Slovakia, its state and perspective. 11.-12. 12. 2012, Štrba.
4. Majerčáková, O., Majerčák, J.: Water management and its future. Conference: Water management in Slovakia, its state and perspective. 11.-12. 12. 2012, Štrba.
5. Novák, V.: Water on the Earth and in the space. Astronomical seminar for teachers. 27.4.2012, Vysoké Tatry.
6. Velísková, Y.: Impact of water structures on formation and protection of the landscape, 20 years of the Gabčíkovo water structure operation. CONECO 2012. 29.3.2012, Bratislava.

2013

7. Gomboš, M.; Pavelková, D.: Recent topics of the basic hydrologic research in the VHZ IH SAS in Michalovce, conference „XVII. District water days in Michalovce“, 11. – 12. April 2013
8. Pekárová, P.; Miklánek, P.: Variability of the world rivers runoff, conference „XVII. District water days in Michalovce““, 11. – 12. April 2013

2014

9. Novák, V.: Virtual fluxes of water on the Earth: who is the biggest water exporter and why. Klub Alumni SAV, KC Smolenice
10. Novák, V.: What is the relation between soil water and biomass production?, conference „XVIII. District water days in Michalovce““, 3. – 4. April 2013
11. Velísková, Y.: The ability of water streams to transport pollution, conference „XVIII. District water days in Michalovce““, 3. – 4. April 2013

2015

12. Vitková, J.: Climate change and its impact on soil water storage, World Day of Water 2015, SPU Nitra

**2.3.14. List of researchers who served as members of organising and programme committees of national conferences**

**1. GOMBOŠ, M. PAVELKOVÁ, D.**

*XVI. District Days of Water in Michalovce, 29. – 30. April 2012*

*XVII. District Days of Water in Michalovce, 11. – 12. April 2013*
*XVIII. District Days of Water in Michalovce, 3. – 4. April 2013*
*XIX. District Days of Water on Zemplínska šírava, 9. - 10. April 2015*

**2. PEKÁROVÁ, P.**

*Water management in Slovakia, its state and perspective. 11.-12. 12. 2012, Štrba*

- **Supplementary information and/or comments documenting the** international and national status of the Institute

The Institute of Hydrology SAS was honoured with following awards:

- Prize of Ľudo Molnár for contribution to the goals of the International Hydrological Programme of UNESCO, which was granted by the Slovak Committee for Hydrology on 21 May 2013
- Golden Medal of the Slovak Hydrometeorological Institute in Bratislava for credits to development of hydrology and meteorology, which was granted by the Director General of SHMI RNDr. Martin Benko, PhD. on 23 September 2013
- Plaque of the Civil Engineering Faculty of the Slovak University of Technology in Bratislava (CEF SUT) at the occasion of the 60. Anniversary of the institute for significant longstanding scientific collaboration and for the contribution to forming of the CEF SUT graduates, which was granted by the Dean of Faculty Prof. Ing. Alojz Kopáčik, PhD. on 23 September 2013
- Golden Medal of the Horticulture and Landscape Engineering Faculty of the Slovak University of Agriculture in Nitra (HLEF SUA) at the occasion of the 60. Anniversary of the institute for outstanding contribution to the development of the landscape engineering study programme at the HLEF SUA in Nitra, which was granted by the Dean of Faculty Ing. Klaudia Halászová, PhD. on 24 September 2013
- Plaque of the Geological Institute SAS, 2013
- Letter of Merit of the Institute of Agrophysics of the Polish Academy of Sciences in Lublin, on 24 September 2013

## 2.4. Tables of project structure, research grants and other funding resources

- **International projects and funding**

### 2.4.1. Major projects within the European Research Area and other important project – Framework Programmes of the EU, ERA-NET, European Science Foundation, NATO, COST, INTAS, etc. (here and in items below please specify: type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator "C", work package leader "W", investigator "I"),

| | Project title | Typ / Project number | Duration in months | Funding for the Institute (EUR) | Role of the Institute / Responsible person |
|---|---|---|---|---|---|
| **2012** | Estimation of Uncertainty in Rainfall Runoff Modelling | FP7 KORANET2-051 | 10/2012-9/2014 | 42768 | W RNDr. P. Miklánek, CSc. |
| | System monitoring of selected parameters of porous substances by EIS method in a wide spectrum of applications | EUREKA E!4981 | 01/2010-10/2012 | 0 | W Ing. M. Gomboš, PhD. |
| | A System of Monitoring of Selected Parameters of Porous Substances Using the EIS Method in a Wide Range of Applications | EUREKA E!7614 | 11/2012-12/2017 | 8926 from nat.sources | W Ing. M. Gomboš, PhD. |
| | Flood Regime of Rivers in the Danube Basin | IHP UNESCO Danube 9 | 1/2012-12/2016 | 10111 | C RNDr. P. Pekárová, DrSc. |
| | The Role of Snow in Hydrological Cycle of the Upper Vah River Basin | IAEA 16061/RO | 6/2010-6/2015 | 6251 | C RNDr. L. Holko, PhD. |
| | Basin-scale recharge estimation in the Upper Váh river basin, Slovakia | IAEA 15997/R0 | 3/2010-3/2013 | 12500 | C RNDr. Z. Kostka, PhD. |
| **2013** | Detection of watercourse contamination in developing countries using sensor networks – ENLARGED, Goldfish – enlarged | FP7 Project 269985 | 11/2013-4/2015 | 126000 | I Ing. Y. Velísková, PhD. |
| | | | | | |
| **2014** | | | | | |
| **2015** | | | | | |

**Main results of the finished projects:**

**Title of the project: Estimation of Uncertainty in Rainfall Runoff Modelling Korea, Poland, Slovakia**
Project registration number: **KORANET2-051**
Duration of the project: 1. 10. 2012 - 30. 9. 2014
Co-ordinator: prof. Hyosang Lee, Chung Buk National University, Cheong-ju, Korea

Task leader: Pavol Miklánek
Major achievements: Method of rainfall-runoff model parameters calibration was developed, programmed and tested. The method is based on switching according to different magnitude of runoff. Application of the method significantly improved the simulation quality of maximum discharge in the pilot basins. The tested rainfall-runoff models were improved with respect to flood risk management. A new modelling tool was prepared. It includes the uncertainty estimation of the runoff forecasts and flood risk management in Korea and in the European partner countries.

**Title of the project: System monitoring of selected parameters of porous substances by EIS method in a wide spectrum of applications**
**Belgium, Cyprus, Czech Republic, Switzerland, Italy**
Project registration number: **E!4981 APPL-EIS**
Duration of the project: 1. 10. 2010 - 31. 10. 2012
Co-ordinator: GEOTEST BRNO, INC. SMAHOVA, 112 627 00 -BRNO CZECH REPUBLIC
Task leader: Milan Gomboš
Major achievements: The project dealt with the implementation of a set of instruments of a multi-channel automated system of monitoring of electrical impedance of the porous environment and its changes caused by loading a monitored site or a monitored point with water. Principle of monitoring changes of non-electric quantity through electric quantities, when the indirect non-invasive method is electrical impedance spectrometry (or tomography) was applied. A 128-channel, fully digitised device Z-meter with remote data transmission was developed. The given system works with an indirect method of electrical impedance spectrometry. Its implementation allows for measuring both the real (electric resistance or conductivity) and the imaginary parts (reactance) of electrical impedance. The system was primarily applied in monitoring soil moisture changes (electric conductivity) caused by its suction capability (bank, induced, from precipitation) and by water infiltration.

**Title of the project: The Role of Snow in Hydrological Cycle of the Upper Vah River Basin Slovakia**
Project registration number: **IAEA 16061/RO**
Duration of the project: 17. 06. 2010 - 11. 06. 2015
Co-ordinator: Ladislav Holko
Major achievements: The objective of the project was determination of the role of melting snow in hydrological cycle of the upper Váh river basin at different spatial scales. Specific objectives included runoff separations during snowmelt in a small mountain catchment (area 45 $km^2$), in its mountain sub-catchment (area 22 $km^2$) and in the upper Váh river basin (1100 $km^2$) by means of stable environmental isotopes, monitoring of spatial distribution of isotopic composition of snow cover before the snowmelt, temporal variability of isotopic composition of snow cover, soil water and streamwater during the snowmelt and estimation of snowmelt contributions to groundwater recharge by means of stable environmental isotopes. A modified device to collect snowmelt water samples was developed and tested worldwide by project participants (Penna et al., 2014).

**Title of the project: Basin-scale recharge estimation in the upper Váh river basin Slovakia**
Project registration number: **15997/R0**
Duration of the project: 18. 03. 2010 - 31. 03. 2013
Co-ordinator: Zdeněk Kostka
Major achievements: The project used tracer data from streams and springs to estimate groundwater recharge at selected sites or river sections. Physical characteristics of the basin (e.g. slope, elevation, landuse, vegetation, depth of unsaturated zone, hydraulic conductivity) were used to determine the correlations with point recharge. Chloride was

applied as a tracer for the first time in Slovakia to provide realistic estimation of the basin scale groundwater recharge.

**Title of the project: Detection of watercourse contamination in developing countries using sensor networks – ENLARGED**
**Austria, Bolivia, Colombia, France, Croatia, Poland, Sweden, Vietnam**
Project registration number: **FP7 Project 269985**
Duration of the project: 01. 11. 2013 - 30. 04. 2015
Co-ordinator: Warsaw University of Technology, Poland
National leader: Yvetta Velísková
Major achievements:
The study about possible way of numerical and analytical solutions to analyse spread of contamination in surface stream from various pollutant source was performed. Potential risks of these solutions were evaluated. The risks are connected with uncertainty of the outputs of the models (mathematical relationship) applied in the natural flow conditions with various degrees of inputs schematization. The analysis allowed design and elaboration of algorithm of the inverse task solution, i.e. the algorithm by which the source of contamination is located from the distribution of contaminant concentration in the stream. The pilot version of the software tool for contaminant source localization was developed and tested. Data from field measurements or modelled values from different numerical models capable to simulate the contamination spreading in surface streams were used in testing. Developed software was finally successfully applied under real world conditions at the Liwiec river (Poland) and the Coello River (Colombia).

### 2.4.2. Other international projects, incl. total funding and funding for the institute

1. Title of the project: ***ERB - European Network of Experimental and Representative Basins*** (UNESCO, project without numbering 2007–2016, 23 participating countries, ad hoc funding of travel costs from the Slovak Commission for UNESCO up to 1500 EUR yearly, responsible persons RNDr. Ladislav Holko, PhD. - international coordinator and RNDr. Pavol Miklánek, CSc., national correspondent till 2012, RNDr. Ladislav Holko, PhD. national correspondent since 2013)
2. Title of the project: ***Policy oriented study on remote sensing agricultural drought monitoring methods***, multilateral project, 35-IDMP–2014, (2013–2015), project coordinator: Regional Centre GWP CEE Sweden, funding for IH SAS: 7000 €, coordinator for IH SAS: Ing. V. Nagy, PhD.
3. Title of the project: ***EUROFRIEND - Flow Regimes from International Experimental and Network Data*** (UNESCO, Cross-Cutting Programme Component 2007–2016, 37 participating countries, ad hoc funding of travel costs from the Slovak Commission for UNESCO up to 1500 EUR yearly, responsible person RNDr. Pavol Miklánek, CSc., national correspondent)
4. Title of the project: ***Managing water as a shared responsibility across geographical & social boundaries – Regional cooperation of Danube Countries*** (UNESCO, project without numbering 2007–2013, ad hoc funding of travel costs from the Slovak Commission for UNESCO up to 1500 EUR yearly, responsible person RNDr. Pavol Miklánek, CSc., national representative)
5. Title of the project: ***IHP-VIII Regional cooperation of the Danube countries*** (UNESCO, project without numbering 2014–2021, ad hoc funding of travel costs from the Slovak Commission for UNESCO up to 1500 EUR yearly, responsible person RNDr. Pavol Miklánek, CSc., national representative)

### 2.4.3. Other important, international projects and collaborations without direct funding (max. 10 projects)

1. Project: Data analysis of soil and groundwater regime in lowland areas of Slovakia and Hungary, applying modern mathematical methods, (2010–2013), Ing. Viliam Nagy, PhD.

   Partner institutions: *Institute of Geography and Earth Sciences of Eötvös Loránd University, Budapest*
2. Project: Evaluation methods of water balance catchment components, taking into account their regional specifications, (2011–2015), RNDr. Juraj Majerčák, PhD.

   Partner institutions: *Water Problems Institute of the Russian Academy of Sciences, Moscow*
3. Project: Root uptake modelling with field scale parameters assessment, (2012–2015), Ing. Viliam Novák, DrSc.

   Partner institutions: *Institute of Hydraulics and Rural Water Management, University of Natural Resources and Life Sciences, Vienna*
4. Project: Modelling of water and thermal regimes in relation to the soil management, (2010-2012), RNDr. Juraj Majerčák, PhD.

   Partner institutions: *Institute of Agrophysics, Polish Academy of Sciences, Lublin*
5. Project: Soil water regime evaluations with respect to the vegetation need, (2010–2012), Ing. Viliam Nagy, PhD.

   Partner institutions: *RISSAC - Institute of Soil Science and Agricultural Chemistry, Budapest*
6. Project: Evaluation of the soil water regime at the Slovakian and Hungarian side of the Danube River according to the vegetation needs, (2013–2015), Ing. Viliam Nagy, PhD.

   Partner institutions: *RISSAC - Institute of Soil Science and Agricultural Chemistry, Budapest*
7. Project: Regional problems of environmental sciences, (2011–2012), Ing. Viliam Nagy, PhD.

   Partner institutions: *Centre for Regional Studies of Hungarian Academy of Sciences, Pécs*
8. Project: Assessment of soil water regime in the context of ensuring the moisture needs for vegetation, (2010-2012), Ing. Viliam Nagy, PhD.

   Partner institutions: *Institute of Biosystems Engineering, University of West Hungary, Mosonmagyaróvár*
9. Project: Evaluation of surface soil moisture from satellite and ground-based measurements, MAD project no. 23, (2013–2015), coordinator for IH SAS: RNDr. J. Majerčák, PhD.
   Partner institutions: *Institute of Agrophysics PAS Lublin*,
10. Project: Waterproofing of soil aggregates, MAD project no. 6, (2013–2015), coordinator for IH SAS: Ing. Ľ. Lichner, DrSc..
    Partner institutions*: Institute of Agrophysics PAS Lublin*

- **National projects and their funding**

### 2.4.4. Projects supported by the Slovak Research and Development Agency (APVV)

Role of the Institute e.g. coordinator “C”, investigator “I”.

| | Project title | Typ / Project number | Duration in months | Funding for the Institute (EUR) | Role of the Institute / Responsible person |
|---|---|---|---|---|---|
| **2012** | Hydrological regime changes identification of rivers in the Danube River basin (started in 2011) | APVV-0015-10 | 05/2011 10/2014 | 92036 | C / Pekárová |
| | Quantification of input data influence on correctness of outputs of dispersion simulation models for surface water (started in 2011) | APVV-0274-10 | 05/2011 10/2014 | 149661 | C / Velísková |
| | Spatial interpretation of soil hydrophysical characteristics in relation to their hydrological regime (started in 2011) | APVV-0139-10 | 05/2011 10/2014 | 121310 | C / Štekauerová, Vítková |
| | Analyses of soil properties and landscape development for non-regularly overflowed areas | APVV-0163-11 | 07/2012 12/2015 | 13463 | I / Pavelková |
| | Multivariable frequence analysis of hydrological extremes for water resources planning and design (started in 2011) | APVV-0496-10 | 05/2011 10/2014 | 49998 | I / Halmová |
| | Hydraulic conductivity of soils and its spatio-temporal variability | SK-CZ-0192-11 | 01/2012 12/2013 | 3750 | I / Šurda |
| | Specifity of heavy soils retention curves and its impact on the water regime analysis | SK-CZ-0169-11 | 01/2012 12/2013 | 3970 | I / Kandra |
| 2013 | Analysis of nitrous oxide emmissions from agricultural used soils and proposal of measures for their reduction | APVV-0512-12 | 10/2013 09/2017 | 66042 | I / Šurda |
| 2015 | New possibilities of use of drainage canal systems with taking into account the protection and use of a landscape | APVV-14-0735 | 07/2015 06/2018 | 59142 | I / Velísková |
| | „Detection of Watercourse Contamination in Developing Countries using Sensor Networks - Enlarged | APVV DO7RP-0050-12 | 11/2013 04/2015 | 32000 | I / Velisková |
| **sum** | 2012-2015 | | | 591372 | |

9 projects were submitted in the APVV 2014 general call, one of them was accepted with the start in 2015.

6 projects were submitted in the APVV 2015 general call, two of them were accepted with the start in 2016.

### 2.4.5. Projects supported by the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education (VEGA) for each year, and their funding

| VEGA | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| **Number** | 9 | 9 | 9 | 9 |
| **Funding in the year (EUR)** | 60677 | 56039 | 53617 | 63836 |

[1]

- **Summary of funding from external resources**

### 2.4.6. List of projects supported by EU Structural Funds

1. Centre of excellence for the integrated water regime management in the changing environment"
2. Project DIHYS: „Infrastructure completion of hydrological research stations"

Projects are described in 2.3.9 and in Table 2.4.7.

### 2.4.7. Summary of external resources of the EU Structural Funds (ERDF/ESF)

Role of the Institute in the project, e.g. coordinator "C", work package leader "W", investigator "I".

| Year | Project title | Project number | Duration in months | Funding for the Institute (EUR) | Role of the Institute |
|---|---|---|---|---|---|
| 2012 | Centre of excellence for the Integrated River Basin Management in the Changing Environmental Conditions | ITMS 26220120062 | 10/2010 06/2013 | 1590612 | coordinator |
| | Completion of infrastructure of hydrological research stations | ITMS 26220120009 | 11/2012 11/2014 | 2924647 | coordinator |
| | | | | | |

| External resources | 2012 | 2013 | 2014 | 2015 | total | average |
|---|---|---|---|---|---|---|
| **External resources (milions of EUR)** | 1.105 | 2.846 | 1.756 | 0.000 | **5.707** | **1.427** |
| **External resources transfered to coooperating research institute (milions of EUR)** | 0.589 | 0.805 | 0.000 | 0.000 | **1.394** | **0.349** |

- **Supplementary information and/or comments on research projects and funding sources**

None

[1] Excluding projects for the popularisation of science

## 2.5. PhD studies and educational activities

### 2.5.1. List of accredited programmes of doctoral studies, period of validity

Institute of Hydrology SAS is an external educational institution for doctoral (PhD) study in study programme

**Water Management Engineering, study field 5.1.6**

(in cooperation with Faculty of Civil Engineering, Slovak University of Technology in Bratislava). Study has the full-time form (duration 4 years) or an external form (duration 5 years). In 2015 we were reaccredited up to August, 31, 2020.

### 2.5.2. Summary table on doctoral studies (number of internal/external PhD students; number of foreign PhD students, number of students who successfully completed their theses, number of PhD students who quit the programme*)*

| PhD study | 31/12/2012 | | | 31/12/2013 | | | 31/12/2014 | | | 31/12/2015 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of potential PhD supervisors | 13 | | | 12 | | | 12 | | | 15 | | |
| PhD students | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted | number | defended thesis | students quitted |
| Internal | 4.0 | 1.0 | 0.0 | 5.0 | 2.0 | 0.0 | 6.0 | 0.0 | 0.0 | 5.0 | 1.0 | 0.0 |
| External | 3.0 | 0.0 | 0.0 | 2.0 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 | 1.0 | 0.0 |
| Other supervised by the research employees of the institute | | | | | | | | | | | | |

**Research stay –** Our PhD. student Pavol Krajčí - May, 4 2015 – October, 30 2015, (Ernst Mach Stipendien), Vienna University of Technology, Institute of Hydraulic Engineering and Water resources management

**Scholarship Programs realized at our Institute:**

**Hungarian Public Administration Scholarship Program –**Thank you letter from Hungarian Scholarship Programme April, 3, 2012 (Ms Edina Balogh Research stay at our Institute)

**National Scholarship Programme of the Slovak Republic** - Igor Leščešen, Serbia, 3. March - 30. April 2014, project Flood Regimes of the Rivers in the Danube Basin

### 2.5.3. Summary table on educational activities

| Teaching | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| Lectures (hours/year)[2] | 40 | 12 | 2 | 4 |
| Practicum courses (hours/year)[2] | 52 | 60 | | 30 |
| Supervised bachelor theses (in total) | 1 | 2 | 1 | 2 |
| Supervised diploma theses (in total) | 3 | | | 1 |
| Supervised PhD theses (in total) | | 8 | 6 | 6 |
| Members in PhD committees (in total) | | | 3 | 6 |
| Members in DrSc. committees (in total) | 1 | 1 | 1 | 1 |
| Members in university/faculty councils (in total) | 5 | 2 | 2 | 1 |
| Members in habilitation/inauguration committees (in total) | 1 | 1 | 1 | 1 |

*2*

### 2.5.4. List of published university textbooks

*None*

### 2.5.5. Number of published academic course books

*None*

### 2.5.6. List of joint research laboratories/facilities with universities

1. *Joint research facility/laboratory within the Centre of Excellence of Integrated Flood Protection Systems:*
   Common infrastructure for systematic monitoring of the amount and environmental quality of waters and introduction of new methods for water planning and catchment areas' management
   Instrumentation of IH SAS: Disc Permeameter, Set for pF Curve Measurement, Guelph Permeameter, Double Ring Infiltrometer, ArcGIS, FlowTracker Handheld-ADV (Acoustic Doppler Velocity meter)-3D, Electromagnetic Open Channel Flow Meter - model 801, GRS-1-Handheld GNSS REC, MIKE SHE – software – groundwater flow modelling, Sonar Lowrance HDS 10 + accessories
   Partner universities:
   - Slovak University of Technology in Bratislava (Faculty of Civil Engineering, Faculty of Chemical and Food Technology)
   - Comenius University, Bratislava (Faculty of Natural Sciences)

2. *Joint research facility/laboratory within the Centre of Excellence for Protection and Use of Landscape and for Biodiversity:*
   Common facility for collecting of data on the country abiotic components in order to the landscape protection and to maintain its biodiversity. Part of it is hydrological laboratory for the study of the effect of hydrological regime on land and changes in land use and biodiversity.
   Instrumentation of IH SAS: Limnigraph, Portable Spectrophotometer VIS DR 2088, Flow Tracker 2D, Hydrometric Wing Valeport 801C, Visual MODFLOW software, Vector map of SR

[2] Do not include time spent with bachelor, diploma or PhD students during their supervising

Partner institutions:

- Institute of Botany
- Institute of Zoology
- Institute of Molecular Biology
- Chemical Institute

Partner universities:

- Comenius University, Bratislava (Faculty of Natural Sciences)

3. *Joint research facility/laboratory within the Centre of Excellence for the Integrated River Basin Management in the Changing Environmental Conditions:*
   Common facility for continual monitoring of soil water storage together with flow measuring and measuring of meteorological and climatic
   Instrumentation of IH SAS: automatic monitoring kit for moisture and soil temperature, rainfall and groundwater level measurement, laser particle size analyzer, set for soil water retention determination, calcimeter, air pycnometer, soil water permeameter, system for field measurement of electrical conductivity and induced polarization of soil profile, device for accurate measurement of the concentration of oxygen isotope and deuterium in water samples (PICARRO), instrument assembly for measuring the speed of water flow in natural river channels, system for measuring leaf area index (LAI) of forest cover, multispectral camera
   Partner universities:
   - Slovak University of Agriculture, Nitra (Horticulture and Landscape Engineering Faculty)
   - Technical University in Zvolen (Faculty of Forestry)

- **Supplementary information and/or comments on doctoral studies and educational activities**

- Organization of field trips for primary school students at the meteorological station of the institute operated at the base in Liptovský Mikuláš
- Discussions with students of primary and secondary schools - science professions presentations
- Production of interactive educational programs for primary and secondary schools
- Organization of experimental snow measurements for students from Slovak University of Technology, Bratislava
- Long-term internships at the workplace

Decrease in the number of educated specialists – hydrologists, water managers, meteorologists – at the universities in Slovakia represents a serious problem. The number of students enrolled in hydrology and water management programs decreases every year as a result of higher requirements on students (mathematics, statistics, modelling, GIS) and low appraisal of the employees in the water sector.

Currently, there is no PhD study program in hydrology accredited at any university in Slovakia. According to Slovak legislation, the institutes of SAS are not allowed to educate PhD students if they are not affiliated with PhD programs accredited at the universities. Thus, a new generation of hydrologists capable to solve challenging tasks is missing. As a response to this situation we will try to teach higher number of specialists in the framework of the second stage of study.

## 2.6. Social impact

### 2.6.1. List of the most important results of applied research projects. Max. 10 items

Almost all outputs of our research projects have the potential for application in practice.

Applied research projects:

- APVV-14-0735 New possibilities of use of drainage canal systems with taking into account the protection and use of a landscape, Ing. Velísková
- APVV-0163-11 Analyses of soil properties and landscape development for non-regularly overflowed areas, Ing. Pavelková
- EUREKA E!498 System monitoring of selected parameters of porous substances by EIS method in a wide spectrum of applications, Ing. Gomboš
- EUREKA E!7614 A System of Monitoring of Selected Parameters of Porous Substances Using the EIS Method in a Wide Range of Applications, Ing. Gomboš
- FP7 Project 269985 Detection of watercourse contamination in developing countries using sensor networks – ENLARGED, Goldfish – enlarged, Ing. Velísková
- VEGA project 2/0010/11 "Sensitivity of the river water temperature of the Slovak rivers to hydrologic extremes and climate variability" will be used for determining the limit values of the classification scheme for the water temperature for different types of surface water bodies in the Slovakia, Dr. Pekárová

Norms and standards:

- NOVÁK, Viliam. Kvantita povrchových vôd - OTN ŽP 3302-2: Hydrológia. Hydrologické údaje pôdnych vôd. Časť 2: Výpočet evapotranspirácie pre potreby bilancie vody v povodí [Surface water quantity – OTN ŽP 3302-2: Hydrology. Soil water hydrology. Part 2. Evapotranspiration calculation to evaluate water balance of catchment]. Bratislava: Ministry of environment of SR, 2012, 24 p.

Professional books published in Slovak:

- BIČÁROVÁ, Svetlana - BEZÁK, Vladimír - BILČÍK, Dušan - ČEPČEKOVÁ, Eva - FLEISCHER, Peter - HLAVATÁ, Helena - HOLKO, Ladislav - JAKUBJÁK, Ondrej - MAČUTEK, Jozef - MAJCIN, Dušan - OSTROŽLÍK, Marian - RADIMÁKOVÁ, Alžbeta - SMOLEN, František - ŠKVARENINA, Jaroslav. SAV Observatory Skalnaté Pleso: 70 years of meteorologic measurements. Stará Lesná: Geofyzikálny ústav SAV, 2013. 63 p. ISBN 978-80-85754-29-2.
- BROSKA, Igor - BALÁŽ, Peter - BEZÁK, Vladimír - BRIMICH, Ladislav - ĎURIŠOVÁ, Anna - HUDÁČKOVÁ, Natália - JELEŇ, Stanislav - KOVÁČOVÁ, Marianna - LEXA, Jaroslav - MADARÁS, Ján - MALÍK, Peter - MICHALÍK, Jozef - NELIŠEROVÁ, Eva - ORFÁNUS, Tomáš - PAŽÁK, Peter - PETRÍK, Igor - PORUBČAN, Vladimír - PUŠKELOVÁ, Ľubica - SIMAN, Pavol - SLÁDEK, Ján - STAREK, Dušan - ŠEFČÁKOVÁ, A. - ZAHRADNIKOVÁ, Barbara - ŽENIŠOVÁ, Zlatica. Planéta, na ktorej žijeme [The Planet we live on]. 1. ed. Bratislava: VEDA, Publishing House of SAS, 2015. 170 p. The World of science, vol. 36. ISBN 978-80-224-1436-4.

### 2.6.2. List of the most important studies commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes

1. *Monitoring of the soil moisture on forested monitoring plots for the pursuance of the intergovernmental Treaty of April 19, 1995.* Contract with the Ministry of Environment

SR related to monitoring of environmental impacts of the Gabčíkovo water works construction 2012.
Monitoring of the area impacted by water work Gabčíkovo – research report: Mészároš, I.: Soil moisture in the floodplain forest. Report HZ 2012, IH SAS, 51 p.
(The soil moisture monitoring enables to evaluate the water content in the zone of aeration accessible for the plants and the possibility to effectively regulate the intended flooding of the Danube arms. The soil moisture and depth of water table were measured on 12 monitoring plots in two-weeks and monthly intervals during all assessment period. The results and assessment of the water content wre delivered to governmental authorities).

2. *Monitoring of the soil moisture on forested monitoring plots for the pursuance of the intergovernmental Treaty of April 19, 1995.* Contract with the Ministry of Environment SR related to monitoring of environmental impacts of the Gabčíkovo water works construction 2013.
   Monitoring of the area impacted by water work Gabčíkovo – research report: Mészároš, I.: Soil moisture in the floodplain forest. Report HZ 2013, ÚH SAV, 50 p.
3. *Monitoring of the soil moisture on forested monitoring plots for the pursuance of the intergovernmental Treaty of April 19, 1995.* Contract with the Ministry of Environment SR related to monitoring of environmental impacts of the Gabčíkovo water works construction 2014.
   Monitoring of the area impacted by water work Gabčíkovo – research report: Mészároš, I.: Soil moisture in the floodplain forest. Report HZ 2014, ÚH SAV, 51 p.
4. *Monitoring of the soil moisture on forested monitoring plots for the pursuance of the intergovernmental Treaty of April 19, 1995.* Contract with the Ministry of Environment SR related to monitoring of environmental impacts of the Gabčíkovo water works construction 2015.
   Monitoring of the area impacted by water work Gabčíkovo – research report: Mészároš, I.: Soil moisture in the floodplain forest. Report HZ 2015, ÚH SAV, 52 p.
5. *Analysis of soil samples for the Institute of forest ecology SAS: basic analysis of hydrophysical characteristics of soils in three stands of sweet chestnut in Modrý Kameň area, Ing. Justína Vitková, PhD.*
6. Slovak commission of UNESCO - NC IHP UNESCO
   IHP UNESCO ERB (European Reference Basins) Statistical processing of data from the experimental basin of the Belá river, meteorological data from station Kasprowy Wierch, Poland. Report.
7. GWP (Global Water Partnership)
   Multilateral project, coordinated by Regional Centre GWP CEE. Project: Policy oriented study on remote sensing agricultural drought monitoring methods, 2014.

### 2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues

*None*

### 2.6.4. List of licences sold abroad and in Slovakia, incl. revenues

*None*

### 2.6.5. List of most important social discourses under the leadership or with significant participation of the institute (max. 10 items)

*None*

### 2.6.6. Summary of relevant activities

Our research is focused on water problems of Slovakia and the central Europe. Almost all outputs of our research projects do have application in practice, such as methods for assessment of hydrophysical characteristics of soils in Slovakia, formulation of standards, or development of hydrological or hydrochemical forecasting models. The assessment of disposable water storage in Slovakia and prediction of it's the evolution of water resources are becoming key issues for the future development of the society.

## 2.7. Popularisation of Science (outreach activities)

### 2.7.1. List of the most important popularisation activities, max. 20 items

1. Kováčová Viera: Presentation of IH SAS at civil engineering fair CONECO being accompanied by the energy efficiency fair Racioenergy with Water exhibition, Bratislava (2012–2015); Presentation of institute at the Stone Industry and Geology Exhibiton (2012, 2014);
   Year 2015: http://www.incheba.sk/buxus/generate_page.php?page_id=11740,
   Year 2014: http://expocenter.sk/ExhibitionAction.aspx?ExhibitionID=263&ItemID=17
2. Novák Viliam: About water and marathon run, RTVS - Radio and Television of Slovakia, session on the Radio Slovensko, 1.10.2012
3. Pekárová Pavla: There is not enough water in the reservoirs for the case of extreme drought, article in daily newspaper Pravda, 22.09.2012; http://spravy.pravda.sk/domace/clanok/248248-v-nadrziach-nie-je-dost-vody-pre-katastrofalne-sucho/
4. Danko Michal: Presentation of IH SAS on the social network - administrator of facebook page, 2013 - 2015, https://www.facebook.com/ustavhydrologie/
5. Novák Viliam: Water as strategic raw material, scientific debate with students of High Schools, Slovak Centre of Scientific and Technical Information, 19.3.2013, https://www.vedatechnika.sk/SK/enoviny/ZakciiNCPVaT/Stranky/Vedecka-cukraren%E2%80%93voda-ako-strategicka-surovina.aspx
6. Gomboš Milan: Reportage and interview for regional television Mistral from events "Water Days", 2012–2015
7. Novák Viliam: Water on the Earth and in the space, public lecture, The Slovak National Museum, 14.11.2013
8. Pekárová Pavla: In fifty years this dike will not be sufficient, article in daily newspaper SME, 2013, vol. 21, no. 130, p. 4; http://domov.sme.sk/c/6826409/riaditelka-ustavu-hydrologie-o-50-rokov-ani-tato-hradza-stacit-nebude.html
9. Pekárová Pavla: The normal Danube will be back in two weeks time, the water level will drop down slowly, article in daily newspaper SME, 2013, vol. 21, no. 132, p. 3, http://domov.sme.sk/c/6829193/bezny-dunaj-sa-vrati-az-o-dva-tyzdne-voda-bude-opadavat-pomaly.html
10. Danko Michal: Confirmation of snow quantity during last 30 years, article in journal Horolezec, 2014; http://www.bokami.sk/data/userfiles/clanok_2014.pdf
11. Nagy Viliam: is the global water shortage threatening? Water as strategic raw material and source of energy for the future, article in daily newspaper Új Szó, 1. 9. 2014; http://ujszo.com/napilap/interju/2014/08/01/globalis-vizhiany-fenyeget
12. Orfánus Tomáš: 132 trips to knowledge - interactive educational programs for primary and secondary schools, 2014
13. Rodný Marek: Forget about the big bang theory, lifestyle magazine La Femme, 2014
14. Danko Michal: Organization of field trip for primary school students at the EHZ IH SAS in Liptovský Mikuláš, 3.-4. 4. 2014;
    https://www.facebook.com/ustavhydrologie/photos/?tab=album&album_id=450471745085134
15. Orfánus Tomáš: Planet, where we live, scientific - popularisation literature, ISBN: 9788022414364, publisher: VEDA, year of publication: 2015
16. Gomboš Milan: About the hydrologic base, tv show, regional television Mistrál, 2015

17. Novák Viliam: Interwiev for TASR and cooperation in the creation of web pages "IN that Time" of TASR (News Agency of the Slovak Republic), http://www.vtedy.sk/prehradenie-dunaja-oktober-1992
18. Orfánus Tomáš: Does Slovakia have enough water?, discussion within the series of scientific coffee houses SAVinci; e-news of SAS: https://www.sav.sk/index.php?lang=sk&doc=servicesnews&source_no=60&news_no=6008; https://www.facebook.com/events/1707840432772887/
19. Pekárová Pavla: Can we expect series of several dry years?, article in daily newspaper SME, 2015; http://www.sme.sk/c/7951899/mozeme-ocakavat-seriu-viacerych-suchsich-rokov.html
20. Halmová Dana: XIII. edition of science professions presentation, discussion with students of primary and secondary schools, Nové Zámky, 10.3.2015 http://www.novezamky.sk/stretnutie-s-hydrologickou/a-1091

### 2.7.2. Table of outreach activities according to institute annual reports

| Outreach activities | 2012 | 2013 | 2014 | 2015 | total |
|---|---|---|---|---|---|
| **Articles in press media/internet popularising results of science, in particular those achieved by the Institute** | 8 | 5 | 7 | 10 | 30 |
| **Appearances in telecommunication media popularising results of science, in particular those achieved by the Institute** | 4 | 1 | 4 | 3 | 12 |
| **Public popularisation lectures** | 4 | 7 | 1 | 3 | 15 |

- **Supplementary information and/or comments on popularisation activities,**

We significantly improved the popularization activities at the Institute in the assessment period.

- Regularly updated news about the events in the Institute are published on the Institute's web site
- Leaflets about the Institute in Slovak and English languages were updated and printed every year
- Our young colleagues established a Facebook page
- A new web site was constructed
- Free access to the full texts of articles published in our international journal (Journal of Hydrology and Hydromechanics), and in our national journal (Acta Hydrologica Slovaca) is available on the web site
- Selected data from the mountain catchment of the Jalovecký creek are presented on-line at our web site.

## 2.8. Background and management. Human resources and implementation of recommendations from previous assessment

### 2.8.1. Summary table of personnel

| Personnel | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| All personnel | 47.0 | 50.0 | 51.0 | 46.0 |
| Research employees from Tab. Research staff | 29.0 | 29.0 | 30.0 | 29.0 |
| FTE from Tab. Research staff | 26.600 | 25.030 | 25.030 | 25.500 |
| Average age of research employees with university degree | 46.5 | 45.2 | 45.1 | 46.5 |

#### 2.8.1.1. Professional qualification structure (as of 31.12. 2015) FEMALE

| FEMALE | AGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of | < 30 | 31 - 34 | 35 - 39 | 40 - 44 | 45 - 49 | 50 - 54 | 55 - 59 | 60 - 64 | > 65 |
| DrSc. / prof. | | | | | | | 1 | | |
| II.a / Assoc. prof. | | | 1 | | 1 | 1 | | | |
| Other researchers PhD./CSc. | 1 | 3 | 1 | 1 | | 1 | | | |
| doc. / Assoc. prof. | | | | | | | | | |

#### 2.8.1.2. Professional qualification structure (as of 31.12. 2015) MALE

| MALE | AGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number of | < 30 | 31 - 34 | 35 - 39 | 40 - 44 | 45 - 49 | 50 - 54 | 55 - 59 | 60 - 64 | > 65 |
| DrSc. / prof. | | | | | | | | | 2 |
| II.a / Assoc. prof. | | 1 | 1 | 1 | | 2 | 2 | 1 | 1 |
| Other researchers PhD./CSc. | | 3 | 1 | | | | | | 1 |
| doc. / Assoc. prof. | | | | | | | | | |

### 2.8.2. Postdoctoral and mobility scheme

#### 2.8.2.1. Postdoctoral positions supported by national and international resources

Margarita Himmelbauer, PhD, Austria, 1. July – 31. December 2012, OAD – SAIA Project (ICM- 2012 -00327), The impact of different root data details in models of soil water transport.

Igor Leščešen, Serbia, 3. March - 30. April 2014, National Scholarship Programme of the Slovak Republic, project Flood Regimes of the Rivers in the Danube Basin (IHP UNESCO).

#### 2.8.2.2. Postdoctoral positions supported by external funding

None

#### 2.8.2.3. SAS stipends and SASPRO stipends

None

#### 2.8.2.4. Internal funding - the Slovak Academy of Sciences Supporting Fund of Stefan Schwarz

Ing. Marek Rodný, PhD., 2012-2016, "Hydro-pedological modelling in cloud"

### 2.8.3. Important research infrastructure

Research infrastructure of the Institute since the last assessment has significantly improved thank to the support from the EU Structural Funds. The acquired equipment allows much better monitoring of hydrological cycle (atmospheric, surface and subsurface waters), measurement of water fluxes (transpiration of trees, river flows, soil water movement) including tracing of water sources and history based on chemical and isotopic composition of water samples. Indirect approaches based on geophysics (electrical resistivity and induced polarization, ground penetrating radar) and photogrammetry (ground/aerial including thermal images) can be applied as well. Several complex mathematical models are used to simulate various parts of the hydrological cycle.

Fully equipped meteorological stations and stand-alone weighting (OTT Pluvio2) and tipping bucket rain gauges (Minikin Eri) are used in monitoring of precipitation which represents input into hydrological cycle of a catchment. Form of precipitation, particle size and velocity is measured by disdrometer (OTT Parsivel2). Meteorological stations provide also data on wind direction and speed, global and reflected solar radiation, air temperature and humidity and soil moisture at several depths.

Leaf area index of trees and shorter vegetation for the assessment of interception can be determined by hemispheric photographs and measurement of radiation (Sun Scan Canopy Analysis System, Delta-T), respectively.

SOMMER Snow Pack Analyzer, SOMMER Snow Scale and SOMMER Snow Depth Sensor measure and record the snow water equivalent, snow density, liquid water content, ice content and snow depth. Liquid water content of snow and snow density is also measured by the portable device Toikka Snow Fork.

River discharge is measured by electromagnetic (Valeport) and acoustic (SonTek FlowTracker and River Surveyor) devices. Pressure transducers are available to provide data on river and groundwater levels.

Water quality and surface water bodies morphology data are obtained by the autonomous underwater vehicle EcoMapper (YSI) which is a unique system designed for water quality, water currents and bathymetry mapping applications. The Institute is the sole owner of this platform in the Central Europe. The vehicle (torpedo) can measure and monitor data of reservoirs and waterways at a continuous interval for missions ranging from 8 to 12 hours.

Precise surveying of water depth (from 1m), bottom structure and thickness of sediments in rivers, channels and water reservoirs can be conducted by professional sonar EA 400SP with accessories which are also rare in the Central Europe. Undisturbed samples of bottom sediments can be collected by the Beeker sampler. Automatic devices (ISCO, Water Sam) for collection of water samples for chemical (spectrophotometry) or isotopic (laser spectrometry) analyses are available as well.

Lysimeter station built in the East Slovakian Lowland is a unique infrastructure that allows monitoring of complex ecosystems in nature-close conditions. It consists of five lysimeters with different soil monoliths of cylindrical shape with area $1m^2$ and depth 2.5 m with groundwater table regulation. All lysimeters have a highly accurate weighing system and very extensive sensor equipment for measuring volumetric soil moisture (by 0.10 m), soil water potential and soil temperature (each 0.40 m) and also sampling devices for the collection of soil water in three

height levels. It includes special software for automatic data collection, wireless transmission, processing and storage in a database.

Soil moisture can be measured in the field also independently by the portable neutron probe or handled devices (Delta-T) as well as by stand-alone systems with dataloggers.

Equipment for field and laboratory measurements of selected soil characteristics (hydraulic conductivity, porosity, water retention curve) is available as well. Soil samples from deeper layers can be collected by the machine drilling.

Improved research infrastructure allowed elimination of technological lag of the Institute behind similar institutions in Europe. Our researchers can now use the equipment comparable with that employed in other developed countries. Better possibilities of conducting measurements, monitoring and data processing will be reflected in new data and approaches which should eventually improve the publication results of the Institute and services the Institute can provide to other domestic and international institutions. Thanks to the new equipment we could already contribute to the training of colleagues from Nepal in isotopic analyses of water samples, investigate the value of soil conductivity measurements in a small research catchment in Luxembourg, successfully apply for a research project with Slovak Technical University or start a joint monitoring of precipitation form with the Earth Science Institute SAS. It can be expected that the number of similar cooperations will increase with time. Nevertheless, the improved infrastructure will first of all serve in research projects of the Institute itself.

### 2.8.4. Description of how the results and suggestions of the previous assessment were taken into account

Organization's comments to suggestions and specific tasks of the previous assessment:

Comments, objections to organization's activities1 in form of suggestions and specific tasks which must be performed by organization before next regular evaluation, etc.

1) Define and develop 2-3 principal themes in which the institute can fulfil the highest international criteria
2) Substantially improve structure of publications
3) Create a more motivating intellectual environment with respect to young employees
4) Substantially improve internal management processes
5) Better use of the potential of databases from studied catchments in outputs and international cooperation
6) Be more concrete in specification of future research strategy, especially taking into account the infrastructure which is being built

1. In response to the recommendations we have changed the structure of the Institute. Two departments instead of four were created and the main activities of each department were redefined. We focus on the topics of floods and droughts.

2. Number of publications in high quality journals registered in CC, WOS and SCOPUS databases stabilized to about 14 per year. Number of publications in other foreign and domestic journals is about three times higher. The action was taken in the last few years to change the proportion in favour of the CC, WOS and SCOPUS publications. However, since a lot of results are of regional validity and we feel obliged to contribute to dissemination of research results to Slovak water professionals, we are of the opinion that publications in domestic journals should remain an important part of the Institute's publication activity. A lot of knowledge was obtained in research over the last decade. Community of water professionals feels a gap between the research and practice which we try to fill at least partially by publishing in domestic journals.

Average number of citations in WOS and SCOPUS was approximately 182 and 34 per year, respectively. Given the average number of 29 employees with university degree (including PhD students) it represents about 7 citations per person per year. It is promising that the number of citations in WOS has been steadily increasing in the assessment period from 125 in 2001 to 249 in 2014.

3. In addition to consultations with supervisors, the PhD students regularly present their results at seminars. This should contribute to their preparation in terms of the ability to present the work as well as to foster the discussion with their colleagues from the Institute.

4. The new executive body of the Institute, which is in service since June 2012, introduced new methods of management. The governing body of the Institute (Operational briefing) meets regularly every week. The records of the briefing, as well as all directives and guidelines are available to the employees on the intranet. The staff outside Bratislava receives them by e-mail. Personnel change was introduced at the Institute's secretariat – the position of secretary with secondary education was changed to assistant of director with university education. Changes in positions of heads of the economic and research departments were made. The regular seminars of the researchers were revitalised and they are accessible for public. More thorough discussions are organized in the project teams and once per year each team presents its main activities.

5. Selected data measured in the Jalovecký creek research catchment in the Western Tatra Mountains are presented to public on the Institute's web site.

6. Infrastructural improvement was completed in the last years. The Institute moved to a new place in Bratislava and the entire Slovak Academy of Sciences is in the process of restructuralization which has been several times postponed. New director of the Institute is being elected as well. Research strategy was, and will have to be discussed again in the near future.

- **Supplementary information and/or comments on management, research infrastructure, and trends in personnel development**

Due to regular problems with approval of the SAS budget it was necessary to accomplish the restructuralization of the organization followed by the cut-down of the number of employees from 45 to 42 (from FTE 29.6 to 25.5 of employees with university degrees engaged in research and development). The cut-down was done in Bratislava and did not affect the experimental bases in Liptovský Mikuláš and Michalovce. The main reason was that the experimental bases received a lot of new equipment from the Structural funds which needs personnel for operation. After moving of the Bratislava staff to the new facility at the Dúbravská cesta street the working conditions improved for the Bratislava staff as well.

Major generational exchange of the researchers occurred in the last four years in Bratislava, mainly in the Department of subsurface water hydrology.

Recently, the Institute was very well equipped with modern technologies, the buildings of the Institute are well maintained and the Institute is without financial obligations. The Institute's personnel is stabilized and the Institute has good conditions to execute its mission.

# 3. Research strategy and future development of the institute for the next five years (2016–2020)

## 3.1. Present state of the art in both the national and the international contexts

### Present state of the art in the international context

Water is vital to life, maintenance of ecological balance, economic development, and sustenance of civilization. The uneven distribution of water resources over time and space and their modification through human use and mismanagement have led to water crises in many parts of the world. Deaths and material damage from extreme floods can be high, and more intense droughts, affecting increasing numbers of people, have been observed during the first decade of the 21st century.

We live in a highly dynamic world with many changes occurring simultaneously (in Anthropocene). In the Anthropocene, humans significantly affect the water cycle as well as water quality. Agriculture is the largest consumptive user of freshwater. In addition to agriculture, water is needed for domestic and industrial use. These two are not significant consumptive uses, but it is critical to have the water available when needed. Large-scale transfers of water via canals from water-rich regions to water-poor regions are conducted to meet the water demands. Dams have been built for water supply storage, flood control, hydropower generation, and navigation. In the process, they have led to fragmented river systems with impacts on the hydrologic cycle. Globally, water withdrawals and reservoirs decreased annual discharge to the oceans by 2.7% with significant changes to the seasonal cycle of streamflow. Human appropriation of water resources and modification of landscapes exert an accelerating influence on water-cycle dynamics from local to global scales and decadal to century timescales. Human actions scale up in surprising and unpredictable ways to generate a suite of diverse water sustainability challenges that must be incorporated into new approaches to water science and management.

From an environmental perspective, the attention of the media is frequently focused on **climate change**, while this is only one of the many changes that are occurring and not necessarily the most important one. Amongst such changes, **global population growth** is perhaps the most compelling reason for concern. There is a remarkable increase of population in less developed countries, while other countries such as Russia and those of Eastern Europe are experiencing population decrease. There are also **significant population movements**, both towards cities and between countries. As a consequence, there is an increase in the proportion of people living in cities that has significant implications for urban water management and potentially a decrease in the level of connectedness that citizens have with their environment. Population growth leads to greater demand for food, electricity and industrial processes and hence, **greater demand on water**. In such a critical situation, **water security** is likely to become an emerging issue for many countries in the world.

Several legislative acts of EU were introduced in previous period – Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy), Flood Directive (Directive 2007/60/EC on the assessment and management of flood risks), and others.

In response to the priorities and needs of society, the International Hydrological Programme of UNESCO (in its eighth phase "**Water security: Responses to local, regional, and global challenges**") focuses on six knowledge areas translated into themes:

1. managing water security, water quality and pollution control;
2. adaptation to the impacts of climate change and natural disasters on water resources;
3. management and protection of groundwater resources for sustainable living and poverty alleviation in developing countries and in arid and semi-arid regions and small islands;
4. integration of catchment scale ecohydrological concepts and processes in advanced water management models;
5. management of water resources for human settlements of the future; and water education as a key element to attain water security.

Similarly, the new Scientific Decade 2013–2022 of IAHS, entitled **"Panta Rhei—Everything Flows",** is dedicated to *research activities on* ***change in hydrology and society***. The Scientific Decade 2013–2022 will devise innovative theoretical blueprints for the representation of processes including change and focus **on advanced monitoring and data analysis techniques**. Interdisciplinarity will be sought by increased efforts to connect with the **socio-economic sciences and geosciences** in general. The main concepts of the scientific activity being developed in Panta Rhei can be summarized in the following statements:

1. The interaction between hydrology and society is changing, generating new connections and, in particular, more significant feedbacks which need to be understood, assessed, modelled and predicted by adopting an interdisciplinary approach. Humans are an important part of the system: there is a need to study the two-way coupling between humans and nature (socio-hydrology) within a more comprehensive framework.
2. Co-evolution of hydrological and connected systems (including society) needs to be recognized and modelled with a suitable approach, in order to predict their reaction to change. The feedbacks between hydrological processes, catchment structure, society and ecosystems provide important information on catchment functioning.
3. Hydrological processes determine the relationship between environment and humans (by determining, among others, water-related risks and water security). Hydrological change is vital to society, as well as to the environment itself.
4. Change results from the superimposition of natural variability and human-induced effects. Understanding their interaction is critical for deciphering the feedbacks on the environment and hydrological systems.
5. Advances in hydrology are currently limited by the available measurement techniques. The community should therefore be proactive in devising innovative monitoring strategies by taking advantage of new technologies and new generations of data.
6. Future science must necessarily be based upon an interdisciplinary approach.

**Present state of the art in the national context**

The hydrological research in Slovakia reacts to international trends and problems. At our Institute there is the National Committee for the intergovernmental International Hydrological Programme of UNESCO and the non-governmental International Association for Hydrological Sciences. Some of the topics were treated in collaboration with the hydrological community in the framework of the EU projects. The research in Slovakia is mostly related with hydrological problems of the central European region, of the Danube river basin and, of course, on local problems of Slovakia. Global problems – as defined above – do not keep away from our territory and we cannot rely on anyone`s solutions.

## 3.2. Research strategy of the institute in the national and the international contexts, objectives and methods

Institute of Hydrology, Slovak Academy of Sciences is undoubtedly the most significant workplace in the fields of hydrology and soil hydrology in Slovakia. Although there are other institutions that devote part of their effort to hydrology and soil hydrology (Slovak Agricultural University, Nitra, Technical University Zvolen, Slovak University of Technology, Bratislava and Comenius University Bratislava), their activities are specific and focused on particular fields such as forest soils, pedology, engineering hydrology, etc. The position of the IH SAS is expressed by publications in journals indexed in WOS. In international scale, the activity of the Institute is wide. The Institute cooperates with top research workplaces like the Soil Salinity Laboratory USDA – ARS, Riverside, USA, University of California, Riverside with joint publications. In Europe, our cooperation is focused mostly on the neighbouring countries (BOKU Wien, Institute of Agrophysics, Lublin, Poland, Institute of Water Problems, RAS, Moscow, Institute of Pedology and Agricultural Chemistry, Hungarian Academy of Sciences). Exchange of information and jointly performed research in the framework of joint projects are continuous.

The Institute is a leading organisation in Slovakia in the field of experimental hydrology and tracer hydrology. It is also the principal research organisation in Slovakia for solution of pollutant dispersion in surface water from the hydrodynamic point of view. In the international context the Institute developed intensive contacts with European research organisations in framework of the European Network of Experimental and Representative Basins (20 countries) and in the framework of the International Hydrological Programme of UNESCO project EUROFRIEND (39 countries). In the field of runoff changes and flood regimes the Institute is leading the project on Flood Regimes of Rivers in the Danube Basin (14 countries) in the framework of the Regional collaboration of the Danube countries in IHP UNESCO.

The research themes of the Institute are manifold, covering different areas of theoretical as well as experimental surface and subsurface hydrology. Almost all of our researchers are experimentally oriented; the most important research activities are focused on experimental hydrology in Slovak conditions. In this field we significantly improved the quality of instrumentation in the past period, mainly with the help of the Structural funds of EU. Efficient use of the new experimental equipment will provide basis for excellent research in the next period. Both departments and groups are very active in international collaborations.

The research team of the Department of the surface water hydrology is long-term focused on components of the water balance and hydrological processes in catchments (both mountainous and lowland). The research is focused mainly on processes related to surface water sources, but marginally also on processes related to interaction of surface and ground waters. In this framework the primary axis of research is in quantitative aspect of the problems, such as water accumulation in the catchment in form of snow cover, changes of the runoff regime in surface streams due to climate change and anthropogenic impacts. The number of catchments with natural regime decreases and the number of catchments with anthropogenic regime increases which is one of the flood origin factors. The assessment of water resources is not restricted to quantitative aspect only, as for many purposes it is vital to assess the qualitative aspects as well (drinking water supply, food industry, reclamation, …). Therefore, the department also deals with pollution transport processes in the surface streams and the utilization of the obtained knowledge for improvement of the stream water quality.

The research in the topics mentioned above will continue and it is supposed that new equipment will enable to use modern methods of measurement, faster and more effective processing and assessment of the collected data and publication of new results in high quality outputs. The master theme of the department will be **hydrological balance and processes in various types of catchments with focus on surface water sources** in following structure:

<table>
<tr><td rowspan="4">hydrological balance and processes in various types of catchments</td><td rowspan="3">quantity</td><td>accumulation of water in the catchment (snow, runoff formation)</td></tr>
<tr><td>changes of runoff regime in the stream</td></tr>
<tr><td>interaction of SW-GW</td></tr>
<tr><td>quality</td><td>parameters of transport processes</td></tr>
</table>

It will be necessary to apply new approaches and procedures, relevant to the new conditions or have better capability to describe hydrological (natural) processes in changed conditions. By means of theoretical and experimental research a new original knowledge will be obtained on hydrological cycle (flood or drought formation, mechanism of flow and transport of material in water environment, …), and impacts of global, regional and local phenomena (anthropogenic activities, pollution, climate change, …) on water resources. In line with international trend we will focus on the long-term prediction of changes in hydrology and society.
Acquired knowledge will be published in peer-reviewed international and domestic periodicals. Their dissemination should result in better versatility and upward revaluation of the IH SAS position in the context of international research area.

Research team of the Department of Subsurface Water Hydrology (OHPPV) is focused on generating new knowledge on the process of water, energy and dissolved substances transport in the soil, as part of the groundwater – soil – plant – atmosphere system (GW-S-P-A) and the creation of generalized quantitative patterns of these processes. One of the main objectives was modification and verification of mathematical simulation models of transport processes in the system GW-S-P-A (GLOBAL, HYDRUS). Another task is proposal of new methods of determination of soils physical and hydrophysical characteristics and processes in the context of rapidly advancing technology, taking into account also the effect of biological factors, particularly the impact of soil water repellency on infiltration and evaporation. Another trend of research is the quantification of the transport of water and energy in a non-homogeneous forest soils rich in stones, with the organic layer on the surface, and with a significant inclination of the soil surface. Inputs into databases will be obtained by using field and laboratory measurements and experiments.
As a team of OHPPV we want to mention several more specific topics within this main research theme which will be developed in future:

- Improvement of soil water dynamics calculation methods algorithms for agricultural and mountainous catchments, allowing evaluation of the land use influence on water dynamics under conditions of global changes, with accent to climatic changes and anthropogenic influences.
- Proposal and improvement of field methods to measure and calculate basic hydrophysical characteristics of non – homogeneous, heavy, and stony soils and canopies to evaluate input data to simulation models of soil water regime diagnosis.
- Quantification of organic horizon influence of forest soil and their hydrophysical characteristics on infiltration and other hydrological processes.
- Biotechnological modification of soil hydrophysical properties leading to synergies between soil water conservation, low carbon economy, biomass production and sustainable land use.
- Quantification of the influence of biological factors on hydrological processes in the soil, particularly the impact of soil water repellency on infiltration and evaporation.

***Objectives of the Concept***

Main objective of the concept is to improve quality of conducted research and focus on promising research topics within the European research area. We would like to improve collaboration with universities and thus increase the possibility to employ young promising scientists.

The great problem is the decrease in the number of graduated specialists – hydrologists, water managers, meteorologists – at the universities in Slovakia. Due to higher requirements on students and low appraisement of the employees in the water sector, the number of students in hydrology and water management decreases. Recently, there is no study program in hydrology at the third study stage accredited at any university in Slovakia. According to Slovak legislation, the institutes of SAS are not allowed to educate PhD students in such study programs. The new generation of hydrologists capable to solve challenging tasks is missing. Therefore, we will try to teach higher number of specialists in the framework of the second and third stage of study – in doctoral study.

Hydrological research in general can be classified as object-oriented basic research. In other words, there are no sharp boundaries between the basic and applied research. Therefore, the strategy and objectives of the research conducted at the Institute should be oriented so, that they cover the whole society needs for new knowledge in the field of hydrology. At the same time, research activities of the Institute must reflect the worldwide trends in hydrology and effectively contribute to the international hydrological research with new knowledge from our country.
In terms of methodological approach, the accent should be on the four pillars:

1. The use of modern scientific infrastructure and equipment.
2. The application of scientific methods based on the use of current scientific infrastructure. It includes the use of sophisticated automated measuring systems with remote data transfer,

the use of software systems for the transformation of data files into the appropriate object format relevant to used information technology.

3. Cooperation with domestic and foreign scientific institutions but also with the private sector in the joint research projects of basic and applied research; participation in competitive research funding schemes from Slovak as well as from the European funding agencies with an ultimate goal to be successful in funding by the ERC (European Research Centre); utilization of available infrastructure in collaboration with universities and when possible and suitable creation of common research laboratories with universities and; hiring more diploma students, PhD students and postdocs.
4. Dissemination of results:
   a) publications in top ranking journals
   b) non-impact publications in international and domestic scientific journals
   c) active participation at scientific conferences to maintain the personal contacts
   d) popularization activities – media

| Project proposals submited to 7RP or H2020 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| **Institute as coordinator** | 1 | 0 | 0 | 0 |
| **Institute as participant** | 1 | 1 | 2 | 2 |

In 2012 Dr. Onderka submitted the ERC project proposal “Scaling properties of runoff in nested catchments and their relation to physiographic features and climate variability” (FP7-PEOPLE-2012-CIG_06/03/2012, Proposal number: 321864)

In 2012-2014 the institute was partner in 7FP project KORANET with Korea and Poland.

In 2013 several 7FP proposals were submitted, one of them was successful - GOLDFISH.

In 2014 two project proposals were submitted into HORIZON 2020/7FP.

In 2015 we submitted two project proposals into INTERREG, one proposal to COST, and one into HORIZON 2020.

## *4. Other information relevant for the assessment*

Institute of Hydrology SAS is one of the smaller institutions among the institutes of the Slovak Academy of Sciences with regard to the number of employees. However, it is the only institution in Slovakia conducting comprehensive research of the hydrological cycle. Water and water management are the areas that will increasingly need to implement the latest research results. Thus, the importance of our research for Slovakia to keep up with the current state of the art of hydrology as a scientific discipline is indisputable. The expertise obtained in any discipline by the long-term systematic effort can not be substituted by the short-time or ad hoc activities. Publication of the results of our work in the top water resources journals confirms that our research contributes also to the worldwide effort of international scientific community aimed at improving knowledge on the hydrological cycle.

Bratislava, August, 02, 2016

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