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

Period: January 1, 2016 - December 31, 2021

1. Basic information on the institute:

1.1. Legal name and address

Geografický ústav Slovenskej akadémie vied, Štefánikova 49, 814 73 Bratislava, Slovakia
Institute of Geography of the Slovak Academy of Sciences *(hereinafter only IG SAS or institute)*

1.2. URL of the institute web site

http://www.geography.sav.sk/

1.3. Executive body of the institute and its composition

Directoriat	Name	Year of birth	Years in the position, from - to
Director	Mgr. Daniel Michniak, PhD.	1974	May 1, 2016 –
Director	Prof. RNDr. Vladimír Ira, CSc.	1952	to April 30, 2016
Deputy director	Mgr. Ján Novotný, PhD.	1976	July 1, 2016 –
Deputy director	Prof. RNDr. Vladimír Ira, CSc.	1952	May 1, 2016-June 30, 2016
Deputy director	Mgr. Daniel Michniak, PhD.	1974	to April 30, 2016
Scientific secretary	Ing. Daniel Szatmári, PhD.	1986	July 1, 2018 –
Scientific secretary	Mgr. Pavel Šuška, PhD.	1978	to June 30, 2018

Add more rows for any changes during the evaluation period

Scientific Departments	Heads of Departments by December 31, 2021
Department of Geoinformatics:	RNDr. Monika Kopecká, PhD.
Department of Human and Regional Geography:	Mgr. Kristína Bilková, PhD.
Department of Physical Geography, Geomorphology and Natural Hazards:	Ing. Anna Kidová, PhD.

1.4. Head of the Scientific Board

Mgr. Pavel Šuška, PhD. – since November 1, 2018

RNDr. Monika Kopecká, PhD. – to October 31, 2018

1.4.1 Composition of the International Advisory Board

Assoc Prof. Marek Więckowski – Deputy Director at the Institute of Geography and Spatial Organization Polish Academy of Sciences

Prof. Marián Halás – Head of Department of Geography at Palacký University in Olomouc

Prof. Jaroslav Hofierka – Director of the Institute of Geography at Pavol Jozef Šafárik University in Košice

1.5. Basic information on the research personnel

1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
30,44	17,73	27,84	17,82	28,84	18,75	28,80	19,79	30,48	20,22	29,57	19,39	**29,33**	**18,95**

1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes

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1.6. Basic information on the funding of the institute

1.6.1. Institutional salary budget, other salary budget[1], non-salary budget[2]

Salary budget	2016	2017	2018	2019	2020	2021	average
Institutional salary budget *[millions of EUR]*	0,469	0,497	0,538	0,615	0,711	0,663	**0,582**
Other salary budget *[millions of EUR]*	0,006	0,027	0,043	0,065	0,023	0,023	**0,031**
Total salary budget *[millions of EUR]*	0,475	0,524	0,580	0,680	0,734	0,686	**0,613**
Non-salary budget *[millions of EUR]*	0,112	0,141	0,267	0,172	0,171	0,181	**0,174**

[1] Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.

[2] Includes Goods and Services and PhD fellowships

1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised

The Mission Statement Presented in the 2008 Foundation Charter in a Revised Version from 2018

The institute focuses on basic research into the spatial structure and development of natural and socio-economic systems and their interrelations at various spatial levels – be they European, national, regional or local – with a particular focus on the territory of Slovakia. The activities of the institute contribute to increasing the level of knowledge and education and to the practical application of the results of scientific research.

The research activities are focused on (1) research into the spatial structure and development of river systems, their responses to changing environmental conditions, and flood risk assessment; (2) the identification, analysis and evaluation of the spatial distribution of the Earth's surface objects and the monitoring of their changes over time using geographic information systems (GIS) and remote sensing data; (3) the analysis of the spatio-temporal aspects of economic, socio-cultural and environmental phenomena, processes and structures; and (4) integrated geographical research into the dynamics of natural and socio-economic systems in their interrelationships and the assessment of the conditions of the quality of life and (sustainable) local and regional development. The geographical research responds to the current and geographically relevant problems of society.

The institute provides doctoral studies in accordance with generally binding legal provisions. The institute presents the results of its research and scientific activities in periodic and non-periodic publications.

1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)

The R&D activities of the IG SAS from 2016 to 2021 were divided into three research clusters in accordance with the strategic plan.

Research cluster*:* ***Landscape Changes Explored by the Application of Remote Sensing Data and Geographic Information Systems***

The key research topic of this cluster is land cover that reflects the state of the landscape in different stages of development. In this context land cover changes can be regarded as a relevant information source about processes (flows) in the landscape.

The progressive trend of geoscience-oriented research that began to develop in the early 1970s is related to analysing and evaluating global changes based on satellite imagery. The IG SAS has joined this trend by participating in CORINE Land Cover (CLC) pan-European projects since the 1990s, being particularly involved in 1990, 2000, 2006 and 2012. The objectives of these projects focused mainly on the identification, analysis and evaluation of land cover at both European and national levels. Land cover, being an integral part of the landscape, is used to monitor the state of its development, which is an important contribution to assessing the changes on our planet. During the evaluation period the IG SAS contributed to the finalisation of information on land cover in Europe and Slovakia from 1990 to 2012, and the research results were presented in two scholarly books: (1) European Landscape Dynamics: CORINE Land Cover Data (Feranec et al. eds. 2016 FAI01) published by CRC Press (Taylor and Francis Group) and (2) The Land Cover of Slovakia and its Change in 1990–2012 (Feranec et al. 2018 AAB01[3]), which was published by Veda (Bratislava). The analysed results on land changes within Europe and Slovakia document similar development trends: the growth of deforestation, a decrease in the intensification and extensification of agriculture and the occurrence of afforestation, and a hybrid trend of development dynamics (a decrease from 2000 to 2006 and an increase from 2006 to 2012 compared to the 1990–2000 period).

[3] The codes e. g. AAB01, ADCA08 and ADNB 22, refer to the publications from Annex 1 - the official publication list of the IG SAS for the 2016–2021 period prepared by the Central Library of the SAS.

For Slovakia, we evaluated the following spatial patterns of different landscape change trajectories: urbanisation, intensification, extensification and forest disturbance. Using a developed modelling framework, we evaluated the past, current and plausible future extents of all these landscape change trajectories. We then identified the plausible reasons for their occurrence (Pazúr & Bolliger 2017 ADCA23). Maps of future land cover scenarios for Slovakia may serve as a baseline to inform society about future land cover changes and help to improve the accuracies of various models that deal with the impacts of land cover change (e.g. climate, biodiversity and society).

The impact of built-up areas, land cover quality and green infrastructure, and the occurrence of urban heat islands (UHIs) in the summer months on the creation and distribution of environmentally sensitive urban areas was analysed and evaluated within the PEDO-CITY-CLIMA (APVV 15-0136) interdisciplinary project. Impermeable surfaces in the urban environment were identified, soil properties and quality were mapped and classified, and unfavourable microclimatic conditions, especially the occurrence of UHIs, were modelled to meet the project goals. In a densely populated urban environment with changing climatic conditions, it was confirmed that UHI areas are increasing and intensifying the deterioration of living conditions in cities. The definition of environmentally sensitive urban areas was addressed in terms of housing comfort and the quality of life of the urban population. Sensitive areas in Bratislava, Trnava and Žilina were identified in terms of the shared overlap of built-up areas, soil quality, greenery and UHI events. Impermeable surfaces are one of the main causes of the increased incidence of heat; however, adverse conditions can also be attributed to local microclimatic conditions and the occurrence of industrial plants that produce emissions. The analysis showed that environmentally sensitive areas are mainly in intensive industrial, commercial and public areas within continuous and incoherent urban structures. The most ecologically sensitive areas are urban centres, which are characterised by dense historical development and impermeable or semi-permeable land cover (more than 80%), where the increased effect of UHIs and the reduced degree of the availability of public greenery can be observed (Feranec et al. 2018 ABC03; Sobocká et al. 2021 ADCA35; Feranec et al. 2019 ADMA 01; Holec et al. 2020 ADCA2020; Holec et al. 2021 ADCA11; Kopecká et al. 2017 ADMB 09; Saksa et al. 2021 ADNB 34).

The ATBIOMAP project (within the ESA-PECS programme) aimed to provide a methodology and models for mapping and identifying successive stages and biomass estimation on abandoned agricultural land (AAL) using a novel combination of data obtained by optical and radar remote sensing sensors. Three basic classes of the abandonment of farmland were identified in terms of the overgrowth of various species of vegetation and its tallness, density and clustering. Training and test sites were located in two study areas. The first one had a dominance of arable land and vineyards, and the second one had mosaic meadows, pastures and arable land. The obtained results confirmed the possibility of identifying three different classes of AAL using high-resolution orthophotos. We tested several classification methods for the sufficient identification of AAL. The AAL classes are fragmented and occupy small areas of overgrowing vegetation. Some of the tested AAL areas were too heterogeneous, and it was impossible to identify more detailed subclasses of AAL. Further improvements could probably be made using a higher frequency of obtained satellite data from the vegetation period and data sets with a higher spatial resolution (Bucha et al. 2021 ADCA03; Goga et al. 2019 ADCA 08; Szatmári et al. 2021 ADCA40 - see Figure 1; Goga et al. 2020 ADMB03).

Within the Solutions for Climate-smart Land Use on the Dry Steppes of Russia project, which was supported by ERA.NET.RUS Plus, the IG SAS actively contributed to the evaluation of grassland changes and their drivers on a national and international level. In Slovakia, we allocated and evaluated the recultivation and abandonment of agricultural landscapes within different time periods from 1985 to 2018 (Pazúr et al. 2020 ADCA24), and we provided the plausible areas for such changes of agricultural land use in the future. Internationally, we conducted similar initiatives in different study areas in Switzerland and Russia. In southern Russia, we evaluated the drivers of change in the steppe landscapes' agricultural use (Pazúr et al. 2021 ADCA25). Such findings may help design grassland protection frameworks in the future (e.g. the Post-2020 Global Biodiversity Framework) and help design similar research in different parts of the world. Furthermore, we also evaluated different methods of mapping the landscapes dominated by agricultural land use using satellite-based data (Pazúr et al. 2021 ADCA26).

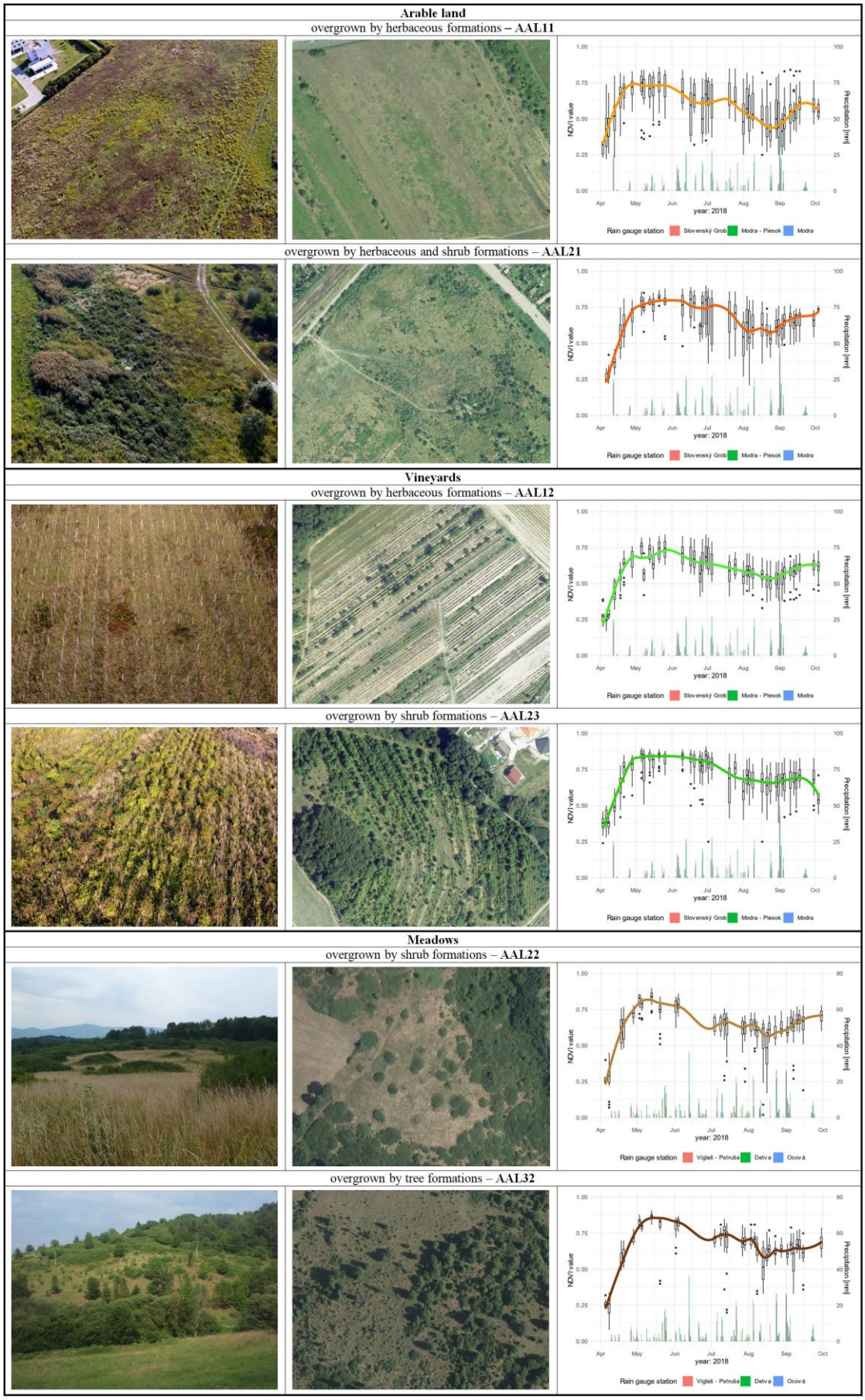

Figure 1: Comparison of the physiognomic characteristics of AAL classes recorded via field survey (left column) and orthophotos (middle column) with their spectral characteristics – NDVI curves (right column).
Source: Szatmári et al. (2021, ADCA40)

Research cluster: ***Structures, Processes and Hazards of River Systems: Their Response to and Impact on Natural and Socio-economic Systems***

Riparian landscapes and the study of long-term river morphology evolution and flood hazard and risk were the main research themes in this cluster, which was worked on within six domestic and three international projects. All elements of nature are determined by water from precipitation and run-off water. Nowadays, landscapes impacted by climate change connected with the higher frequency of extreme precipitation and the occurrence of floods, increased evapotranspiration and changed run-off conditions have become the focus of much recent research worldwide. A key foundation for sustainable river management is having knowledge of the morphological properties of watercourses that correspond to issues raised in the Water Framework Directive. River morphology and river channel research at the IG SAS aimed to identify sediment fluxes, the connectivity of gravel bars in meandering and wandering-braided river systems and large river morphology changes (the bypassed Danube channel). Morphologic-sedimentary research of recent river valley bottoms evolution. In-channel changes and floodplain evolution have been conditioned by lateral movement and incision due to altered environmental conditions.

The original methodology of research of coarse-grained sediments over a long-term period (1949–2009) was applied by the connectivity between sediment deposition and erosion as well as the connection of these processes at the levels of floodplain–channel, channel–bar and bar–bar. The results showed that all river sections exhibit a generally declining trend in sediment connectivity but also that they are characterised by a different response to flood events (Lehotský et al. 2018 ADCA16). This in-channel connection of sediments was supplemented by a mass movement and sedimentary supply from high cut-bluff banks and landslides (30 m height). A series of TLS (terrestrial laser scanning) data were used for the identification of the gravitationally conditioned mass movement on the slope and detailed sediment cascade calculation (Rusnák et al. 2020 ADCA34 - see Figure 2b).

The effects of extreme flood events clearly pointed to a declining trend in the active river zone area and to a decrease in the geomorphic diversity of the studied braided-wandering river system in relation to flood events with a low recurrence interval (5 to10-years), leading to a decrease in the geomorphic diversity of the studied braided-wandering river system (Kidová et al. 2016 ABB01; Kidová et al. 2016 ADCA13). This also points to the long-term degradation of the Belá River (in the form of the simplification of a braided planform to a braided-wandering one) (Kidová et al. 2017 ADMB08), an increase in the area of the islands, and the narrowing and straightening of the river course. This trend is highlighted by intensive human impact (channelisation, hydropower plant construction and river training). After a flood event in 2018, the undesirable simplification of the river planform, a loss of geodiversity, a decrease in the connectivity in the side-arm system and the disturbance and limitation of hydro-morphological continuity were all identified. Negative human impact is reflected in increased flow velocity, erosive force and a flow capacity that is capable of transporting sediments. Negative changes in these studied parameters has led to accelerated erosion of the river bed and the need of mitigate flood waves in the future as well as the reduced resilience of the already disrupted ecosystem (Kidová et al. 2021 ADCA14). The negative consequences of the floods are seen in lateral migration and bank erosion. In the Flysch Carpathians (documented on the Topľa River) the recorded river bank erosion is 0.8 m/year (1987–2002) in the low-flood period and approximately 1.6 m/year (2002–2009) in the period with intensive floods. From an economic point of view, the eroded floodplain with arable land and grassland is a negative consequence of channel migration (Rusnák et al. 2016 ADCA31; Lehotský et al. 2017 ABC08). The influence of long-term water management on changes in sediment flow connectivity in the large and bypassed Váh River were studied, where changes reflect a reduction in the long-term connectivity rate (sediment capture in dams and reduced water entrainment capacity) as well as in lateral terms (the stabilisation of bars, the disconnection of the riverbed system, and valley bed slopes) and the creation of disconnected river sections (Novotný & Cebecauerová 2016 ADNB24). Based on the morphometric R-index, Prokešová (2020 ADNB28) assessed how the fluvially eroded landscape in the selected part of the Hron river basin responded to the youngest phase of tectonic uplift.

Morphological changes (morphological-substrate and hydrological properties) affected macroinvertebrates' spatial distribution and longitudinal zoning (connectivity). The effect of longitudinal zonation patterns and macroinvertebrate responses to changes in habitat characteristics has been given much attention; however, there is a need for more studies of changes in macroinvertebrate assemblages along small upland undisturbed watercourses (Lehotský et al. 2016 ADDA03). Modern UAV (Unmanned Aerial Vehicle) technology and SfM (Structure from Motion) photogrammetry was also developed for riparian ecosystem monitoring. A template for mapping high-resolution river systems using UAVs was presented in some publications (Lehotský et al. 2017 ABC08; Rusnák et al. 2019 ADCA32). The procedure consists of five steps: (i) reconnaissance of the mapped site, (ii) pre-flight work, (iii) the flight task, (iv) data quality control and processing, and (v) operations on defined layers and the extraction of landforms. With the application of these modern technologies, it is possible to map the river landscape and identify fluvial forms and vegetation with resolution down to the centimetre and through manual or supervised automatic classification (Rusnák et al. 2018 ADNB31 - see Figure 2a; Rusnák et al. 2019 ADCA33).

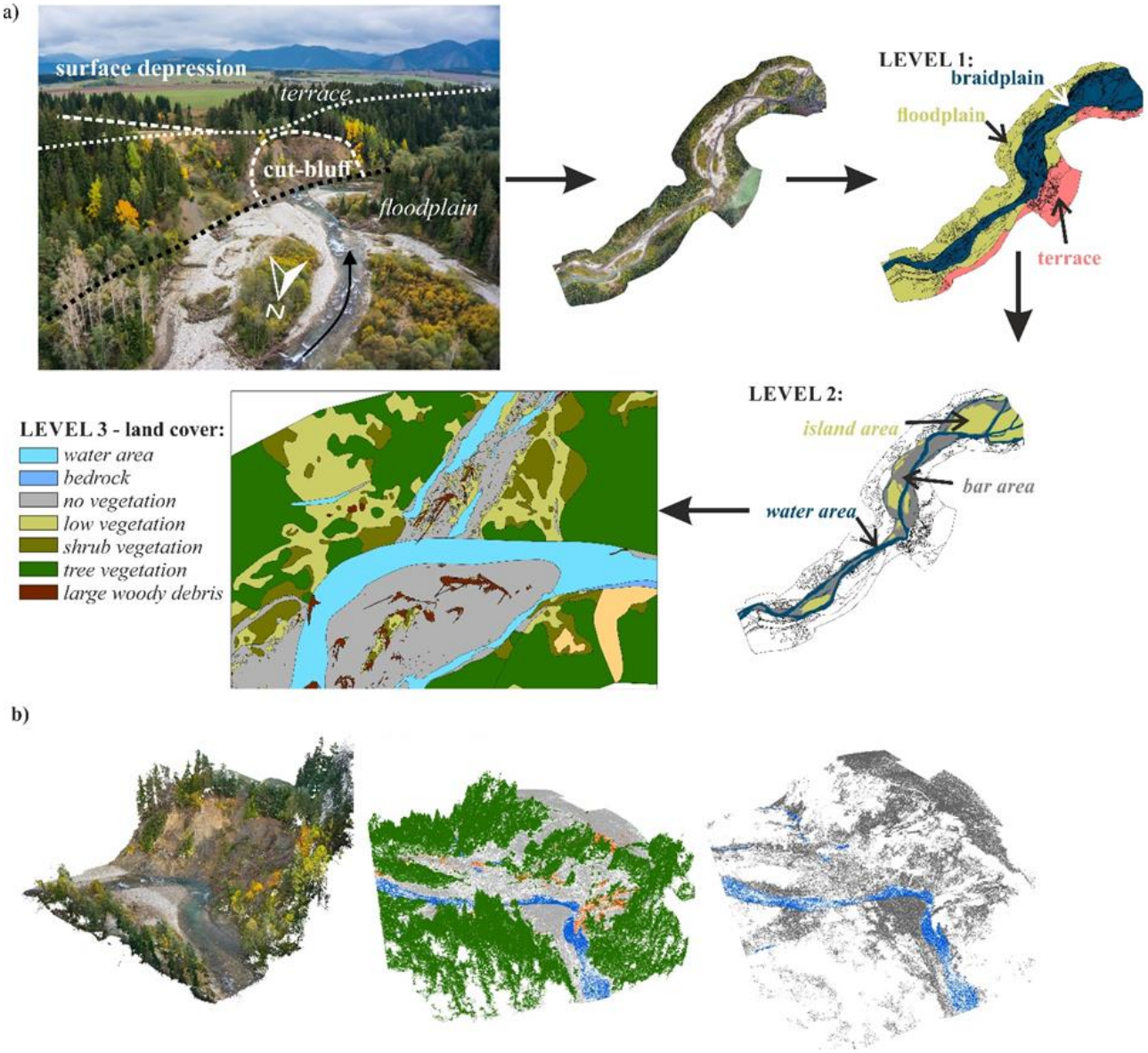

Figure 2: Vectorisation and identification of objects in the 3-level database with its three main components: braidplain, floodplain and terrace (a); Photorealistic, classified colorised point cloud landscape model in the Belá River study area (b).
Sources: Rusnák et al. (2018, ADNB31) and Rusnák et al. (2020, ADCA34)

The integrated flood risk assessment and management focused on several topics: the experience of households with different types of flood hazards, the susceptibility of property to damage as well as the susceptibility of people to physical and psychological harm, and the ability of households to cope

with the negative consequences of floods. A questionnaire survey was delivered to more than three thousand households in six municipalities in the Upper Myjava river basin. The findings show that, in addition to the natural river flooding, households were also affected by the very frequent occurrence of pluvial flooding due to water flowing from the slopes and flooding due to local factors (wood and debris in the channel). Households perceived unmaintained and polluted watercourses as an urgent problem. The level of vulnerability of households to flood risk was relatively high because many respondents lived in single-storey houses built before 1945 with unfired bricks and doors and windows that are not waterproof; with the exception of respondents in Myjava itself, most households had a low financial ability to deal with the negative consequences of floods (Solín et al. 2018 ADCA36; Solín et al. 2018 ADCA38).

Only a few insurance companies in Slovakia provide flood risk insurance as a separate insurance product. An analysis of the trends and spatial variability of flood insurance coverage in Slovakia pointed to a decreasing interest among people in property insurance against flood risks. One of the causes possibly lies in the specific limits and exclusions from flood risk insurance in the policy conditions of insurance companies. The majority of those insured are not aware of these facts when signing the contract; therefore, the rejection or reduction of payments for flood damage is then a source of frustration (Solín et al. 2018 ADCA37; Madajová & Solín 2016 ADMB29).

As a part of the methodology for preliminary flood risk assessment in connection with the implementation of EU Directive 2007/EC on the assessment and management of flood risk, a preliminary flood risk assessment in Slovakia identified areas with a potentially significant flood risk upon the basis of critical river sections of watercourses; however, such an approach to flood risk assessment is not sufficient to address flood risk management in an integrated way. We therefore developed a more comprehensive assessment of flood risk potential which is based on a systematic assessment of the attributes of cadastral areas in terms of their impact on individual types of flood hazards and vulnerability. A change in the conceptual approach to flood risk assessment, together with systematic and consistent data processing attributes affecting flood risk, brings a wide range of knowledge of the structure of flood risk and its spatial variability (Solín & Rusnák 2020 ADCA39).

Flood risk governance and management in Slovakia is based on the definition of "forces of stability" and "forces of change", which are analysed in relation to four basic dimensions of public administration: (i) actors and coalitions of actors, (ii) power and resources, (iii) operating rules, and (iv) discourse. The analysis showed that there is still a persistent state-centralised governance of flood risk in Slovakia and a focus of flood risk management only on flood protection strategies due to stability forces that outweigh the forces of change. This type of flood risk governance is unsustainable in the long term, and it will need some decentralisation and diversification of flood risk management for society to adapt to climate change and increase societal resilience to flood risk (Solín 2020 ADNB36; Solín 2017 ADFB18).

Research cluster: ***Development Trajectories of Localities and Regions in the Context of Socio-economic Change***

Four main research topics (suburbanisation, spatial and regional disparities, sustainable mobility and shopping behaviour) have been the subject of our research within this cluster. Four APVV projects, 11 VEGA projects and two international projects (ESPON and NCN) supported this research.

The most important research activity supported by the APVV project (SUBURBA) was the research on suburbanisation in the hinterland of Bratislava, the capital city of Slovakia. Suburbanisation represents the most significant transformation of residential and socio-spatial relationships in the post-socialist history of Slovakia, and its trajectory and parameters will significantly affect possibilities for the future development of this dynamically growing region as well as spaces far beyond local administrative and even national borders. Pioneering empirical research and acquired knowledge about the basic parameters of the process of urban transformation and suburbanisation in the metropolitan area of Bratislava was summarised in two edited monographs (Šveda & Šuška eds. 2019 FAI13; Šveda & Šuška eds. 2020 FAI14) and an atlas (Šveda et al. 2021 AAB07). This strong empirical and regional emphasis on suburbanisation research does not mean that there are no outputs engaging in international scientific debate. The development of innovative methods and methods of data processing that open up new possibilities of research of socio-spatial interaction was also important: namely, the discovery of the possibilities of using mobile phone data applied, for example, in risk analysis associated with urban heat generation (Holec et al. 2021 ADCA11) and daily mobility and daily rhythms in the metropolitan region itself (Šveda et al. 2020 ADCA44 - see Figure 3; Šveda & Barlík 2018 ADMB33). Furthermore, the methods of displaying geographical data

were developed in a comprehensive form in the Atlas of Suburbanisation (Šveda et al. 2021 AAB07), a theoretical and conceptual reflection on postsocialism and community (Blažek & Šuška 2017 ADCA02), an international comparison of urban changes (Malý et al. 2020 ADCA17; Osman et al. 2020 ADCA20) and a synthesising generalisation of spatial manifestations of suburbanisation in the Bratislava hinterland (Šveda et al. 2016 ADCA43).

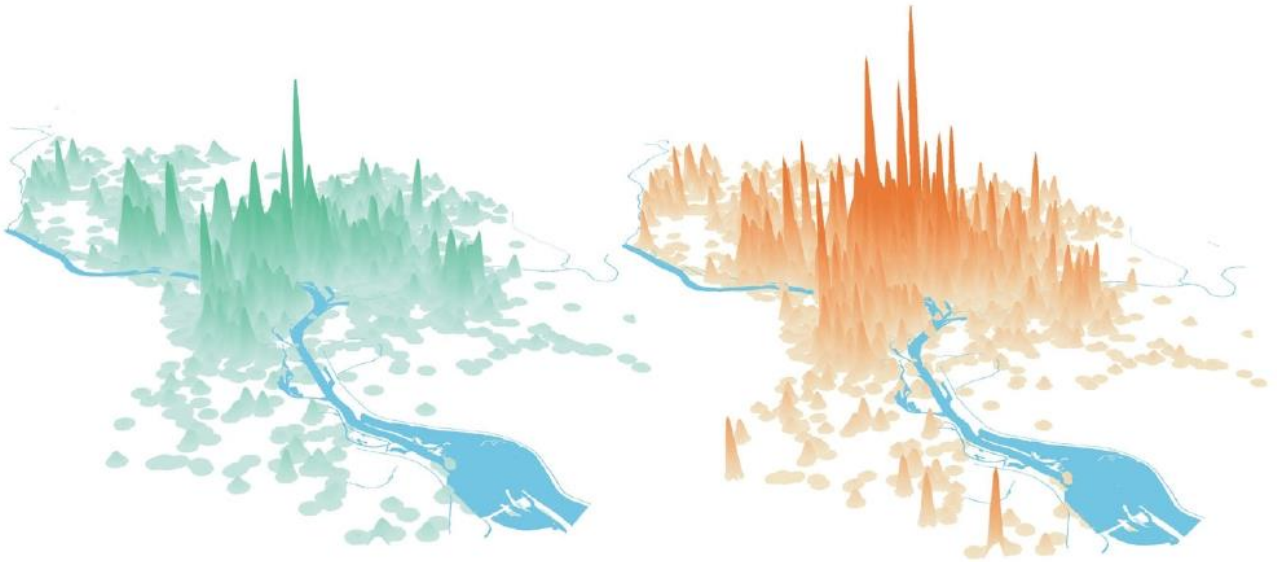

Figure 3: Nighttime (left) and daytime (right) localisation of mobile phone users in Bratislava. Kernel density of the number of unique phone IDs with a long-term day and night localisation
Sources: Šveda et al. (2020, ADCA44, (data) Market Locator SK: N = 822,165)

Another crucial component of the human geography research cluster was the research on spatial and regional inequalities, the trends of their development, and the identification and typification of marginal and poor regions in Slovakia. A wide range of topics focusing on the aspects of inequalities was addressed in two consecutive VEGA projects. Both of these projects were awarded a certificate of excellence for their results. The research shows that in recent years Slovakia has been characterised by a process of regional divergence. The process has been accompanied and manifested by the growth of marginality and poverty in some regions. A mono-thematic publication on the spatial aspects of poverty in Slovakia was published (Michálek & Podolák eds. 2016 FAI08), and a generally valid conceptual and methodological framework for classifying poverty regions applicable to other countries was developed (Michálek & Sládeková Madajová 2018 ADMB19). Research on the temporality of poverty in the districts of Slovakia confirmed the existence of different "temporal" types of poverty that determine their profile on the timeline. It has been shown that there is a direct relationship between the severity and duration of poverty in Slovakia (Michálek 2018 ADNB20). Examining the impact of economic growth and inequality on poverty at the regional level in Slovakia has provided relevant insights into the current status, development and trends of the studied phenomena in the analysed regions (Michálek & Výbošťok 2018 ADMB17). The presentation of a range of appropriate methods for measuring income inequalities and their classification and applicability in geographical analyses was also published (Výbošťok & Michálek 2020 ADNB45). Analyses focusing on EU countries (Michálek & Výbošťok 2019 ADCA19) confirmed our hypothesis that economic growth positively affects (reduces) the poverty rate and that a rise in income inequality increases it. The results also confirmed the existence of common systemic and developmental patterns valid for different types of countries (see Figure 4).

Sustainable mobility is an essential element of successful regional and urban development. Using sustainable transport modes (e.g. public transport, cycling and walking) contributes to social equality and economic effectiveness and gives us environmental benefits; however, since 1989 post-socialist countries have faced massive automobilisation along with lapses in other transport modes. Our research has focused on public transport at both the regional and urban levels (with a particular emphasis on international research and cooperation) and walking in an urban environment. A comparative study on the urban rhythms of Bratislava and Brno (Osman et al. 2020 ADCA20) revealed that rhythms were operationalised through the timetables of their public transport systems. The detailed analysis made it possible to assess the time policies in both cities and their implications for planning. Research on gender differences in urban walking revealed that adolescent girls

perceived more threats, and their walkability perception was affected by fear to a greater extent compared to boys (Rišová & Sládeková Madajová 2020 ADCA28). We found out that the walking activity space of girls was more compact and questioned the validity of the paradigm that girls and women walk less than boys and men in general terms and in city centres specifically (Rišová 2021 ADCA29). We pointed to the fact that despite the favourable effect of public transport on achieving sustainability, there was a decline in public transport connectivity at the national level (Michniak & Székely 2019 ADMB22) as well as a significant decrease in cross-border public transport in the Slovak-Polish borderland (Michniak & Więckowski 2021 ABC10). Identifying localities with insufficient public transport accessibility is a key socio-economic issue for excluding affected inhabitants from everyday activities (Székely & Novotný 2020 AFA03). We also analysed the changes, problems and challenges of passenger railway transport in Slovakia (Michniak 2018 ADNB22), the role of railway transport in tourism (Michniak 2016 ADMB21) and transport-related problems in the case of Bratislava and its suburban region (Michniak 2019 ADMB23).

Figure 4: The complex classifcation of EU member states by GDP, inequality and poverty
Source: Michálek & Výbošťok (2019, ADCA19)

Retail, consumption and shopping behaviour are dynamic in time and space; this is the reason why the research of transformative trajectories of retail, being one of the most dynamically changing economic sectors and creating an integral part of our day-to-day lives, became a part of the research cluster. The research of these matters was carried out thanks to the financial support of two completed VEGA grants (the results of the latter one were awarded a certificate of excellence) and one ongoing APVV grant. Within the frame of multiple research activities, we focused on retail and consumption research (Križan & Bilková 2019 AAB03) and, more precisely, on participants in the process of buying – i.e. consumers (Križan et al. 2020 AAB04). Even though the retail transformation took place in the context of globalisation processes, there are certain particularities typical for urban retail (Križan et al. 2019 ADDA02) and rural retail (Bilková et al. 2018 ADMB01). We observed a

significant concentration of retail shops and the construction of wide-area stores such as supermarkets. Shopping centres became important locations of consumption (Križan et al. 2018 ADMB11), even being called "cathedrals of consumption" (Križan et al. 2020 ABD13). On the contrary, a decrease in retail stores was monitored in the countryside, leading to the more frequent development of areas called "food deserts" (Opravil et al. 2020 ABD13), where consumers are limited by accessibility to affordable and healthy food. Many consumers living in the countryside take advantage of going grocery shopping outside their area of residence. This crossed national boundaries in certain cases, and this phenomenon is called "cross-border shopping" (Bilková et al. 2017 ABD01; Kita et al. 2020 ADMA04). We carried out a study of changes in shopping behaviour patterns with a sample of senior citizens and teenagers (Križan et al. 2018 ADCA15; Nájdený et al. 2019 ADNB23). Slovak consumers follow the trend of transition from consumerism to sustainable consumerism, where we focused on the research of alternative food chains, particularly in the form of farmers' markets and community gardens (Hencelová et al. 2020 ADDA01; Hencelová et al. 2021 ADMA02). From a methodical point of view, the utilisation of localisation data from mobile operators for delimiting trade areas by means of GIS can serve as an example (Križan et al. 2020 ADFB09) or visualisation of the time and spatial records of individuals and their utilisation for the monitoring of shopping behaviour (Križan et al. 2017 ABD11).

In addition to research that empirically documents spatio-temporal changes, research that monitors changes (developments) in geographical was also important (Ira & Matlovič 2019 ADEB03; Ira & Matlovič 2020 ADMB07).

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, international/regional (in percentage)

Basic research – 70% / Applied research – 30%;

International research – 30% / Regional research – 70%.

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organisations should be underlined.

AAB01 FERANEC, Ján - OŤAHEĽ, Ján - KOPECKÁ, Monika - NOVÁČEK, Jozef - PAZÚR, Róbert. *Krajinná pokrývka Slovenska a jej zmeny v období 1990-2012*. [Land Cover of Slovakia and its changes in the period 1990-2012]. Rec. F. Petrovič, J. Kolář. Bratislava : Veda, 2018. 160 s. ISBN 978-80-224-1648-1

ADCA10 HOLEC, Juraj** - FERANEC, Ján - ŠŤASTNÝ, Pavel - SZATMÁRI, Daniel - KOPECKÁ, Monika - GARAJ, Marcel. Evolution and assessment of urban heat island between the years 1998 and 2016: case study of the cities Bratislava and Trnava in western Slovakia. In *Theoretical and Applied Climatology*, 2020, vol. 141, iss. 3-4, p. 979–997. (2019: 2.882 - IF, Q2 - JCR, 0.966 - SJR, Q2 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 0177-798X. Dostupné na: https://doi.org/10.1007/s00704-020-03197-1

ADCA11 HOLEC, Juraj - ŠVEDA, Martin - SZATMÁRI, Daniel - FERANEC, Ján - BOBÁĽOVÁ, Hana - KOPECKÁ, Monika - ŠŤASTNÝ, Pavel. Heat risk assessment based on mobile phone data: case study of Bratislava, Slovakia. In *Natural Hazards*, 2021, vol. 108, no. 3, p. 3099-3120. (2020: 3.102 - IF, Q2 - JCR, 0.760 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 0921-030X. Dostupné na: https://doi.org/10.1007/s11069-021-04816-4

ADCA13 KIDOVÁ, Anna - LEHOTSKÝ, Milan - RUSNÁK, Miloš. Geomorphic diversity in the braided-wandering Belá River, Slovak Carpathians, as a response to flood variability and environmental changes. In *Geomorphology*, 2016, vol. 272, p. 137-149. (2015: 2.813 - IF, Q1 - JCR, 1.385 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS). ISSN 0169-555X. Dostupné na: https://doi.org/10.1016/j.geomorph.2016.01.002

ADCA14 KIDOVÁ, Anna** - RADECKI-PAWLIK, Artur - RUSNÁK, Miloš - PLESIŃSKI, Karol. Hydromorphological evaluation of the river training impact on a multi-thread river system (Belá River, Carpathians, Slovakia). In *Scientific Reports*, 2021, vol. 11, art. no. 6289. (2020: 4.380 - IF, Q1 - JCR, 1.240 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents, WOS, SCOPUS). ISSN 2045-2322. Dostupné na: https://doi.org/10.1038/s41598-021-85805-2

ADCA17 MALÝ, Jiří - DVOŘÁK, Petr** - ŠUŠKA, Pavel. Multiple transformations of post-socialist cities: Multiple outcomes? In *Cities*, 2020, vol. 107, art. no. 102901. (2019: 4.802 - IF, Q1 - JCR, 1.606 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 0264-2751. Dostupné na: https://doi.org/10.1016/j.cities.2020.102901

ADCA19 MICHÁLEK, Anton** - VÝBOŠŤOK, Ján. Economic Growth, Inequality and Poverty in the EU. In *Social Indicators Research*, 2019, vol. 141, no. 2, p. 611-630. (2018: 1.703 - IF, Q2 - JCR, 0.881 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, Scopus). ISSN 0303-8300. Dostupné na: https://doi.org/10.1007/s11205-018-1858-7

ADCA22 PAZÚR, Róbert - FERANEC, Ján - ŠTYCH, Přemysl - KOPECKÁ, Monika - HOLMAN, Lukáš. Changes of urbanised landscape identified and assessed by the urban atlas data: case study of Prague and Bratislava. In *Land Use Policy : the International Journal Covering All Aspects of Land Use*, 2017, vol. 61, p. 135-146. (2016: 3.089 - IF, Q1 - JCR, 1.408 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0264-8377. Dostupné na: https://doi.org/10.1016/j.landusepol.2016.11.022

ADCA25 PAZÚR, Róbert** - PRISHCHEPOV, Alexander V. - MYACHINA, Ksenya - VERBURG, Peter H. - LEVYKIN, Sergey - PONKINA, Elena V. - KAZACHKOV, Grigory - YAKOVLEV, Ilya - AKHMETOV, Renat - ROGOVA, Natalia - BÜRGI, Matthias. Restoring steppe landscapes: patterns, drivers and implications in Russia's steppes. In *Landscape Ecology*, 2021, vol. 36, p. 407-425. (2020: 3.851 - IF, Q2 - JCR, 1.304 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 0921-2973. Dostupné na: https://doi.org/10.1007/s10980-020-01174-7

ADCA28 RIŠOVÁ, Katarína** - SLÁDEKOVÁ MADAJOVÁ, Michala. Gender differences in a walking environment safety perception: A case study in a small town of Banská Bystrica (Slovakia). In *Journal of Transport Geography*, 2020, vol. 85, art. no. 102723. (2019: 3.834 - IF, Q1 - JCR, 1.777 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 0966-6923. Dostupné na: https://doi.org/10.1016/j.jtrangeo.2020.102723

ADCA32 RUSNÁK, Miloš** - SLÁDEK, Ján - KIDOVÁ, Anna - LEHOTSKÝ, Milan. Template for high-resolution river landscape mapping using UAV technology. In *Measurement*, 2018, vol. 115, p. 139-151. (2017: 2.218 - IF, Q2 - JCR, 0.733 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 0263-2241. Dostupné na: https://doi.org/10.1016/j.measurement.2017.10.023

ADCA34 RUSNÁK, Miloš** - KAŇUK, Ján - KIDOVÁ, Anna - ŠAŠAK, Ján - LEHOTSKÝ, Milan - PÖPPL, Ronald - ŠUPINSKÝ, Jozef. Channel and cut-bluff failure connectivity in a river system: Case study of the braided-wandering Belá River, Western Carpathians, Slovakia. In *Science of the Total Environment*, 2020, vol. 733, art. no. 139409. (2019: 6.551 - IF, Q1 - JCR, 1.661 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 0048-9697. Dostupné na: https://doi.org/10.1016/j.scitotenv.2020.139409

ADCA37 SOLÍN, Ľubomír** - SLÁDEKOVÁ MADAJOVÁ, Michala - SKUBINČAN, Peter. Mitigating flood consequences: analysis of private flood insurance in Slovakia. In *Journal of Flood Risk Management*, 2018, vol. 11, no. S1, p. S173-S185. (2017: 2.483 - IF, Q2 - JCR, 0.754 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 1753-318X. Dostupné na: https://doi.org/10.1111/jfr3.12191

ADCA38 SOLÍN, Ľubomír** - SLÁDEKOVÁ MADAJOVÁ, Michala - MICHALEJE, Lukáš. Vulnerability assessment of households and its possible reflection in flood risk management: The case of the upper Myjava basin, Slovakia. In *International Journal of Disaster Risk Reduction*, 2018, vol. 28, p. 640-652. (2017: 1.968 - IF, Q2 - JCR, 0.769 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 2212-4209. Dostupné na: https://doi.org/10.1016/j.ijdrr.2018.01.015

ADCA40 SZATMÁRI, Daniel** - FERANEC, Ján - GOGA, Tomáš - RUSNÁK, Miloš - KOPECKÁ, Monika - OŤAHEĽ, Ján. The Role of Field Survey in the Identification of Farmland Abandonment in Slovakia Using Sentinel-2 Data. In *Canadian Journal of Remote Sensing*, 2021, vol. 47, no. 4, p. 569-587. (2020: 2.000 - IF, Q3 - JCR, 0.694 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 0703-8992. Dostupné na: https://doi.org/10.1080/07038992.2021.1929118

ADCA44 ŠVEDA, Martin** - SLÁDEKOVÁ MADAJOVÁ, Michala - BARLÍK, Peter - KRIŽAN, František - ŠUŠKA, Pavel. Mobile phone data in studying urban rhythms: Towards an analytical framework. In *Moravian Geographical Reports*, 2020, vol. 28, no. 4, p. 248-258. (2019: 2.479 - IF, Q2 - JCR, 0.693 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 1210-8812. Dostupné na: https://doi.org/10.2478/mgr-2020-0018

ADMB09 KOPECKÁ, Monika - SZATMÁRI, Daniel - ROSINA, Konštantín. Analysis of urban green spaces based on Sentinel-2A: case studies from Slovakia. In *Land*, 2017, vol. 6, no. 2, art. no. 25. (2016: 0.481 - SJR, Q2 - SJR). (2017 - WOS, Scopus). ISSN 2073-445X. Dostupné na: https://doi.org/10.3390/land6020025

FAI01 ***European Landscape Dynamics : Corine Land Cover Data***. Edited by J. Feranec, T. Soukup, G. Hazeu, G. Jaffrain. Boca Raton : CRC Press, Taylor & Francis Group, 2016. 337 p. ISBN 978-1-4822-4466-3 https://doi.org/10.1201/9781315372860
(3 larger and 14 smaller chapters co-authored by Assoc. Prof. J. Feranec)

FAI07 *Príjmové nerovnosti a ich prejavy v regiónoch Slovenska* = Income inequality and their effects in regions of Slovakia. Editor+autor Anton Michálek ; rec. J. Kunc, D. Gerbery, F.

Križan. Bratislava : Veda, 2020. 168 s. ISBN 978-80-224-1820-1
(7/7 chapters authored or co-authored by researchers from the IG SAS)

FAI13 ***Suburbanizácia : ako sa mení zázemie Bratislavy?*** **[Suburbanization: to what extent has Bratislava's hinterland changed?]**. Eds. Martin Šveda, Pavel Šuška ; rec. Vladimír Ira, Marián Halás. Bratislava : Geografický ústav SAV, 2019. 297 s. Dostupné na internete: <http://www.geography.sav.sk/web-data/news/data/2019_suska-sveda_monografia/2019_Sveda-Suska_Suburbanizacia_dvojstranky.pdf>. ISBN 978-80-89548-08-8 (10/12 chapters authored or co-authored by researchers from the IG SAS)

2.1.3 List of monographs/books published abroad

FAI01 *European Landscape Dynamics : Corine Land Cover Data*. Eds. J. Feranec, T. Soukup, G. Hazeu, G. Jaffrain. Boca Raton : CRC Press, Taylor & Francis Group, 2016. 337 p. ISBN 978-1-4822-4466-3 (3 larger and 14 smaller chapters co-authored by Assoc. Prof. J. Feranec)

2.1.4. List of monographs/books published in Slovakia

AAB01 FERANEC, Ján - OŤAHEĽ, Ján - KOPECKÁ, Monika - NOVÁČEK, Jozef - PAZÚR, Róbert. *Krajinná pokrývka Slovenska a jej zmeny v období 1990-2012*. Rec. F. Petrovič, J. Kolář. Bratislava : Veda, 2018. 160 s. ISBN 978-80-224-1648-1

AAB02 KITA, Jaroslav - KITA, Pavol - KRIŽAN, František - BILKOVÁ, Kristína - KUNC, Josef. *Marketing spotreby* [Marketing of consumption]. Rec. J.W. Wiktor, R. Štefko, Z. Szczyrba. Bratislava : Univerzita Komenského v Bratislave, 2019. 161 s. ISBN 978-80-223-4773-0

AAB03 KRIŽAN, František - BILKOVÁ, Kristína. *Geografia spotreby: úvod do problematiky* [Geography of consumption: introduction]. Rec. Jana Mitríková, Zdeněk Szczyrba. Bratislava : Univerzita Komenského v Bratislave, 2019. 120 s. ISBN 978-80-223-4676-4

AAB04 KRIŽAN, František - BILKOVÁ, Kristína - HENCELOVÁ, Petra - DANIELOVÁ, Katarína - ČULÁKOVÁ, Katarína - ZEMAN, Milan. *Nákupné správanie spotrebiteľov na Slovensku vybrané kapitoly*. 1. vyd. Bratislava : Univerzita Komenského v Bratislave vo vydavateľstve UK, 2020. 134 s. ISBN 978-80-223-5070-9

AAB05 ROSINA, Konštantín - HURBÁNEK, Pavol. *Spatial Disaggregation of Population Density Using Land Cover and Remote Sensing Data* = Priestorová dezagregácia hustoty zaľudnenia s využitím máp krajinnej pokrývky a údajov diaľkového prieskumu Zeme. Rec. Jaroslav Hofierka, Dagmar Kusendová. Bratislava : Geografický ústav SAV, 2016. 80 s., obraz. príl. Geographia Slovaca, 31. ISBN 978-80-89548-02-6. ISSN 1210-3519. Available: <https://www.sav.sk/journals/uploads/12150909GS_31_web.pdf>.

AAB06 SLÁDEKOVÁ MADAJOVÁ, Michala - HURBÁNEK, Pavol. *Areálová transformácia geografických dát: princípy, metódy a aplikácia* = Areal Transformation of Geographical Data: Principles, Methods and Application. Rec.: Marián Halás, Ladislav Novotný. Bratislava : Geografický ústav SAV, 2016. 112 s. Geographia Slovaca, 32. Available: <https://www.sav.sk/journals/uploads/12151056GS%2032.pdf>. ISBN 978-80-89548-03-3. ISSN 1210-3519

AAB07 ŠVEDA, Martin - VÝBOŠŤOK, Ján - GURŇÁK, Daniel. *Atlas suburbanizácie Bratislavy*. Rec. Novotný Ladislav, Bačík Vladimír. Bratislava : Geografický ústav SAV, 2021. 120 s. ISBN 978-80-89548-10-1

FAI09 *Slovensko*. Editori: Ján Lacika, Ján Hanušin, Peter Podolák, Kliment Ondrejka. 2. dopl. a aktual. vyd. Bratislava : Ikar, 2020. 583 s. Unikátny obrazový sprievodca. ISBN 978-80-551-7449-5 (three editors and 10 co-authors from the IG SAS)

FAI07 *Príjmové nerovnosti a ich prejavy v regiónoch Slovenska* = Income inequality and their effects in regions of Slovakia. Editor+autor Anton Michálek ; rec. J. Kunc, D. Gerbery, F. Križan. Bratislava : Veda, 2020. 168 s. ISBN 978-80-224-1820-1 (7/7 chapters authored or co-authored by researchers from the IG SAS)

FAI13 *Suburbanizácia : ako sa mení zázemie Bratislavy?* [Suburbanization: to what extent has Bratislava's hinterland changed?]. Eds. Martin Šveda, Pavel Šuška ; rec. Vladimír Ira, Marián Halás. Bratislava : Geografický ústav SAV, 2019. 297 s. Available: <http://www.geography.sav.sk/web-data/news/data/2019_suska-

sveda_monografia/2019_Sveda-Suska_Suburbanizacia_dvojstranky.pdf>. ISBN 978-80-89548-08-8 (10/12 chapters authored or co-authored by researchers from the IG SAS)

FAI14 *Suburbanizácia 2 : sondy do premien zázemia Bratislavy*. Eds. Martin Šveda, Pavel Šuška ; rec. Vladimír Ira, Marián Halás. Bratislava : Geografický ústav SAV, 2020. 241 s. Available: <http://www.geography.sav.sk/suburbanizacia-2/>. ISBN 978-80-89548-09-5 (7/9 chapters authored or co-authored by researchers from the IG SAS)

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on

ABC01 FERANEC, Ján - SOUKUP, Tomáš - TAFF, Gregory N - ŠTYCH, Přemysl - BIČÍK, Ivan. Overview of Changes in Land Use and Land Cover in Eastern Europe. In *Land-Cover and Land-Use Changes in Eastern Europe after the Collapse of the Soviet Union in 1991*. - Springer International Publishing Switzerland, 2017, p. 13-33. ISBN 978-3-319-42636-5. Dostupné na: https://doi.org/10.1007/978-3-319-42638-9_2

ABC12 SOLÍN, Ľubomír - SLÁDEKOVÁ MADAJOVÁ, Michala. Flood Risk of Municipalities in Upper Basins of Slovakia. In *Water Resources in Slovakia: Part II : climate Change, Drought and Floods*. - Cham : Springer International Publishing AG, 2019, p. 173-193. ISBN 978-3-319-92864-7. ISSN 1867-979X. Dostupné na: https://doi.org/10.1007/698_2017_173

ADCA08 GOGA, Tomáš** - FERANEC, Ján - BUCHA, Tomáš - RUSNÁK, Miloš - SAČKOV, I. - BARKA, Ivan - KOPECKÁ, Monika - PAPČO, Juraj - OŤAHEĽ, Ján - SZATMÁRI, Daniel - PAZÚR, Róbert - SEDLIAK, Maroš - PAJTÍK, Jozef - VLADOVIČ, Jozef. A Review of the Application of Remote Sensing Data for Abandoned Agricultural Land Identification with Focus on Central and Eastern Europe. In *Remote Sensing : Open Access Journal*, 2019, vol. 11, no. 23, art. no. 2759. (2018: 4.118 - IF, Q1 - JCR, 1.430 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents). ISSN 2072-4292. Dostupné na: https://doi.org/10.3390/rs11232759

ADCA23 PAZÚR, Róbert - BOLLIGER, J. Land changes in Slovakia: past processes and future directions. In *Applied Geography*, 2017, vol. 85, p. 163-175. (2016: 2.687 - IF, Q1 - JCR, 1.250 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS. SCOPUS). ISSN 0143-6228. Dostupné na: https://doi.org/10.1016/j.apgeog.2017.05.009

ADCA29 RIŠOVÁ, Katarína**. Questioning gender stereotypes: A case study of adolescents walking activity space in a small Central European city. In *Journal of Transport Geography*, 2021, vol. 91, art. no. 102970. (2020: 4.986 - IF, Q1 - JCR, 1.809 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 0966-6923. Dostupné na: https://doi.org/10.1016/j.jtrangeo.2021.102970

ADCA31 RUSNÁK, Miloš - LEHOTSKÝ, Milan - KIDOVÁ, Anna. Channel migration inferred from aerial photographs, its timing and environmental consequences as responses to floods: a case study of the meandering Topľa River, Slovak Carpathians. In *Moravian Geographical Reports*, 2016, vol. 24, no. 3, p. 32-43. (2015: 1.093 - IF, Q3 - JCR, 0.507 - SJR, Q2 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 1210-8812. Dostupné na: https://doi.org/10.1515/mgr-2016-0015

ADCA33 RUSNÁK, Miloš** - SLÁDEK, Ján - PACINA, Jan - KIDOVÁ, Anna. Monitoring of avulsion channel evolution and river morphology changes using UAV photogrammetry: Case study of the gravel bed Ondava River in Outer Western Carpathians. In *Area*, 2019, vol. 51, no. 3, p. 549-560. (2018: 2.133 - IF, Q2 - JCR, 1.137 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents). ISSN 0004-0894. Dostupné na: https://doi.org/10.1111/area.12508

ADCA39 SOLÍN, Ľubomír** - RUSNÁK, Miloš. Preliminary flood risk assessment: case study of systematic processing of available of readily derivable information. In *Water and Environment Journal*, 2020, vol. 34, supp. S1, p. 683-698. (2019: 1.426 - IF, Q3 - JCR, 0.378 - SJR, Q2 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 1747-6585. Dostupné na: https://doi.org/10.1111/wej.12570

ADCA43 ŠVEDA, Martin - MADAJOVÁ, Michala - PODOLÁK, Peter. Behind the Differentiation of Suburban Development in the Hinterland of Bratislava, Slovakia. In *Sociologický časopis / Czech Sociological Review*, 2016, roč. 52, č. 6, s. 893-925. (2015:

0.262 - IF, Q4 - JCR, 0.278 - SJR, Q2 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0038-0288. Dostupné na: https://doi.org/10.13060/00380288.2016.52.6.290

ADMB07 IRA, Vladimír** - MATLOVIČ, René. Challenges and opportunities for human geography: a few remarks. In *Geographia Polonica*, 2020, vol. 93, no. 4, p. 525-537. (2019: 0.294 - SJR, Q1 - SJR). ISSN 0016-7282. Dostupné na: https://doi.org/10.7163/GPol.0184

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

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

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2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)

Human activity changes the Earth's surface and landscape, and it transforms both natural and socio-economic systems. Our primary mission is basic research into the spatial structure and development of natural and socio-economic systems and their interrelations at various spatial levels (European, national, regional and local) with a particular emphasis being placed on the territory of Slovakia. This means that spatio-temporal changes and the development, transformation and evolution of landscapes, regions and localities have a central importance in our research activities, which contribute to increasing the level of knowledge and education and practically applying the results of scientific research. Geographical research tries to respond to current and geographically relevant problems in society.

The use of remote sensing in conjunction with GIS has proven to be effective in identifying various environmental characteristics such as vegetation cover, urban sprawl, forest changes and particularly variations in land cover/use changes over time. Land use managers and decision-makers may better understand the relationships between human and natural processes by analysing land cover change patterns.

CORINE Land Cover (CLC) data became a valuable source of original information for those interested in understanding the European landscape and its dynamism. The book *European Landscape Dynamics* (Feranec et al. eds. 2016, FAI01) is a comprehensive compendium on the European CLC. It is the result of almost thirty years of participation of the IG SAS in CLC projects and the multi-year activities of Ján Feranec (the book's chief editor and author or co-author of three longer and fourteen shorter chapters) in the CLC Technical Team. As a member of this team, he also contributed to the formation of reputable and experienced specialists to prepare the book. Several published reviews in reputed journals show that this book can be recommended as a valuable source of information for land use scientists, post-secondary students of geosciences, cartographers and practitioners who need access to more in-depth information about CLC beyond available publications (International Journal of Applied Earth Observation and Geoinformation, IF 5.933, https://doi.org/10.1016/j.jag.2017.02.020; Progress in Physical Geography, IF 3.795, https://doi.org/10.1177/0309133316680399). The intellectual and cognitive structure assessment of CORINE Land Cover research applications, including at the IG SAS, can be found in a study by Bielecka & Jenerowicz (2019) https://www.mdpi.com/2072-4292/11/17/2017.

The temporal and spatial characteristics of land cover changes over more than two decades in Slovakia indicate an increasing trend in deforestation, a decreasing trend in forestation, an intensification of agriculture, the construction of water reservoirs and some other changes. The results of this research are summarised in a book entitled *Land Cover of Slovakia and its Change in 1990–2012* (Feranec et al. 2018 AAB01).

Widespread agricultural abandonment and associated negative phenomena have been documented in many Central and Eastern European countries after the political and socio-economic changes in 1989. Involvement in this research topic documents the international relevance of the IG SAS because it was supported by two international projects under the ESA-PECS and ERA.Net RUS Plus programmes.

Agricultural land abandonment across the steppe belt of Eurasia has provided an opportunity for the restoration of steppe landscapes in recent decades; however, global food demands are about to revert this trajectory and put restored steppe landscapes at risk. The CLIMASTEPPE project team within the ERA.Net RUS Plus Programme assessed steppe development in southern Russia over the last forty years and its spatial patterns and drivers of change for several periods (Pazúr et al. 2021 ADCA25). Steppe restoration has appeared in areas marginal for agricultural production that have poor natural conditions and a small human footprint. Consequently, the permanent steppe became less fragmented, and a more continuous steppe landscape has appeared. The remaining isolated steppe patches require attention in restoration programmes as they are mostly located in areas of intensive agricultural land use.

Agricultural land abandonment is a dynamic process characterised by significant spectral variability and spectral similarity to areas of agricultural land. We pointed out that field surveys must precede the identification of abandoned agricultural land (AAL) based on remote sensing data focused on acquiring physiognomic characteristics (the composition of species, height of vegetation, textures, and clustering into patterns) of these areas. We compared the differences between several classes of AAL, interpreted the results and combined the information from the different satellite data sets in Slovakia (Szatmári et al. 2021 ADCA40).

The riverine landscape is one of the most dynamic and vulnerable types of landscapes. Six VEGA projects have supported research into riverine landscapes, and research activities were also included in three COST projects. The recognition of behaviour and the responses of morphological and sedimentary properties of channels and floodplains over time is therefore fundamental for these landscapes' preservation and conservation (Kidová et al. 2016 ADCA13; Rusnák et al. 2020 ADCA34). It is also necessary to consider changing climatic conditions and human activities (Kidová et al. 2021 ADCA14) as well as their effect on the further development of riverine landscapes. Floodplains are an important part of the landscape in terms of ecology and the economy, and they concentrate agriculture, population and industrial activities. Human settlements coexist with the power of the river; however, the mitigation of negative consequences must be supported by detailed analyses, assessments and the identification of hotspots (Kidová et al. 2016 ADCA13). In this context, vulnerability and expressing people's capacity to anticipate, cope with, resist and recover from the impact of a natural hazard must also be considered in flood risk assessment and management. Indeed, integrated flood risk management (Solín et al. 2018 ADCA38) is entwined with current societal issues. Combining approaches to the physical and geographical parameterisation of riverine landscapes and the flood risk assessment of inhabited floodplains brings a holistic perspective to the evaluation of river management issues.

Understanding geomorphic river responses to floods requires a complex palette of methods and approaches to reveal general trends of river evolution. The development of the Post-flood Period Serial Geomorphic Analysis (POPSEGA) approach was applied to infer the impact of flood events and environmental changes on the evolutionary trend of Carpathian rivers (e.g. Belá, Váh, Topľa, Ondava and Poprad) from the mid-twentieth century. Coupled with complex GIS analysis, remote sensing data processing and detailed field research, an identification of spatio-temporal geomorphic changes of the studied rivers that occurred during particular flood periods was performed. The final output identifies different evolutionary stages of in-channel morphology (contraction, stable or expansion phases), bank erosion risk and the negative effect of channel degradation (Kidová et al. 2016 ADCA13).

The monitoring of the landscape is connected with the modern technology development in sensor resolution and data processing. Close-range monitoring with optical and laser sensors is gradually replacing time-consuming and labour-intensive traditional fieldwork. High precise spatial data sources such as Terrestrial Laser-Scanning (TLS) and drones undertaking optical, multispectral and lidar mapping allow for sophisticated analyses of relief attributes, water parameters, topography changes, substrate properties and vegetation attributes (Rusnák et al. 2018 ADCA32; Rusnák et al. 2020 ADCA34). Effective and operative field-based river monitoring with TLS produces a centimetre-level resolution elevation model to assess sediment cascade and in-channel sediment supply and detect detailed morphological changes. This database is useful for the interpretation and conceptualisation of the cascade model with a level of detail and process connection that has not been seen before (Rusnák et al. 2020 ADCA34).

The negative effect of the human impact on rare and unique river systems in nature conservation areas is still detectable and is in contrast to the recommendations of scientific and international documents (e.g. the Water Framework Directive and the EU Biodiversity Strategy). Analyses of

spatio-temporal variations in river morphology (twelve channel parameters) and changes in cross-section and hydraulic parameters (flow velocity, shear stress, stream power and W/D ratios) between pre- and post-flood management periods were performed. The research hypotheses relating to decreasing geodiversity in managed river reaches, a rapid increase in flow velocity during extreme floods in river reaches where there is no sufficient floodplain inundation due to artificially high banks built by river training works, and an increasing erosive force in the channel zone due to river management intervention were all confirmed (Kidová et al. 2021 ADCA14).

Based on the National Strategy for Security Risk Management of the Slovak Republic from 2015, natural hazards are divided into four categories according to the degree of relevance. For Slovakia, hazards caused by the weather, almost always by intensive precipitations and floods, are considered to be a very high risk for society, which is increasingly looking for a way to eliminate this effect and therefore address the issue of flood risk. The research concept is based on the paradigm that the central idea of current adaptation strategies of flood risk management to climate change is not flood protection itself but rather increasing the resilience of society to flood risk as such. Reducing the vulnerability of households to flood threats is a prerequisite for increasing the resilience of society to flood risk. This issue has been addressed at both the local (Solín et al. 2018 ADCA37) and the national level. Flood protection based solely on technical infrastructure is no longer sufficient, and a diversification of flood risk management strategies is needed. Achieving society's resilience and adaptation to flood risk through a diversified approach requires the decentralisation of flood risk management. For this reason, an analysis of flood risk governance in Slovakia was undertaken (Solín 2020 ADNB34).

Spatio-temporal changes and the development and transformation of regions and localities have been an important part of our research activities. A significant feature of such research is its social science character, which has specific social, economic, political and cultural attributes that affect the regional specificity of the research.

Suburbanisation in the hinterland of Bratislava is the most significant transformation in residential and socio-spatial aspects in the post-socialist history of Slovakia, and its trajectory and parameters will significantly affect the future development possibilities of this dynamically growing region. This research was supported by a APVV project, where the IG SAS was the lead partner. The most important research output is a scientific monograph (Šveda & Šuška eds. 2019 FAI13), which provides a comprehensive study on this complicated phenomenon. The research, presented in twelve chapters (ten of which were written by authors from the IG SAS), focused on the evaluation of intensity and the spatial range of suburbanisation in the Bratislava hinterland, its demographic and social impacts, and spatial patterns of development. The researchers analysed a wide range of attributes from land use, housing, migration, mobility and impacts on demographic (age, ethnic and socio-economic) structures and associated cultural changes in the suburban area (value orientation and electoral behaviour), impacts on security and shopping behaviour, housing affordability and the specifics of cross-border suburbanisation. Besides the standard methods of social sciences, state-of-the-art methods of dynamically developing GIS and remote sensing were deployed. In addition to an in-depth analysis of particular aspects of suburbanisation, the work attempted to seek out relationships of mutual interdependencies and the connectivity necessary for the comprehensive evaluation of suburbanisation.

Several tendencies seemed to indicate that new residential zones with a different socio-economic structure were forming in the hinterland of Bratislava. A study by Šveda et al. (2016 ADCA43) analysed the hinterland of Bratislava from various perspectives of suburban development. The selection of variables covered the origin of immigrants and their economic activity, education and family status. The data were processed based on a factorial ecology approach which tried to discover the basic dimensions of the socio-spatial structure and cluster analysis. The study sought to identify key factors that affect the formation of individual suburban zones and has thus contributed to a better understanding of the processes that decisively shape the socio-spatial organisation of hinterlands in post-socialist cities today.

Within international cooperation on the topic of suburbanisation, a gap in understanding and interpreting the various trajectories of urban development among individual post-socialist cities was identified. By using the conceptual framework of multiple transformations and methodical approaches of urban ecology, we revealed specifics of urban and socio-demographic changes in Brno and Bratislava and pointed to the limitations of the framework when evaluating divergent paths of post-socialist transformation. The spatio-temporal analysis provided empirical evidence of distinct patterns of post-socialist transformations, which are related to the heterogeneity of socialist legacies,

residential policy and institutional factors with the capital city status in particular, and it showed that multiple outcomes of transformation are produced even in similar-sized cities with a common history of having been in the same socialist state (Malý et al. 2020 ADCA17).
The importance of the study of Bratislava and its suburban region for society can be documented by the interest of the media in this topic after the book was published and by cooperation with the Bratislava Metropolitan Institute and the involvement of some authors in preparing the strategic plan for the city of Bratislava (see Section 2.6.1).
A significant study has been created on the intersection of urbanisation and sustainable mobility research. It is worthwhile noting the research into gender differences in the perception of urban walking by adolescents (Rišová & Sládeková Madajová 2020 ADCA28). In empirical research, adolescent girls perceived the presence of more threats and their walkability perception was affected by fear to a greater extent compared to boys.
The existence of regional (income) inequalities is a significant phenomenon that determines and adversely affects several essential aspects of life. The excessive level of income inequality and the increasing concentration of wealth among the high-income population has led to social polarisation and social tension in Slovakia. This is accompanied by negative phenomena such as poverty. Numerous publications have been produced as a part of research, and they have provided a detailed overview of the theoretical concepts and methodological approaches to the spatial dimension of poverty and inequality. One of the most significant outputs on this topic is a monograph comprehensively describing relevant information on the level of income and income inequality in the regions of Slovakia (Michálek et al. 2020 FAI07); it consists of seven chapters and all chapters feature co-authors from the institute. It provides an overview of the theoretical background and concepts of research on the spatial dimension of income inequality. It focuses on phenomena where income is the dominant factor influencing quantitative and qualitative levels and development trends. These include the following: human development, population migration, suburbanisation, cardiovascular disease and food deserts. The monograph examines the problems of low-income populations concentrated mainly in southern and eastern regions in Slovakia from several points of view. The results show that in Slovakia even relatively high economic growth cannot significantly improve the lives of broad populations because its effects primarily benefit a relatively narrow group of people.
Combating poverty and social exclusion are among the main objectives of the EU Cohesion Policy. High levels of inequality in some EU countries increase the incidence and level of relative poverty. The question is what impact economic growth has on the level of inequality and how this can be expressed as accurately as possible. Further research has been aimed at determining the impact and consequences of economic growth in EU countries on inequality and the depth of poverty (Michálek & Výbošt'ok 2019 ADCA19). An analysis of Bourguignon's model (the Poverty–Growth–Inequality Triangle) showed that only a few EU member states have successfully benefited from rising aggregate wealth and thus experienced a decline in inequality and poverty. By contrast, most countries have not been able to fully reap the benefits of economic growth for the whole population. According to this model, a development strategy should be based on income growth and reducing inequalities. The contribution of this study is such that it offers a tool identifying relevant factors of poverty and inequality production that is also usable for international comparison. Two projects that dealt with the topics of spatial inequalities achieved excellent results based on the final evaluation by the Scientific Grant Agency (VEGA).
Geography combines aspects of natural science with social science approaches. This is visible in the abovementioned study concerning the vulnerability assessment of households and its possible reflection in flood risk management (Solín et al. 2018 ADCA38). Other important studies apply land use/land cover data in connection to changes in the urban environment.
Data from the Copernicus Urban Atlas are useful in studies in urban environment assessment. For example, we examined and compared the land use/cover change (LUCC) of Bratislava and Prague from 2006 to 2012. The results confirmed the dominance of present trends in modern industrial cities in the transformation of agricultural land into residential and industrial areas. Most urbanisation occurred on agricultural land with a good accessibility level. The coupling of Urban Atlas data with cadastral statistics helps identify city change processes (Pazúr et al. 2017 ADCA22).
Urban expansion and its ecological footprint is increasing globally at an unprecedented scale, and consequently the importance of urban greenery assessment is growing. The diversity and quality of urban green spaces (UGSs) and human well-being are tightly linked. UGSs provide a wide range of ecosystem services (e.g. urban heat mitigation, stormwater infiltration, food security and physical

recreation). Analyses and inter-city comparisons of UGS patterns and their functions require detailed information on their relative quantity and a closer examination of UGSs in terms of quality and land use, which can be derived from the land cover composition and spatial structure. We presented an approach to UGS extraction from newly available Sentinel-2 satellite imagery provided within the European Copernicus programme. We investigated and mapped the spatial distribution of UGSs in three cities in Slovakia: Bratislava, Žilina and Trnava. The presented case studies showed the possibilities for the semi-automatic extraction of UGS classes from Sentinel-2A data that may improve the transfer of scientific knowledge to local urban environmental monitoring and management (Kopecká et al. 2017 ADCA22).

Urban areas are generally expected to experience higher temperatures than surrounding rural areas due to the effect of urban heat islands (UHI). The outputs of the Mikroskaliges Urbanes KLIma MOdell (MUKLIMO) numerical model were used to evaluate the field of mean air temperature during selected days of a summer heatwave. The following layers were created to compute the risk index: the hazard layer of air temperature, a mitigation layer of tree vegetation, an exposure layer of population and a vulnerability layer of individuals over 65 years of age. Population density data are based on mobile positioning data, and elderly population data are based on a gridded database from the statistical census. Our results reflect the variability of the population (including the elderly) within the city and the variability of the temperature field, which is caused by the combined effect of UHIs and topography. The highest risk index values occur within the broader city centre, with specific hot spots in several places (Holec et al. 2021 ADCA11). The results of this APVV multidisciplinary project were included in the Excellence in Science 2021 report published by the APVV, which assesses the implementation and results of the best projects in various fields of science.

2.1.9. Table of research outputs

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

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad *(AAA, ABA)*	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	0	0,000	0,000	**0**	**0,000**	**0,000**	**0,000**
Scientific monographs and monographic studies in journals and proceedings published in Slovakia *(AAB, ABB)*	3	0,169	6,312	0	0,000	0,000	2	0,107	3,446	2	0,101	2,942	1	0,049	1,362	1	0,052	1,459	**9**	**1,500**	**0,079**	**2,446**
Chapters in scientific monographs published abroad *(ABC)*	4	0,226	8,416	3	0,168	5,724	**1**	0,053	1,723	5	0,253	7,356	1	0,049	1,362	1	0,052	1,459	**15**	**2,500**	**0,132**	**4,077**
Chapters in scientific monographs published in Slovakia *(ABD)*	9	0,508	18,936	9	0,505	17,173	0	0,000	0,000	13	0,657	19,125	18	0,890	24,511	0	0,000	0,000	**49**	**8,167**	**0,431**	**13,317**
Scientific papers published in journals registered in Current Contents Connect *(ADCA, ADCB, ADDA, ADDB)*	8	0,451	16,832	5	0,281	9,540	9	0,480	15,509	6	0,303	8,827	13	0,643	17,702	12	0,619	17,503	**53**	**8,833**	**0,466**	**14,404**
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above *(ADMA, ADMB, ADNA, ADNB)*	15	0,846	31,560	8	0,449	15,265	17	0,907	29,294	16	0,808	23,538	14	0,692	19,064	16	0,825	23,337	**86**	**14,333**	**0,756**	**23,373**
Scientific papers published in other foreign journals (not listed above) *(ADEA, ADEB)*	2	0,113	4,208	2	0,112	3,816	3	0,160	5,170	3	0,152	4,413	1	0,049	1,362	1	0,052	1,459	**12**	**2,000**	**0,106**	**3,261**
Scientific papers published in other domestic journals (not listed above) *(ADFA, ADFB)*	0	0,000	0,000	8	0,449	15,265	3	0,160	5,170	4	0,202	5,885	4	0,198	5,447	0	0,000	0,000	**19**	**3,167**	**0,167**	**5,164**
Scientific papers published in foreign peer-reviewed proceedings *(AECA)*	14	0,790	29,456	0	0,000	0,000	2	0,107	3,446	1	0,051	1,471	0	0,000	0,000	0	0,000	0,000	**17**	**2,833**	**0,150**	**4,620**
Scientific papers published in domestic peer-reviewed proceedings *(AEDA)*	0	0,000	0,000	2	0,112	3,816	1	0,053	1,723	1	0,051	1,471	3	0,148	4,085	0	0,000	0,000	**7**	**1,167**	**0,062**	**1,902**
Published papers (full text) from foreign scientific conferences *(AFA, AFC)*	2	0,113	4,208	0	0,000	0,000	1	0,053	1,723	3	0,152	4,413	1	0,049	1,362	2	0,103	2,917	**9**	**1,500**	**0,079**	**2,446**
Published papers (full text) from domestic scientific conferences *(AFB, AFD)*	1	0,056	2,104	1	0,056	1,908	2	0,107	3,446	1	0,051	1,471	1	0,049	1,362	0	0	0	**6**	**1**	**0**	**2**

2.2. Measures of research outputs (citations, etc.)

2.2.1. Table with citations per annum (without self-citations)

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) are listed separately

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	416	23,46	564	31,65	429	22,88	561	28,35	431	21,32	493	25,43	**2 894**	**482,33**	**25,45**
Citations in SCOPUS (1.2, 2.2) if not listed above	173	9,76	158	8,87	178	9,49	217	10,97	165	8,16	114	5,88	**1 005**	**167,50**	**8,84**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	0	0,00	0	0,00	0	0,00	1	0,05	0	0,00	0	0,00	**1**	**0,17**	**0,01**
Other citations (not listed above) (3.1, 4.1)	316	17,82	441	24,75	325	17,33	346	17,48	331	16,37	151	7,79	**1 910**	**318,33**	**16,80**
Reviews (5,6)	0	0,00	1	0,06	2	0,11	0	0,00	0	0,00	1	0,05	**4**	**0,67**	**0,04**

2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

1. BOSSARD, M. - FERANEC, Ján - OŤAHEĽ, Ján. CORINE land cover technical guide - Addendum 2000 : technical report. No. 40. Copenhagen : European Environment Agency, 2000. 105 p. https://www.eea.europa.eu/publications/tech40add. Type: AAA
   Citations: 432
2. FERANEC, Ján - JAFFRAIN, Gabriel - SOUKUP, Tomáš - HAZEU, Gerard. Determining changes and flows in European landscapes 1990-2000 using CORINE land cover data. In Applied Geography, 2010, vol. 30, no. 1, p. 19-35. (2009: 2.324 - IF, 0.744 - SJR, Q1 - SJR, karentované - CCC). (2010 - Current Contents). ISSN 0143-6228. https://doi.org/10.1016/j.apgeog.2009.07.003. Type: ADCA
   Citations: 183
3. ŠÚRI, Marcel - HOFIERKA, Jaroslav. A New GIS-based Solar Radiation Model and Its Application to Photovoltaic Assessments. In Transactions in GIS, 2004, vol. 8, no. 2, p. 175-190. (2004 - SCOPUS). ISSN 1361-1682. Type: ADEB
   Citations: 151
4. FERANEC, Ján - HAZEU, Gerard - CHRISTENSEN, Susan - JAFFRAIN, Gabriel. Corine land cover change detection in Europe (case studies of the Netherlands and Slovakia). In Land Use Policy, 2007, vol. 24, iss. 1, p. 234-247. (2006: 1.581 - IF, Q1 - JCR, 1.039 - SJR, Q1 - SJR, karentované - CCC). (2007 - Current Contents). ISSN 0264-8377. Type: ADCA
   Citations: 133
5. HOFIERKA, Jaroslav - ŠÚRI, Marcel. The Solar Radiation Model for Open Source GIS: Implementation and Applications. In Proceedings of the Open Source Free Software GIS - GRASS users conference 2002. Editor M. CIOLLI, P. ZATELLI. - Trento, 2002, [17 p.]. Type: AEC
   Citations: 116
6. ŠÚRI, Marcel - HULD, T.A. - DUNLOP, E.D. PV-GIS: a web-based solar radiation database for the calculation of PV potential in Europe. In International Journal of Sustainable Energy, 2005, vol. 24, no. 2, p. 55-67. (2005 - SCOPUS). ISSN 1478-6451. Type: ADEB.
   Citations: 107
7. GERARD, France - PETIT, Sandrine - SMITH, Geoff - THOMSON, Andrew - BROWN, N. - TUOMINEN, Sahari - WADSWORTH, Richard - BUGÁR, Gabriel - HALADA, Ľuboš - BEZÁK, Peter - BOLTIŽIAR, Martin - DE BADTS, Els - HALABUK, Andrej - MOJSES, Matej - PETROVIČ, František - GREGOR, Mirko - HAZEU, Gerard - MÜCHER, C.A. - WACHOWICZ, M. - HUITU, Hanna - KÖHLER, Raul - OLSCHOWSKY, Konstantin - ZIESE, H. - KOLAŘ, Jan - ŠUSTERA, Jiří - LUQUE, Sandra - PINO, Joan - PONS, Xavier - RODA, Ferran - ROSCHER, Margareta - FERANEC, Ján. Land cover change in Europe between 1950 and 2000 determined employing aerial photography. In Progress in Physical Geography, 2010, vol. 34, no. 2, p. 183-205. (2009: 2.261 - IF, Q2 - JCR, 1.519 - SJR, Q1 - SJR, karentované - CCC). (2010 - Current Contents). ISSN 0309-1333. https://doi.org/10.1177/0309133309360141. Type: ADCA
   Citations: 80
8. PAZÚR, Róbert - LIESKOVSKÝ, Juraj - FERANEC, Ján - OŤAHEĽ, Ján. Spatial determinants of abandonment of large-scale arable lands and managed grasslands in Slovakia during the periods of post-socialist transition and European Union accession. In Applied Geography, 2014, vol. 54, p. 118-128. (2013: 2.650 - IF, Q1 - JCR, 1.335 - SJR, karentované - CCC). (2014 - Current Contents). ISSN 0143-6228. https://doi.org/10.1016/j.apgeog.2014.07.014. Type: ADCA
   Citations: 75
9. RUSNÁK, Miloš - SLÁDEK, Ján - KIDOVÁ, Anna - LEHOTSKÝ, Milan. Template for high-resolution river landscape mapping using UAV technology. In Measurement, 2018, vol. 115, p. 139-151. (2017: 2.218 - IF, Q2 - JCR, 0.733 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents). ISSN 0263-2241. https://doi.org/10.1016/j.measurement.2017.10.023. Type: ADCA

Citations: 65

10. MARIOT, Peter. Geografia cestovného ruchu [Geography of tourism]. Bratislava : VEDA, 1983. 248 p. Type: AAB
    Citations: 61

2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

1. BOSSARD, M. - FERANEC, Ján - OŤAHEĽ, Ján. CORINE land cover technical guide - Addendum 2000 : technical report. No. 40. Copenhagen : European Environment Agency, 2000. 105 p. Available on: https://www.eea.europa.eu/publications/tech40add Type: AAA
   Citations: 924
2. FERANEC, Ján - OŤAHEĽ, Ján. Krajinná pokrývka Slovenska = Land cover of Slovakia. 1. vyd. Bratislava : VEDA, 2001. 124 p. ISBN 80-224-0663-5. Type: AAB
   Citations: 276
3. ŠÚRI, Marcel - HOFIERKA, Jaroslav. A New GIS-based Solar Radiation Model and Its Application to Photovoltaic Assessments. In Transactions in GIS, 2004, vol. 8, no. 2, p. 175-190. (2004 - SCOPUS). ISSN 1361-1682. Type: ADEB
   Citations: 264
4. FERANEC, Ján - JAFFRAIN, Gabriel - SOUKUP, Tomáš - HAZEU, Gerard. Determining changes and flows in European landscapes 1990-2000 using CORINE land cover data. In Applied Geography, 2010, vol. 30, no. 1, p. 19-35. (2009: 2.324 - IF, 0.744 - SJR, Q1 - SJR, karentované - CCC). (2010 - Current Contents). ISSN 0143-6228. https://doi.org/10.1016/j.apgeog.2009.07.003 Type: ADCA
   Citations: 262
5. FERANEC, Ján - HAZEU, Gerard - CHRISTENSEN, Susan - JAFFRAIN, Gabriel. Corine land cover change detection in Europe (case studies of the Netherlands and Slovakia). In Land Use Policy, 2007, vol. 24, iss. 1, p. 234-247. (2006: 1.581 - IF, Q1 - JCR, 1.039 - SJR, Q1 - SJR, karentované - CCC). (2007 - Current Contents). ISSN 0264-8377. Type: ADCA
   Citations: 211
6. BEZÁK, Anton. Funkčné mestské regióny na Slovensku [Functional regions in Slovakia]. Bratislava : Geografický ústav SAV, 2000. 89 p. Geographia Slovaca, 15. ISSN 1210-3519. Type: AAB
   Citations: 196
7. HOFIERKA, Jaroslav - ŠÚRI, Marcel. The Solar Radiation Model for Open Source GIS: Implementation and Applications. In Proceedings of the Open Source Free Software GIS - GRASS users conference 2002. Editor M. CIOLLI, P. ZATELLI. - Trento, 2002, [17 p.]. Type: AEC
   Citations: 190
8. ŠÚRI, Marcel - HULD, T.A. - DUNLOP, E.D. PV-GIS: a web-based solar radiation database for the calculation of PV potential in Europe. In International Journal of Sustainable Energy, 2005, vol. 24, no. 2, p. 55-67. (2005 - SCOPUS). ISSN 1478-6451. Type: ADEB
   Citations: 189
9. MAZÚR, Emil - LUKNIŠ, Michal. Regionálne geomorfologické členenie SSR. In Geografický časopis, 1978, roč. 30, č. 2, p. 101-125. ISSN 0016-7193. Type: ADFB
   Citations: 173
10. BÜTTNER, George - FERANEC, Ján - JAFFRAIN, Gabriel. CORINE land cover update 2000 : technical guidelines [elektronický zdroj]. Copenhagen : European Environment Agency, 2002. 56 p. Technical report, 89. http://www.pedz.uni-mannheim.de/daten/edz-bn/eua/02/techrep89.pdf. ISBN 92-9167-511-3. Type: AAA
    Citations: 173

2.2.4. List of 10 most-cited publications published during the evaluation period (2016-2021) with the address of the Institute, with number of citations obtained until 2021

ADCA32 RUSNÁK, Miloš - SLÁDEK, Ján - KIDOVÁ, Anna - LEHOTSKÝ, Milan. Template for high-resolution river landscape mapping using UAV technology. In *Measurement*, 2018, vol. 115, p. 139-151. (2017: 2.218 - IF, Q2 - JCR, 0.733 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 0263-2241. https://doi.org/10.1016/j.measurement.2017.10.023
Citations: 89

FAI01 *European Landscape Dynamics : Corine Land Cover Data*. Edited by J. Feranec, T. Soukup, G. Hazeu, G. Jaffrain. Boca Raton : CRC Press, Taylor & Francis Group, 2016. 337 p. ISBN 978-1-4822-4466-3
Citations: 65

ADMB09 KOPECKÁ, Monika - SZATMÁRI, Daniel - ROSINA, Konštantín. Analysis of urban green spaces based on Sentinel-2A: case studies from Slovakia. In *Land*, 2017, vol. 6, no. 2, art. no. 25. (2016: 0.481 - SJR, Q2 - SJR). (2017 - WOS, Scopus). ISSN 2073-445X. https://doi.org/10.3390/land6020025
Citations: 43

ADCA47 YOUSEFI, Saleh - POURGHASEMI, Hamid Reza - HOOKE, Janet - NAVRÁTIL, Oldřich - KIDOVÁ, Anna. Changes in morphometric meander parameters identified on the Karoon River, Iran, using remote sensing data. In *Geomorphology*, 2016, vol. 271, p. 55-64. (2015: 2.813 - IF, Q1 - JCR, 1.385 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS). ISSN 0169-555X. https://doi.org/10.1016/j.geomorph.2016.07.034
Citations: 32

ADCA13 KIDOVÁ, Anna - LEHOTSKÝ, Milan - RUSNÁK, Miloš. Geomorphic diversity in the braided-wandering Belá River, Slovak Carpathians, as a response to flood variability and environmental changes. In *Geomorphology*, 2016, vol. 272, p. 137-149. (2015: 2.813 - IF, Q1 - JCR, 1.385 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents, WOS). ISSN 0169-555X. https://doi.org/10.1016/j.geomorph.2016.01.002
Citations: 31

ADCA23 PAZÚR, Róbert - BOLLIGER, J. Land changes in Slovakia: past processes and future directions. In *Applied Geography*, 2017, vol. 85, p. 163-175. (2016: 2.687 - IF, Q1 - JCR, 1.250 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents, WOS. SCOPUS). ISSN 0143-6228. https://doi.org/10.1016/j.apgeog.2017.05.009
Citations: 30

ADCA46 XIAO, Han - KOPECKÁ, Monika - GUO, Shan - GUAN, Yanning - CAI, Danlu - ZHANG, Chunyan - ZHANG, Xiaoxin - YAO, Wutao. Responses of Urban Land Surface Temperature on Land Cover: a Comparative Study of Vienna and Madrid. In *Sustainability*, 2018, vol. 10, no. 2, art. no. 260. (2017: 2.075 - IF, Q2 - JCR, 0.537 - SJR, Q2 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 2071-1050. Názov z webovej stránky. Požaduje sa internet, Adobe Reader. https://doi.org/10.3390/su10020260
Citations: 30

ADCA22 PAZÚR, Róbert - FERANEC, Ján - ŠTYCH, Přemysl - KOPECKÁ, Monika - HOLMAN, Lukáš. Changes of urbanised landscape identified and assessed by the urban atlas data: case study of Prague and Bratislava. In *Land Use Policy : the International Journal Covering All Aspects of Land Use*, 2017, vol. 61, p. 135-146. (2016: 3.089 - IF, Q1 - JCR, 1.408 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0264-8377. https://doi.org/10.1016/j.landusepol.2016.11.022
Citations: 25

ADCA19 MICHÁLEK, Anton - VÝBOŠŤOK, Ján. Economic Growth, Inequality and Poverty in the EU. In *Social Indicators Research*, 2019, vol. 141, no. 2, p. 611-630. (2018: 1.703 - IF, Q2 - JCR, 0.881 - SJR, Q1 - SJR, Current Contents - CCC). (2019

- Current Contents, WOS, Scopus). ISSN 0303-8300. https://doi.org/10.1007/s11205-018-1858-7
Citations: 24

ADCA43 ŠVEDA, Martin - MADAJOVÁ, Michala - PODOLÁK, Peter. Behind the Differentiation of Suburban Development in the Hinterland of Bratislava, Slovakia. In *Sociologický časopis / Czech Sociological Review*, 2016, roč. 52, č. 6, s. 893-925. (2015: 0.262 - IF, Q4 - JCR, 0.278 - SJR, Q2 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0038-0288. https://doi.org/10.13060/00380288.2016.52.6.290
Citations: 19

2.2.5. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015– 2020). The cited papers must bear the address of the institute

1. Feranec Ján - 1,525 citations
2. Oťaheľ Ján - 944 citations

2.2.6. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute

1. Feranec Ján - 3,665 citations
2. Oťaheľ Ján - 3,079 citations

2.2.7. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute

1. Feranec Ján - 202 citations
2. Kopecká Monika - 194 citations

2.3. Research status of the institute in international and national context

- **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 for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on

1. European Landscape Dynamics – ediding and co-authoring of the monograph published by CRC Press, Taylor & Francis Group
2. Project ATBIOMAP supported by the ESA-PECS Programme
3. Project CLIMASTEPPE supported by the EraNET RusPlus Programme, Lead Partner: Institute of Steppe of the Ural Branch of the Russian Academy of Sciences
4. Project COMPASS supported by the ESPON Programme, Lead Partner: Delft University of Technology
5. Projects COST: COST Action ES1306, Cost Action CA16208 and COST Action CA20118
6. Bilateral projects with academic institutes in Czechia, Poland and Ukraine.
7. Organisation of The 42nd International Association for Danube Research (IAD) Conference Danube - a lifeline governed by multiple uses, pressures and a multitude of ecosystem services, July 02-06, 2018
8. Research stay of Dr Pazúr at the Swiss Federal Research Institute for Forest, Snow and Landscape (WSL) (2015-2021), Dr Rosina at the Joint Research Centre in Ispra (2016-2018) and Dr Ján Výbošťok at the Charles University in Prague and stay of students from Japan (Akie Koga), China (Xiao Han) and Poland (Anna Chrobak) in the IG SAS.

9. Activities in the International Geographical Union (IGU), the International Cartographic Association (ICA), International Association for Danube Research (IAD), European Rural Development Network (ERDN), the Man and the Biosphere (MAB) Programme – UNESCO and in the UNESCO's Management of Social Transformations (MOST) Programme.
10. The researchers of the Institute of Geography were members of editorial boards of 15 scientific journals published abroad (11 memberships in Poland, 9 in Czechia, 3 in Switzerland, 2 in Hungary and Romania and 1 in Austria, Bulgary and Ukraine) mostly indexed in Web of Science and SCOPUS.

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

1. Geomorphological processes and landscape changes, Zuberec, October 4–6, 2016
2. Activities in cartography – Cartographic conference 2016, Bratislava, October 20–21, 2016
3. 21st Czecho-Slovak geographical academic seminar, Bratislava, November 3–4, 2016
4. 8th Slovak-Polish Geographical Seminar "Socio-economic vulnerability and resilience of regions in Poland and Slovakia", Bratislava, December 5–6, 2016
5. 22nd Czecho-Slovak geographical academic seminar, Brno, October 19–20, 2017
6. Transboundary ecological connectivity – modelling landscapes and ecological flows, Stará Lesná, June 25–28, 2017
7. 23rd Czecho-Slovak geographical academic seminar, Mikulov, October 17–18, 2018
8. International workshop on ecological connectivity modelling, Cracow, March 3–6, 2018
9. 42nd IAD Conference: Danube – a lifeline governed by multiple uses, pressures and a multitude of ecosystem services, Smolenice, July 2–6, 2018
10. Knowledge for Ageing Society – Contextualising Ageing, Bratislava, June 27–28, 2018
11. GeoKARTO 2018, Zvolen, September 6–7, 2018
12. 24th Czecho-Slovak geographical academic seminar, Polička, November 5, 2019
13. GeoKARTO 2020, Košice, September 10–11, 2020

2.3.3. List of edited proceedings from international scientific conferences

1. Danube - A lifeline governed by multiple uses, pressures and a multitude of ecosystem services : book of abstracts. Editors: Milan Lehotský, Anna Kidová, Miloš Rusnák, Jozef Dudžák. Bratislava: Institute of Geography of SAS, 2018. 53 p. ISBN 978-80-89548-07-1 (The 42nd IAD Conference 2018).

2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

1. Geografický časopis [Geographical Journal]. ISSN 0016-7193. Indexed in Scopus (Scimago Journal & Country Rank: SJR 2021: 0.26 – Q3 (2021 CiteScore: 1.2 – 47th percentile Geography, Planning and Development, 41th percentile Earth-Surface Process, 37th percentile Geology) and WOS (Emerging Sources Citation Index (ESCI) – articles published after January 1, 2018). Scimago Journal & Country Rank: SJR 2020: 0.26 – Q3. Published since 1953. http://geograficky-casopis.sav.sk/
2. Kartografické listy [Cartographic Letters]. ISSN 1336-5274. Since 2020 the journal is indexed in Scopus (Scimago Journal & Country Rank: SJR 2021: 0.17 – Q4). Since 2018 the journal is indexed in ERIH PLUS – European Reference Index for Humanities and Social Sciences. Published since 1993. https://gis.fns.uniba.sk/kartografickelisty/?&l=en
3. Geomorphologia Slovaca et Bohemica. ISSN 1337-6799 – published 2007-2019

- **National position of the institute**

2.3.5. List of selected activities of national importance

1. Six APVV projects – the IG SAS as lead partner in 4 projects (see Section 2.4.3.).
2. The results of the APVV multidisciplinary project PEDO-CITY-CLIMA focused on the topic of urban heat island were included into the publication Excellence in Science 2021 published by the APVV.
3. Twenty-one VEGA projects – the IG SAS as lead partner in 19 projects (see Section 2.4.4.).
4. Three VEGA projects were awarded by a certificate of excellence for their results (VEGA 2/0101/15, VEGA 2/0009/18 and VEGA 2/0113/19). Two of them were focused on the topic of spatial inequalities and later on the topic of cosumer behaviour).
5. Nine national conferences – the IG SAS as organiser or co-organiser:
   - Poznávanie a interpretácia kultúrnej krajiny ako súčasť environmentálnej výchovy a vzdelávania [Cognition and interpretation of the cultural landscape as part of environmental education and training], Bobrovec, September 16–17, 2016;
   - Spotreba, maloobchod a konzumná spoločnosť 2016 [Consumption, retail, and consumer society 2016], Banská Štiavnica, November 21–22, 2018;
   - Sto rokov česko-slovenskej spolupráce pri ochrane prírody a krajiny [One hundred years of Czech-Slovak cooperation in nature and landscape protection], Bobrovec, September 7–9, 2018;
   - Aktivity v kartografii 2019 [Activities in Cartography 2019], Bratislava, October 24, 2019
   - Urbanizovaná krajina, pôda a klíma [Urban landscape, soil, and climate], Bratislava, November 7, 2019;
   - Spotreba, maloobchod a konzumná spoločnosť 2019 [Consumption, retail, and consumer society 2019], Skalica, November 25–26, 2019;
   - Spotreba a konzumná spoločnosť 2020 [Consumption and consumer society 2020], Skalica, September 16–17, 2020;
   - Sociálne siete v starnúcej spoločnosti [Social networks in an aging society], Bratislava, November 26, 2020;
   - Aktuálne environmentálne problémy a výzvy 30 rokov po Dobříšskej konferencii [Current environmental problems and challenges 30 years after the Dobříš Conference], Varín, September 3–5, 2021;
6. Preparing of 55 national project proposals in the 2016–2021 period
   - APVV 26 project proposals (6 succesfull);
   - VEGA 16 project proposals;
   - Research Agency 2 project proposals (Structural Funds).
7. Cooperation in with 9 other institutes of the SAS
   - Institute of Landscape Ecology of the SAS (EraNet project, Research Agency and APVV project proposals),
   - Institute of Sociology of the SAS (APVV project and APVV project proposal);
   - Institute of Ethnology and Social Anthropology of the SAS (two APVV projects and APVV project proposals);
   - Plant Science and Biodiversity Centre of the SAS (APVV project proposals);
   - Biomedical Research Centre of the SAS (APVV project proposal);
   - Institute of Mathematics of the SAS (Research Agency and APVV project proposals);
   - Centre of Social and Psychological Sciences of the SAS (APVV project proposal);
   - Institute of Physics of the SAS (APVV project proposal);
   - Earth Science Institute of the SAS (doctoral studies).
8. Cooperation with 7 universities
   - Comenius University in Bratislava, Faculty of Natural Sciences (three APVV projects, VEGA project, doctoral studies, pedagogical activities) and Faculty of Law (APVV project proposals);
   - University of Prešov (VEGA project, pedagogical activities);
   - Pavol Jozef Šafárik University in Košice (APVV project proposals);
   - Constantine the Philosopher University in Nitra (pedagogical activities, VEGA project proposal);
   - Slovak University of Technology in Bratislava (pedagogical activities, APVV project proposal);
   - Catholic University in Ružomberok (pedagogical activities);
   - Technical University of Košice (APVV project proposal),

9. Cooperation with other research institutions in Slovakia
    - National Forest Centre in Zvolen (ESA-PECS project and project proposal);
    - Slovak Hydrometeorological Institute (ESA-PECS project and APVV project proposal);
    - Soil Science and Conservation Research Institute of the National Agricultural and Food Centre (ESA-PECS project, APPV project proposals).
10. 32 memberships in 11 editorial boards of journals published in Slovakia (Geografický časopis, Geographia Slovaca, Geomorphologia Slovaca et Bohemica, Kartografické listy Acta Environmentalica Universitatis Comenianae, Acta Geographica Universitatis Comenianae, Folia Geographica, Geografická revue, Historia Ecclesiastica, Životné prostredie and Krásy Slovenska)
11. Cooperation and common activities with scientific Societies
    - Slovak Geographical Society;
    - Association of Slovak Geomorphologists;
    - Cartographic Society of the Slovak Republic.
12. Geografický časopis/Geographical Journal, published by the Institute since 1953, is the most important scientific journal published in Slovakia (indexed in WOS and SCOPUS).
13. The geographical library of the IG SAS is the most extensive and most important geographical library in Slovakia with more than 14.5 thosands of books and other documents.
14. Cooperation with state government, local government, the non-governmental and the private sectors
    - National Council of the Slovak Republic - Mikuláš Huba served as a member of the in the 2012–2016 period and Ján Szőllős has been an MPs since 2020;
    - President of the Slovak Republic - Mikuláš Huba served as a member External team of advisers to the President
    - Ministry of Education, Science, Research and Sport of the Slovak Republic - Ján Feranec Commission for space activities in the Slovak Republic;
    - Ministry of the Environment of the Slovak Republic - five researchers from the IG SAS - Miloš Rusnák, Anna Kidová, Ľubomír Solín, Lukáš Michaleje and Šárka Horáčková served as working groups members for the document *Water Policy Concept for 2030 with a View to 2050*;
    - Ministry of Transport and Construction of the Slovak Republic - Monika Kopecká as a member of the Working Group for the Preparation of the Law on Landscape Planning;
    - Ministry of Agriculture and Rural Development of the Slovak Republic - Mikuláš Huba served as a member of the Board of Advisors to the Minister;
    - Slovak Accreditation Agency for Higher Education - René Matlovič served as a Vice-Chairman of the Executive Board;
    - Institute of Educational Policy at the Ministry of Education, Science, Research and Sport of the Slovak Republic - Ján Výbošťok participated in Creating a model of rationalization of primary schools in Slovakia;
    - Institute of Health Analyses of the Ministry of Health of the Slovak Republic - Ján Výbošťok participated in the preparation of a time accessibility model of Slovak hospitals
    - Slovak Environment Agency (project proposal Programme Copernicus - procedure No EEA/IDM/R0/16/009);
    - Slovak Environmental Inspectorate (Regional Inspectorate in Žilina) providing the research results (see section 2.6.1. Case Study 3);
    - Statistical Office of the Slovak Republic - Vladimír Ira served as a member of the expert team for the National Action Plan for the Population Census 2021
    - Geodesy, Cartography and Cadastre Authority of the Slovak Republic - Ján Novotný as a member of the Nomenclature Commission;
    - Terminological Commission of the Ministry of the Interior of the Slovak Republic – Peter Podolák and Daniel Michniak served as members of the Permanent Nomenclature Subcommittee;
    - Union of Slovak Cities - Mikuláš Huba and Vladimír Ira served as as experts;
    - City of Bratislava - Monika Kopecká and Daniel Szatmári prepared an analysis *Identification and classification of green areas in Bratislava using satellite data Sentinel-2A* for the Public Greenery Project and the new Territorial Plan of Bratislava;
    - Bratislava Metropolitan Institute - Pavel Šuška, Martin Šveda and Ján Výbošťok were co-authors of the Bratislava Participatory Planning Manual (see section 2.6.1. Case Study 4);
    - Society for Sustainable Living – co-organisation conferences and publication activities
    - Stengl Consulting - a research contract (see Section 2.6.2.);
    - Carretera, Ltd. - a research contract (see Section 2.6.2.);

- Solargis, Ltd. – preparing an ESA-PECS project approved in 2021.

2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

GEOGRAFIA – Časopis pre základné, stredné a vysoké školy [Geography – Journal for primary, secondary and higher education]. ISSN: 1335-9258. Published since 1993 in cooperation with the IG SAS. http://www.casopisgeografia.sk/index.php/Geografia/index

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

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

1. Michniak Daniel: Problems and challenges of passenger rail transport in Slovakia. 2nd International Scientific Conference "Problems and challenges of geography of transport", Gdansk (Poland), April 6–7, 2017.
2. Feranec Ján: Land cover and its change monitoring in Slovakia using remote sensing data. New Generation Space Policy: space Strategy for Europe, Bratislava, October 19–20, 2017.
3. Feranec Ján: CORINE Land Cover and Urban Atlas – data source for evaluation of the landscape changes and urban heat islands. COPERNICUS training and information session, Bratislava, June 12, 2018.
4. Huba Mikuláš: Environmentálna politika na Slovensku (1989 – 2019) s dôrazom na ochranu prírody a krajiny (Environmental policy in Slovakia (1989 - 2019) with emphasis on nature and landscape protection). 30 let od revoluce uskutočnená STUŽ v spolupráci so Správou NP České Švýcarsko a Geografickým ústavom SAV v Bratislave v rámci Memoriálu J. a P. Vavrouškovcov. Česká Lípa (Czechia), June 14–15, 2019.

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

name	programme committee	organising committee	organising and programme committees
Bilková Kristína	0	1	0
Feranec Ján	4	0	0
Huba Mikuláš	0	0	1
Ira Vladimír	0	1	0
Kidová Anna	0	1	1
Kopecká Monika	1	2	0
Lehotský Milan	2	0	1
Michniak Daniel	1	0	0
Novotný Ján	0	2	1
Pazúr Róbert	0	0	2
Rusnák Miloš	0	0	1
Székely Vladimír	6	0	0
Šuška Pavel	0	1	3
Total	**14**	**8**	**10**

2.3.9. List of researchers who received an international scientific award

1. Ira Vladimír – Honorary membership awarded by the Czech Geographical Society, Czechia.
2. Székely Vladimír – Commemorative diploma awarded by Commission of Communication Geography of the Polish Geographical Society, Poland.

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

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

1. Feranec Ján: Ukážky využitia satelitných údajov pri výskume urbanizovanej a poľnohospodárskej krajiny. [Demonstrations of the use of satellite data in the research of urbanised and agricultural land]. 27th Slovak geodetic days, Žilina, November 7–8, 2019.

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

name	programme committee	organising committee	organising and programme committees
Bilková Kristína	0	0	3
Huba Mikuláš	0	0	2
Kopecká Monika	0	1	0
Šuška Pavel	0	0	1
Total	**0**	**1**	**6**

2.3.12. List of researchers who received a national scientific award

1. Huba Mikuláš – Cena za najlepší publicistický príspevok v oblasti kvality práce, produkcie a života (Award for the best journalistic contribution in the field of quality of work, production and life). Awarded by: Slovak Office of Standards, Metrology and Testing, 2017.
2. Feranec Ján – Cena P SAV za monografiu (Award of the Presidium of the Slovak Academy of Sciences for the monograph): Feranec, J.; Soukup, T.; Hazeu, G.; Jaffrain, G.: European Landscape Dynamics: CORINE Land Cover Data. Boca Raton: CRC Press. Taylor & Francis Group. 2016.
3. Rusnák Miloš – Súťaž mladých vedeckých pracovníkov SAV do 35 rokov. 3. miesto. (Competition of young scientists of SAS up to 35 years. 3rd place). Awarded by the Slovak Academy of Sciences, 2018.
4. Huba Mikuláš – Cena Samuela Zocha (Samuel Zoch Award). Awarded by: Chairman of the Bratislava Self-Governing Region, 2019.
5. Huba Mikuláš – Rad Ľudovíta Štúra, I. triedy (Order of Ludovit Stur 1st Class). Awarded by: President of the Slovak Republic, 2018.
6. Huba Mikuláš – Sto najvýznamnejších Slovákov a Sloveniek (One hundred most important Slovaks). Awarded by: Forbes, 2018.
7. Huba Mikuláš – Zlatý odznak (Golden badge). Awarded by: Občianske združenie Vlkolínec, 2018.
8. Oťaheľ Ján – Významná osobnosť SAV v roku 2019 (An important personality of the Slovak Academy of Sciences in 2019). Awarded by: President of the Slovak Academy of Sciences, 2019.
9. Huba Mikuláš – Čestné uznanie (Honorable mention). Awarded by: Slovenský zväz ochrancov prírody a krajiny, 2019.
10. Ira Vladimír – Pamätná medaila pri príležitosti 100. výročia založenia Univerzity Komenského v Bratislave (Commemorative medal on the occasion of the 100th anniversary of the founding of Comenius University in Bratislava). Awarded by: Rector of the Comenius University Bratislava, 2019.

11. Oťaheľ Ján – Ďakovný list (Letter of thanks). Awarded by: Dean of the Faculty of Humanities and Natural Sciences of the University of Prešov, 2019.
12. Feranec Ján – Zlatá medaila SAV (SAS Gold Medal). Awarded by the Scientific Board of the Slovak Academy of Sciences, 2021.
13. Rišová, Katarína – Súťaž doktorandov a mladých vedeckých pracovníkov SAV do 35 rokov. 3. Miesto v kategórii doktorandov (Competition of PhD students and young scientists of SAS up to 35 years. 3rd place in the PhD student's category, 2021.
14. Lehotský Milan – Významná osobnosť SAV v roku 2020 (An important personality of the Slovak Academy of Sciences in 2020). Awarded by the Presidium of the Slovak Academy of Sciences, 2021.

2.4. Research grants and other funding resources

(List 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". Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**

2.4.1. List of major projects of Framework Programmes of the EU (which pilar), NATO, COST, etc.

1. ESA-PECS Programme (European Space Agency – Plan for European Cooperating States), Techniques for Biomass Mapping in Abandoned Agriculture Land using Novel Combination of Optical and Radar Remote Sensing Sensors (ATBIOMAP), AO/1-8673/16/NL/NDe, 2018-2020, 71,206 € (22,314 € / 2018; 16,681 € / 2019; 32,211 € / 2020), Ján Feranec – W, Lead partner: the National Forest Centre in Zvolen, interdisciplinary project
2. COST, Connecting European connectivity research, COST Action ES1306, 2014-2018, 8,143 € (3,500 € / 2016; 3,150 € / 2017; 1,493 € / 2018), Milan Lehotský – I
3. START Danube Region Project Fund, Quantification of morphological changes in river channels and its impact on flood risk, 12_PA05-C2, 2015-2016, 6,984 € / 2016, Anna Kidová – I, Lead partner: University in Ostrava
4. ESPON, Comparative Analysis of Territorial Governance and Spatial Planning Systems in Europe (COMPASS), 2016-2018, (10,150 € / 2017), Daniel Michniak – I, Lead Partner: Delft University of Technology, interdisciplinary project
5. International Visegrad Fund, Transboundary ecological connectivity – modelling landscapes and ecological flows, IVF No. 21640051, 2017-2018, 19,660 € (3,141 € / 2017; 16,519 € / 2018), Róbert Pazúr – C, Project partner: Jagiellonian University in Cracow, interdisciplinary project
6. COST, Knowledge conversion for enhancing management of European riparian ecosystems and services, COST Action CA16208, 2019-2021, 8,919 € (2,848 € / 2019; 3,440 € / 2020; 2,631 € / 2021), Anna Kidová – I
7. National Science Centre in Poland, Polish borders as a resource – between heritage and tourism product, 2019-2022, (3,412 € / 2019; 3,440 € / 2020, 3,523 € / 2021) Daniel Michniak – I, Lead Partner: Institute of Geography and Spatial Organization of the Polish Academy of Sciences
8. International Visegrad Fund, V4 communication platform for use of Earth Observation methods in biotic forest disturbances, IVF No. 21920035, 2019-2020, 3,559 € (1,266 € / 2019; 2,293 € / 2020), Monika Kopecká – I, Lead Partner: Faculty of Environmental Sciences of the Czech University of Life Sciences in Prague
9. COST, Three-dimensional forest ecosystem monitoring and better understanding by terrestrial-based technologies, COST Action CA20118, 2021-2025, Miloš Rusnák – I

Add information on your activities in international networks

International project proposals with participation of the IG SAS

- **Interreg V-A SK – CZ**, bilateral project: Project for the renewal of Czech-Slovak reciprocity in the field of transport and tourism, project partner: Transport Research Center, Brno, Czechia;
- **SAS-MOST Taiwan programme**, bilateral project Constructing transportation framework of facilities to improve accessibility and maintain sustainability for tourism development, project partner: National Quemoy University, Department of Tourism Management, Taiwan;
- **ESPON Targeted Analysis**, two multilateral projects: The Material Cultural Heritage as a Strategic Territorial Development Resource: Mapping Impacts Through a Set of Common European Socio-Economic Indicators, lead partner: University of Bucharest and Spatial dynamics and integrated territorial development scenarios for the functional area of central Europe–CE FLOWS, lead partner: Institute of Geography Polish Academy of Science
- **ERA.Net RUS PLUS**: The potentials of Russian steppes to reduce Greenhouse Gases (GHG) emissions, lead partner: Kazan Federal University, Russia;
- **Era.Net Belmont Forum/BiodivErsA**, two multilateral projects: Climate Scenarios applied for assessing Impacts on Biodiversity and Ecosystem Services at different spatial scales across the Carpathian Mountains for multiple decisions, lead partner: Romanian Space Agency; Nature-based and socially acceptable solutions in management of river landscapes to mitigate the impacts of climate change, lead partner: Global Change Research Institute of the Czech Academy of Sciences, Brno, Czechia;
- **CREATIVE EUROPE** (European Commission's flagship programme), multilateral project: Web portal of the cultural and natural heritage of the transborder region of the Eastern Carpathians, lead partner: Institute of Geography, National Academy of Sciences of Ukraine, Kyiv;
- **Horizon 2020**, multilateral project: Social platform on the impact assessment and the quality of interventions in wooden churches, lead partner: Institute of Geography, Romanian Academy;
- **Interreg Danube Transnational Programme**, multilateral project: Geochronological investigation of Danube floodplain sediments pollution as a tool for harmonizing the risk management system, lead partner: University of Ljubljana, Croatia;
- **Horizont 2020 – RIA**, multilateral project: People's forum in green and sustainable Europe: Involvement and engagement of citizens in defining and supporting the transition to green and sustainable local, national and European societies, lead partner: Slovak Academy of Sciences;
- **COST**, multilateral project: Sediment dynamic changes in the Anthropocene, lead partner: University of Lincoln;
- **BIODIVERSA,** Grasslands for biodiversity: supporting the protection of the biodiversity-rich grasslands and related management practices in the Alps and Carpathians, lead partner: Swiss Federal Institute for Forest, Snow and Landscape Research
- **CHANSE** (Horizon 2020), multilateral project: Digital rurality in Central Europe - towards new representations of the rural space, lead partner: Institute of Geography and Spatial Organization, Polish Academy of Sciences;
- **International Visegrad Fund**, multilateral project: Jewish cultural heritage of Ukraine and the Visegrad Four countries in a joint tourist route, lead partner: Lviv Polytechnic National University, Ukraine;
- **APVV,** two bilateral projects with University of Belgrade and Pedagogical university in Cracow
- **Mobility,** bilateral project with Global Change Research Institute of the Czech Academy of Sciences, Brno, Czechia.

Active participation in activities of the International Societies

- **International Geographical Union** (IGU) - four publications were prepared in collaboration with the IGU commissions, Ján Feranec served as a Vice-chair and Monika Kopecká as a Members of the Steering Committee of the Commission for Land Use and Land Cover Change;
- **International Cartographic Association** (ICA) - Ján Feranec served as a Vice-chair of the Commission for Thematic Mapping Using Remote Sensing Data (ICA) and cooperation concerning the Barbara Petchenik Children's World Map Drawing Competition;
- **International Association of Geomorphologists** (IAG);
- **International Association for Danube Research** (IAD) - the IG SAS was the main organiser of the 42nd IAD Conference in 2018;
- **European Rural Development Network** (ERDN) - the IG SAS is a member of network and participates at the conferences.

- **National projects, incl. international projects with only national funding**

2.4.2. List of ERA-NET projects funded from SAS budget

1. Solutions for climate-smart land use in the dry steppes of Russia (CLIMASTEPPE), ERA-NET RusPlus, RUS_ST2017-559, 2018-2021, 10080 € / 2018, 15237 € / 2019, 10537 € / 2020, 10950 € / 2021, Róbert Pazúr – I

2.4.3. List of projects of the Slovak Research and Development Agency, APVV

1. Effect of impermeable soil cover on urban climate in the context of climate change (PEDO-CITY-CLIMA), APVV-15-0136, 2016-2020, 51,270 € (6,000 € / 2016; 10,000 € / 2017; 13,000 € / 2018, 13,000 € / 2019, 9,270 € / 2020), Ján Feranec – I, Lead partner: National Agriculture and Food Centre (Soil Science and Conservation Research Institute), Project partner: Slovak Hydrometeorological Institute, interdisciplinary project
2. Intergenerational social networks in an aging city, continuity and innovation (STARCI), APVV-15-0184, 2016-2020, 70,448 € (9,595 € / 2016; 17,567 € / 2017; 16,740 € / 2018; 16,700 € / 2019; 9,846 € / 2020), Vladimír Ira 2016-2017 and Pavel Šuška 2018-2020 – I, Lead partner: Faculty of Natural Sciences of the Comenius University in Bratislava, Project partner: Institute of Ethnology and Social Anthropology of the SAS, interdisciplinary project
3. Suburbanisation - development and impacts on socio-spatial structure in Bratislava hinterland (SUBURBA), APVV-16-0462, 2017-2020, 149,154 € (20,627 € / 2017, 53,251 € / 2018, 45,044 € / 2019, 30,232 € / 2020), Martin Šveda – C, Project partner: Institute of Sociology of the SAS, interdisciplinary project
4. Alternative food networks: a shift from consumerism to sustainable consumption (ALTERCONSUM), APVV-20-0302, 2021-2024, 14,911 € / 2021, Kristína Bilková – C, Project partner: Faculty of Natural Sciences of the Comenius University in Bratislava
5. Mapping population distribution and mobility in Slovakia using mobile network data (METELCO), APVV-20-0586, 2021-2024, 14,829 € / 2021, Konštantín Rosina – C
6. Suburbanisation: Community, identity and everydayness (SUB-KIK), APVV-20-0432, 2021-2025, 77,26 € / 2021, Pavel Šuška – C, Project partners: Faculty of Natural Sciences of the Comenius University in Bratislava and Institute of Ethnology and Social Anthropology of the SAS

2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

1. Production, verification and application of population and settlement spatial models based on European land monitoring services, VEGA 1/0275/13, 2013-2016, Ján Oťaheľ – I
2. Analysis of temporal-spatial dynamics of the selected cultural landscape structures in Slovakia, their protection and sustainable use, VEGA 2/0023/15, 2015-2017, Ján Hanušin – C
3. Specifics of time-space human behaviour under the impact of socio-economic changes, VEGA 1/0082/15, 2015-2017, Vladimír Ira – I
4. Response of geomorphic-sedimentary connectivity/disconnectivity in fluvial system to environmental impacts, VEGA 2/0020/15, 2015-2017, Milan Lehotský – C
5. Regional divergence, spatial disparities and marginal regions in the context of socio-economic development in Slovakia, VEGA 2/0101/15, 2015-2017, Anton Michálek – C
6. Flood risk assessment and its integrated management on regional level, VEGA 2/0038/15, 2015-2017, Ľubomír Solín – C
7. Development trajectories of localities and regions - product of sector and spatial policies, territorial capital and decisions, VEGA 2/0035/15, 2015-2017, Vladimír Székely – C
8. Changes in agricultural land use: assessment of the dynamics and causes applying land cover data and selected environmental characteristics, VEGA 2/0096/16, 2016-2018, Róbert Pazúr – C
9. Evaluation of the transformation of natural and socio-cultural diversity of the cultural landscape in Slovakia (on example of selected areas), VEGA 2/0013/18, 2018-2020, Ján Hanušin – C

10. Discontinuities in the development of the Slovak geographical thought in the 20th and 21st centuries: Objective and subjective dimensions, VEGA 1/0049/18, 2018-2020, Vladimír Ira – I
11. Recent lateral and vertical evolution of river valley bottoms under changing environmental conditions and their impact on riverine landscape ecosystem services, VEGA 2/0098/18, 2018-2020, Anna Kidová – C
12. Growing and deepening ineguality in regions of Slovakia and the effects on polarisation of human development, VEGA 2/0009/18, 2018-2020, Anton Michálek – C
13. Integrated flood risk assessment: A Basis for Updating of the Flood Risk Management Plans, VEGA 2/0006/18, 2018-2020, Ľubomír Solín – C
14. Evolution of localities and regions: new theoretical and empirical approaches to understanding of spatial development paradigms, VEGA 2/0095/18, 2018-2020, Vladimír Székely – C
15. Urban and suburban environments: a space for innovations and alternatives in the retail and services sector, VEGA 2/0113/19, 2019-2021, Kristína Bilková – C
16. Land cover dynamics as indicator of changes in landscape, VEGA 2/0023/19, 2019-2022, Monika Kopecká – C
17. Relationships of paradigms in Slovak geographical thought: Competition, Indifference or Cooperation?, VEGA 2/0024/21, 2021-2023, Vladimír Ira – C
18. Assessment of the impact of extreme hydrological phenomena on the landscape in the context of a changing climate, VEGA 2/0086/21, 2021-2023, Anna Kidová – C
19. Spatially differentiated impacts and manifestations of COVID-19 in Slovakia, VEGA 2/0037/21, 2021-2023, Anton Michálek – C
20. Evaluation of uneven spatial development: causes and consequences of socio-economic growth, stagnation or decline of selected localities and regions, VEGA 2/0019/21, 2021-2023, Vladimír Székely – C
21. Land surface topography – a source of data on the tectonic evolution of the Western Carpathians in the Pliocene-Quaternary period, VEGA 2/0052/21, 2021-2024, Roberta Prokešová – C

Year	Funding – VEGA
2016	41,678 €
2017	44,201 €
2018	45,171 €
2019	49,081 €
2020	49,703 €
2021	52,562 €

2.4.5. List of projects supported by EU Structural Funds

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2.4.6. List of other projects funded from national resources

1. Identification of abandoned agricultural land using optical and radar remote sensing data, Doktogrant, 2020, Tomáš Goga – I

2.4.7. List of projects funded from private funds

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2.4.8. List of projects funded from other competitive funds

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2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity, source of funding

until September 1, 2019:

Physical Geography and Geoecology – 4.1.36 – Faculty of Natural Sciences, Comenius University Bratislava

Regional Geography – 4.1.38 – Faculty of Natural Sciences, Comenius University Bratislava

after September 1, 2019:

Physical Geography, Geoecology and Geoinformatics – Faculty of Natural Sciences, Comenius University Bratislava

Regional Geography – Faculty of Natural Sciences, Comenius University Bratislava

The SAS finances both programmes in the study field of Earth Sciences.

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

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors	18			20			23			25			22			22		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	unumber, end of yea	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	5	0	0	7	0	0	6	0	1	5	0	1	6	2	0	5	3	0
from which foreign citizens	1	0	0	1	0	0	1	0	0	1	0	0	2	0	0	1	1	0
External	3	0	0	3	0	0	2	0	1	2	0	0	2	0	0	1	1	0
Other supervised by the research employees of the institute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute

1. Lukáš Michaleje – defended in 2020 – a postdoctoral researcher at the Institute
2. Ján Výbošťok – defended in 2020 – a postdoctoral researcher at the Institute
3. Tomáš Goga – defended in 2021 – a postdoctoral researcher at the Institute
4. Katarína Rišová – defended in 2021 – a postdoctoral researcher at the Institute
5. Ana Uher (Internal/foreign citizen) – defended in 2021 – n/a
6. Luděk Krtička (External/foreign citizen) – defended in 2021 – Department of Human Geography and Regional Development, Faculty of Science, University of Ostrava, Czechia

2.5.4. Summary table on educational activities

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)*	319	412	292	251	242	242
Practicum courses (hours/year)*	208	457	510	311	208	230
Supervised diploma and bachelor thesis (in total)	10	6	10	9	7	6
Members in PhD committees (in total)	8	7	6	6	3	6
Members in DrSc. committees (in total)	2	2	1	1	1	0
Members in university/faculty councils (in total)	2	2	2	3	2	2
Members in habilitation/inauguration committees (in total)	3	2	4	3	2	3

2.5.5. List of published university textbooks

1. FALŤAN, Vladimír - OŤAHEĽ, Ján - GÁBOR, Marián - RUŽEK, Ivan. Metódy výskumu krajinnej pokrývky: vysokoškolská učebnica [Land cover research methods: a university textbook]. Rec. F. Petrovič, Z. Izakovičová, B. Olah. Bratislava : Univerzita Komenského v Bratislave, 2018. pp. 123. ISBN 978-80-223-4441-8.

2.5.6. Number of published academic course books

1. VAJSÁBLOVÁ, Margita - SZATMÁRI, Daniel. Matematická kartografia v príkladoch [Mathematical Cartography in Examples]. Rec. R. Feciskanin, V. K. Droppová. Bratislava : Slovenská technická univerzita v Bratislave vo Vydavateľstve SPEKTRUM STU, 2018. pp. 134. ISBN 978-80-227-4857-5.

2.5.7. List of joint research laboratories/facilities with universities

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2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

The system of doctoral studies has partially changed during this evaluation period. The main reason was the change of the system of fields of study in Slovakia in 2019 because Geography became a part of Earth Sciences field. *The System of Ph.D. Study Quality Assurance in the IG SAS* document was adopted in 2020 upon the basis of the *SAS's Internal System of Quality Assurance for Doctoral Studies*. Dr Igor Broska from the Earth Science Institute of the SAS became the guarantor for doctoral studies at the IG SAS. The guarantor participates in doctoral seminars and is actively interested in the course of doctoral studies. The coordinator of doctoral studies in the IG SAS is Dr Anton Michálek. The SAS Presidium has approved our system and agreed to finance doctoral studies in the IG SAS from central sources. There is a limit on the number of doctoral students in the IG SAS (two new doctoral students per year), although there can be some exceptions approved by the SAS Presidium.

Other comments on doctoral studies and educational activities are in Chapter 3.

2.6. Societal impact

2.6.1. The most important case studies of research a with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study

Case Study 1: **Heat risk assessment and its mitigation**

Summary of the impact

In cooperation with the Slovak Hydrometeorological Institute, scientists at the IG SAS applied a model to assess the heat risk for Bratislava as the capital city of Slovakia. The results reflected the variability of the population (including the elderly) within the city and the variability of the temperature field, which is caused by the combined effect of UHIs and topography. The highest risk index values occur within the broader city centre, with specific hotspots at several places. We further developed systems to identify and classify urban green areas as a key tool for mitigating heat waves. Our analysis was used as the input data for Bratislava City Hall's Text for the Public Greenery Project and for the latest Territorial Plan of Bratislava.

Underpinning research

In 2016, the IG SAS started cooperation with the National Agriculture and Food Centre (Soil Science and Conservation Research Institute) and the Slovak Hydrometeorological Institute as a part of the *Effect of Impermeable Soil Cover on the Urban Climate in the Context of Climate Change* (PEDO-CITY-CLIMA) project, which was supported by the Slovak Research and Development Agency (APVV). The main contribution of the IG SAS within this project was the identification and delimitation of land cover/use classes based on Copernicus Urban Atlas data from 1998 to 2016 and their effect on temperature change. The Local Climate Zones concept was used as an input for UHI modelling with the application of the MUKLIMO numerical model. The project was applied in three cities in Slovakia (Bratislava, Trnava and Žilina) characterised by extremely extensive constructions with minimal respect for the intrinsic risk of the changed climatic conditions. The MUKLIMO model was validated by data taken at five stations in Bratislava, two stations in Trnava and one station in Žilina, and a good agreement rate between the modelled and measured data was statistically proven. The spatial manifestation of UHIs was assessed for the situations in 1998, 2007 and 2016 to assess the effect of LUCC on the distribution of temperatures.

References to the research

ADCA10 HOLEC, Juraj** - FERANEC, Ján - ŠŤASTNÝ, Pavel - SZATMÁRI, Daniel - KOPECKÁ, Monika - GARAJ, Marcel. Evolution and assessment of urban heat island between the years 1998 and 2016: case study of the cities Bratislava and Trnava in western Slovakia. In *Theoretical and Applied Climatology*, 2020, vol. 141, iss. 3-4, p. 979–997. (2019: 2.882 - IF, Q2 - JCR, 0.966 - SJR, Q2 - SJR). https://doi.org/10.1007/s00704-020-03197-1

ADCA11 HOLEC, Juraj - ŠVEDA, Martin - SZATMÁRI, Daniel - FERANEC, Ján - BOBÁĽOVÁ, Hana - KOPECKÁ, Monika - ŠŤASTNÝ, Pavel. Heat risk assessment based on mobile phone data: case study of Bratislava, Slovakia. In *Natural Hazards*, 2021, vol. 108, no. 3, p. 3099-3120. (2020: 3.102 - IF, Q2 - JCR, 0.760 - SJR, Q1 - SJR), https://doi.org/10.1007/s11069-021-04816-4

ADMA01 FERANEC, Ján** - KOPECKÁ, Monika - SZATMÁRI, Daniel - HOLEC, Juraj - ŠŤASTNÝ, Pavel - PAZÚR, Róbert - BOBÁĽOVÁ, Hana. A review of studies involving the effect of land cover and land use on the urban heat island phenomenon, assessed by means of the MUKLIMO model. In *Geografie : sborník České geografické společnosti*, 2019, roč. 124, č. 1, s. 83-101. (2018: 0.540 - IF, Q4 - JCR, 0.343 - SJR, Q2 - SJR). https://www.geografie.cz/archiv/stahnout/114

AFC02 FERANEC, Ján - HOLEC, Juraj - ŠŤASTNÝ, Pavel - SZATMÁRI, Daniel - KOPECKÁ, Monika. Visualising a comparison of simulated urban heat islands: a case study of two Slovakian cities. In *Advances in Cartography and GIScience of the ICA*. Vol. 1 [elektronický zdroj]. Ed. H. Fujita. - Tokyo : International Cartographic Association, 2019, p. [1-8]. https://doi.org/10.5194/ica-adv-1-6-2019

AFC03 KOPECKÁ, Monika** - SZATMÁRI, Daniel - HOLEC, Juraj - FERANEC, Ján. Urban heat island modelling based on MUKLIMO: examples from Slovakia. In *The AGILE: GIScience Series, vol. 2 : open-access proceedings of the Association of Geographic Information Laboratiories in Europe*. Eds. Partsinevelos, P., Kyriakidis, P., Kavouras, M. - Copernicus Publication, 2021, p. [1-11]. https://doi.org/10.5194/agile-giss-2-5-2021

Sources to corroborate the impact

The project's outputs were presented to the representatives of local municipalities as an important tool for the informed and scientific planning and decision-making processes of communal authorities in terms of environmental territorial design. As a result, Bratislava City Hall asked the IG SAS to prepare an analysis for the Public Greenery Project and the new Territorial Plan of Bratislava.

KOPECKÁ, Monika – SZATMÁRI, Daniel. Identification and classification of green areas in Bratislava using satellite data Sentinel-2A. Text and graphic analysis for the needs of the Capital City Hall for Public Greenery Project and the new Territorial Plan of Bratislava

Case Study 2: **Identification and classification of abandoned agricultural land**

Summary of the impact

The main output of the research and field survey is the identification of the physiognomic characteristics of the classes of abandoned agricultural land (including the dominant vegetation species) of training and test sites. Based on Sentinel-2 satellite imagery, our results provide a background source and input data for the automatic identification of abandoned arable land, abandoned vineyards, and abandoned meadows in the lowland and basin landscapes of Slovakia.

Underpinning research

From 2018 to 2020, the IG SAS, in cooperation with the National Forest Centre, worked on the *Advanced Techniques for Biomass Mapping in Abandoned Agricultural Land Using a Novel Combination of Optical and Radar Remote Sensing Sensors* (ATBIOMAP) project, which was supported by the European Space Agency.

The results of the research document the physiognomic and spectral differences between abandoned agricultural land and other land cover/use classes in Slovakia. The Normalised Difference Vegetation Index (NDVI), derived from the Sentinel-2 time series for vegetation from April to September 2018, was applied. NDVI values were calculated for each Sentinel-2 scene, and NDVI profiles for selected samples were used to create phenological profiles for abandoned land and other land cover/use classes. The dispersion of the NDVI values for these classes, their median, and the root mean square error between NDVI data show that overgrowth by herbaceous plants is characterised by more significant dynamics, resulting in better spectral discriminability than classes overgrown by shrubs and trees. These findings are helpful for the identification of farmland abandonment in its early stages. Field survey data are a fundamental prerequisite for the correct explanation of the discriminability of abandoned land classes. The spectral proximity of different land cover/use classes to abandoned land requires a greater emphasis on the use of field surveys to make it possible to determine the relevant physiognomic characteristics that contribute to their identifiability using satellite images.

References to the research

ADMB03 GOGA, Tomáš** - SZATMÁRI, Daniel - FERANEC, Ján - PAPČO, Juraj. Abandoned Agricultural Land Identification Using Object-based Approach and Sentinel Data in the Danubian Lowland, Slovakia. In *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science - ISPRS Archives*, 2020, vol. 43-B3, p. 1539-1545. (2019: 0.367 - SJR). ISSN 1682-1750. https://doi.org/10.5194/isprs-archives-XLIII-B3-2020-1539-2020

ADCA08 GOGA, Tomáš** - FERANEC, Ján - BUCHA, Tomáš - RUSNÁK, Miloš - SAČKOV, I. - BARKA, Ivan - KOPECKÁ, Monika - PAPČO, Juraj - OŤAHEĽ, Ján - SZATMÁRI, Daniel - PAZÚR, Róbert - SEDLIAK, Maroš - PAJTÍK, Jozef - VLADOVIČ, Jozef. A Review of the Application of Remote Sensing Data for Abandoned Agricultural Land Identification with Focus on Central and Eastern Europe. In *Remote Sensing : Open Access Journal*, 2019, vol. 11, no. 23, art. no. 2759. (2018: 4.118 - IF, Q1 - JCR, 1.430 - SJR, Q1 - SJR), Current Contents - CCC). (2019 - Current Contents). ISSN 2072-4292. https://doi.org/10.3390/rs11232759

ADCA40 SZATMÁRI, Daniel** - FERANEC, Ján - GOGA, Tomáš - RUSNÁK, Miloš - KOPECKÁ, Monika - OŤAHEĽ, Ján. The Role of Field Survey in the Identification of Farmland Abandonment in Slovakia Using Sentinel-2 Data. In *Canadian Journal of Remote Sensing*, 2021, vol. 47, no. 4, p. 569-587. (2020: 2.000 - IF, Q3 - JCR, 0.694 - SJR, Q1 - SJR), Current Contents - CCC). (2021 - Current Contents). ISSN 0703-8992. https://doi.org/10.1080/07038992.2021.1929118

Sources to corroborate the impact

A position on the results of the ATBIOMAP project (the prime contractor: National Forest Centre, Zvolen; subcontractor: IG SAS, Bratislava; supported by the European Space Agency) was issued by the Ministry of Agriculture and Rural Development of the Slovak Republic, which was a recipient

of these results. Their standpoint shows that the developed approach could identify stocks of biomass on abandoned agricultural land. The application of this approach would also contribute to the fulfilment of the inventory of greenhouse gas emissions in the Land Use, Land Use Change and Forestry (LULUCF) sector in Slovakia (according to Article 3 of the European Parliament and the Council of the European Union Decision No. 529/2013 and the Kyoto Protocol Addendum).

Case Study 3: **The learned lesson from the river training impact on the multi-thread river system as a part of the Natura 2000 network**

Summary of the impact

The results deal with the evaluation of the impact of flood protection works on the morphology and hydraulic parameters of the Belá River belonging to the Natura 2000 network (Kidová et al. 2020 ADCA14). The most serious consequences of the river training were the simplification of the river planform, the reduction of the geodiversity index of the in-channel landforms and the reduction and loss of the hydro-morphological lateral connectivity between the low flow channel and floodplain. The analysed hydraulic parameters before and after river training revealed an increased flow rate and increased values of shearing stress and water energy on all studied cross-sections. Identifying the main conflicts in the management of the Belá River by using an objective scientific approach contributed to revealing the negative consequences of the current engineering approach of stakeholders in the studied area.

Underpinning research

In 2018, the participation of the IG SAS in the preparation of the documentation for the management programme of the Belá River for the period 2018–2047 became a reality. The primary document focused mainly on setting operational objectives in ecologically functional zones represented by specifically protected habitats of fauna and flora; the idea of integrated river management and the development of strategic issues in the management of the Belá River is presented there. The strong need for consensus between water management, forest management and nature conservancy in this case study is desirable.

Cooperation with the World Wide Fund for Nature in Bratislava resulted in a hydro-morphological assessment of the mentioned river training on the multi-thread Belá River. Cooperation with an expert from the Plant Science and Biodiversity Centre of the SAS responsible for the assessment of the river training in Natura 2000 habitats was also carried out.

Evident non-compliance of river management with the strategy documents has caused a public nuisance for inhabitants in settlements linked to the Belá River and evoked discussion about the consequences and correctness of the chosen management procedure among experts (Association of Slovak Geomorphologists based on IG SAS, Association of Limnology) as well as non-government organisations (World Wide Fund for Nature and the Fishing Union) and ecological activists, resulting in the preparation of a memorandum on cooperation. The common output of this cooperation was presented in the public media (via the main televised news programme, the Pravda newspaper and online social media).

References to the research

ADCA13 KIDOVÁ, Anna - LEHOTSKÝ, Milan - RUSNÁK, Miloš. Geomorphic diversity in the braided-wandering Belá River, Slovak Carpathians, as a response to flood variability and environmental changes. In *Geomorphology*, 2016, vol. 272, p. 137-149. (2015: 2.813 - IF, Q1 - JCR, 1.385 - SJR, Q1 - SJR). https://doi.org/10.1016/j.geomorph.2016.01.002

ADCA14 KIDOVÁ, Anna** - RADECKI-PAWLIK, Artur - RUSNÁK, Miloš - PLESIŃSKI, Karol. Hydromorphological evaluation of the river training impact on a multi-thread river system (Belá River, Carpathians, Slovakia). In *Scientific Reports*, 2021, vol. 11, art. no. 6289. (2020: 4.380 - IF, Q1 - JCR, 1.240 - SJR, Q1 - SJR). https://doi.org/10.1038/s41598-021-85805-2

Details of the impact

A lack of appropriate river management of the Belá River was identified in this case study. The key challenge from this point of view is engagement activities in knowledge exchange among stakeholders, researchers and the public as well as involving local communities in the decision-making process as far as possible by sharing evidence, listening to ideas and assessing priorities. The main challenge of sustaining the Belá River in the face of climate change was raised as additional issues to respect all national and international strategic documents where supporting their implementation lead to greater enforcement of existing regulations. The need for better-integrated planning focusing on economic balance to provide multiple benefits to water users (e.g. recreation,

hydropower) is crucial to achieving environmental improvements. The importance of wider landscape management and the value of looking at the river landscape as an entire system emphasises attention to protection purposes. Further operative steps within these challenges cover flood risk management coordination with planning environmentally friendly and nature-based approaches (e.g. room for the river concept). The importance of the main conflict identification based on revealing the management operating shortages supports the redirection of future activities in a more appropriate way.

Sources to corroborate the impact

This research was the output of the Recent Lateral and Vertical Evolution of River Valley Bottoms Under Changing Environmental Conditions and Their Impact on Riverine Landscape Ecosystem Services (VEGA 02/0098/18) national project. On the basis of the published results, the authors of the study were officially asked to provide the results of this research for the needs of the Žilina Environmental Inspectorate within administrative tort proceedings pursuant to section 90 para. 1 letter (a) of Act 543/2002 Coll. concerning a change in the state of the watercourse, which was said to have occurred during the implementation of river training after the flood of 19 July 2018 in selected reaches of the Belá River without the consent of the relevant nature protection authority.

Case Study 4: **Manifestations of suburbanization in the hinterland of Bratislava**

Summary of the impact

Extensive pioneering research on suburbanisation processes and their manifestations in the Bratislava metropolitan area brought several original analyses of socio-spatial relations and introduced a young research team to the general professional public and to stakeholders. The results, which were supported by publicity obtained mainly through monographic publications, were a part of unprecedented interinstitutional cooperation which the researchers of this project carried out. Several project researchers were invited to expert participation in the preparation of new residential projects across the Bratislava region or as consultants for public administration bodies (Bratislava Metropolitan Institute). Under the auspices of the Bratislava Metropolitan Institute, methodological proposals and spatial analyses leading to the preparation of a “manual of participation” were also formulated (Hurný et al. 2021). Based on the outputs of the suburbanisation project, the institute was approached by the Ministry of the Interior of the Czech Republic for expert cooperation concerning a large-scale public administration reorganisation project using data from mobile phone networks (Improving the Conditions for the Decentralisation and Accessibility of Public Administration in the Territory, GG-PDP1-001). Another example of a newly created partnership can be seen in the cooperation with the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Ministry of Health of the Slovak Republic which resulted in joint projects analysing the capacity and availability of preschool facilities in Bratislava and cooperation in creating a model of primary school network optimisation in Slovakia. The documented experience with the research of socio-spatial transformations in the project outputs became the basis for establishing cooperation with the Ministry of the Interior of the Slovak Republic, wherein the researchers of the institute were invited to participate in public administration reform of the Slovak Republic. One of the tasks within the Commission for Public Administration Reform is to adapt territorial division to new functional ties, which to a large extent have transformed the process of suburbanisation (for instance, concerning the metropolitanisation of Bratislava).

References to the research

FAI13 *Suburbanizácia : ako sa mení zázemie Bratislavy?* [Suburbanization: to what extent has Bratislava’s hinterland changed?]. Eds. Šveda, M. & Šuška, P. Bratislava : Geografický ústav SAV, 2019. 297 p.

FAI14 *Suburbanizácia 2 : sondy do premien zázemia Bratislavy*. [Suburbanization 2: probes to the transformation of the Bratislava hinterland]. Eds. Šveda, M. & Šuška, P. Bratislava : Geografický ústav SAV, 2020. 241 p.

AAB07 ŠVEDA, Martin - VÝBOŠŤOK, Ján - GURŇÁK, Daniel. *Atlas suburbanizácie Bratislavy*. Bratislava : Geografický ústav SAV, 2021. 120 s.

ADCA02 BLAŽEK, Matej - ŠUŠKA, Pavel. Towards dialogic post-socialism: Relational geographies of Europe and the notion of community in urban activism in Bratislava. In *Political Geography*, 2017, vol. 61, p. 46-56. (2016: 2.410 - IF, Q1 - JCR, 2.098 - SJR, Q1 - SJR), https://doi.org/10.1016/j.polgeo.2017.06.007

ADCA44 ŠVEDA, Martin** - SLÁDEKOVÁ MADAJOVÁ, Michala - BARLÍK, Peter - KRIŽAN, František - ŠUŠKA, Pavel. Mobile phone data in studying urban rhythms: Towards an analytical framework. In

Moravian Geographical Reports, 2020, vol. 28, no. 4, p. 248-258. (2019: 2.479 - IF, Q2 - JCR, 0.693 - SJR, Q1 - SJR). https://doi.org/10.2478/mgr-2020-0018

ADNB35 SLÁDEKOVÁ MADAJOVÁ, Michala - ŠVEDA, Martin - VÝBOŠŤOK, Ján. Bude miesto pre všetky deti? Kapacita predškolských zariadení v Bratislavskom samosprávnom kraji = Will there be a place for all children? Capacity of pre-school facilities in the Bratislava self-governing region. In *Geografický časopis*, 2021, vol. 73, no. 4, p. 301-322. (2020: 0.263 - SJR, Q3 - SJR).. https://doi.org/10.31577/geogrcas.2021.73.4.16

Sources to corroborate the impact

Three chapters (1) ŠUŠKA, Pavel et al. Ľudia Bratislavy : - čo nám hovoria dáta? (People of Bratislava: - what do the data tells us? (2) ŠVEDA, Martin et al.. Ľudia Bratislavy - čo nám hovoria dáta? : Obyvatelia/ obyvateľky (Inhabitants). (3) VÝBOŠŤOK, Ján et al.. Ľudia Bratislavy - čo nám hovoria dáta? : Denní návštevníci/ návštevníčky (Daily visitors). In the moograph HURNÝ, Juraj et al. Ako porozumieť mestu a jeho ľuďom? (How to understand the city and its people?) Bratislava : Metropolitný inštitút Bratislavy, 2021. ISBN 978-80-973834-4-2. https://mib.sk/wp-content/uploads/2021/11/MANUAL_VERZIA_FINAL.pdf

The Analytic Part of the strategic plan Bratislava 2030 https://bratislava2030.sk/en/

In addition, the researchers participating in the suburbanisation project were interviewed on Slovak and Czech radio and gave eight interviews to print and electronic media with nationwide coverage. They also appeared in regional media. They also participated in several public discussions and presentations.

2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words))

1. ***Urban Atlas***, name of the institution: Institute Geographique National France International, contract value: 15,000 €, country of partner: France, duration: 2013–2016, purpose: In the context of the Urban Atlas project, linked to the pan-European Copernicus program, the IG SAS provided interpretation of checkpoints on satellite images of selected European cities.
2. ***Analysis of the macroeconomic strategy and development potential of the regions of the Slovak Republic***, name of the institution: Stengl a.s., contract value: 22,400 €, country of partner: Slovakia, duration: 2017–2018, purpose: Advisory and consulting activities for the Central Coordinating Body (Office of the Deputy Prime Minister for Investment and Informatization) – analysis of the macroeconomic strategy and development potential of the regions of the Slovak Republic.
3. ***Comparative Analysis of Territorial Governance and Spatial Planning Systems in Europe***, name of the institution: Delft University of Technology., contract value: 7,000 €, country of partner: Netherland, duration: 2017, purpose: Analysis of the spatial planning system in Slovakia for the international project supported by ESPON.
4. ***Framework Service Contract EEA/ IDM/ R0/ 16/ 009/ Slovakia***, name of the institution: Slovak Environment Agency, contract value: 4,906 €, country of partner: Slovakia, duration: 2018, purpose: Verification of the Urban Atlas (UA) and UA Street Tree Layer of the pan-European Copernicus program in accordance with the EEA methodology.
5. ***Identification and classification of green areas in Bratislava using satellite data Sentinel-2A***, name of the institution: Bratislava – municipality, contract value: 9,990 €, country of partner: Slovakia, duration: 2018–2019, purpose: Identification and classification of urban green spaces in Bratislava for the needs of the Public Greenery Project and the General City Plan of Bratislava.
6. ***Polish borders as a resource – between heritage and tourism product***, name of the institution: Institute of Geography and Spatial Organization Polish Academy of Sciences, contract value: 2,800 €, country of partner: Poland, duration: 2019-2021, purpose: The boundary landscape case study of the Western Beskids Mountains under the project supported by National Science Centre in Poland.
7. ***Vibrant Rural Areas: Rural Services***, name of the institution: European Network of Rural Development, contract value: 2,000 €, country of partner: Belgium,

duration: 2020, purpose: point out the differentiated approaches to the definition of rural areas and the problems associated with spatial, economic, and social marginalisation of the selected population groups.

8. ***Economy of Southern Slovakia in the Normalisation Period (1969–1989)***, name of the institution: J. Selye University Komárno, contract value: 560 €, country of partner: Slovakia, duration: 2020–2021, purpose: Cartographic visualisations for the book publication.
9. ***North-South interconnection within the network of motorways and expressways in central Slovakia***, name of the institution: Carretera s.r.o., contract value: 15,000 €, country of partner: Slovakia, duration: 2021, purpose: North-South interconnection within the network of motorways and expressways in the area of central Slovakia – comparison of changes in time availability and interaction potential for two variants VR1 and VR3.

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))

-

2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR

-

2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))

-

2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorisation in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.

Four contracts with international institutions from France, Belgium, Netherland and Poland brought totally 26,800 €.and five contracts with Slovak institution 52,756 €.

2.7. Popularisation of Science (outreach activities)

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

1. The Barbara Petchenik Children's World Map Drawing Competition (a biennial map drawing competition for children). The IG SAS organised the national round of this competition in 2017, 2019 and 2021. Selected drawings from Slovakia were sent to the International Cartographic Association and are exhibited during the International Cartographic Conferences. Drawings from Slovakia won 3rd place in 2019 and in 2021. https://icaci.org/petchenik/
2. SAS educates students - Geography: 8 videos for students – educational material from the beginning of the Covid-19 pandemics https://www.youtube.com/playlist?list=PLnoxuocIGZfTXghVB6tXxsnO9IFiRaEbd
3. European Researchers' Night – active participation at the festival of science in 2016, 2019, 2020 and 2021
4. Weekend with the SAS – popularisation event in the centre of Bratislava in 2018 and 2019
5. Young researchers at schools – participation in the SAS project in 2017 and 2019 (Goga, Rusnák)

6. Advanced Techniques for Biomass Mapping – a short movie about the ATBIOMAP project, 2020. Slovak and English version, http://www.geography.sav.sk/en/research/projects/atbiomap/
7. FERANEC, Ján - GOGA Tomáš. Život s vedou: Mapujú nevyužívanú pôdu (Life with science - They map abandoned land). Document at the TA3 TV station, 20.10.2020 https://www.youtube.com/watch?v=MsneVM1aQT0
8. IRA, Vladimír. Prečo sa orientujeme v priestore a zároveň v čase? (Why do we orient ourselves in space and time?) Lecture at the Comenius Children's University, 3.8.2016.
9. KIDOVÁ, Anna. Spútame aj poslednú divokú rieku? (Do we also tie the last wild river?) Article in daily paper Pravda, appendix Víkend 15.12.2018. https://zurnal.pravda.sk/reportaz/clanok/495749-sputame-aj-poslednu-divoku-rieku/
10. RUSNÁK, Miloš. The ecosystem in danger: How man and climate change are changing the face of Slovak rivers. Lecture at the Slovak Centre of Scientific and Technical Information (CVTI), https://vedanadosah.cvtisr.sk/podujatia/8049/bratislavska-vedecka-cukraren-ekosystem-v-ohrozeni-2020-02
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12. VÝBOŠŤOK, Ján. Spravodlivá nerovnosť? (Fair inequality?) In Quark : a magazine for science and technology, 2020, vol. 26, no. 9. ISSN 1335-4000. Dostupné na internete: https://www.quark.sk/spravodliva-nerovnost/
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14. LEHOTSKÝ, Milan - RUSNÁK, Miloš - KIDOVÁ, Anna - SOLÍN, Ľubomír. Watercourses, their changes and flood risk. Brochure published under the Open Academy project in 2018.
15. SLÁDEKOVÁ MADAJOVÁ, Michala - ŠVEDA, Martin - VÝBOŠŤOK, Ján. Will there be a place for all children? The capacity of pre-school facilities in the Bratislava self-governing region, Press conference, 24.5.2021. https://www.facebook.com/watch/live/?ref=watch_permalink&v=500364514644356
16. KRIŽAN, František - BILKOVÁ, Kristína - ZEMAN, Milan. Effect of COVID-19 pandemics on changes in consumer behaviour. Press conference,10.8.2021. https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=9802
17. FERANEC, Ján. Nielen fascinujúce, ale aj užitočné pohľady na Zem zo satelitov (Not only fascinating, but also useful views of the Earth from satellites). In Aktuality.sk. https://www.aktuality.sk/clanok/vp8qc0q/nielen-fascinujuce-ale-aj-uzitocne-pohlady-na-zem-zo-satelitov/
18. FERANEC, Ján. Geoinformatika a diaľkový prieskum Zeme (Geoinformatics and remote sensing of the Earth). Radio Devín, Radio broadcast Academy, 28. 2. 2021.
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2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	17	20	31	23	39	16	146
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	8	6	7	13	16	10	60
Public popularisation lectures	7	8	7	10	3	9	44

2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

2.8.1. Summary table of personnel

2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	1	21	3	1	1	16	5
Female	0	9	0	0	0	5	4

I. – director of research with a degree of doctor of science/DrSc.

II.a – Senior researcher

II.b – PhD holder/Postdoc

2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Male	2,0	2,0	2,0	2,0	3,0	1,6	4,0	2,4	1,0	1,0	1,0	0,1	2,0	1,1	1,0	1,0	5,0	2,8
Female	1,0	1,0	2,0	2,0	4,0	2,6	0,0	0,0	1,0	1,0	1,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0

A – number

B – FTE

2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

2.8.2.1. MoRePro and SASPRO fellowships

2.8.2.2. Stefan Schwarz fellowships

1. Šárka Horáčková – June 1, 2019-May 31, 2021 – graduated (PhD) from the Comenius University Bratislava, postdoctoral researcher at the Institute after receiving PhD degree
2. Lukáš Michaleje – January 1, 2022-December 31, 2023 – graduated (PhD) from the Institute, postdoctoral researcher at the Institute after receiving PhD degree

2.8.2.3. Postdoctoral positions from other resources (specify)

The IG SAS employed six postdocs instead of retired researchers: Kristína Bilková in 2017, Šárka Horáčková in 2018, Lukáš Michaleje and Ján Výbošťok in 2020, Tomáš Goga and Katarína Rišová since September 2021.

2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding *(max. 2 pages)*

The IG SAS is gradually adapting to current trends in using open-source policy while obtaining open-source data or software. Usage of open-source GIS software like QGIS is already the standard, while encouragement for using script-based tools implemented within Python or R libraries is growing. High-performance computing and data processing is taking off hand in hand by engaging young scientists in more complex project schemes. For this purpose, using (up-to-now) freely available tools like Google Earth Engine or Microsoft Planetary Computer is becoming a new standard for young scientists, especially young scientists.

On the other hand, research tasks at the IG SAS are still supported by commercial products like ArcGIS, LAStools, SPSS or e-Cognition Developer. Maintaining costly licence fees is becoming challenging for some of these packages, and maintenance fees are no longer paid while using the last available paid software packages (ArcGIS Desktop 10.5 or eCognition Developer 10.2). Given the above, the shift to open-source software is becoming essential.

Local computational requirements for scientific research are covered by the high-performance workstation obtained in 4Q.2018. The workstation consists of an Intel i9-7900X processor, supported by DDR4 64GB 2666MHz RAM, Samsung 970 PRO 1TB SSD M.2 and graphic card ASUS TURBO GTX1080 8GB. Higher computational demands are routed to resources secured by the Computing Centre of SAS or open-source opportunities like Google Earth Engine. Technological upgrade (replacement) for this workstation will be required during 2023.

The data policy of the IG SAS is provided by local data storage based on Synology technology. Currently, approximately 20TBs of data storage are available with complete data backup. Preparation for data storage solutions up to 72TBs is a final phase (3Q.2022) while the hardware is available (Synology DS918+ and Synology DS920+ with Synology DX517). Disk arrays are compound from highly reliable Western Digital disks – WD Red Pro (up to 18TBs).

Security of the local internet network was upgraded in 1Q.2021. Based on Mikrotik solutions, all local devices are secured through a locally provided firewall. The connection for devices outside the local network is secured via an open-source VPN tool (OpenVPN). This solution also enables remote work while providing users with local IP addresses. Two types of local wireless networks were established, providing the connection for external guests and local users with fewer firewall restrictions. All network-based devices (like PC or laptops) are secured by the commercial licence of ESET PROTECT solutions (3Q.2021). Currently, 71 devices are remotely managed using ESET PROTECT SERVER with ESET Endpoint Antivirus and ESET LiveGuard Advanced.

Additional pieces of equipment and technical infrastructure are related to acquiring spatial data from field measurement and encompassing the software for data extraction, management, and analyses. This technical infrastructure for field survey is concentrated mainly in the Department of Physical Geography, Geomorphology and Natural Hazards, and it is frequently used in research projects. The available research infrastructure of the IG SAS Laboratory of geomorphology and natural hazards provides the acquisition of spatial data from field measurement. The spatial data information and high accuracy are obtained by total positioning station Leica TCR 307, GPS Leica GS20 and GPS Leica Zeno 5. For data management in GPS or for extraction and converting of data is used DigiTerra Explorer software and GIS Data Pro. Other specialised tools or software for field research are LaserTech – Trupulse 360B (laser distance meter), SonTek YSI FlowTracker (handheld acoustic doppler velocimeter), RETSCH – AS200 Digit (sediment sieve shaker), AND EJ 300 (analytical laboratory scales), GRADISTAT software (statistical analyses of sediment particle size), SEDIMETRICS Digital Gravelometer (optical sediment analyses), Proceq SilverSchmidt BN (measurement of rock surface hardness). Peat corer ejkelkamp that is compatible with variable

extensions to different sedimentary layers is well used for sediment stratigraphy prospection, soil research and sample collection for dating and various sedimentary analyses. A binocular microscope with the camera is fully compatible and well suitable for investigating samples of subfossil pollen, spores, charcoal, parasites, or macrofossil remains.

The Institute of Geography has successfully established Unmanned Aerial Vehicles (UAVs) to research river landscapes. The previous research focused on the evolution of the avulsion channel of the Ondava River, a digital elevation model of the landslide area inside Svätý Anton village and a 3D model with an orthophoto of the Belá River. Currently, the IG owns a UAV – DJI Mavic 2 Pro for monitoring the dynamic river systems (Belá River, Hornád River), their channel evolution, and their response to human intervention.

2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)

Supplementary information and comments are in Chapter 3.

3. *Implementation of the recommendations from the previous evaluation period*

Meta-panel assessment report for the period January 1, 2012 — December 31, 2015, stated the following specific recommendations and comments:
- It seems, that the institute did not yet arrive at the point where an overarching theme "water, landscape evolution and future climate change and its impact on society" will build strong bridges between existing small clusters. In addition, the water-climate theme is also addressed in other institutes. An intense collaboration between geography, hydrology, earth sciences and others is strongly recommended. Team-building across discipline boundaries (transdisciplinary) will be of importance. Broad collaboration will provide opportunities to get better national and international funding.
- Improve gender balance — women are dramatically underrepresented (1:12, assistant profs)
- PhD's - a better collaboration with university is recommended structural/legal problems between the SAS and the universities seem to complicate collaboration in some disciplines. We recommend that researchers become more active members of university departments, which could give them an opportunity to be supervisors of more PhD-theses. Collaboration with researchers abroad as part of PhD study is strongly recommended. Learning by good practice in other SAS Institutes is even more important for small SAS Institutes like geography. We recommend that the institute tries to have more visitors, guests, guest speakers for invited talks.
- Public outreach - Activities should be intensified in the fields where society is involved
Funding: the trend to decreased funding on EU-level should be reversed
New research focus, PhD recruiting plans, improvement of m/f ratio, teaching and outreach activities should become part of a strategic plan, including goals, milestones.
An international advisory board should accompany strategic planning.

The IG SAS adopted the strategic plan (SP) with the aim to meet the general recommendations of the meta-panel to increase the level of scientific research of the SAS and the recommendations of the meta-panel addressed to the IG SAS.
The first version of the SP was approved in 2017. It was updated in 2018 based on the comments of SAS Presidium members and then at the end of 2020 when we decided to evaluate our progress and start discussions concerning the scientific orientation for the new evaluation period. The SP sets out specific activities, actions and tasks in the following areas: (1) human resources, (2) research priorities, (3) project activities and extra-budgetary resources, (4) international cooperation, (5) publication activities, (6) doctoral studies and educational activities, and (7) social impact and the popularisation of research. All areas of IG SAS activities are essential and interconnected, and we paid attention to each of them.

(1) Human resources
We aimed to maintain or slightly increase the number of researchers (FTE) to ensure a critical number of scientists in each research cluster, optimise the ratio of researchers and other staff, create the conditions for an increase in the number of female researchers and create the conditions for improving the age structure of researchers.
The number of researchers increased from 18.8 FTE in 2015 to 20.50 FTE in 2021[4]. From 2019 to 2021, competitive job interviews were held to fill research positions. The number of other staff decreased from 13.34 FTE in 2015 to 9.07 FTE in 2021. The number of female researchers has increased from three in 2015 to nine in 2021 (from 2.33 to 7.6 FTE). Indeed, the share of women reached 36.6% in 2021. Currently, all three heads of the scientific departments are women. Retired researchers are gradually being replaced by young researchers. This generational change was one of the most significant challenges of the previous period. This is still one of our risks because of the fact that successful researchers also have offers from the private sector, where there are higher salaries. If this generational change process is successful, this change will be our strength. Figure 5 shows that the generational change is thus far successful and that the focus of scientific performance has shifted to the middle and younger generations.

[4] The data in Chapter 3 are taken from the IG SAS annual reports for the years 2016–2021.

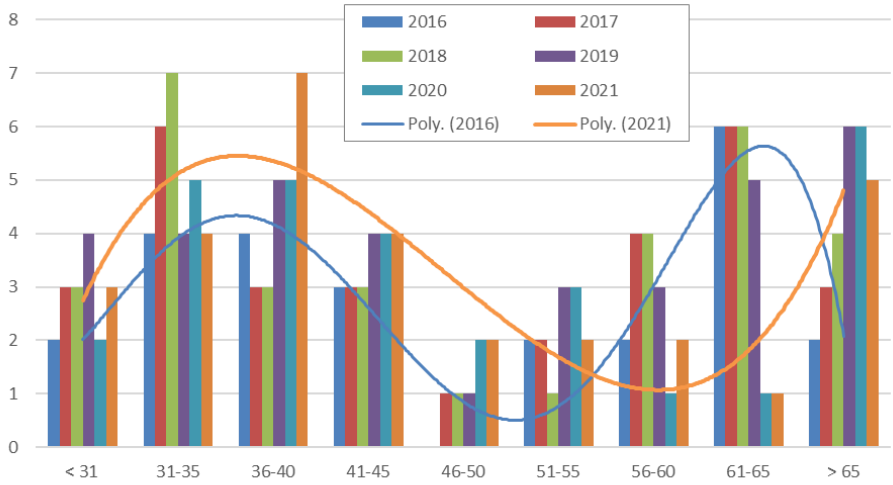

Figure 5: The age structure of researchers in the period 2016–2021

(2) Research priorities

We consider three smaller clusters to be justified. It is important that they are open to other clusters at the IG SAS, which is reflected in the completion and submission of project proposals and in resulting publications. The topic of landscape development plays a significant role in integrating three smaller research clusters. Intensive cooperation can be mainly seen between members of the *Structures, Processes and Hazards of River Systems: Their Response to and Impact on Natural and Socio-economic Systems Cluster* and the *Land Use and Land Cover Based on the Application of Remote Sensing Data* cluster. Landscape development is also an important part of the *Development Trajectories of Localities and Regions in the Context of Socio-economic Change* cluster. All clusters still have their specific features.

In 2021, there was a discussion within the individual departments and in the Scientific Board and the Board of Director regarding the new research clusters for the period 2022–2026. Three clusters, which follow the content of the previous period, were defined: (1) *Riverine Landscape: Driving Forces, Evolution and Natural Hazards*; (2) *Landscape and its Changes in the Context of Geoinformatics*; and (3) *Regions, Localities and Communities in the Spatio-temporal Move*.

The openness of clusters is also directed towards other research institutions of the Slovak Academy of Sciences. From 2016 to 2021, the IG SAS participated in projects with the Institute of Landscape Ecology of the SAS (EraNet project), the Institute of Sociology of the SAS (APVV project), and the Institute of Ethnology and Social Anthropology of the SAS (two APVV projects). Project proposals were submitted in cooperation with the Plant Science and Biodiversity Centre of the SAS, the Biomedical Research Centre of the SAS, the Centre of Social and Psychological Sciences of the SAS, the Institute of Mathematics of the SAS, and the Institute of Physics of the SAS.

The topic of water (as an overarching topic of activities of many institutes from all three SAS sections) has been discussed at the SAS level. The WATERS programme has been implemented, and researchers from the IG SAS are actively involved in it.

Cooperation with other research institutions in Slovakia included the following project partners: the Faculty of Natural Sciences of Comenius University in Bratislava (three APVV projects), the National Forest Centre in Zvolen (an ESA-PECS project), the Slovak Hydrometeorological Institute (an ESA-PECS project), and the Soil Science and Conservation Research Institute of the National Agricultural and Food Centre (an ESA-PECS project). Other projects have been prepared with Constantine the Philosopher University in Nitra, Pavol Jozef Šafárik University in Košice, the Slovak University of Technology in Bratislava, the Technical University of Košice and the Faculty of Law of Comenius University in Bratislava.

At the international level, successful project cooperation has included the following partners: the Delft University of Technology (an ESPON project), the Swiss Federal Research Institute for Forest, Snow and Landscape (WSL) in Birmensdorf (an EraNet project), the Institute of Geography and Spatial Organisation of the Polish Academy of Sciences in Warsaw (NCN and inter-academic projects), the Institute of Steppe of the Ural Branch of the Russian Academy of Sciences (an EraNet project), and the Czech University of Life Sciences in Prague (an IVF project). Project proposals

were prepared in cooperation with the University of Lincoln, the National Quemoy University in Taiwan, Charles University in Prague, the Global Change Research Institute of the Czech Academy of Sciences in Brno, the Transport Research Centre in Brno, the Pedagogical University of Krakow, the University of Ljubljana, the Institute of Geography of the National Academy of Sciences of Ukraine in Kyiv, Lviv Polytechnic National University, the Institute of Geography of the Romanian Academy, the University of Bucharest, the Romanian Space Agency and the University of Belgrade. Cooperation with many national and international partners resulted in the preparation of 86 project proposals (fourteen per year on average), and 37 of them were successful. Great effort was made to prepare the APVV project proposals. Four of them were successful, and the IG SAS has been the lead partner in all of them. The successful projects will aid the institute's development, particularly in improving the research infrastructure and partially also the motivation of researchers.

(3) Project activities and extra-budgetary resources

The precondition for the successful implementation of the development strategy is to create better economic conditions: i.e. obtain funding from extra-budgetary sources. We focused on searching for project opportunities on the national and international level, improving cooperation between our three departments and improving cooperation with other research institutions (other institutes within the SAS and other research institutes in Slovakia and abroad).

Cooperation with other institutes of the SAS and other research institutions in Slovakia has brought new transdisciplinary projects and better levels of national and international research funding. Finances from domestic projects increased from €48.6 thousand per year in the 2012–2015 period to €98.9 thousand per year in the 2016–2021 period. Since 2016, the IG SAS has participated in six domestic projects financed by the APVV (four of them as lead partner). Financial support from the APVV totalled €308 thousand in the 2016–2021 period. The budget of APVV projects for the IG SAS in 2022 is €173 thousand.

Since 2016, the IG SAS has been involved in international projects within the ESA-PECS programme, the EraNet programme, the International Visegrad Fund, the ESPON programme, the COST programme, the Start Danube programme, and with the National Science Centre in Poland. These have all contributed to a significant improvement in the institute’s financial situation. Finances from international projects increased from €23.3 thousand per year in the 2012–2015 period to €31.5 thousand per year in the 2016–2021 period.

(4) International cooperation

Our aim has been to develop international contacts and cooperation at the level of individual employees as well as the level of the IG SAS as a research istitution.

The international cooperation of the IG SAS is developed within the completion of international scientific projects, the preparation of project proposals and joint publications, the organisation of international scientific events and within the framework of memberships and positions in international scientific organisations. International projects were supported within the programmes ESA-PECS, EraNet, the International Visegrad Fund, ESPON, COST, Start Danube, and the National Science Centre in Poland. From 2016 to 2021, thirty-five international project proposals were prepared within the Horizon 2020, EraNet, ESPON, ESA-PECS, COST, CHANSE and BIODIVERSA programmes, as well as many others, and eleven of these proposals were successful. Some efforts to develop international cooperation have been limited due to the COVID-19 pandemic. The development of international cooperation is still one of our most significant challenges.

(5) Publication activities

The main aim has been to increase the number of publications in scientific monographs and journals registered in the CCC, WOS and SCOPUS databases (see Figure 5). We decided to motivate authors for their publications in monographs and journals registered in the CCC, WOS and SCOPUS databases. Since 2019, the financial rewards for publications have increased. The number of publications in journals registered in the CCC, WOS and SCOPUS databases increased from 11.75 per year from 2012 to 2015 to 21.67 from 2016 to 2021 (see Figure 6). In 2021 we secured 31 such journal publications, and sixteen of these were in Q1 journals. Since 2016, nine monographs have been published, representing an average of 1.5 monographs per year. In addition, 11 chapters in monographs were published annually in the 2016–2021 period.

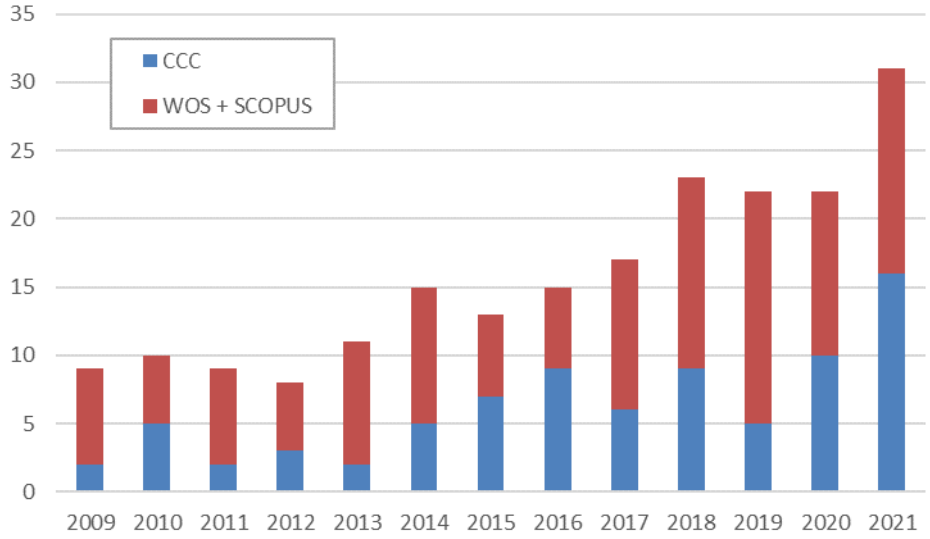

Figure 6: Publications in journals registered in the CCC, WOS and SCOPUS databases

(6) Doctoral studies and educational activities

The main aims were to maintain existing accredited study programmes and enable researchers to participate in educational activities at universities.

In cooperation with the Faculty of Natural Sciences of Comenius University in Bratislava, the IG SAS provides doctoral studies in two accredited study programmes: (1) Regional Geography and (2) Physical Geography, Geoecology and Geoinformatics. During this evaluation period, the system of doctoral studies partially changed (see Section 2.5.8). Unlike foreign experts, who saw problems in doctoral studies (at the Ph.D. level) in the 2012–2015 period, we ranked doctoral studies in that period as being among the most successful stages of doctoral studies in the entire history of the IG SAS. In the later period, however, we have faced several problems in this area. From 2016 to 2019, no doctoral student successfully completed their studies. In 2018 and 2019, no new student even started a Ph.D. at the IG SAS. This is related to a decrease in the number of students at universities, the preference for undertaking doctoral studies in a familiar environment at universities (such as Comenius University) and the departure of doctoral students to the private sector during their studies. There are also personal reasons (e.g. moving elsewhere and a changing family situation). Doctoral studies have thus become our priority. The topics of Ph.D. research have been prepared in advance and in English with the aim of attracting international students. Since 2019, undertaking doctoral studies has been promoted among geography students at Comenius University. Some of our younger colleagues have also developed their cooperation with universities in the field of educational activities. These activities and personal meetings with students have improved the situation. This improvement became visible in 2020, when three internal doctoral students (including one from Iran) began their studies, with two more doing so in 2021. In 2020 two doctoral students successfully completed their studies, and in 2021 four doctoral students successfully finished – including one from Czechia and one from Serbia.

Researchers from the IG SAS have been involved in educational activities for university students in Czechia and in Slovakia. This was done at the Faculty of Natural Science of Comenius University in Bratislava (lectures for students at master's level, two doctoral students completing their studies under the guidance of supervisors from the institute, memberships in the boards of doctoral programmes, and lectures and seminars for doctoral students); the Faculty of Education of the University of South Bohemia in České Budějovice (lectures and seminars for students at master's level); the Faculty of Science of Palacký University in Olomouc (lectures for students at master's level, memberships on the boards of doctoral programmes, lectures and seminars for doctoral students, and one doctoral student completed her studies under the guidance of supervisors from the institute); the Faculty of Science of the University of Ostrava (membership on the board of the doctoral programme); the Faculty of Education of the Catholic University in Ružomberok (lectures for students at master's level); the Faculty of Humanities and Natural Sciences of the University of Prešov (lectures for students at master's level and lectures and seminars for doctoral students, and membership on the board of the doctoral programme); and the Faculty of Natural Sciences of Constantine the Philosopher University in Nitra (lectures for students at master's level).

During this period, two distinguished university teachers from the IG SAS, Professor Oťaheľ and Associate Professor Lacika, retired. We still have researchers who have been involved in educational activities for a long time, such as Professor Ira and Dr Lehotský. One important matter is that several younger researchers (Sládeková Madajová, Kidová, Šveda, Výbošťok and Hurbánek) and doctoral students (Čuláková) have also taken part in the pedagogical process. Educational activities play a significant role in university students' motivation to apply for doctoral studies at the IG SAS.

(7) Social impact and popularisation of research
Our main aim has been to improve the social impact and popularof geographical research. The IG SAS provides information on its activities to the Department of Communication and Media of the SAS, publishes current information on its website and social networks and participates in scientific and-popularisation events (Researchers' Night, Weekend with the SAS, and the Young Scientists Roadshow). The researchers participated in many individual popularisation activities, including writing articles in newspapers and magazines and on websites, and appearing in TV and radio interviews and discussions (see Section 2.7.1.).
One specific activity is the organisation of the national round of the Barbara Petchenik Children's World Map Drawing Competition (a biennial map drawing competition for children). Selected drawings from Slovakia are sent to the International Cartographic Association and are exhibited during the International Cartographic Conference, where the international winners are selected. It is also worth mentioning a video on abandoned landscapes that was prepared by a professional agency within an ESA-PECS project.
The IG SAS actively cooperated in 2016–2021 with:

- international organisations: the European Network for Rural Development in Brussels (research contract), the European Rural Development Network in Poland (participation in conferences), and World Wide Fund for Nature (WWF Slovakia; preparing a report)
- state government: the Ministry of the Environment of the Slovak Republic; the Slovak Environment Agency (SAŽP); the Slovak Environmental Inspectorate (Regional Inspectorate in Žilina); the Ministry of Transport and Construction of the Slovak Republic; and the Institute of Educational Policy at the Ministry of Education, Science, Research and Sport of the Slovak Republic (consultancy, membership in working groups, and reviews)
- local government: e.g. the City of Bratislava; the Bratislava Metropolitan Institute; the Municipal Office in Trnava; and the Municipal Office in Žilina (a research contract, publications, and the presentation of results)
- the non-governmental sector: the Society for Sustainable Living (conferences and publications)
- the private sector: Stengl Consulting (a research contract); Carretera, Ltd. (a research contract); and Solargis, Ltd. (an ESA-PECS project); and others

The IG SAS makes efforts to react to current societal problems like climate change and the COVID-19 pandemic.
Climate change has primarily been reflected in our research priorities within two clusters: *Structures, Processes and Hazards of River Systems: Their Response and Impact on Natural and Socio-economic Systems* and *Land Use and Land Cover Based on the Application of Remote Sensing Data* (see Section 1.8 and Chapter 4 for more information).
The COVID-19 pandemic became the subject of five project proposals. Three of these were successful, and they focused on spatially differentiated impacts and manifestations of COVID-19 in Slovakia and the impact of the pandemic on changes in consumption and its manifestations in new patterns of consumer behaviour in Slovakia). At the beginning of the pandemic, our colleagues joined the SAS Educates Students project and prepared ten videos for children who did not have any experience with online education and who were lacking educational resources. Two press conferences focusing on the impact of the COVID-19 pandemic on shopping behaviour and the availability of preschool education in the Bratislava region were organised in 2021.

An international advisory board of the IG SAS was established in 2018. It consists of three members (see Section 1.4.1). The board members provided comments and recommendations on the activities of the IG SAS.

4. ***Research strategy and future development of the institute for the next five years*** (Recommended 3 pages, max. 5 pages)

Research strategy of the institute in the national and international contexts, objectives, and methods (including the information on when the strategy was adopted)

The institute adopted the strategic plan in 2017 (the latest version from the end of 2020) with the aim of meeting the general recommendations of the meta-panel to increase the level of scientific research of the SAS and the recommendations of the meta-panel addressed to the IG SAS. The strategic plan sets out specific activities, actions and tasks in six areas: human resources, research priorities, project activities and extra-budgetary resources, international cooperation, publication activities, doctoral studies and educational activities, and social impact and popularisation of research (see Chapter 3 for details). Progress in these areas is consistent with the aims of various strategic international and national documents (e.g. the Horizon Europe programme and the Through Knowledge Towards Prosperity: Research and Innovation Strategy for Smart Specialisation of the Slovak Republic document – updated for 2021 to 2027) that emphasise research excellence, strengthening human potential and researcher mobility, and fostering transnational research and cooperation contributing to solving social challenges.

The management of the IG SAS implements the system measures for improving governance with the support of external and internal organisations, particularly the SAS Presidium, the International Advisory Board and the Scientific Board of the IG SAS. The institute regularly assesses progress in meeting the meta-panel's recommendations.

The IG SAS creates a system of management and institutional standards, such as regular external evaluations, staff recruitment and the development of a system of cooperation with foreign and domestic institutions. A significant goal is to create good governance and a culture and standards which are based on appropriate governance structures fully comparable to EU standards.

The research strategy and research priorities were discussed in 2021 (details in Chapter 3). During the next period, we will continue research in three clusters. These clusters follow up on the previous period, are open to mutual cooperation and reflect new research opportunities. National and international projects support a majority of future research topics. We want to take advantage of our personal structure, which enables us to carry out interesting research with excellent results. The names of clusters for the next period are (in comparison to the previous names of clusters) slightly modified with the aim to precise or generalise their content. Our main aims are to continue the generational change and the improved publication activities, to improve the international position of the institute (international projects and international PhD students) and research infrastructure and strengthen research application.

Research cluster: ***Landscape and its Dynamics in Terms of Geoinformatics***

The European Green Deal represents the comprehensive biodiversity strategy of the EU to 2030, and its implementation is currently one of the main priorities of the European Commission. The EU's priorities for increasing the diversity of agricultural land have also been reflected in the Strategic Plan of the Common Agricultural Policy for 2023–2027. The intention to increase the diversity of agricultural land should be realistically associated with a change in the structure of land cover and land use in individual regions. Sustainable management of individual measures needs indicators that provide fast and reliable information on these planned changes. Monitoring changes in landscape diversity is connected with the implementation of the European Green Deal and measures focused on the radical elimination of greenhouse gas emissions. The European Parliament and Council Regulation No. 841/2018 sets the commitments of EU member states concerning the LULUCF sector, which contributes to the fulfilment of the aims of the Paris Agreement on Climate Change and the intentions of the EU in the area of reduced greenhouse gas emissions from 2021 to 2030. The identification and subsequent monitoring of land cover classes based on satellite data allow a more accurate specification of basic land use classes (as inputs for greenhouse gas emissions accounting in the LULUCF sector) and determine rules and verify compliance by the EU member states.

The strategic initiatives within this cluster will continue activities in land cover and its change through monitoring and assessment based on remote sensing data. The main goal of the land cover research will be the development of innovative approaches to the processing and visualisation of satellite data

in the study of the diversity of different types of landscapes. This activity will include the design of a methodological procedure for the automated classification of landscape diversity using a set of indicators relevant to the European Green Deal and other strategic documents focusing on landscape structure. Key research fields will include:

- defining a set of country diversity indicators derived from satellite data
- the experimental testing of diversity indicators based on satellite data (Sentinel and Landsat) and databases derived from them (Copernicus HRL, LUCAS and LPIS)
- the application of the proposed indicators in the evaluation of landscape changes in selected model areas
- the design of the cartographic visualisation of the results of the spatio-temporal analysis of landscape dynamics.

We expect the fulfilment of these goals within the *Detection of Landscape Diversity and its Changes in Slovakia Based on Remote Sensing Data in the Context of the European Green Deal* project and the *Assessment of Ecosystem Services and Their Adaptation into the Strategic Planning and Future Development of National Parks and Their Hinterland* project; both of these projects are supported by the Scientific Grant Agency (VEGA). There is also the *Species-rich Carpathian Grasslands: Mapping, History, Drivers of Change and Conservation* project, which is supported by the Slovak Research and Development Agency (APVV). The IG SAS will also participate in the *Rescuing Biodiversity to Safeguard Life on Earth* project as part of a European Partnership in the Horizon Europe programme.

Data obtained by remote sensing methods, mainly aerial and satellite images, have become an irreplaceable source of information for analysing changes and the dynamics of the development of landscape components thanks to repeated scanning of the Earth's surface (e.g. every five days by Sentinel-2). Indeed, Sentinel-2 satellites have been scanning the Earth's surface since 2015 in thirteen spectral bands with a swath width of 290 km and a resolution of 10, 20, and 60 m. The high imaging frequency provides quality data for monitoring changes in vegetation during the growing season. Data from pan-European and national databases will also serve as inputs.

The Copernicus Local Land Monitoring Service also generates more detailed data about the land cover – high resolution layers (HRL) with a spatial resolution of 10 m and 5 m: Imperviousness, Forests, Grassland, Water & Wetness, Small Woody Features. Using these data, we will propose a new methodological procedure to monitor the implementation of the measures in the Strategic Plan of the Common Agricultural Policy 2023–2027 as the main benefit. Other benefits will include the assessment of the biodiversity of particular experimental territories and the proposal of measures optimising the current status as part of the process of land consolidation. A theoretical contribution to the development of landscape diversity indicators will be the definition of the parameters of individual indicators based on experimental research. In terms of application, there will be several publications dedicated to the innovative methods of processing and interpreting satellite data, specifically in monitoring land cover and land use classes (e.g. in terms of EU Regulation No. 841/2018 for the estimation of carbon stock and greenhouse gas removal) and including the monitoring of urbanisation and farmland abandonment and the assessment of landscape changes in selected model areas based on relevant indicators in the light of EU strategy documents focusing on landscape structure.

Accurate and detailed satellite data is increasingly used to research the components of landscapes, requiring new methods of processing and interpretation. In addition to these data, there are also data from unmanned aerial vehicles, laser scanning, digital relief models, digital surface models and aerial photogrammetry (digital orthophotos). Another important topic related to satellite data is solar radiation short-term forecasting, which is of increasing societal relevance. The IG SAS will participate in improving existing forecasting tools which will enhance solar radiation nowcasting based on geostationary satellite data. A developed method is expected to predict the movements of regional cloud structures affected by the blocking effect of regional and local orography. This research is supported by the European Space Agency under the Plan for European Cooperating States (PECS) from 2022.

The IG SAS will continue research on trends in monitoring built-up area dynamics on a regional level within international cooperation using Copernicus data. This research will focus on a multi-temporal comparative analysis of urban extension in two European capital cities – Bratislava and Bucharest – which have different population densities and economic conditions. Selected indicators of urban landscape structure based on satellite data will be calculated. Deepening the knowledge about the monitoring of land development using remote sensing data can help provide accurate, up-to-date

and reliable data for the decision-making sphere. This evaluation also includes monitoring and forecasting the expansion of built-up areas, which is a prerequisite for taking fundamental measures to regulate land use, optimising the functional use of urban space, building infrastructure, and proposing measures to eliminate negative side effects (e.g. UHIs).
The IG SAS will also participate in the Farmland Abandonment in Europe: *Establishment of Network, Testing Novel Data Sets and Methods to Monitor the Patterns and Evaluate its Drivers* 4EU+ collaborative project (Flagship 4: Biodiversity and Sustainable Development) managed by Charles University in Prague (Faculty of Sciences, Department of Applied Geoinformatics and Cartography).

Research cluster: ***Riverine Landscape: Driving Forces, Evolution and Natural Hazards***
Modern and innovative approaches in spatial data acquisition and the processing of novel ones comprise a good established methodological background to achieving national and international cooperation and knowledge exchange with experts in this field. Remote sensing data, fieldwork and GIS processing are all important tools supporting the long-term monitoring of unique Carpathian rivers. Research on the morphological evolution of river systems and their response to various environmental factors is a matter of high international importance as it will contribute to an overall knowledge base of this natural phenomenon. Furthermore, the usage of detailed remote sensing data is applicable in the preliminary flood hazard assessment for large areas. Taking into account the social aspects of flood risk reduction using the multi-criteria analysis to select an optimal strategy for flood risk management is an important part of integrated flood risk management.
Rivers morphologies are affected by various external (i.e. tectonics, human intervention and climate change) and internal (hydrological regime, sediment dynamics, lithology and rock hardness) factors; as a result, future research shall be related to the assessment of the geomorphic recovery and hydro-morphological adjustment of river systems to changing climate and human interventions. At the same time, river networks act as transmitters of these drivers to adjacent hillslopes and the rest of the landscape. Knowledge of river morphologies and channel networks is thus essential for revealing the impact of these factors on the landscape evolution, and it serves as a basic precursor for assessing various rates and intensities of different earth surface processes, including those with destructive potentials such as landslides and floods. Understanding and predicting multiple environmental stressors, e.g. extreme hydro-climatic events (water stress and floods), including anthropogenic pressures as well as barriers, will be crucial for developing improved tools for adaptation to and mitigation of hydro-climatic extreme events, especially floods (including “flash-floods”) and droughts in a catchment context. Exploring synergies between green and blue nature-based solutions will help to mitigate and adapt to water-related natural hazards in both natural and urban environments, providing biodiversity maintenance. The analysing of the geomorphic linkage between upstream and downstream areas (longitudinal sediment connectivity) and of the role and functional importance of floodplain (lateral connectivity) and channel dynamics (sediment transport) will be a particular research interest. The study of sediment transport requires a multi-temporal and multiscale approach using more sophisticated tools, such as precise imaging and the generation of novel 3D technology, a calculation elevation model, tracer particles analyses, ground-penetrating radar recording, and grain-size analyses. High-resolution imagery and elevation models constructed from lidar or close-range photogrammetry will provide a detailed data set of the three-dimensional morphology of the bank, floodplain and valley. Another research aspect will relate to the quantification of sediment transfer magnitude due to channel scouring or the rate of incision or the volume of temporal sediment deposition. The developed methodological framework will support planning strategies for restoring rivers and floodplains in constraining legislative frameworks on the national scale. A process-oriented model of the current lateral and vertical development of the river floodplain based on the identification of geomorphological phases of floodplain development in connection with changes in discharge and the occurrence of hydrologically extreme events as well as changes in land cover and anthropogenic interventions will be created.
The floodplain is defined as an important part of the landscape in terms of ecology as well as in the economy. Our attention will be focused on marginalised Roma communities (MRCs) living on the floodplains directly endangered by flood events. A specific focus of the scientific effort will be placed on looking at the increase in environmental inequality in recent years as well as spatially segregation from the majority population and poverty indicator. In Slovakia, interest in the issue of inequality has grown significantly. The geomorphological approach to the identification of flood hazard hotspots within these communities based on geomorphometry, the frequency of floods, and their distances to

the nearest drainage (the height above the nearest drainage and downslope distance to the stream) will be developed on a national scale. An analysis of the spatio-temporal evolution of selected MRCs in relation to the nearest river channel and its prevailing geomorphological processes identification will help propose flood hazard mitigation measures in the selected settlements on a local scale. When assessing a flood hazard, the focus is often only on one type of flood, be it fluvial or pluvial. The origin, course and extent of these floods are very different. Our goal is to link the assessment of two types of floods into one preliminary flood hazard assessment. The knowledge of run-off processes in the river basin allows us to identify areas more susceptible to surface run-off and pluvial floods. For this purpose, based on detailed lidar data and orthophotos, river channels will be automatically identified. The river channel delineation represents a basis for the calculation of basic hydraulic parameters such as the area of flow section, the wetted perimeter and hydraulic radius. In Slovak conditions, little attention has been paid to this type of flood hazard assessment so far. At the same time, it focuses on the physical principles of water run-off in the river basin and water flow in the riverbed. The results of the assessment of run-off processes and the flow capacity of the channel provide us with information for detailed research into flood hazards in areas prone to pluvial and fluvial floods. The importance of spatial planning is one of the crucial issues for future development in flood risk management. Based on the analysis of the legislation on flood protection and the legislation on spatial planning, the position of spatial planning in flood risk management in Slovakia will be specified. Subsequently, analyses of specific zoning plans of municipalities in the Myjava region will be carried out. The real possibilities of municipal zoning plan to reduce flood risk in the rural landscape will be assessed as well. The next issue is the resilience of society to flood risk as a challenge for local government. Local authorities (municipalities) should play an important role in flood risk management at the local level. But are they ready for the task? Getting the answer to this question will be the goal of future research. The last important issue for future research consists of an assessment of watercourses in terms of their impact concerning flood hazards. The maintenance of watercourses is the first and basic step in flood hazard management. Maintaining the vegetation of watercourses and sediments in the riverbed, as well as removing obstacles from the riverbed (e.g. solid waste and trees) requires a systematic approach based on knowledge of the behaviour of the river watercourse. The research will focus on the assessment of the current state of watercourses in terms of their impact on flood hazards, which is conditioned by the geomorphological attributes of the river channels, the attributes of the land cover of the floodplain, the attributes of the in-channel and bank vegetation and large wooden debris attributes. Flood management based solely on technical infrastructure is not sustainable in the long term due to the natural conditions in Slovakia. Due to this, diversified flood risk management is essential. The strengthened role of the government in the management of flood risk at the local level, along with well-defined stakeholder responsibility for reducing flood hazard potential and defined communication channels to ensure the harmonisation of management objectives across hierarchical levels, will be essential as well.

Research cluster: ***Regions, Localities and Communities on the Spatio-temporal Move***

The Regional Policy of the European Union, also known as the EU Cohesion Policy, targets all regions and cities in the EU in order to support job creation, business competitiveness, economic growth and sustainable development and to improve citizens' quality of life. Each territory of the EU has the potential to contribute to the sustainable and balanced development of the EU as a whole. The aim of research activities is to identify political, economic, social, environmental and cultural changes of an endogenous and exogenous nature that cause the uneven socio-economic development of localities and regions. A particular focus of the scientific effort will be placed on an explanation of the existing spatial differences – and consequently the possibilities of consensus between the ideas of permanent economic growth and the spatial efficiency of the organisation of society – and ideas based on the concept of spatially balanced sustainable development reducing the spatial and social exclusion of affected residents in economically less developed and/or spatially marginalised areas.

The research cluster covers a broad spectrum of topics that are examined from various aspects. A particular emphasis will be placed on the analysis of geographically relevant spatio-temporal changes in different types of regions (urban, suburban and rural) and different spatial scales at European, national, regional and local levels. Research topics include suburbanisation, mapping population distribution and mobility in Slovakia using mobile network data, spatially differentiated impacts and manifestations of COVID-19 in Slovakia, alternative food networks and preschool education in Slovakia. All these topics are supported by four APVV and four VEGA projects.

In the next period, we will expand our knowledge about the current suburbanisation process in the hinterland of Bratislava. The study of suburbanisation has so far been dominated by a quantitative analysis of basic processes (migration, construction, and changes in landscape structures) which are viewed from the perspective of the metropolitan area; however, this dynamic environment is characterised by social transformations, the negotiation and creation of new identities, a reassessment of the relationship to the localities, and a (re)definition of the individual perception of home. Therefore, the main objective of the project is to analyse the specific place-making processes and relationships realised by participants with different socio-demographic characteristics (such as age, gender, ethnicity, religious affiliation, and social status) and related social and individual identities. These are further reflected in their individual preferences, ideas, and norms and confronted with the socio-cultural and institutional context in the suburbs.
In upcoming years, the research will also focus on the current topic of preschool education (nursery and kindergarten networks) in Slovakia from the aspect of spatial accessibility and social justice. The project responds to the current topic of the introduction of compulsory pre-primary education for five-year-old children since September 2021. In such a necessary and socially sensitive area as preschool education, authorities should be aware of the spatial, temporal and socio-economic consequences. On the basis of research into the heterogeneity of pre-primary education facilities and the environment in which they are located, the intention is to introduce several concepts of commuting areas based on modelling both temporal and spatial accessibility through traditional approaches as well as by using more sophisticated mathematical methods which take into account travel-to-work commuting and individual decision strategies. The analysis of the current state of affairs, the design of solutions and the forecasting of future developments will create a comprehensive analytical document that will allow the adoption of effective and timely strategic measures at various levels (individual, local, regional, and national).
The COVID-19 pandemic has already caused a major loss of life, a recession in the world economy and many other problems. In Slovakia, the consequences of the pandemic have been felt in all spheres of socio-economic life for a long time. The aim of future research will be to provide the most comprehensive view of the differentiated consequences and impacts of COVID-19 in the regions of Slovakia. The research will focus on the most significant changes associated with the pandemic. The research and results should lead to an explanation and understanding of the spatially and temporally differentiated impacts of the pandemic on selected relevant regional characteristics. The specific focus and nature of the project will bring principally new knowledge and create a framework for further research into the issue.
Due to the pandemic, people were forced to change our typical activities and consumption patterns. Future research will also focus on evaluating and analysing the impacts of the COVID-19 pandemic on consumption as well as consumer reaction to current social developments. Various methods and unique data (data sets from Focus, GfK, and e-Kassa) will be used to analyse the effects of the pandemic on the retail and services sectors in Slovakia and the adaptation to changes in consumption patterns. Future research will also focus on consumption and consumer behaviour in response to changes in society (a shift from consumerism to sustainable consumption and the transformation from utilitarian to hedonistic consumers).
Despite the fact that we live in an era characterised by massive development in information and communication technologies, current knowledge of population counts and distribution is still very limited. Mobile phone data has surfaced in recent years as one of the big data sources with a lot of promise for its use in official statistics. Although mobile phone data does not provide the accuracy of a census, a comparison of this new data source with the census and the population register shows a high correlation and much more dynamism in terms of rapid changes. Mobile phone data can therefore be used as an additional source of population information. The research aims to develop and implement a consistent and validated methodology to produce a multi-temporal population distribution for Slovakia by utilising the localisation data of mobile networks. Such data sets will expand the knowledge base of spatio-temporal population patterns across the country. Moreover, multi-temporal population grids can be a useful and straightforward input for several models, particularly those concerning transport, land use, the economy and the environment.

Some of the presented research topics in the three research clusters can be strengthened in a targeted manner. On the other hand, depending on overall funding and their relevance in science, society and practice, some themes can be reduced to allow the IG SAS to remain a flexible, innovative and competitive institution.