Geoinformatics and Remote Sensing

Mapping and analysis of agriculture landscape dynamics at a high spatial resolution using unmanned aerial vehicles
supervisor: prof. Mgr. Jaroslav Hofierka, PhD.
study form: full time
Annotation: This work is focused on detailed mapping of agriculture landscape and dynamics of the selected landscape components as a result of ongoing processes. This includes vegetation changes (various plants) during the growing season, or terrain changes as a consequence of soil erosion or landslides. The main tool of mapping will be UAVs equipped with sensors and terrestrial laser scanner. It is expected to process a large amount of data using special softwares and methods for landscape changes detection.

Multiscale 3-D gemorphometric analysis of surfaces
supervisor: prof. Mgr. Jaroslav Hofierka, PhD.
study form: full time
Annotation: This work is focused on derivation of 3-D morphometric parameters for 3-D surfaces and geomorphologic forms, e.g., in caves. In connection with modern mapping methods such as laser scanning it is necessary to apply a multiscale approach reflecting various levels of spatial detail. The definition of morphometric parameters and surface forms should indicate their physical interpretation related to processes contributing to the development of surfaces and possible applications in geomorphological and hydrological research.

Dynamic 3-D city models and their application to SmartCity concept
supervisor: prof. Mgr. Jaroslav Hofierka, PhD.
study form: full time
Annotation: This work is focused on dynamic 3-D city models reflecting the ongoing processes in a urban space using various time scales. The selected urban processes (urban greenery changes, movement of persons, traffic) will be analyzed using virtual 3-D city models and their contribution to a better city management. The required spatial level of detail will be analyzed as well as a multiscale approach in a digital representation of the city, movement of persons, mass and energy.

Modelling dynamics of terrain micromorphology using laser scanning
supervisor: doc. Mgr. Michal Gallay, PhD.
study form: full time
Annotation: Laser scanning (LIDAR) has become standard technology, for non-contact mapping utilizing laser ranging for acquiring a point based 3D representation of objects. In this way it provides means for a highly precise and detailed 3D modelling of objects and landscape which would be virtually impossible without the lidar technology. In case lidar mapping is applied repeatedly over the same area it is possible to capture changes of the 3D spatial structure of relief in the order of centimeters to millimeters. In this way it is possible to evaluate the dynamics of the surface, for example those which are the result of surface runoff. The aim of the doctoral thesis is to design new methods for the quantification of the microstructure of relief as well as a methodology for modeling and evaluating the dynamics of different kinds of surfaces in landscape. The preliminary focus could be given on soil erosion of farmland or land sliding using aerial and terrestrial lidar. The expected results will

also comprise new knowledge on functioning of spatially variable geomorphological processes in high resolution.

Integrated use of hyperspectral and lidar data acquired unmanned remote sensing
supervisor: doc. Mgr. Michal Gallay, PhD.
study form: full time
Annotation: The aim of the doctoral project will be the development of new approaches for mapping landscape by passive hyperspectral scanning and active laser scanning (lidar). The advantage of the first method is the high spectral resolution of electromagnetic radiation reflected from the surface of the country, while the advantage of laser scanning is a high spatial resolution of the geometric structure of the country. Integrated use of both types of collected data provides new possibilities for studying landscape processes in high resolution. Both methods generate high load of spatially registered data which brings new challenges in the context of the data processing, analysis, modelling, and interpretation. The project assumes the use of unmanned technologies and sensors available at the home institution for applications in agriculture.

Integrated use of data obtained by multispectral satellite sensors and airborne laser scanning
supervisor: doc. Mgr. Michal Gallay, PhD.
study form: full time
Annotation: Nowadays, a plethora of spaceborne platforms allows for Earth observation. In particular, this doctoral project concerns those based on passive multi-spectrum imaging, such as SPOT, Landsat, GeoEye. The new generation of Sentinels 2A and 2B provides higher spatial resolution, in more spectral bands and more frequently than its competitors. Thus new opportunities for landscape monitoring emerge with such data. On the other hand, these sensors do not enable capturing the geometric structure of the landscape in high resolution for which airborne laser scanning (lidar) has been used since several decades. While airborne lidar is suitable for mapping smaller areas in high spatial resolution, multispectral-satellite sensors are useful for mapping the whole world in much lower spatial resolution, but in order of few days. Integrated use of both types of data can improve land cover mapping. The aim of the PhD project is to develop new approaches, strategies and methods for integration of multispectral satellite imagery and lidar data focusing on vegetation mapping in urban and rural areas. The scientific challenge is in the diverse spatial, temporal and spectral resolutions of lidar data and space borne imagery.

Simulation and dynamic visualization of selective migration of population in urban regions of Slovakia
supervisor: prof. RNDr. Peter Spišiak, CSc.
study form: full time
Since the post-socialist transformation in Slovakia and other post-socialist countries, a lot of scientific attention has been paid to the migration as a key component of growth and spatial redistribution of population. Majority of research on urban development perceive migration as an internally homogeneous phenomenon. This enables to identify certain general migration patterns. However, to understand regularities and causalities of migration processes, it is necessary to gain insight into internal structure of migration. Geographers agree that different population categories are characterized by various migration preferences. Research confirmed that the age, social status, education, and in certain cases also ethnicity are among the features differentiating migration preferences of individuals the most. This is reflected in heterogeneity of migration patterns when considering various population subgroups.

Nevertheless, such perceived migration has been addressed almost exclusively at the level of national populations, particularly because of lacking reliable statistical data, difficulty and complexity of their analysis and interpretation. The aim of this thesis is to identify dominant processes of inter-regional and intra-regional migration with emphasis on its selective character, and to interpret them using dynamic simulations and visualizations; and so to assess urban development in functional urban regions of Slovakia.

Modelling dynamics of selected parameters of a cave environment
supervisor: doc. RNDr. Zdenko Hochmuth, CSc.
study form: full time
Annotation: Recent processes in karst areas are characterised by rainwater infiltration, surface water immersion, corrosive processes, and underground erosion. As a result, we can observe long-term changes but also events of short duration such as riverbed changes caused by flooding, tectonic movements, or changes of microclimate. Also for these reasons, it is important to develop new methods of karst mapping which enable to capture the karst properties in sufficient level of detail and complexity. Monitoring of the mentioned environmental parameters requires complex monitoring network which has to be continually maintained and the collected data need to be processed with progressive methods. The result of the proposed research will contribute to better understanding and forecasting of dynamic parameters of the karst microclimate and karst hydrosphere.