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Landscape Architecture and Green Infrastructure in the Slovak Countryside

Attila Tóth, Roberta Štěpánková, Ľubica Feriancová

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Authors

Ing. Attila Tóth, PhD.

doc. Ing. arch. Roberta Štěpánková, PhD.

prof. Ing. Ľubica Feriancová, PhD.

Authors' affiliation

Department of Garden and Landscape Architecture, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture in Nitra

Peer review

O.Univ.Prof.i.R. Dipl.-Ing. Dr. techn. Gerlind Weber, University of Natural Resources and Life Sciences, Vienna, Austria

doc. Ing. arch. Jan Vaněk, CSc., Czech University of Life Sciences, Prague, Czech Republic

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Preface by Michal Šarafín

Slovakia is a rural country. Villages, in contrast to cities, have the gift of nature, the face of landscape and demonstrate their own culture. Countryside is looking for its own architecture, with inspiration in local cultural and historical legacies. European rural architectural schools agree that the countryside is the cultural treasury of every nation. Its heritage consists in its peculiarity and scenic beauty. Slovakia is rediscovering the unique charm of its rural landscapes.

The countryside of the Nitra Region has two different faces: a rather industrial and metropolitan in the north and a more agricultural and cross-border in the south. It has its regional peculiarities, folk culture and traditions. It has an irreplaceable position in the life of the region.

Green infrastructure appears to be a new and highly topical phenomenon of process management in rural landscapes, their design and development. It is an important scientific issue in countryside preservation and rural development. It has a strong ecological dimension and an important contribution to the sustainability of the countryside. It has a potential to enhance the aesthetic value of the countryside and to underline its unique landscape character. The main contribution of this monograph is a thorough diagnosis of the countryside through its green infrastructure, which proves its ability to improve rural environments.

prof. Ing. arch. Michal ŠARAFÍN, DrSc.
Slovak University of Technology in Bratislava
Atelier Domova, Bratislava

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Preface by Richard Stiles

Although the term 'green infrastructure' might be considered as a contemporary 'buzzword', apart from this name, this monograph is very much in the time-honoured Slovak tradition of taking a broad analytical perspective on the rural landscape, and one might perhaps suggest that the rest of Europe was now finally catching up with this kind of approach. Of course 30 years ago, no one was talking about 'green infrastructure', nor its fashionable contemporary cousin 'ecosystem services' but these concepts were precisely what was behind the Slovak LANDEP and the 'Territorial System of Ecological Stability', as well as concepts like 'ecological', 'biotope' or 'habitat networks', which have been part of landscape planning thinking for decades, going back to Ian McHarg's 'Design with Nature' and beyond. What this monograph does is to take the general idea of green infrastructure, which has at last seemingly been discovered by the European Union, and apply it in an analytical manner to the investigation of a specific territory. It is to be hoped that the policy makers at the European Union may also learn from this study and begin to appreciate that landscape needs to be a key aspect of rural policy and that it is something which links together concerns such as biodiversity, ecosystem services and green infrastructure. The eminent biologist Theodosius Dobzhansky is famous for having written that nothing in biology makes any sense except in the light of evolution; the same could perhaps be said for rural policy – nothing makes any sense except in the light of an understanding of the interconnectedness of the landscape as a whole. This monograph makes a valuable contribution to furthering this understanding.

o.Univ.Prof. Richard STILES, MA Dip LD Dr. hc²
Vienna University of Technology

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Introduction

The current and future existence of human society strongly depends on our common natural capital and the services and benefits that it provides. These services and benefits are often referred to as ecosystem services and the natural system, which provides them, as green infrastructure. It consists of a complex system of greenery elements in settlements and open landscapes, which include point, linear and areal vegetation structures. Green infrastructure has gone through different development phases and transformations and depends on the territorial and spatial development of human settlements, as well as on socio-economic features of the society and landscape-ecological conditions of an area. Transformations of agricultural landscapes have brought about many significant changes, which have left behind a visible footprint on urban and landscape structures.

Despite of many changes that have affected our landscapes, they have preserved many environmental, natural, cultural, historical and aesthetic values, which are to be preserved also for future generations. It requires enhancing of the natural capital, which is the main richness of the countryside. A strong tool for achieving this objective is represented by green infrastructure. Green villages, which can combine human activities and their works with natural values, can be considered the sustainable villages of the future.

Current and future land use has to be based on a rational natural capital management, as the human society faces global challenges, such as changing climate or the need for a resilient food system for future generations. A conception is therefore needed, which will achieve and sustain a balance between productivity of the agricultural landscape and protection of its natural values and capital. One of the main prerequisites for this is a complex research into green infrastructure and the subsequent planning and design, which is an important task and challenge for contemporary landscape architecture.

This scientific monograph presents original findings of a complex digital spatial research, field research and research by design focused on green infrastructure in selected rural settlements of the Nitra Region. Its aim is to contribute to the state of the art in green infrastructure of rural landscapes and thereby also to the preservation and enhancement of natural, landscape, cultural, historical, aesthetic and architectural values of the Slovak countryside and European rural landscapes in a wider sense.

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State of the art

Definition, significance and benefits of green infrastructure

Green infrastructure (GI) is a strategically planned system of natural and semi-natural areas, elements and green spaces in rural and urban environments with environmental elements designed and managed for providing a wide range of ecosystem functions and services (e.g. water regulation, which contributes not only to the environment, but also to human wellbeing and quality of life). GI includes terrestrial (green spaces) and aquatic ecosystems (blue spaces) and its elements show health and well-being benefits, such as purified air and high-quality water resources. In urban landscapes, GI includes also man made elements, such as green rooms, ecoducts, cycle routes or restored natural areas. Implementation of GI components in urban areas has also an important social dimension, as it binds the community, initiates voluntary actions by the public and helps avoiding social isolation. It represents a physical, psychological, emotional and socio-economic benefit for individuals and the community as a whole (Benedict and McMahon, 2006; European Commission, 2010, 2012, 2013a, b; Naumann et al., 2011; Pauleit, 2012).

Egoz (2012) has a more holistic approach and considers landscape as infrastructure. She argues that infrastructure is the basic structure of a certain organisation or system and is therefore a key requirement for the existence of this system. Landscape as a concept is the spatial infrastructure of our world, an integrated system of our physical and social environment, which affects our well-being and quality of life. She states that landscape is spatial in its definition, but at the same time temporary, physical and intangible; an artefact or idea. Landscape is thus a framework, which aims at improving human lives, be it green or blue; urban, peri-urban or rural infrastructure.

The American Society of Landscape Architects (ASLA) defines GI as a framework concept for understanding valuable services provided by nature for human environments. At the national and regional level, the interconnected networks of park systems and natural corridors sustain ecological functions,

regulate water systems, create wildlife environments, create and sustain a balance between built and natural environment. By an efficient use of GI at the settlement scale, we can reduce energy consumption using the passive heating or cooling; filter air and water pollutants; create clean and tempered air; mitigate the heat island effect; lower the cost of stormwater management infrastructure; ensure flood protection and food resources; stabilise soils through elimination of erosion. Thanks to the listed characteristics, it can be stated that GI represents a significant ecological, economic and social contribution to our society and a tool for climate change mitigation, creation of healthy human environments and enhancement of the quality of life in urban areas (ASLA, 2013).

GI includes all natural elements in settlements, which fulfill ecological and ecosystem functions (e.g. parks, green walls, green roofs and other forms), support biodiversity and enable the ecosystems to perform functions, such as linking urban, peri-urban and rural spaces. The proximity of GI to urban environments is related to a high potential of providing multiple services for the society (Losarcos and Romero, 2012).

A document dedicated to the multifunctionality of GI states that the role of GI is to improve the life in different ways, through its environmental, social and economic potential based on a multifunctional use of the natural capital (European Commission, 2012).

GI is a successfully verified tool for providing ecological, economic and social benefits through nature based solutions, which have a high return on investment. Thanks to GI, we realise the importance of nature for human society and for mobilising investments into sustaining and enhancing natural systems. GI helps avoiding the dependence on grey infrastructure, which is significantly more expensive to establish than permanent nature based solutions. It is based on the principle that protection and support of nature and natural processes is accompanied with a range of benefits for the human society and it is therefore necessary to integrate GI in spatial planning and development. Compared to the single-purpose grey infrastructure, GI is not limited to spatial development, but at the same time it supports nature based solutions, if they represent the best alternative (European Commission, 2013a).

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GI can be strengthened through strategic and coordinated initiatives, which focus on maintenance, restoration, improvement and interlinking of existing and creation of new areas and elements (Naumann et al., 2011). Contemporary research into green infrastructure can be divided into two main categories: conceptual research and practical application (Mell, 2008). For instance, the visual impact of green infrastructure is assessed by Kabai (2011) who states that the visual function is an important component of social functions of GI and has to be considered in GI planning, for it can mitigate the negative visual impact of rapid urbanisation and contribute to the formation of settlement and landscape character. Melnichuk and Ignatieva (2012) understand GI as a factor of sustainable urban development and elaborated on a wide range of principles for urban GI. Slovak authors also deal with structures, functions and categorisation of greenery (Supuka et al., 2008; Supuka, 2011; Rózová et al., 2013). Dobrucká (2009) elaborates on methodical approaches to green space assessment in urban areas and a doctoral research into GI was conducted by Tóth (2015).

The importance of GI in urban environments in terms of its components is elaborated by Czech authors Šimek and Štefl (2014), who argue that the main green areas often represent the most valuable places in the urban landscape. GI has an extraordinary importance in the context of sustainable development, which represent a 21st-century paradigm, which originated as a reaction to growing environmental issues, such as environmental pollution, exploitation of natural resources, endangering the biodiversity, a higher occurrence of natural risks and hazards, a higher illness rate resulting from environmental pollution and other issues (Izakovičová, 2014).

GI projects are becoming important elements of the urban environment as they provide a wide range of health benefits, such as clean air, a higher quality of water and others. GI elements in urban areas improve the sense of community, support voluntary initiatives and help eliminating social exclusion and isolation. They have a psychological, emotional and socioeconomic importance for individuals and the community as a whole. Moreover, GI links urban and rural areas and provides attractive spaces for housing and work.

In order to contribute to the elaboration of a common GI strategy as an efficient tool for protection and design of sustainable landscapes, it is important to continue in a comprehensive research into historical development and cur-

rent conditions of GI. Based on this, it will be possible to elaborate conceptual tools for GI implementation into planning tools and contribute thereby to a sustainable development of European cultural landscapes.

Green infrastructure in rural cultural landscapes

Green infrastructure (GI) is a compositional element of cultural landscapes forming its spatial composition, character and identity. It is important to define natural and cultural heritage, which represent the main construction elements and values of cultural landscapes. Natural and cultural heritage is part of the territorial capital and identity of the European Union. Ecological, environmental and cultural values are necessary requirements for a common well-being and economic prosperity in Europe. Overexploitation of natural resources threatens a sustainable territorial development. Cooperation with nature, in harmony with the local cultural landscape, ensures significant benefits and services through projects of GI, which underline local identity and enhance the cultural landscape. Such a local approach is financially efficient end helps preserving physical compositional elements, structures and identity of cultural landscapes (European Commission, 2013a).

Verešová and Supuka (2012) consider cultural landscape as a manifestation of cultural diversity and as quality rate of human life and well-being, which bases on the adaptation of people to specific local conditions formed by historical development. The structure of cultural landscape is related to the formation, modification and implementation of human creations along the timeline of human society and every cultural landscape is in terms of origin, structure, function and morphology a unique and unrepeatable formation or a common creation of nature and man. Salašová (2006; 2010) and Pšenáková (2014) deal with the evaluation of landscape character and historical landscape structures as phenomena of cultural landscapes. Rózová et al. (2010) deal with the importance of cultural landscape aesthetics, perception and visual qualities. Halajová (2016) assesses the accessibility of public green spaces as part of rural cultural landscapes and their GI.

The multifunctional use of natural resources in agricultural landscapes is directly related to environmental networks and GI, including among others

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permanent grasslands and woodlands. There are diverse types of GI elements in agricultural landscapes, which can be defined by their functions, ecosystem services, spatial and species composition, utilitarian values, biodiversity and origin of woody plants (Kuczman, 2014). Green networks and vegetation structures in agricultural landscapes can be classified by their origin and physiognomic characters, as follows (Halászová et al., 2015):

Natural vegetation elements include areal and line elements of GI occurring in specific locations. They can often be found in extreme soil, hydrological and relief conditions and locations in the form of relict ecosystems and habitats of current agricultural landscape structure.

Semi-natural vegetation elements can be found for instance on field terraces, balks and other sorts of land boundaries (including vegetation growing on border stones), as well as in the form of successive vegetation on abandoned lands, extensive orchards and vineyards.

Cultural vegetation elements have been created by purposeful human activities and landscape interventions. They represent up to 70 % of all green elements in agricultural landscapes and include following structures: accompanying vegetation structures of roads and other anthropogenic linear structures in the landscape, protective forest belts and woodlands, cultural vegetation species in orchards and vineyards.

Natural ecosystems, preserved habitats and elements of designed cultural landscapes and their anthropogenic vegetation structures form an important and valuable component of agricultural landscapes. They significantly contribute to the formation of a spatially integrate and continuous GI in the landscape. GI can be considered a „building material" of the landscape, which through human hands creates the „building" of the landscape (Halászová et al., 2015).

The type, shape and construction of settlements has been strongly influenced by the housing units, farm buildings, social aspects and the surrounding landscapes. Settlements are complex organisms, which originated and have been developed based on several interrelated functional components in space and time. These include different types of work, natural-resource conditions, location of housing units in the settlement and the role and form of the cen-

tre and the landmark as its dominant feature. Settlement centres and their landmarks have always been important meeting places and sites of cultural and social interaction. An important aspect of settlement structures is represented also by the character of the road network enabling the movement of inhabitants within the settlement and from the settlement outwards. Another key aspect of settlements was the water source. An important role is played by the situation of the house towards the street. The role of the front facade as part of the house was very important, since it was an interface between the private and the public, between inhabitants of the house and the inhabitants of the street as public space. The entrance to the house enabled the inhabitants of the house to communicate with the yard and the street. The wells were not only a very important source of water, but also a place of social interaction and contact.

In the twentieth century in Slovakia, there were mainly settlements with mass, mainly organised and regular building structures along the street, the stream or the road with several centres and a landmark. The landmark was mostly in mountain areas a natural scenery with the highest point, in mountainous villages, it was usually the castle and in most of the settlements, it was the church. In the nineteenth and twentieth century, the scale of landmarks has been extended with new types, which could be diverse school or administrative buildings. Centres in the form of squares, commons or wider streets developed around dominant landmarks or around those buildings, which accumulate the societal and cultural life of the community, such as the mayor's house, the notariate or the pub. The newer arose in connection with cultural and business buildings, new schools, restaurants, accommodation services, sport grounds and others. The way of building along streets with a square or common and a landmark in the centre has had a long tradition in our area throughout centuries. It originated at the end of the thirteenth century and has further developed. Settlements in peripheral mountainous areas and mining towns were established in a 'chain-form' urbanisation scheme. Scattered settlements developed on greenfields in the sixteenth and nineteenth century from the main settlements that were already overcrowded. The norm of regular streets and village centres with a sacral landmark in the middle was obligatory throughout centuries. At the end of the nineteenth

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and in the first half of the twentieth century, also many original 'chain' and scattered settlements were re-built to regular villages with central squares or commons. Currently it is enriched by new aspects connected to new types of work, modern transportation, grow of cultural needs and desires on the housing which strongly influences the character of the settlement in the countryside up to the present day. These aspects and conditions have an impact on the fact, that most of the settlements are becoming of mass character, while in its centre or in the peripheries, there is it is still possible to recognize the footprints of the original type.

Scattered settlements have survived despite of tendencies to move inhabitants to 'mother' settlements or to new housing estates in towns and cities during the communist era. This required establishment of new communication networks and electrification of settlements. In connection with cottage recreation, also a new form of scattered seasonal settlements has arisen. Thanks to this, old houses, farms and vine cellars have been restored.

The growing need for social services in continuously developing rural settlements in the communist era has led to the implementation of the concept of central villages. A significant interconnection between social services and the origin of new urban centres can be observed mainly since the second half of the nineteenth century, when commercial infrastructure, health care services, cultural services and centres and post offices have been built (Kovačevičová, 1990).

Greenways and green infrastructure

Greenways are linear compositional elements of GI, which according to Benedict and McMahon (2006) is a continuous interlinked network of natural areas and other open spaces, which preserve values and functions of natural ecosystems, sustain clean air and water and provide a wide range of benefits for the human society and wildlife. It is a complex interconnected network of watercourses, wetlands, forests and woodlands, wildlife biotopes and other natural areas; greenways, parks and other protected areas; farms, ranches and production forests; natural reserves and other open spaces, which support the preservation of native animal and plant species; sustain natural and ecological processes; maintain clean air and water resources and contribute to

health and quality of life of settlements and their residents. In this context, GI represents an ecological system supporting a healthy environmental, social and economic development or our natural life-support system.

Urban GI consists of a system of multifunctional open green spaces that are integrated and interlinked in the landscape (Grant, 2010). The linkages between them are provided by greenways. The concept of GI is beneficiary for the perception of green space planning and protection. Many people consider open spaces simply as (yet) non-built-up spaces. For green spaces, they normally consider isolated parks, recreational localities or natural areas. Most people understand infrastructure as roads, sewerage system, underground services and other grey infrastructure or hospitals, schools and other social infrastructure. These two main categories of infrastructure represent the built infrastructure. GI emphasises the importance of creating new and enhancing existing elements of green open space systems, including greenways. It is therefore important that GI progressively becomes an integrated part of master plans and/or other equivalent plans at the local, micro-regional, regional or national level.

GI can also be considered a process, which supports a systematic and strategic approach to nature and landscape protection at the national, regional, micro-regional and local level. GI as a process supports diverse planning tools. As a concept, GI can facilitate the creation of open space systems, which are interconnected by greenways. Greenways create linkages between existing and planned green spaces and fill gaps in the system of GI. As a process, GI provides a functioning mechanism for coordinating diverse interests in order to determine priority areas for protection. GI and greenways represent a framework, which can be used for managing future development of an area with the aim to protect natural resources and interests of municipalities. Greenways have a potential to become part of a continuous planning process of settlements in different ways. Integrated planning connects green and grey infrastructure into a more efficient and better functioning system. The most ideal starting points for creating and revitalising greenways are existing linear structures in the landscapes, such as field roads, old and abandoned railways or strips of land along watercourses. Ideal areas for implementation of GI projects in the open landscape are floodplains and wetlands.

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Greenways are good starting points in building a comprehensive and continuous GI in cultural landscapes (Benedict and McMahon, 2006).

Urban greenways represent a spatially efficient strategic method based on the concept of coexistence, as they enable protecting a high amount of natural resources, while consuming a low amount of land. The interconnectedness contained in the concept of greenways supports many biological, physical and cultural functions of the landscape, which are important for its sustainable development. Greenways theory and planning form a rational basis for protection of greenways and GI in settlements and landscapes. Greenways stand for a strategic planning concept developed with the aim to change environmental, cultural, political, social and economic factors. The interest in alternative planning models and methods was initiated mainly by the major expansion of decentralised urban development. In greenways concepts, there is an emphasis on physical and organisational linkages. Physical linkages provide benefits in terms of individual, material or nutrient flows. Moreover, greenways provide a social, societal and political network, which integrates people with diverse values and perspectives in relation to contemporary land use and planning practice. This is perhaps the most significant attribute of greenways, which differentiates them from other landscape planning concepts (Ahern, 2004). The focus of greenways concept is the territorial interconnectedness and the integrated functional network created for diverse functions, interlinking rural and urban areas. The main role of greenways is to make open landscapes directly accessible for urban residents. Greenways represent networks in the landscape, which are planned, designed and managed for multifunctional purposes, including ecological, recreational, cultural, aesthetic or other purposes that are compatible with the concept of sustainable land use (Ahern, 2010).

The European Landscape Convention and green infrastructure

Landscape has an important role for public interests in cultural, ecological, environmental and social spheres and it represents a source, which positively impacts the economic activity. Its protection, management and planning can

contribute to job creation. Landscape contributes to formation of local cultures and is a basic component of the European natural and cultural heritage that contributes to human well-being and consolidation of the European identity. Landscape is a key component of the quality of life of urban and rural residents, in degraded or high-quality areas, in areas recognised for their extraordinary beauty, as well as in everyday landscapes (Council of Europe, 2000).

The Council of Europe aims with the European Landscape Convention (ELC) to react on the fact that the development of agriculture, forestry, industry and raw material extraction, regional and urban planning, transportation, infrastructure, tourism and recreation or common changes in the global economy in many cases accelerate landscape transformations. The public wants to enjoy high-quality landscapes and actively participate in their development and design. Landscape is a key element of individual and societal well-being. Its protection, management and planning bring about rights and responsibilities for everyone. The quality and diversity of European landscapes represents a common resource and it is therefore important to cooperate on its protection, management and planning, while the ELC is supposed to be the key tool for fulfilling this commitment (Council of Europe, 2000). The ELC was signed by Slovakia and ratified in 2005, when it came into force.

According to the ELC:

*"**Landscape** means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors;*

***Landscape policy** means an expression by the competent public authorities of general principles, strategies and guidelines that permit the taking of specific measures aimed at the protection, management and planning of landscapes;*

***Landscape protection** means actions to conserve and maintain the significant or characteristic features of a landscape, justified by its heritage value derived from its natural configuration and/or from human activity;*

***Landscape management** means action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes;*

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***Landscape planning** means strong forward-looking action to enhance, restore or create landscapes"* (Council of Europe, 2000).

The ELC deals natural, rural, urban and peri-urban areas; from terrestrial, through water, sea or shore areas; from landscapes considered extraordinary to landscapes considered everyday or even degraded. Its aim is to support protection, management and planning of the landscape and to organise the European cooperation in landscape issues.

Natural and cultural heritage is part of the territorial capital and identity of the European Union. Ecological values, environmental quality and cultural heritage are key aspects of wellbeing and economic potential, while an overexploitation of these natural resources is considered a threat for the territorial development. Cooperation with nature, in harmony with the local landscape, with the aim to provide important goods and services through projects of local GI is therefore economically efficient and it preserves significant physical features of the landscape and the local identity of a certain area (European Commission, 2013a). As stated by the European Commission, GI includes many political areas, which are directly related to landscape. It can be expected that the 25 countries which have already signed and ratified the ELC will integrate and implement the new European strategy on GI in their national landscape policies. The ELC aims to embody the legal protection of landscape and it recognises the multifunctional value of the landscape and its position as an integrating media in spatial planning. Landscape is considered from the beginning of the planning process, which is consistent with the GI approach (Natural England, 2009). The implementation of the ELC was published also in the form of popular and awareness-raising publications, for instance in Slovakia (Jančura, 2008), however it is critically assessed by Miklós (2014) who argues that ELC-based projects do not consider landscape as a geosystem and do not have a practical utilisation or implementation.

The EU Strategy on Green Infrastructure

GI has a potential to significantly contribute to an efficient implementation of European landscape policies, strategic documents and directives, the aims of which are entirely or partly achievable through nature based solutions.

The European Commission has evidence of a high return of investments into GI through restoration projects. GI has a significant potential in the regional policy of the EU, as the European Commission has identified GI as one of the investment priorities within the Cohesion Fund and the European Regional Development Fund. The contribution of GI to a smart and sustainable growth of Europe is highly recognised. Approaches based on ecosystems and the services they provide are strategies and tools utilising the adaptive capacity of nature. Thus they are applied, economically efficient and sustainable tools of climate change mitigation. These approaches utilise GI based solutions, as they use biodiversity and ecosystem services as part of the complex adaptive strategy, with the aim to mitigate adverse effects of the changing climate. The EU Strategy on Adaptation to Climate Change (European Commission, 2013c) of climate change aims therefore at application of approaches and solutions based on GI, ecosystems and ecosystem services. GI initiatives in agriculture and forestry have a mitigating effect in relation to emissions of CO_2 and greenhouse gases.

One of the examples featured by the European Commission (2013a) in relation to the interconnectedness of GI with climate change mitigation and adaptation is an ecological restoration of floodplain woodlands as an important element of European natural capital and heritage. Good functioning floodplain forests are able to provide many benefits, such as water filtration, maintaining the groundwater level or protection against erosion. Forests and woodlands also mitigate the negative impact of climate change, e.g. through capturing CO_2 emissions or water retention, which lowers the risk of floods in urban areas. Restoration of floodplain forests is often a cheaper solution, as it is basically a disposable investment into establishment and lower costs of maintenance than in the case of single-purpose technical solutions, such as water dams and reservoirs. Moreover, GI solutions have an added value in terms of ecology, as floodplain forests reconnect the river with its surrounding floodplain, while improving connectivity for valuable European species, such as the otter, important bird and fish species (European Commission, 2013a). The EU Strategy on Adaptation to Climate Change perceives GI as an energetically and financially efficient alternative to conventional air conditioning. A low humidity in urban areas caused by the absence of vegetation

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and a high solar energy absorption by dark surfaces is the main reason for higher temperatures in urban areas compared to surrounding open landscapes. This phenomenon referred to as urban heat island effect can have serious consequences, mainly during heat wells. The creation of humid air, which is produced by nature free of charge, could be replaced by evaporation using electrical energy which would cost around EUR 500,000.- per hectare (European Commission, 2013a), which is in total contradiction with economic and environmental sustainability. On the other hand, cooperation with nature through GI in urban areas, e.g. in the form of parks with a rich biodiversity, public green spaces and bio-corridors would be an efficient tool for heat island effect mitigation.

In urban areas, GI can also contribute to the development of Green Transport Corridors, utilising the potential and ability of healthy ecosystems to sustainably mitigate carbon emissions. GI helps improving the resilience to natural disasters and is an important part of EU policy in management of natural disaster risks, such as extreme weather, floods, landslides, avalanches, forest fires or storms, which cost many lives and investments into remediation of damages and fulfillment of insurance liabilities. Consequences of such extreme situations can be effectively reduced by GI, e.g. in the form of functioning floodplains, protective forests and woodlands (European Commission, 2013a).

As stated in the General Union Environment Action Programme to 2020, GI plays an important role in protection, preservation and enhancement of the European natural Capital (European Commission, 2014). Natural capital means 1) soil, 2) water, 3) nature and landscape protection. Soil is under continuous territorial pressure of urban development, industry, transportation and recreation and it is negatively impacted by erosion, contamination and other factors. In this context, a systematic integration of GI into planning and decision-making processes is of high importance for preservation of ecosystem services and soil functions (European Commission, 2013a). Management of agricultural and forest land has a significant impact on the condition of the European natural capital. The Common Agricultural Policy (CAP) and rural development provide tools and parameters for supporting GI, with the aim to enhance areas of high natural value in rural landscapes, to avoid land abandonment and fragmentation, preserve agricultural land, sustain and enhance

woody vegetation in the landscape and the spatial connectivity and integrity of Natura 2000 areas, to sustain valuable field baulks and to preserve and restore elements of cultural and historical heritage in rural landscapes. The European Commission has included additional ecological aspects in the CAP reform. It is required for instance, that farmers receiving incentives from the first pillar, preserve existing permanent grasslands on their land and dedicate 7 % of their farmland to ecological production. If implemented, these measures can significantly enrich GI in rural landscapes (European Commission, 2013a).

Another important element of the natural capital and one of the most important pillars of GI is water. According to the European Commission, integration of GI in river basin management can significantly contribute to provision of high-quality water, mitigation of hydromorphological pressures and lowering the impact of floods and droughts. GI also provides economically effective solutions for a better implementation of European directives on drinking water and groundwater - Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption; Directive 2006/118/EC of the European Parliament and of the Council on the protection of groundwater against pollution and deterioration. Innovative multipurpose and economically efficient solutions through GI are developed also for wastewater treatment. Besides their main purpose, GI solutions have a wide range of secondary benefits, such as psychological and social benefits for inhabitants through improvement of the environment or ecological benefits in the form of biodiversity enhancement. Moreover, a richer biodiversity and a better landscape quality can create new opportunities for agrotourism or ecotourism (European Commission, 2013a).

The ***EU Strategy on Green Infrastructure*** is elaborated within the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on ***Green Infrastructure (GI) — Enhancing Europe's Natural Capital***.

Natura 2000 and green infrastructure

GI stands for an important contribution to nature and landscape protection within and beyond Natura 2000, which is a Pan-European ecological network

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based on two significant European directives on protection and preservation of European nature - Habitats Directive (1992) and Birds Directive (1979/2009) / Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, The Council of the European Communities; Directive 2009/147/EC of the European Parliament and of the Council of the 30 November 2009 on the conservation of wild birds - codified version / Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds.

Natura 2000 consists of more than 26,000 areas within the EU member states, covering 18 % of the entire territory of the EU and approximately 4 % of sea territories that are under jurisdiction of the member states. It was established with the aim to preserve and protect key species and habitats of the EU, but at the same time it provides a wide range of ecosystem services for the human society. The value of these ecosystem services has been estimated at EUR 200-300 billions per year (European Commission, 2013d).

Work that has been done during the last 25 years on the establishment and enhancement of the Natura 2000 network mean that the backbone of the European GI already exists. Natura 2000 is a biodiversity reservoir, which can be used for restoration of the population and revitalisation of degraded environments on the one hand and catalyzation of GI development on the other hand. A simultaneous development and enhancement of Natura 2000 and European GI can help reducing ecosystem fragmentation, improve the connectivity between Natura 2000 areas and achieve the aims of Council Directive on the conservation of natural habitats and of wild fauna and flora.

The EU Biodiversity Strategy to 2020 and green infrastructure

Developing GI is a key step towards the success of the EU Biodiversity Strategy to 2020 (European Commission, 2011), which is based on the fact that biodiversity is a necessary factor of social well-being. The strategy reacts on the growing pressure on our most valuable natural resources and ecosystem services, on which our society is strongly dependent. Biodiversity preservation is not only about the protection of valuable species and habitats, but also

about sustaining the natural capacity of providing natural goods, materials and services that are needed by the human society and the loss or degradation of which would cause incalculable damage.

The strategy aims at reducing biodiversity loss in the EU and at restoring ecosystems wherever it is possible. It is based on six targets focussing on main sources and reasons of biodiversity loss. One of these targets is to maintain and restore ecosystems and to enhance them by establishing GI and restoring at least 15 % of degraded ecosystems. This target is to be achieved through 3 specific actions to ensure that ecosystems and their services are both restored and enhanced: 1) to map and assess the state and economic value of ecosystems and their services in the entire EU territory; to promote the recognition of their economic worth into accounting and reporting systems across Europe; 2) to restore ecosystems, maintain their services and promote the use of GI; 3) to assess the impact of EU funds on biodiversity and investigate the opportunity of a compensation or offsetting scheme to ensure that there is no net loss of biodiversity and ecosystem services.

GI enables reconnecting of fragmented natural and semi-natural areas and improving their functional connectivity within a wider territory of the rural landscape. It supports a better utilisation of nature based solutions and approaches oriented to climate change mitigation of efficient use of natural resources.

The Slovak landscape policy and green infrastructure

There is no specific legislation on landscape planning in Slovakia and therefore the planning dimension of the Slovak landscape policy has its legislative background mainly in the Act No. 50/1976 on Territorial Planning and Construction Order. Territorial planning is a systematic activity that defines the use of a certain territory in line with the main goals and objectives of national economic plans. It aims at a sustainable balance of all natural, cultural and social values in a territory.

After the establishment of the independent Slovak Republic in 1993, the ecologization and greening of territorial planning and planning in general has started. Competences of territorial planning have been moved to the Ministry

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of Environment of the Slovak Republic and the Slovak Environmental Agency has been established with its regional centres as coordinating bodies of territorial planning.

The term sustainable development has been anchored in the Slovak legislation by the Act No. 17/1992 on Environment as *"such a development that enables present and future generations to satisfy their basic needs, while preserving the diversity of nature and the natural functions of ecosystems"*.

The Slovak landscape policy has two main pillars - LANDEP (Landscape Ecological Planning) and TSES (Territorial System of Ecological Stability), which is part of the territorial planning documentation according to the Act No. 50/1976. An important legislative background on the national level is provided by the Act No. 543/2002 on Nature and Landscape Protection. In specific cases, when it comes to GI elements that are part of the cultural heritage, it comes to interaction with the Act No. 49/2002 on Protection of Monuments and Historic Sites. These acts are the main legislative tools at the national level for the implementation of the GI strategy.

Landscape Ecological Planning and green infrastructure

Landscape Ecological Planning (LANDEP) can be considered the main pillar of Slovak landscape policy. It deals with an ecologically optimal territorial arrangement and functional land use. It is a systematic complex of applied landscape ecological methods, which aims at designing ecologically optimal territorial organisation of the landscape, land use and protection. This results in the proposal of measures for ensuring the functioning of landscape ecological relations and processes (Ružička and Miklós, 1982).

LANDEP synthesises the knowledge of potentials for ecologically optimal land use in terms of creating conditions for maintaining and developing populations of healthy organisms, including man, as well as for the development of the human society (Ružička and Mišovičová, 2013). Miklós (2014) thoroughly characterises the early phase of applied landscape ecological and environmental research and the implementation of its results in the practice through 'biological landscape planning' (Ružička and Miklós, 1979), where the

main methodological steps were formulated as follows: analyses - syntheses - interpretations - evaluations - propositions, which were also implemented in the landscape ecological plan elaborated within methodological guidelines of ecologically optimal land use within research and analyses for the local land use plan (Hrnčiarová et al., 2000). This methodology was named Landscape-Ecological Planning or LANDEP. According to Miklós (2014), the highlight of methodological development and implementation was achieved in the 1980s. The LANDEP methodology was published in the scientific journal Ecology (Ružička and Miklós, 1982) and then applied to land use planning and agricultural landscape projects.

Territorial system of ecological stability and green infrastructure

The most important issues in contemporary landscape research include GI, biodiversity protection, creation of ecological networks, Natura 2000, Territorial System of Ecological Stability, assessment of natural capital and its ecosystem services, landscape assessment and monitoring, assessment of ecosystem and biotope changes and modeling development scenarios (Izakovičová and Oszlányi, 2014; Izakovičová, 2014).

Ecological networks are by Mazza et al. (2011) perceived as important elements of GI plans and projects, which have the potential to provide multiple functions in a certain area and enhance ecosystems and the services they provide for the human society.

According to Izakovičová (2014), GI has to be based on preserving, sustaining and protecting different types of ecosystems from natural, through semi-natural, up to artificial, which provide diverse ecosystem services and benefits for the society, from productive, through ecological, up to cultural services. She considers the methodology of the TSES as a potential theoretical and methodological basis for GI planning and design, as its aim is to create a territorial structure of interconnected ecosystems, the components and elements of which ensure the diversity of conditions of life forms in the landscape. Therefore, she argues that the TSES is suitable for ensuring not only protection, but also an optimal use of GI.

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Miklós (2014) considers LANDEP and TSES as the most important complex landscape ecological methodologies. According to him, the latest applied research into ecosystem services or GI in Slovakia can build upon these methodologies and benefit from them. He considers territorial planning as the most important integrating and implementing tool for GI.

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Aim, goals, objectives

The ***aim*** of research is to elaborate on the contemporary issue of GI in Slovak rural landscapes from the perspective of landscape architecture. The research is conducted in the Nitra Region (Slovakia), on 10 selected rural settlements as research samples: Tvrdošovce, Palárikovo, Maňa, Golianovo, Svätoplukovo, Červený Hrádok, Mojmírovce, Žitavany, Nitrianske Hrnčiarovce and Oponice.

The aim of research is to be achieved through the following ***goals*** (A – F) and ***objectives*** (1 – 10):

A. To reveal different aspects of historical development, territorial and spatial changes, structural and morphological transformations of rural landscapes and their GI since the 18th century;
   1/ To conduct a digital spatial research using a thorough analysis, synthesis, interpretation and evaluation of historical and current maps;

B. To elaborate on strengths, weaknesses, opportunities and threats of current GI in the countryside;
   2/ To conduct a SWOT analysis of GI in the countryside by the example of the Nitra Region as a basis for further research objectives;

C. To explore GI in open rural landscapes, outside the built-up areas of rural settlements;
   3/ To elaborate on GI in extra-urban areas of rural municipalities;
   4/ To evaluate the visual and spatial impact of GI on the perceived landscape using a combination of field research and digital spatial research;

D. To explore GI in intra-urban areas of rural settlements;
   5/ To analyse different types of GI in built-up areas of rural municipalities in terms of location, function, space, architecture, vegetation and other aspects;
   6/ To develop a GI typology of rural settlements and landscapes in the Nitra Region and to elaborate on the main GI types, while emphasising their diversity in character, features, values, vegetation structures and design approaches;

E. To propose qualitative improvements of local GI;
7/ To implement the approach of research by design, while using planning and design tools of landscape architecture in designing rural GI;

F. To set up the main strategic guidelines and objectives for rural development in the Nitra Region through GI;
8/ To define the role of GI in rural development at the regional, micro-regional and local level;
9/ To define the role of education and awareness raising for GI implementation and development in the Nitra Region;
10/ To define and discuss the main outlooks, aims, goals and objectives of a strategic rural development through GI as a planning strategy and concept.

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Materials and methods

Natural characteristics of the Nitra Region

Regional geomorphological structure

The Nitra Region belongs to the Western Pannonian Basin and Western Carpathians. A significant part of the region is located in the Danube Lowland (Western Pannonian Basin). This predominantly lowland landscape is partly interfered by some structures of the Western Carpathians, namely the following hills: Považský Inovec, Tribeč, Pohronský Inovec, Štiavnické vrchy, Krupinská planina and Burda (Mazúr and Lukniš 1990; Slovak Environment Agency, 2002).

Climate

Most of the Nitra Region territory is located in the Hot Climate Area with more than 50 summer days (days, when the maximum air temperature reaches or exceeds 25 °C). The hilly parts belong to the Temperate Climate Area with less than 50 summer days. Only some hill peaks belong to the Cold Climate Area (areas, where the average air temperature in July does not reach 16 °C (Konček 1990; Slovak Environment Agency, 2002).

Geology and soils

Most of the region is based on Neogene and Quaternary sediments, such as pudding stones, sandstones, claystones, limestones, gravels and sands. In the southern part of the region, also Paleogene sediments occur, while in the hilly parts, mainly Neovolcanic rocks, Mesozoic rocks of the central, Klippen and Flysch Belt, Variscan igneous rocks, non- or weakly metamorphosed Paleozoic metamorphic rocks and Paleogene sediments of the Flysch Belt occur (Hanáček, 1990). Soils are very fertile in the Nitra Region, with a large share of black soils, brown soils, Mollic Fluvisols, alluvial soils and areal admixtures of rendzinas. The soils in the Nitra Region belong to the highest quality soils in the Slovak Republic (Hraško and Šurina, 1990; Lukniš, 1990; Slovak Environment Agency, 2002).

Potential natural vegetation and current woody plant species composition of forests and woodlands

The potential natural vegetation is very diverse in the Nitra Region, since the landscape character changes from lowlands in the south to hilly areas in the north. In the southwestern part of the region, the most significant potential natural vegetation is represented by elm (hardwood) floodplain forests in the basins of large rivers (*Fraxinus - Ulmus - Quercus*) and willow-poplar (softwood) floodplain forests in floodplains of large rivers (*Salix - Populus*). This type of potential natural vegetation interferes partly also to the north, when accompanying the main rivers of the region - Váh, Nitra and Hron. The northern and eastern parts of the region have a strong representation of oak forests with *Quercus cerris*, oak forests with *Acer tataricum* and *Quercus pubescens* and Carpathian oak-hornbeam forests. Locally, there is a territorially less significant occurrence oak forests with *Potentilla alba*; oak forests with *Quercus pubescens* partly in combination with dry grasslands on calcareous rocks; peri-Pannonian oak-hornbeam forests; lowland hygrophilous oak-hornbeam forests; in the northeastern parts also submontane beech forests; calciphilous beech forests; beech and fir-beech forests and alder submontane and mountain floodplain forests (Maglocký, 2002). There are not so many forests and woodlands in the Nitra Region (15.18 %), given the fact that the predominant land use of the region is agriculture. In terms of altitudinal forest zones, there are mainly Beech-oak (Fageto-Quercetum) and Oak-beech (Querceto-Fagetum) woodlands, with the admixture of typical beech woods (Slovak Environment Agency, 2002). Scattered woodlands in agricultural lowlands are mainly mixed forests with dominance of broad-leaved species and with admixture of diverse oak species. In the northern hilly landscapes, there is a predominant representation of European hornbeam, diverse oak species and common beech (Bucha et al., 2002). In terms of main functions of forests, most of the woodlands are commercial forests, some of them are special purpose forests and there is a low share of protective forests (Duben and Švec, 2002).

Landscape-ecological complexes

In terms of the level of urbanisation (share of built-up areas of the total area of a landscape-ecological complex), most of the Nitra Region can be considered

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a rural landscape with a low level of settlement (1 to 10 %). Along rivers, the share of built-up areas is higher and there are rural landscapes with a medium level of settlement (11 to 40 %). Continuously built-up territories with an area of more than one square kilometres are represented by the city of Nitra, towns and small towns of the region. In terms of landscape ecological complexes, the region is very diverse. There is a significant areal proportion of lowland depressions, river flatlands, undulated flatlands and river terraces with prevalence of arable land; another significant part of the region is covered by hilly landscapes, mainly polygenic hilly landscapes and low-plain promontories with arable land. Locally, there is a less significant occurrence of tables and fluvial-aeolian plains, such as dune flatlands with mosaics of agricultural crops and arable land or loess tables with prevalence of arable land. There is an occurrence of hill lands and low-plain promontories, uplands on acid rocks, karstic uplands and uplands on varied carbonate and noncarbonate rocks, as well as mountains on acid rocks with prevalence of broad-leaved forest and their mosaics with agricultural crops (Miklós et al., 2002).

Forests and woodlands

The Nitra Region has a relatively low proportion of woodlands. According to the potential natural vegetation, the woodland species composition in the Nitra Region is quite diversified. In the southwestern part of the region, there are willow-poplar forests in floodplains of rivers and ash-elm-oak forests in major river basins. Towards the northwestern part of the region, there are mainly Carpathian oak-hornbeam forests, oak forests and oak forests with Tatarian maple and pubescent oak. The highest woodland or forest land-use proportion is in the Levice (291.62 km2), Zlaté Moravce (226.49 km2) and Topoľčany (169.46 km2) districts.

Territorial System of Ecological Stability

There are several important bio-centres (very varied in size) throughout the region under different levels of territorial protection (1 to 5) and several supra-regionally important terrestrial or water bio-corridors connecting the north with the south of the region. Many of the highly protected bio-centres

are small patterns spread throughout the region, not very well connected with each other through bio-corridors. There are two compact bio-centres in the north and northeast of the region, but most of the region is covered by territories with no or very low occurrence of bio-corridors (Miklós et al., 2002). According to Miklós et al. (2002), it is necessary to increase the share of ecologically valuable areas (bio-centres) in most parts of the Nitra Region, since there are territories with a very low coefficient of ecological quality and stability (mainly conventional farming areas on arable land). The Territorial System of Ecological Stability clearly indicates that it is also necessary to increase the connectivity of the existing and proposed ecologically valuable areas. Green infrastructure as a concept offers a solution for this situation.

Natural and cultural heritage

In the Nitra Region, there are 14 national natural reserves, 44 natural reserves, 19 natural heritage sites and 46 protected areas. There is an intersection between the administrative territory of the region and three large-scale protected landscape areas - Dunajské luhy, Štiavnické vrchy and Ponitrie (Halászová et al., 2015). In the Nitra Region, there are many gardens and parks listed as protected areas (arboretum, park, garden or botanical garden) based on the Act No. 543/2002 on Nature and Landscape Protection or as historical gardens and parks (alley, arboretum, cemetery, park, town park or garden) based on the Act No. 49/2002 on Protection of Cultural Monuments. There are in total 50 historical gardens and parks listed as cultural monuments (Supuka, 2002). These include 47 parks, one garden, one arboretum and one alley. In the Nitra Region, there are valuable natural biotopes and ecosystems of European importance in terms of biodiversity and landscape diversity that are integrated in the Natura 2000 network (Special Protection Areas designated under the Birds Directive and Special Areas of Conservation designated under the Habitats Directive). There are nine Special Protection Areas with a total area of 89,847.6 ha, out of which the largest area is covered by Dunajské luhy (16,511 ha) and 126 Special Areas of Conservation with an overall area of 4,180.43 ha. There are 38 localities with 170 protected trees (3rd highest number among all regions of Slovakia) of 32 species listed as protected trees under the national Act No. 543/2002. The most common protected tree species is *Platanus*

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x acerifolia (85), *Tilia sp.* (35) and *Quercus robur* (18). Most of the municipalities in the Nitra Region have at least 1 to 10 registered cultural monuments in their cadastral territory. There are six municipalities with 11 to 100 registered cultural monuments, including the City of Nitra and some of the district towns. There are seven national cultural monuments in the Nitra Region: one urban historical reserve, four urban historical zones, two rural historical zones and one folk architecture historical reserve (Pinčíková et al., 2002).

Cultural characteristics of the Nitra Region

Regional typology of landscapes, settlements and vernacular architecture

Most of the Nitra region was settled before 1250 AD and the predominant settlement type is the multiple-road type and additionally also the simple-road type, the group-road type and the streamside type of settlement (Verešík et al., 1990). Vernacular architecture in the Nitra Region can be characterised mainly by biaxial gable front facades with wooden gable walls or by biaxial hip-roof frontages. In the southern part of the region, front facades are asymmetrical and one-axial. At the turn of the 19th and 20th century, walls were usually white, plastered with lime; houses had extended walls at or around the entrance [in Slovak: výpustok] and the entrance to the yard was provided by arched wooden or stone gates. Roofs were predominantly made of reed. Less common were straw or shingle roofs. The most common building material in the Nitra Region till the mid 20th century was stiff-mud brick, which has been completely replaced by hard building materials. The most prevailing form of wells till the mid 20th century was the beam well (Kovačevičová 1990). The landscape character was strongly influenced by territorial, administrative and economic organisation of the land. Municipality borders were strongly perceivable in the landscape. The most prevailing forms of border signs in the Nitra Region in the late 19th and first half of the 20th century were individual trees, groups of trees or stones. Less common were streams or heaps of soil, combined also with border stakes. Land parcels were divided by baulks (strips of unploughed land) or furrows (strips of ploughed land) (Rusnáková 1990).

There are special landscape structures in terms of traditional way of land use and traditional culture, such as villages with traditional viticulture from the northwestern to the northeastern part of the region; historical landscapes with small farm buildings and traditional meadow-pasture landscapes mainly in the southeastern part of the region; historical landscapes with water mills along the rivers Váh, Nitra, Hron and Žitava; and historical landscapes of mixed type with technical monuments and folk architectural monuments around the city of Nitra (Podolák et al., 2002).

Settlement structure, population and demography

The Nitra Region has an important settlement heritage dating back to the Stone Age (Slovak Environment Agency, 2002). It was the most densely settled region in the territory of Slovakia in the period between the 10th and the first half of the 13th century (Ruttkay, 2002) and one of the most densely settled regions also in the first half of the 16th century (Žudel, 2002).

Today, there are 686,662 inhabitants in the Nitra Region (Statistical Office of the Slovak Republic, State to December 31 2013). The Nitra Region is administratively divided into seven districts - Komárno, Levice, Nitra, Nové Zámky, Šaľa, Topoľčany and Zlaté Moravce. In the region, there are 354 settlements, out of which 15 are urban settlements (cities and towns) and 339 are rural settlements (small towns and villages).

The Nitra Self-Governing Region covers an area of 6,343.78 km^2, which stands for 12.9 % of the the Slovak Republic territory. It is the fifth largest region of Slovakia in terms of area and the third largest region in terms of population (12.7 % of the total population of Slovakia), after Košice and Prešov regions. A specific feature of the region is the high proportion of Hungarian minority (24.6%.).

It is interesting that the smallest urban settlement Tlmače has less inhabitants (3,738) than the largest village Tvrdošovce (5,181). This is caused by the fact, that the administrative division of settlements into rural and urban does not consider exclusively the size of settlements and the number of inhabitants. Out of the total number of inhabitants, 314,398 live in urban settlements

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(46 %) and 372,264 in rural settlements (54 %), so the majority of inhabitants lives in rural settlements. The largest rural settlement Tvrdošovce has 5,181 inhabitants, while the smallest rural settlement Jesenské only 50 inhabitants. The average number of inhabitants in rural settlements is 1098. The settlement structure of the Nitra Region is dominated by medium-sized villages with a population of 1,000 to 1,999 (28.5 % of the total number of municipalities in the region). There is a large number of rural municipalities (99; 28.0 %) with 500 to 999 inhabitants with an overall concentration of the population at 10.2 %. The smallest municipalities of the region include 16 villages with up to 199 residents each. These represent 2,606 inhabitants (only 0.4 % of the total population of the region).

Three rural settlements have more than 5,000 inhabitants, five more than 4,000, seven more than 3,000, 28 more than 2,000, 101 more than 1,000 and 195 less than 1,000 inhabitants.

Rural character of the region

Based on the analyses by the National Rural Development Strategic Plan, Nitra Region is the second largest significant rural region in Slovakia, on the level NUTS-III, with 51.3 % of the population living in rural areas (the 1st is Banská Bystrica Region with 52.2 %). The 'rurality' of the Nitra Region on the level NUTS-IV is represented by five of seven districts - Topoľčany, Zlaté Moravec, Levice, Nové Zámky and Komárno (Halászová et al., 2015).

Current land use and its ecological carrying capacity

According to the land cover classes created by application of the CORINE land cover data, there is a substantial part (73.73 % of the total regional territory) in the south and southeast of the region dedicated to agricultural land use with high-quality soils, out of which 64 % is arable land. Forests and woodlands cover 15.18 % and water covers 2.47 % of the regional territory (Slovak Environment Agency, 2002; Halászová et al., 2015). The region can be divided into two main viticultural regions - Southern Slovakian Viticultural Region and Nitra Viticultural Region in the north of the region (Slovak Environment Agency,

2002). In terms of agricultural landscape types, Nitra Region consists mainly of agricultural landscapes with the longest vegetation period, with the mildest winter and the highest need for additional irrigation (Slovak Environment Agency, 2002). Hrnčiarová et al. (2002) define the ecological carrying capacity of current land use in Slovakia. According to them, most of the arable land of the region is suitable or moderately suitable in terms of ecological carrying capacity. In these areas, they suggest to maintain the current land use and to increase the share of permanent grasslands. In some parts, mainly along rivers, they suggest to significantly increase the share of permanent grasslands and also non-forest woody vegetation. They also suggest to maintain the existing permanent grasslands and to increase their proportion and distribution. In intensively used smaller forest and woodlands spread throughout the agricultural countryside, they propose to sustain the intensity of use. In northern hilly landscapes, they propose to increase the share of protective forests.

Integration of the countryside: Local Action Groups

According to the LEADER Programme of the Nitra Region (2015), there are currently 17 Local Action Groups in the region: Sotdum, Radošinka, Svornosť, Žibrica, Tríbečsko, Vitis, Dolná Nitra, Požitavie-Širočina, Dolné Považie, Cedron - Nitrava, Tekov - Hont, Termál, Dolný Žitný ostrov, Mikroregión Hurbanovo, Dvory a okolie, Dolnohronské rozvojové partnerstvo, and Ipeľ - Hont.

Urban development, urbanisation and suburbanisation

The urbanisation degree in the Nitra Region is 46.8 %, which is the lowest in Slovakia (the average degree is 55 %). This confirms the fact that the region has a strong rural character. After 2000, due to an intensive construction of industrial parks and a strong housing development, the built-up areas in the region have rapidly increased (now more than 6 % of the total regional area). Urbanisation and suburbanisation strongly affect also high-quality arable land, which has been built up in many suburban areas. The highest level of urbanisation is achieved in the Nitra District. Šaľa, Topoľčany and Komárno district can be characterised as less urbanised and there are three rural districts:

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Nové Zámky, Zlaté Moravce and Levice. Urban development in the Nitra Region follows the Regional Master Plan. According to STATdat.sk (2016), there are two main settlement categories in terms of population - municipalities with up to 1,999 inhabitants (300 in the Nitra Self-Governing Region 85 %) and municipalities with more than 2,000 inhabitants (54 in the Nitra Self-Governing Region, 15 %). Municipalities with more than 2,000 inhabitants should have a master plan. Out of the 54 settlements, 50 have a master plan (93 %). When considering all the 354 municipalities, 211 have a master plan (60 %). There are also municipalities with a population ranging from 500 to 1,999, which have a valid master plan elaborated after 2010, thus Babindol X/2012; Čechynce X/2014; Černík VII/2012; Demandice IX/2015; Hostie V/2015; Jacovce III/2012; and Jatov I/2010.

Case study areas as research samples

Our research was conducted on a case study bases, by the example of 10 rural settlements in the Nitra Region as follows (figures in brackets represent 1/ the approximate driving distance and direction measured from the geographical centre of the City of Nitra to the geographical centre of the respective municipality; 2/ number of inhabitants, state to December 31 2015; 3/ size of the administrative territory of the municipality [km2]): ***Tvrdošovce*** (31 km to S; 5,180; 55.56), ***Palárikovo*** (35 km to S; 4,332; 51.29), ***Maňa*** (32 km to SE; 2,103; 21.59), ***Golianovo*** (12 km to SE; 1,422; 10.70), ***Svätoplukovo*** (12 km to S; 1324; 13.89), ***Červený Hrádok*** (30 km to E; 420; 5.5), ***Mojmírovce*** (14 km to S; 2,854; 19.86), ***Žitavany*** (35 km to NE; 1,873; 18.20), ***Nitrianske Hrnčiarovce*** (5 km to NE; 1,929; 9.95), ***Oponice*** (23 km to NE; 869; 12.29), for the geographical location of study areas see figure 1.

Figure 1 Location of study areas in the Nitra Region, Slovakia: 1/ Tvrdošovce, 2/ Palárikovo, 3/ Maňa, 4/ Golianovo, 5/ Svätoplukovo, 6/ Červený Hrádok, 7/ Mojmírovce, 8/ Žitavany, 9/ Nitrianske Hrnčiarovce, 10/ Oponice.

Maps and planning documents used for analyses

For the analysis of landscape structure and its transformations since the 18th century, the following map documents were used: historical maps of the 1st (1763-1787) and 2nd (1806-1869) military mapping survey of the Habsburg Monarchy (© online database of Mapire, Austrian State Archives and Arcanum Adatbázis Kft).

Furthermore historical cadastral maps from the mid and late 19th century were digitalised, vectorised and analysed. These were obtained from the State Regional Archive in Nitra (Ivanka pri Nitre) and the Geodetic and Cartographic Institute in Bratislava, respectively.

Landscape structure in the 20th century was analysed based on 1) aerial photos from 1950 (© online database of the Centre of Excellence for Decision Support in Forest and Landscape, Technical University in Zvolen; GEODIS SLOVAKIA, s.r.o.; and Topographic Institute Banská Bystrica); 2) Topographic map (M 1:10 000; © National Geoportal of the Slovak Republic, Slovak Environment Agency).

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The 21st century landscape structure was evaluated based on 1) ortographic photomaps from the period between 2006 and 2013 (© EUROSENSE, GEODIS Slovakia), 2) current cadastral maps of selected study areas obtained from municipal authorities, 3) Basic GIS database (©National Geoportal of the Slovak Republic, Slovak Environment Agency); 4) Current master plans of selected study areas obtained from municipal authorities or their web pages.

Research methodology

The applied research methodology follows a logical conceptual line from 1) analysis; through 2) synthesis, 3) interpretation, 4) evaluation; up to 5) proposition.

The complex research methodology consists of three main research methods: 1) digital spatial research; 2) field research; and 3) research by design. In most of the case studies, these three main research methods were combined and they supplemented each other qualitatively.

The ***digital spatial research method*** was used for analyses of landscape structure and green infrastructure development, spatial changes and qualitative transformations. The main research tools were Geographical Information Systems (ArcGIS 10) based on the methodology by Šinka et al. (2013) a vector based graphical programmes (AutoCAD 2011 and Adobe Illustrator CS5), which have the necessary tools for the analysis of landscape structure and green infrastructure that consist of point, linear and areal elements. Within the digital spatial analysis, the following steps were conducted: 1) digitalisation, 2) vectorisation, 3) geo-referencing, 4) analysis, 5) synthesis and 6) interpretation of maps using geographical information systems and vector-based graphical programmes. These steps were followed by visual and perceptual interpretation and evaluation. The object of research were map documents from four time horizons interpreting development phases of settlements and landscapes in the 18th, 19th, 20th and 21st century (see *Maps and planning documents used for analyses*). For the interpretation and evaluation of results, complex and thematic layer maps were used, which enable a better perception and understanding of landscape structures, their development, changes and transformations.

The ***field research method*** focused on analysis of areas, spaces, objects and elements of green infrastructure in rural settlements and landscapes, including their vegetation structures. These were evaluated from the perspective of their cultural, historical, architectural, visual, perceptual and species-diversity characteristics. The aim was to discover the role of rural landscape architecture and green infrastructure for landscape character, local and regional identity in the countryside. The field research consisted of spatial and structural identification and subsequent mapping of green infrastructure elements in built-up areas and open landscape. Within the case studies the woody plant species composition and diversity, as well as the functions of vegetation elements and structures were determined. For intra-urban green infrastructure components, we determined the type, function, use and woody plant species composition.

The ***research by design method*** was applied in the form of landscape architectural design studies within public open space design studios with students of landscape architecture. This method is a third layer of research methodology, which builds upon the digital spatial research and the field research and its aim is to test different design solutions in rural settlements and landscapes. These design solutions are to be understood as propositions and testing models, which base on interpretations and evaluations of research outcomes.

The research findings were interpreted and evaluated mainly using ***graphical tools***, as these represent the most efficient analytical and interpretation tool of landscape architecture research. The graphical interpretation of analyses and syntheses of rural landscape transformation in time and space was processed using complex maps of different time horizons and thematic layer maps of each time horizon and their comparison along a timeline. The focus in landscape structure transformations was on permanent grasslands, woodlands, water, arable land, accessibility and permeability of the landscape, as well as land structure and morphology.

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Results and discussion

This chapter provides an overview of main findings of digital spatial research, field research and research by design conducted in rural cultural landscapes of Nitra Region, by the example of 10 selected rural municipalities as research samples.

Structural changes in the rural landscape and its green infrastructure since the 18th century

The interpretation of historical development and transformations of rural landscapes is based on the spatial analysis of land use changes. For the spatial analysis, several historical maps have been digitalised, vectorised and geo-referenced.

In the southern part of the Nitra Region, agriculture (figure 3) and permanent grasslands (figure 2) were the predominant land uses in the 18th and 19th century. Arable land was characterised by small-scale narrow plots. Densely divided agricultural landscapes provided space for a higher proportion of small-scale permanent grasslands in the form of field baulks with solitary trees or groups and lines of trees (figure 4), green municipal boundaries, accompanying woodlands of dirt roads, scattered woody vegetation on permanent grasslands and others. In the southern part of the Nitra Region, there were larger areas of floodplain forests with small meandering watercourses and wetlands (figure 5).

Agriculture has started to prevail over permanent grasslands mainly by the end of the 19th century and beginning of the 20th century, when the intensification and industrialisation of agriculture has started (figures 2 and 3). This phenomenon has continued in the following decades and it culminated in the collectivization of agriculture in the 1950s (figure 7). It has significantly influenced the road networks and thereby also the accessibility and permeability of the landscape (figure 6). Till the late 19th century, rural settlements were normally surrounded by a greenbelt in the form of meadows and pastures, isolating the settlement from the surrounding fields (figure 2). These were used for grazing the livestock. Collectivization of agriculture in the early

1950s has significantly changed the spatial and structural character of the agricultural landscape (figure 7). In terms of urban design and architecture, the most significant changes in rural landscapes have started after World War II. One of the most significant typological changes in rural architecture occurred in the period from 1960s till 1980s. Architecture and urban design of this period has urbanised most of the rural settlements in Slovakia.

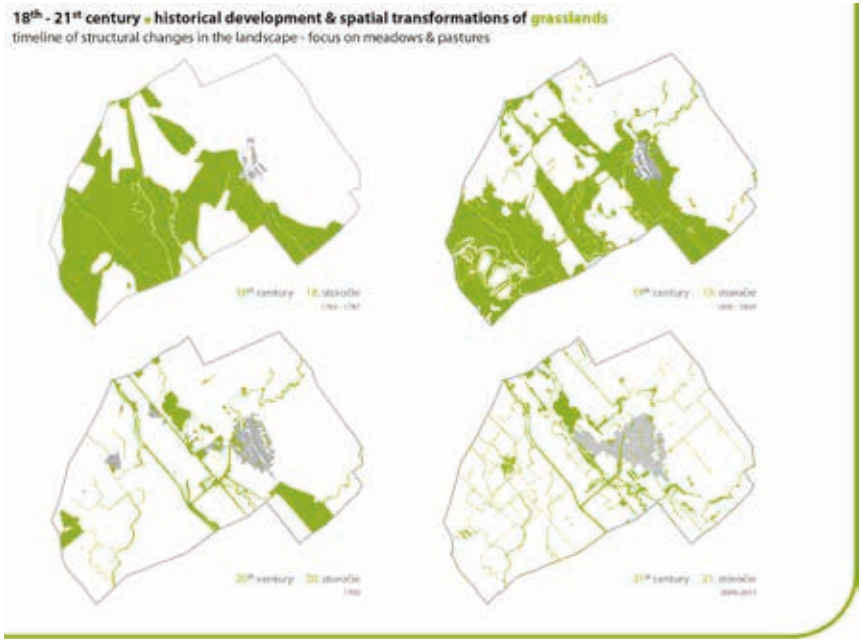

Figure 2 Historical development and spatial transformations of grasslands in the study area Tvrdošovce since the 18th century (Tóth, 2015)

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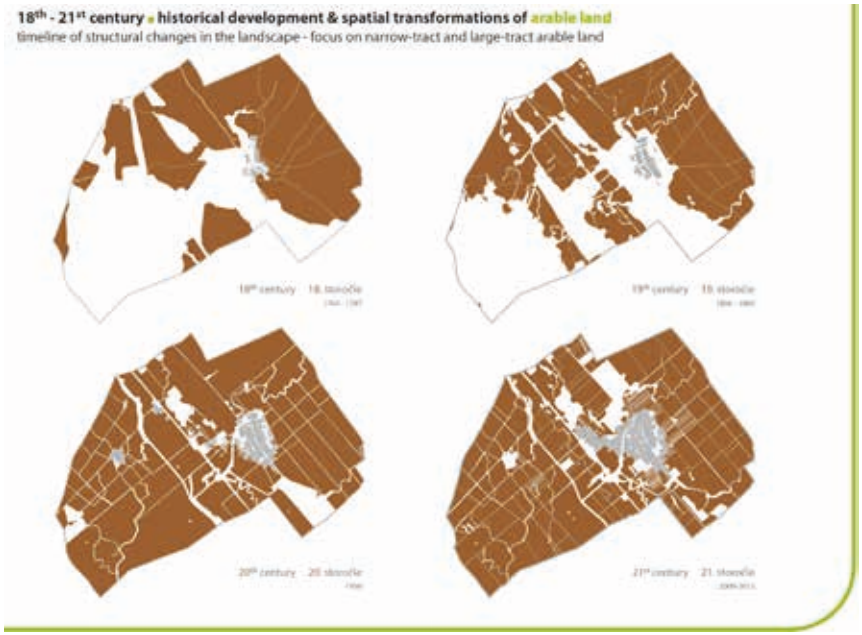

Figure 3 Historical development and spatial transformations of arable land in the study area Tvrdošovce since the 18th century (Tóth, 2015)

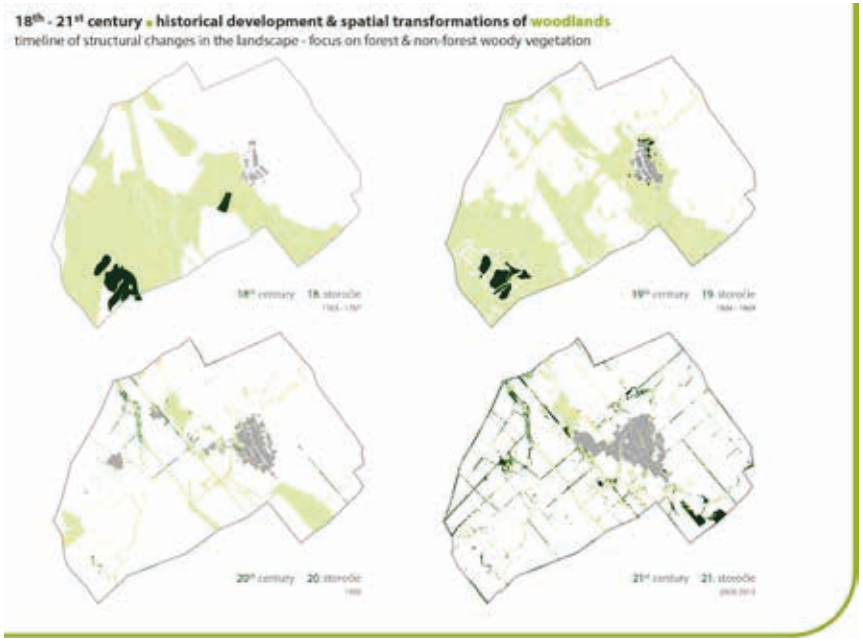

Figure 4 Historical development and spatial transformations of woodlands in the study area Tvrdošovce since the 18th century (Tóth, 2015)

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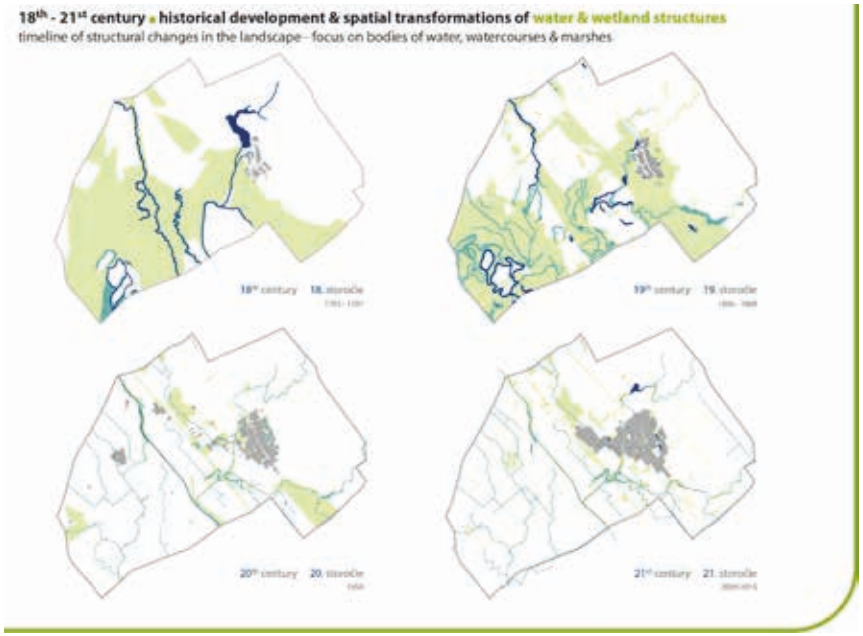

Figure 5 Historical development and spatial transformations of water and wetland structures in the study area Tvrdošovce since the 18th century (Tóth, 2015)

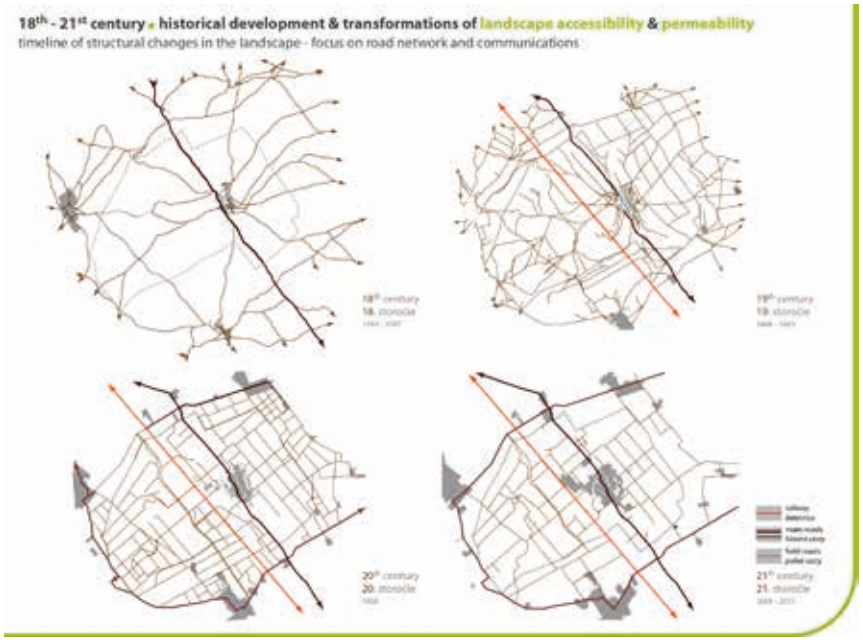

Figure 6 Historical development and spatial transformations of landscape accessibility and permeability in the study area Tvrdošovce since the 18th century (Tóth, 2015)

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Figure 7 Changes in the land structure and morphology caused by collectivization of agriculture by the example of the study area Tvrdošovce - Comparison of the landscape structure in 1950 and 2015 (Tóth, 2015)

Green Infrastructure in the countryside: Results of a SWOT analysis

Green infrastructure is a complexly interconnected system in the organism of the countryside and greenery is its main living element. Green spaces in settlements and open landscapes of the countryside indicate the quality of human environments in terms of physical qualities (air, water and soil cleanness, microclimate improvement or dust and noise reduction), as well as mental values (quality of life and wellbeing of rural inhabitants).

Rural settlements are 'immersed' in greenery. Locally considered, green spaces situated in the village centre are of the highest interest and importance. Villages inherited green commons with the church as the most important ar-

chitectural landmark of the local community (figure 8). It is often surrounded by extensive green spaces, sometimes enriched by a small local stream. Thus, greenery has become an inherent component of village centres. In many cases, valuable exemplars of ornamental and fruit trees are only preserved in period paintings or first photographs of our villages. However, front gardens full of flowers, yards shaded by vine or beautiful tree alleys, 'green gates' at the entrances to villages and other formations of trees in the landscape have always been characteristic features of Slovak villages. Villages were usually integrated with greenery, which was continuously penetrating the surrounding open landscapes through green backyards forming the greenbelt of a village.

Today, ornamental greenery usually consists of traditional tree species, which are characteristic for the countryside of the Nitra Region. Public and special green spaces are part of central open spaces of villages, they co-create the main streetscape, the surroundings of the church and public facility buildings. Greenery is an important part of local vernacular architecture, which is visually perceived as part of public open spaces of the village. It is not possible to divide vernacular architecture from its surroundings. The house with its yard and garden has been an important part of the street line and the entire streetscape. The garden has always been a characteristic feature of vernacular architecture. It has been its vivid face, the manifestation of the spirit of livability of the village house and a functional component of human environment in villages. Today, the garden represents the lifestyle of village inhabitants. It has become a significant feature of individual expression of inhabitants. Today, public open spaces are one of the most important visual features of a village, be it positive or negative. Their visual, aesthetic and functional conditions characterise the cultural level of their inhabitants. Therefore, public open spaces have become objects of specific consideration by local governments. These particularly focus on central open spaces, which have a crucial role in the visual evaluation of each village or small town. Rural settlements have rediscovered their squares and streets as community spaces. In this context, villages face an important challenge to convert their roads to streets and humanise the local transportation.

The diagnosis of strengths, weaknesses, opportunities and threats (SWOT analysis) aims at a better understanding and knowledge of the current state of rural green infrastructure and the possibilities of its sustainable development.

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Figure 8 Historical green infrastructure at the turn of the 19th and 20th century by the example of the study area Tvrdošovce (Tóth, 2015)

Strengths of the countryside are represented by the presence and strong representation of greenery and green spaces in rural settlements. Greenery has a strong ecological dimension. It serves as an ecologically stabilising element in urban areas and open landscapes. It is a significant interconnecting element between settlements and landscapes when considering the physical and spacial dimension; and between man and landscape when considering the social and psychological, as well as visual and perceptual dimension of GI. Greenery is therefore a health-improving and quality-enhancing phenomenon in rural environments.

Villages and small towns have their origin in the landscape. Their greenery is of diverse functional types. Villages are green spots in the rural landscape. There are houses with gardens. Living in villages can therefore be character-

ised by a particular quality of living environment. In terms of ownership, village greenery has a public or private character. GI has an important areal and spatial representation with a wide range of functions in the urban structure and layout of the village. It has a strong historical legacy and value.

Weaknesses of the countryside in terms of GI are represented by an insufficient areal and spatial proportion of ecologically stable greenery in the landscape (e.g. in the form of non-forest woody vegetation). Another weakness of rural GI in settlements and landscapes is a low level of interconnectedness of its elements. There is often a problem of low green space quality manifested by species composition and an insufficient or absenting care of green spaces and elements. Greenery elements, areas and spaces have often a weak ability to compete with other investment aims. Nonconceptual green space creation in public open spaces and tree felling or planting in intra-urban areas belong to the most common problems or weaknesses of rural settlements. After tree felling, compensatory tree plantings are often not implemented or they are realised insufficiently. In new or compensatory tree plantings, the use of allochthonous (non-native) woody plant species is often in conflict with the local identity and traditional character of rural landscapes, be it in their public open spaces in intra-urban areas or in the open landscape. A significant weakness of GI implementation in public open spaces of villages and small towns is the limitation of using native long-lived and medium-lived tree species given by spatial limits of open spaces and other limitations, such as underground or aboveground services. In terms of species composition, a frequent problem is also planting of regionally non-suitable (non-endemic) woody plant species, for instance conifers in southern lowlands. Perennials are often missing in public open spaces.

Rural development has gone through several historical periods that have changed the character and visual features of villages. Villages have become towns and the division line between rural and urban has faded. The main functional open spaces of villages are represented by streets and central open spaces that have been neglected in the recent decades. Urban development of villages is chaotical. Villages do not always respect rural building principles, such as unified street lines and traditional architecture. Underground utilities are often in collision with green spaces and elements of the intra-urban GI.

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Opportunities include one of the most challenging contemporary issues, thus mitigation of climate change effects, such as extreme situations (e.g. floods and droughts). Green infrastructure provides tool for greening villages and creating sustainable, attractive and healthy human environments, which can be considered the green oases of the countryside. Nature based solutions through green infrastructure can provide a wide range of important ecosystem services, such as flood protection. The countryside is a cultural treasury of the regional history and villages represent important historical monuments of the region. The countryside of the Nitra Region is polymorphous, it can be divided into two main cultural and historical regions - the subregion along the river Nitra and the other one along the river Danube. Thanks to the natural capital represented by the countryside, it can be considered an important provider of the ecological stability and resilience of the region. In this sense, villages serve as managers of local and micro-regional landscapes.

An important opportunity and commitment of villages is to preserve traditional tree species, such as alley tree plantings or remnants of tree plantings at historical and cultural monuments in public open spaces. Villages can rediscover their opportunities in traditional ornamental green spaces and the preservation of agricultural activities. In terms of gene pool, there is an opportunity of giving preference to native woody plant species in rural landscapes, which positively affects the local diversity. A strong opportunity of the Nitra Region, given the agricultural character of its countryside, is represented by innovations in agriculture that can follow the aim of greening agriculture and implementation of more ecological practices in traditional and conventional agriculture. The countryside of the Nitra Region has a very rich cultural heritage, which includes religious architecture in rural landscapes, such as small sacral architecture, chapels, roadside crosses, shrines and others. Their rediscovery, restoration and integration in the concept of sustainable rural tourism can be of huge benefit for many rural settlements and their local action groups.

Threats that significantly influence rural areas include many recent revitalisation projects funded by the European Union, which implemented more concrete, paved and other impermeable hard surfaces than open green

spaces. Another threatening issue is a reduction of the share of green spaces and elements in intra-urban areas of rural settlements and their surrounding landscapes. Non-conceptional development projects often neglect or ignore green infrastructure and the natural capital of the countryside and cause a significant spatial and qualitative reduction of green systems in settlements and their surrounding open landscapes. This issue is strongly related to the phenomenon of sub-urbanisation or urban sprawl that mainly affects rural settlements located closer to urban centres, such as district towns or the Nitra city as the regional capital. Suburbanisation is often the result of non-conceptional expansion of settlements towards the surrounding open landscape, as well as conventional planning models and approaches.

The targeted analysis of strengths, weaknesses, opportunities and threats focused on the assessment of the current state of the environment through the spectrum of green infrastructure. It suggests that countryside is becoming an object of professional analysis focusing on the intensity and typological structure of green infrastructure. It can be concluded that green infrastructure is becoming an indicator of the sustainable development of rural settlements.

Green infrastructure in open rural landscapes

In terms of planning, architecture and design, landscape should be understood as a holistic and interconnected system. Greenery in the landscape does not know administrative boundaries or cadastral territories of municipalities. This opens up questions, challenges and opportunities of micro-regional, regional and supraregional cooperation. The aim is to plan, design and implement common landscape greenery and to enhance the common natural capital. It tests the ability of municipalities to cooperate on creation of new and enhancement of existing areal and linear vegetation elements in the landscape or on the management of common recreational areas.

Urban development of settlements has to consider productive components of the agricultural production (valuable arable land, pastures, orchards or vineyards) and other important non-agricultural elements of the natural capital, such as vegetation elements and formations in specific habitats and sites (forests, woodlands, grasslands or wetlands). Therefore, rural municipalities

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have to reduce non-conceptual suburbanisation and urban sprawl, which causes building up valuable arable land and other elements of the natural capital enhancing the ecological stability and living environment in the countryside. In investment and development projects, municipalities should prefer unused and abandoned areas within the built up area, thus a spatially intensive, rather than a spatially extensive form of urban development. Investments should be targeted primarily on reconstruction of existing objects, with the aim of their functional renewal, rather than building up new objects outside the intraurban area. New urban development axes have to be kept as close as possible to existing transportation lines and utilities, in order to utilise existing technical structures more effectively, instead of building up agricultural landscapes or woodlands. An important challenge to the countryside of the Nitra Region is to optimise the metropolisation of its rural landscapes, in order to preserve landscape values and natural capital.

The role of green infrastructure in the open landscape is also flood protection, using green polders, floodplains or semi-natural wetlands, which can retain and purify surface water in rural landscapes. An example of the importance of green infrastructure for climate change mitigation and adaptation to changes, is an ecological restoration of floodplain woodlands as important elements of natural capital and heritage of Europe. Good functioning floodplain forests of the Danube Basin can provide multiple benefits, such as water filtration, surface water retention or erosion prevention. Woodlands mitigate the negative impacts of climate change through absorption of CO_2 emissions or through water retention, which lowers the risk of floods in urban areas of settlements. Restoration of floodplain woodlands is a cheaper nature based solution than building artificial dams and other gray infrastructure solutions. Moreover, floodplain woodlands reconnect the river with its floodplain areas, which enhances the connectivity of important species, such as the otter or valuable fish and bird species, which represent the natural heritage of Danube landscapes. Moreover, GI can be implemented as a strategic tool for enhancement of protected landscapes (figure 9) or improvement of existing green systems in the landscape, in terms of their connectivity and spatial integrity (figure 10).

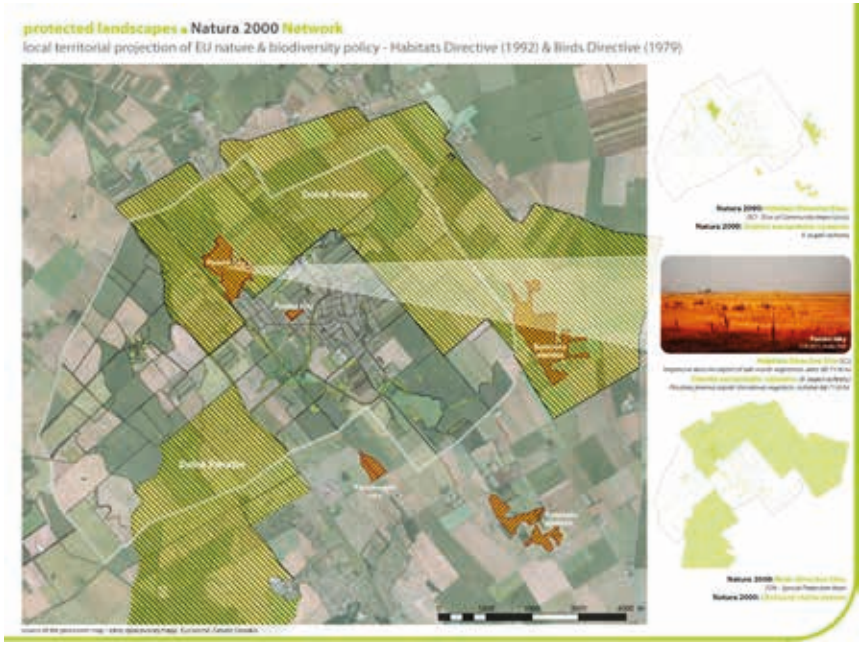

Figure 9 Territorial projection of EU nature and biodiversity policy on the local landscape structure by the example of the study area Tvrdošovce (Tóth, 2015)

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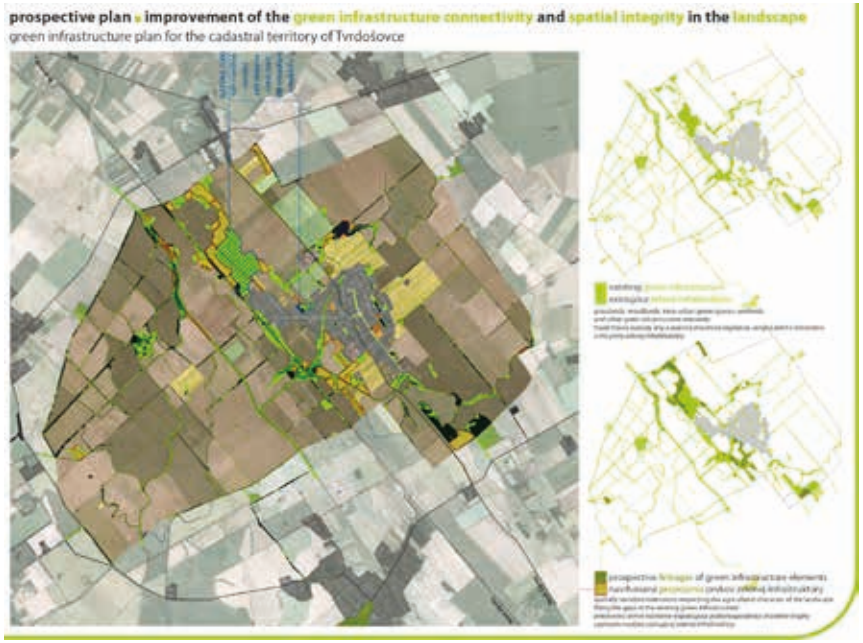

Figure 10 Green infrastructure plan for the study area Tvrdošovce (Tóth, 2015)

Visual and spatial impact of green infrastructure on perceived open landscapes

Within the field research and landscape character assessment in selected study areas in the Nitra Region, we observed diverse visual and perceptual situations, which were strongly influenced by the spatial composition of GI in mainly flat rural landscapes. In GI of non-built-up rural landscapes, woodland structures are spatially and perceptually most dominant. Woody vegetation has been providing diverse functions and services in open rural landscapes. Woodlands have marked administrative boundaries in the form of continuous linear structures along borders of cadastral territories, they often function as windbreaks, accompany watercourses, bodies of water or roads. In terms of visual impact on the perceived local landscape, we have documented trees

which can serve as 1) point elements of the landscape composition, sometimes even as landmarks; 2) linear structures as arrangements of separate point elements or new continuous linear structures; 3) complex landscape compositions, where green infrastructure creates several visual layers and spatial structures in the perceived landscape with foreground, background and inner compositional elements (figure 11). These visual and perceptual situations depend on a wide range of factors, such as the situation of the observer, the season or the age structure of woodlands.

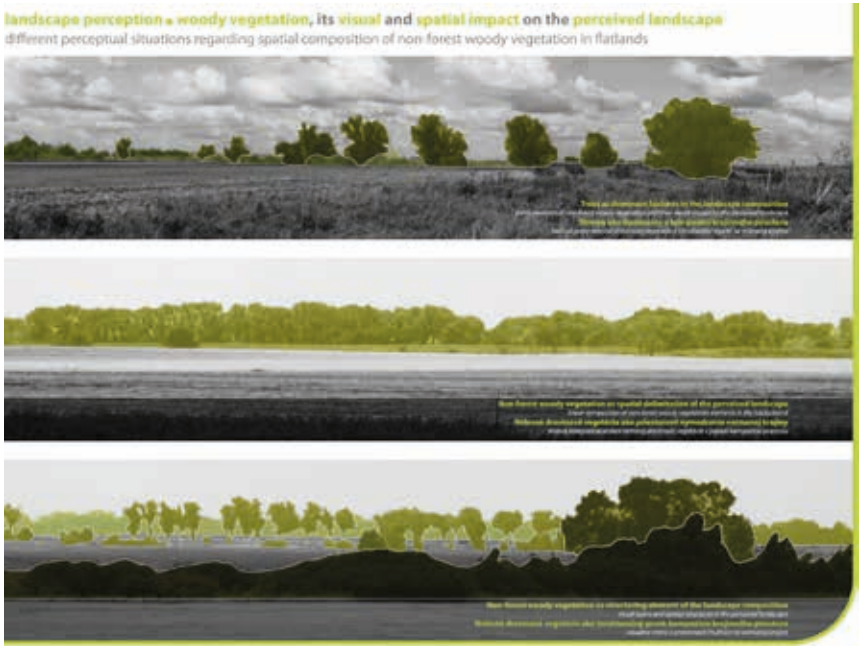

Figure 11 Visual and spatial impact of green infrastructure on perceived local landscapes by the example of the study areas Tvrdošovce and Palárikovo (Tóth, 2015)

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Green infrastructure in rural settlements

Management of green spaces, mainly public and semi-public green spaces, is the competence of local governments. This task should be fulfilled by skilled and competent professionals in each municipality, however it is often done by unskilled employees. The local green infrastructure, its planning, design and management, is the competence of professionally qualified landscape architects. Tree felling requires professional evaluation and competent decision making.

When implementing and effectively using GI, rural settlements will be able to maintain fresh and moist air, lower summer air and surface temperatures. Healthy and functioning green systems in settlements and landscape can support the natural water cycle; improve and recycle water in villages and small towns through stormwater retention in rain gardens, polders or semi-natural wetlands along local streets. Implementation of nature based solutions through GI in urban areas of small rural settlements, e.g. through parks with a rich biodiversity or other green spaces and bio-corridors is an efficient tool for mitigating the heat island effect in small rural settlements.

We propose to extend the local GI and enhance existing structures and elements of local natural capital. It is a challenge to protect and professionally treat the natural capital. Each intervention into existing green systems has to be studied and critically assessed.

In many cases, public spaces of rural settlements significantly contribute to their local GI. Central green spaces with the church as landmark are of particular historic importance. Green spaces in small rural settlements are components of squares, commons, streetscapes, roadsides, waterfronts,

Private and semi-public green spaces represent another significant part of local GI. The role of local governments is to motivate and educate their residents about functional and aesthetic aspects of private gardens (e.g. front gardens or backyards).

Green infrastructure typology of rural settlements in the Nitra Region

Based on our digital spatial research, field research and research by design applied within the educational process, we have set up a categorisation of GI elements in rural settlements and landscapes. The two main categories are represented by 1) GI in open rural landscapes (open green spaces included in the cadastral territory of a municipality, which are outside its intra-urban / built-up area) and 2) GI in rural settlements (open green spaces within the intra-urban / built-up area of a municipality). GI in open rural landscapes includes for instance forests and woodlands, meadows and pastures or vineyards and orchards. Arable land can also be considered a part of the GI with annual crops and fauna, which is primarily bound to agricultural ecosystems. However, if including arable land in the local GI, the management should be based on organic farming and green agriculture principles.

Within built-up areas of rural settlements, the local GI consists of public, semi-public and private green spaces. Private green spaces (e.g. front-gardens or backyards) were not included in our research. The research has been focused mainly on publicly accessible open green spaces and semi-public (special) green spaces.

Public open green spaces include for instance green squares, green commons, street greenery or green spaces accompanying roads. A special category is represented by the combination of green and blue infrastructure, such as green waterfronts (lakesides, riversides, streamsides and others).

Semi-public green spaces can also been referred to as special or institutional green spaces. They can be public or private in terms of ownership, but the public accessibility of these sites is usually conditioned by a special programme or they are accessible only to a certain group of users. Special green spaces in rural settlements include for instance GI in preschool, primary or secondary school premises, GI of different community facilities, church gardens, GI of cemeteries, historical gardens and others.

To better illustrate the character of public and semi-public elements of GI in rural settlements, we have chosen several case studies and GI samples, which were objects of digital and spatial research, field research or research by design.

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Green squares and commons

Green squares and commons represent a specific type of public GI of a particular historical importance and cultural legacy. They are characteristic features of Central-European rural settlements, referred to as: *village square*; *village common*; *square with sward*; *(green) common; common meadow* (translated from Slovak, Czech, German and Hungarian). The national terms often refer to diverse forms and shapes of these spaces, which can be rectangular, triangular, round or spindle-form. These spaces are situated in historical village or town centres, their main landmark is the church, they are often surrounded by the most important administrative or facility buildings. Some rural settlements in the Nitra Region have a very distinctive green common, for instance Tvrdošovce (Nové Zámky District) or Čajkov (Levice District).

Case study Tvrdošovce

A particular focus in the study area Tvrdošovce was dedicated to public open green spaces in the historical town centre, which is formed by a wide and long open streetscape with a linear green common in the middle. This space represents the local GI core surrounded by important buildings and representative architecture. We have evaluated its spatial characteristics, features and qualities through cross sections in four different parts of the streetscape, in order to better represent the spatial and compositional diversity of the green common (figures 12 and 13). In terms of species composition, the predominant tree species is *Betula pendula* Roth, followed by *Fraxinus excelsior* L. and *Tilia cordata* Mill. The predominant shrub species is *Spiraea x vanhouttei* (Briot.) Zabel and *Spiraea salicifolia* L. A relatively high share of *Tilia* sp. in the area can be considered a positive phenomenon of subsequent complementation of the currently predominant short-lived species by new long-lived tree species. In terms of species composition, a negative aspect of this public green space is a relatively high share of non-native conifers *Platycladus orientalis* (L.) Franco, *Thuja occidentalis* L. and native but non-endemic conifers *Picea abies* (L.) H. Karst., which occupy the 4th to 6th place in the species composition. They should play only a complementary role as admixture in the tree species composition. We recommend therefore to avoid their further planting in the area and to prefer native deciduous tree species instead.

Figure 12 The linear green common in the historical centre of the study area Tvrdošovce as the core of the local green infrastructure (Tóth, 2015)

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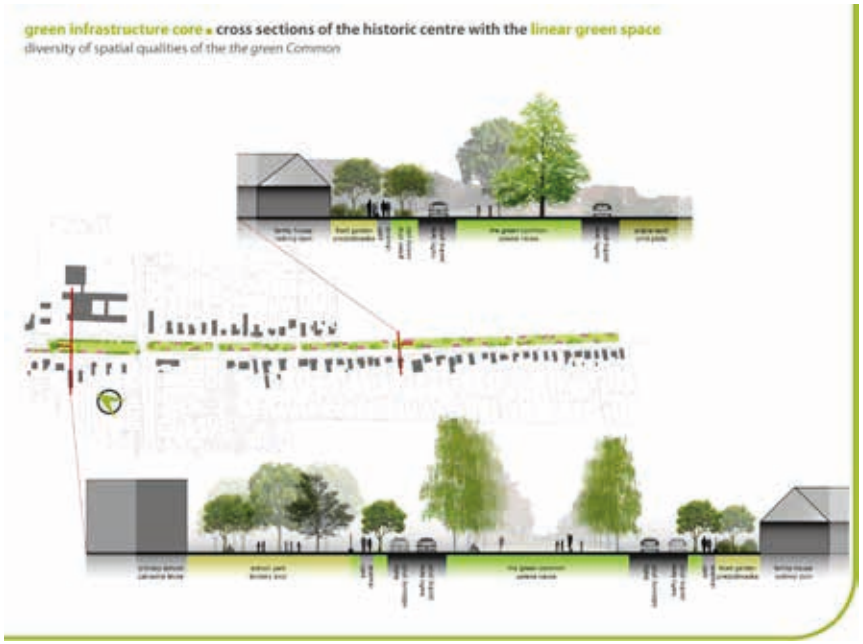

Figure 13 The linear green common of the study area Tvrdošovce in contact with the open agricultural landscape (Tóth, 2015)

Parks in village and small town centres

Parks in rural settlements represent the local landscape character. They are open space galleries created by landscape elements. Their design can be inspired by the surrounding agricultural landscape, which consists of specific landscape components, such as woodlands, arable land, grasslands, bosks, orchards or vineyards.

Case study Tvrdošovce

In Tvrdošovce, we have evaluated the woody plant species composition and diversity in public open green spaces. The predominant tree species is *Platycladus orientalis* (L.) Franco, while there is a high proportion of *Fraxinus*

ornus L., *Picea abies* (L.) H. Karst., *Prunus cerasifera* Ehrh. and *Tilia cordata* Mill. In the context of a lowland rural settlement, the high proportion of *Platycladus orientalis* (L.) Franco and *Picea abies* (L.) H. Karst. can be considered a negative aspect. We propose therefore to subsequently enhance the tree species composition by native deciduous trees. The most frequent complementary tree species in public green spaces is *Juglans regia* L., with a frequent admixture of *Aesculus hippocastanum* L. The most frequent shrub species is *Hibiscus syriacus* L., *Sambucus nigra* L. and *Tamarix tetrandra* Pall., complemented by *Syringa vulgaris* L., with a frequent admixture of *Ligustrum vulgare* L.

Case study Žitavany

In Žitavany, there is a central green space with an area of approximately 2.5 ha. It was originally shared by two neighbouring villages as a green common for livestock grazing. After the fusion of the two settlements, the green common has become an important local natural and cultural heritage with a strong historical legacy. The area is covered partly by ruderal vegetation and partly by a seasonal wetland. The woody vegetation consists mainly of native species.

The main objective was to identify the local rural landscape features, social linkages and cultural values of the village. The design intention was to integrate characteristic landscape features in the central green space in a stylised form and to create a gallery of local landscapes, with the overall aim to improve the space for relax and leisure. The proposed design in five different variations aims to convert the unused green space into a vivid green heart of the community. It bases on the high natural potential of the area and transforms its main negative element (high and changing groundwater level) into the main positive feature of the new green village centre (figure 14). It integrates the currently lacking social, cultural, educational, sports and recreational activities.

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Figure 14 'Landscape Gallery' – a semi-natural green-blue infrastructure proposed in the study area Žitavany within the Public Green Space Design Studio by Roman Šabík, Ľuboš Donoval and Patrik Štefan (students); Ľubica Feriancová and Attila Tóth (supervisors)

Case study Mojmírovce

The study area for research by design in the municipality of Mojmírovce was a central public open space surrounded by the municipal authority and the department store and lined with a small stream. Near the study area, there is the church and a manor house. Thus the study area is very central and represents an important open space in the urban core of the village.

The task was to design a permanently used multifunctional open air theatre for organising the local cultural and social life of the village. The design integrates important views and leisure areas. The designed green space aims to provide space for social interaction activities, diverse festivals or presentations of local crafts, as well as playgrounds for children (figure 15).

The design bases on findings of research into locally specific native species, which are integrated in the planting design as groups of native trees, flower meadows and perennials, aiming at an enhancement of the local rural character of the public open space. For creating convenient shadow in summer months, high tree species have been proposed in the design. GI fulfills also visual isolation from the main road, where it also provides noise and dust reduction.

Figure 15 A central public green space with an open air theatre proposed in the study area Mojmírovce within the Special Green Space Design Studio by Zuzana Blašková and Matej Brodanský (students); Ľubica Feriancová (supervisor)

Case study Svätoplukovo

In the study area Svätoplukovo, the object of research by design was a central public open space consisting of a square with an artesian well, a football field

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and an undefined public open green space along a small watercourse of micro-regional importance. The aim of seven different design solutions was to create a vivid central open space for the community, while dealing with the problem of an unadaptive gipsy community in the neighbourhood. A strong dimension of all design solutions was therefore social inclusion and integration. They build upon a thorough field research and bibliographical research into the history, culture and traditions of the local community. The design process resulted into seven diverse ideas with a strong symbolical dimension. Some of them build upon the history of the site, e.g. in the form of a stylised willow thicket which used to accompany the small watercourse and which is still strongly embedded in local memories and identity. Another approach built upon the wine growing and winemaking tradition of the small rural community. All design solutions included the waterfront of the small stream and converted it into a vivid open space. Figure 16 illustrates the proposed conversion of the central open 'gray' space into a new public green space.

Figure 16 A 'Before & After' visualisation - Public space improvements proposed in the study area Svätoplukovo within the Rural Green Space Design Studio by Zoltán Gonda, Peter Horváth and Beáta Rybanská (students); Attila Tóth (supervisor)

Case study Golianovo

In the municipality of Golianovo, the task was to redesign an undefined public open space in the village centre, surrounded by the church and new blocks of flats. The open space has a multifunctional character, giving place to a sports ground and a health-care centre. The site is spatially dynamic, on a small slope. One of the design solutions is based on the tradition of carter race and is inspired by round timber in the spatial composition and layout. Another one reaches back to the wine-growing and winemaking tradition of the village, while using vine tendrils as the inspiration for the spatial composition and layout (figure 17). The third design solution calls for a return to the nature and proposes a small birch grove and a flower meadow as the main components of the design.

Figure 17 Design of new public green spaces in the study area Golianovo within the Special Green Space Design Studio by Veronika Harabová and Marcela Koštialiková (students); Attila Tóth (supervisor)

Green waterfronts

Water is an important landscape feature in most of the rural settlements, their open landscapes and built-up areas. Many rural settlements have been built-up along small watercourses, on a riverfront or in valuable wetlands. Water has been present in rural settlements also in the form of small lakes, which have had a water-management, fire-safety, farming or other function. Nowadays, they have a significant recreational potential and provide attractive open spaces in residential areas of rural settlements. Waterfronts, riverbanks and embankments represent attractive public open green spaces, which are important elements of rural green infrastructure and through landscape architecture, they can become aesthetic and functional public open spaces.

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Case study Tvrdošovce

Watercourses and bodies of water in the open landscape or built-up area of rural settlements is normally surrounded by green spaces, be it grasslands, woodlands or their combination. In the study area Tvrdošovce, we have mapped the accompanying woody vegetation of watercourses and bodies of water in the intra-urban and extra-urban area of the small town, these included a pond, some small backwaters and small watercourses in the open landscape and lakesides in the built-up area, which create a smart and functioning green-blue infrastructure, providing a wide range of services from water management up to recreation (figure 18). The sophisticated system of water bodies has had a long tradition in this particular area and represents therefore part of the local identity, natural and cultural heritage. In the open landscape, the predominant tree species are *Salix alba* L. and *Populus nigra* L., the most frequent complementary tree species is *Populus alba* L. and there is a frequently occurring admixture of *Robinia pseudoacacia* L. In terms of tree species diversity, we recommend to enhance the proportion of native long-lived trees along watercourses and bodies of water, mainly by *Quercus robur* L., which is a potential natural species but has a very weak representation in current groves. Along watercourses and bodies of water in the built-up area, the most common tree species is *Salix alba* L., mainly the S.a. *Tristis'* variety. This is complemented mainly by the following species and varieties: *Salix matsudana ‚Tortuosa'*, *Juglans regia* L., *Prunus domestica* L. and *Prunus cerasifera* Ehrh. The most frequent admixtures are *Cerasus avium* (L.) Moench, *Platycladus orientalis* (L.) Franco and *Picea abies* (L.) H. Karst., which can be evaluated as a negative phenomenon in terms of biogeography. We propose therefore to limit further plantings of these species. There is a small proportion of the long-lived native and endemic species *Quercus robur* L., which we recommend to continuously increase. The most common shrub species in the

extra-urban area are *Prunus spinosa* L. and *Sambucus nigra* L., often complemented by *Rosa canina* L. and other shrub species. In the intra-urban area, the predominant shrub species is *Sambucus nigra* L., complemented mainly by *Hibiscus syriacus* L., with an admixture of *Syringa vulgaris* L., *Rosa canina* L. and other species. Therefore, we can conclude that green waterfronts are not only attractive public open green spaces, but they are also rich in terms of species diversity.

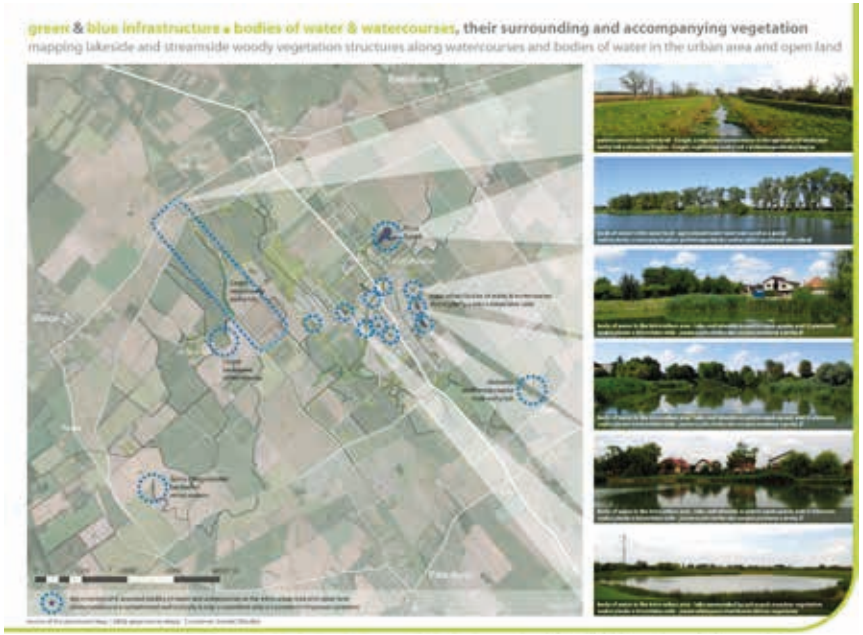

Figure 18 Green and blue infrastructure in the local landscape by the example of the study area Tvrdošovce (Tóth, 2015)

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Case study Maňa

The municipality of Maňa has requested a landscape architectural design for a small village pond situated at the periphery of the settlement, in a direct spatial and visual contact to the surrounding agricultural landscape. The site where it is situated has an important cultural legacy and natural heritage. It used to be one of the side arms and later a backwater of the river Žitava. Its cultural heritage reaches back to the former water mill, which used to stand at the side arm of the river. These two phenomena were strongly reflected in the three design solutions, mainly in the form of a thematic walkway along the backwater of the river Žitava (figure 19) or by stylising the watermill and the mill-wheel in the design layout and in the architectural elements. This approach has not only the potential to enhance the natural and cultural heritage of the community, but it also helps finding a way to use the above described features to create an attractive recreational space for the local community.

Figure 19 'A Walk along the Backwater of the River Žitava' proposed in the study area Maňa within the Special Green Space Design Studio by Agnieszka Adamek, Réka Császár and Orsolya Demková (students), Attila Tóth (supervisor)

Green streetscapes

Village streets provide space for different elements of GI, from conventional green strips between the roadway and pathway to innovative green swales for stormwater infiltration. Contemporary village streets have to deal also with a higher number of cars parking on the street. In such cases, parking strips should be re-designed and greened using for instance grass concrete or other permeable surfaces. Parking places can be divided by small green surfaces with perennials and grasses allowing a better infiltration of rainwater or, if spatially possible, with tree plantings. Smart and sustainable villages will have to include also more innovative forms of GI providing ecosystem services through nature based solutions, for instance for stormwater management. Infiltration strips with perennials and trees will become integral components of contemporary rural streetscapes.

Figure 20 A rural streetscape design proposed in the study area Nitrianske Hrnčiarovce within the Rural Green Space Design Studio by Alexandra Chovanová (student), Gabriel Kuczman and Ľubica Feriancová (supervisors)

Case study Nitrianske Hrnčiarovce

The model of Nitrianske Hrnčiarovce shows that a rural street can be a common garden of local inhabitants. In this case study a design solution has been verified, which aims at creating a common space for people and for greenery. The objective of the streetscape design was to verify the capability of landscape architecture to improve the quality of residential space. The case study

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presents possibilities to eliminate negative impacts of traffic, to create an attractive streetscape with flowering perennials and blossoming woody plants, while providing spaces for recreation and social reaction (figure 20). The case study presents the necessity of investments into streetscape design by landscape architecture, using elements of green infrastructure. This approach has the potential to improve streetscape functionally, as well as aesthetically.

Case study Oponice

The study area Oponice has an important wine-growing and wine-making tradition. This was the main source of inspiration for a streetscape design in the residential area of the village. The aim of the streetscape design was to enhance the streetscape and create a positive visual image of the village. The case study presents opportunities of creating an architectural unification of the streetscape using traditional greenery elements applied in the countryside (figure 21). The design objectives were to create a visual linkage between private and public space using GI, to enhance the proportion of greenery as a flowering and blossoming element and as a green mass. The case study verifies the suitability of landscape architectural design tools and elements for improvement of the quality of life and housing and an overall well-being of local inhabitants through GI and its vegetation elements. The case study has proved the legitimacy of landscape architecture in creating residential streets in the countryside.

Figure 21 A rural streetscape design proposed in the study area Oponice within the Rural Green Space Design Studio by Zuzana Ďuranová (student), Gabriel Kuczman and Ľubica Feriancová (supervisors)

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Green spaces in school and pre-school premises

Green spaces in premises of kindergartens, primary schools or even high schools are essential components of most educational institutions in rural settlements and as semi-public institutional green spaces, they form important elements of intraurban green infrastructure. They create a natural environment for pupils or students and can be well integrated in the educational process.

Case study Tvrdošovce

In Tvrdošovce, premises of two kindergartens and a common area of two primary schools were objects of research, with a particular focus on existing green infrastructure and its woody plant species composition and diversity. The tree species diversity is very low. The predominant tree species is *Betula pendula* and there is a high share of coniferous woody plants, such as *Picea pungens ‚Argentea', Picea abies* and *Thuja occidentalis*. Therefore, we propose to enhance the woody plant species diversity, while considering mainly native deciduous long-lived species. One of the main reasons for this proposal is that a higher species diversity enables a better integration of school exteriors into the environmental education, in the form of small nature trails with informative elements.

Case study Červený Hrádok

The study area in Červený Hrádok is a kindergarten and primary school garden situated at the periphery of the village. There is a dense woody plant composition, which serves as a local green infrastructure spot in the extensive agricultural landscape. The school garden was designed and realised by gardeners of the nearby Arboretum Mlyňany in the second half of the 1960s, however the original planting design documentation has not been preserved. There is only an inventory of ornamental trees and shrubs from 1970, according to which there were 84 woody plant species and a total number of 1,049 woody plants. An ecosystem disservice of the thick woodland is that it hides attractive views to the surrounding hilly landscape, which would be of additional value. One of the problems in the area is the use of unsuitable tree

species, for instance there is a thuja alley leading to the main entrance. Pupils and teachers participate in the maintenance of the school grounds. Due to the already mentioned lack of maintenance, it is necessary to fell some trees due to poor health condition and reduced mechanical stability. Based on the research findings and various design solutions, approximately 8 percents of the trees should be sequentially felled. The predominant species are *Acer platanoides, Pinus sylvestris, Picea abies, Pinus nigra, Thuja occidentalis ‚Malonyana', Populus nigra ‚Italica'* and *Quercus robur*. The design solutions integrate ornamental perennial beds, multifunctional playgrounds, a new path system, diverse small architecture elements and an open air classroom (figure 22). In terms of maintenance, it is necessary to remove successive vegetation consisting mainly of invasive species. Although the peripheral parts of the woody vegetation grove provide a good isolation from the surroundings agricultural area, it would be of additional perceptual value to thin this vegetation wall and open visual links to the adjacent landscape sceneries to enhance the perception of local and regional landscape character. Removal of trees is also needed around the main school building in order to improve the illumination of classrooms during the day. Felling of trees at the entrance part of the school premises aims to open views on the school building. Along the path system, the educational function of local green infrastructure comes through, where there are entertainment and educational tables depicting trees, their leaves, flowers and fruits with a brief descriptions of importance and benefits in a playful way. Local biodiversity is supported by the use of various woody plants with different design aims, for instance birch with its interesting light bark contrasting with the greenery.

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Figure 22 Landscape architectural design for the premises of a kindergarten and primary school proposed in the study area Červený Hrádok within the Public Green Space Design Studio by Magdaléna Hrdličková, Monika Matejovičová, Alica Mlynarčíková and Júlia Kopponová (students), Ľubica Feriancová (supervisor)

Historical green spaces: gardens and parks

Historical gardens and parks represent not only an important part of our cultural heritage, but in many situations also the core component of local GI in rural settlements. These elements and objects of cultural heritage are inseparable features of rural cultural landscapes. They can be spatially and compositionally linked to sacral or secular architecture, for instance in the form of historical gardens and parks, which are of particular significance in terms of local GI.

Case study Palárikovo

In the study area Palárikovo, there were two main objects of research and mapping. One spatially more significant - one of the largest historical parks in Slovakia built in the English Landscape Garden style; and another one spatially spread throughout the cadastral territory of the municipality - elements of small sacral architecture with memorial trees.

The main focus of the selected case study is the landscape garden, currently functioning as a historical public park. It is one of the most significant elements of cultural garden heritage of the Nitra Region and Slovakia. It raises an important issue of preservation, restoration and sustainable use of garden heritage in the countryside. By the case study Palárikovo, we illustrate changes and transformations in time and space and highlight their impact on the spatial composition of the garden (figures 23 and 24). The case study characterises areal, structural and natural transformations. It depicts the historical legacy and its current projection in space. Natural values of the park were evaluated in the vegetation analysis based on size, age and landscape parameters. An important aspect of vegetation analyses was the symbolism of mature and aged memorial trees in the garden composition. Based on the analyses, measures for preservation, sustainable use and development of the site were proposed. The two selected figures illustrate the graphical analysis of historical development and morphological changes of the landscape garden (figures 23 and 24).

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Figure 23 A coloured interpretation of changes in the landscape garden composition in the study area Palárikovo - comparison of the original composition from the 19th century and the current state (Tóth, 2014)

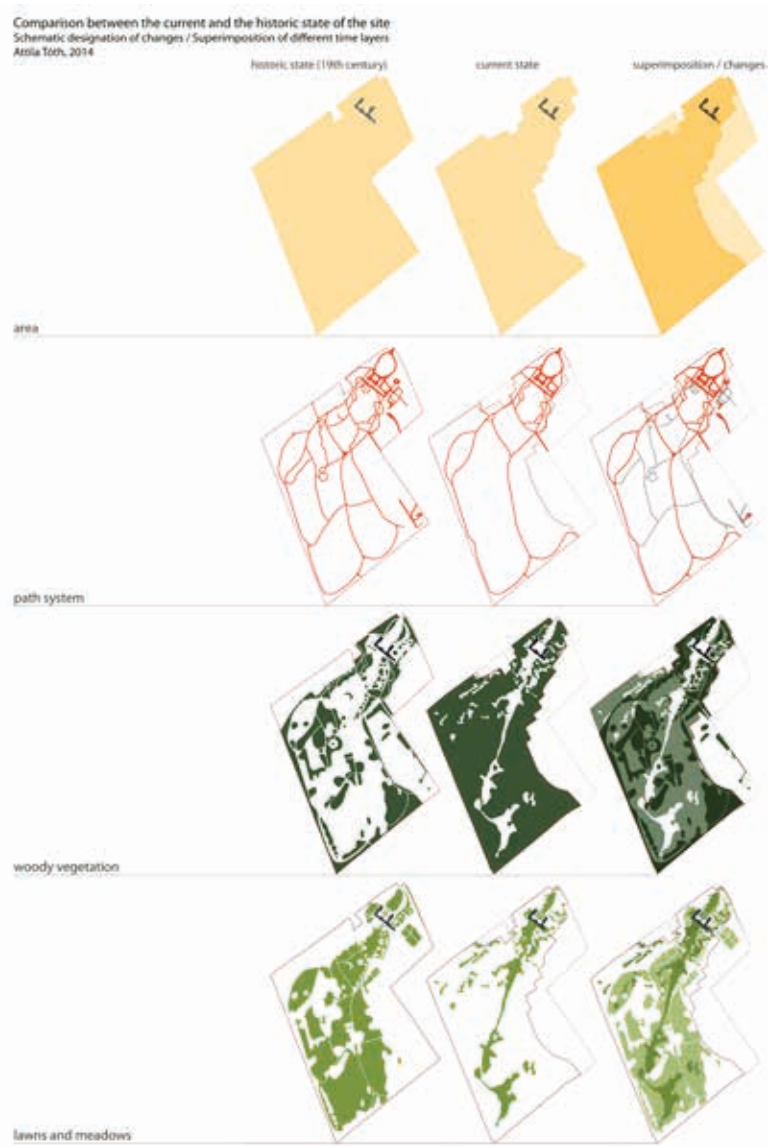

Figure 24 Superimposition of changes in the landscape garden composition (Tóth, 2014)

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Case study Maňa

Restoration of the historical landscape garden in Maňa aims at the renewal of its compositional values and enhancement of its local significance as a cultural and historical heritage site. In this case study, the method of research by design has been implemented, with the aim to restore the garden composition, while adjusting it to contemporary limits and needs. One of the main goals is to come up with adequate present and future uses of the landscape garden, while respecting its historical importance. The garden consists of two parts, out of which one is public, owned by the municipality; and the other one is institutional owned by the Nitra Self-Governing Region, which runs a social services home in the historical manor house and its premises. The public part of the landscape garden has a significant potential to become one of the local community life and action centres. The design objectives in this part of the garden were the following: to enrich the space with new cultural and social functions; to extend the path system in order to meet current users' needs and to improve the open space qualities of the garden (figure 25).

Figure 25 Historical state, current state and restoration design of the landscape garden in Maňa (drawn by: Attila Tóth)

Case study Tvrdošovce

The previous two case studies represent spatially extensive types of garden heritage in the form of designed landscape gardens of significant manor houses. However, there are also many small historical gardens at less significant rural mansions, which are smaller in size, but important in terms of

cultural heritage and local GI. In the study area Tvrdošovce, the object of research and mapping was a small historical garden of a rural manor house, where the particular focus was on tree species composition and diversity. At this site, there are valuable memorial trees of the following tree species: *Acer pseudoplatanus* L., *Acer platanoides* L., *Aesculus hippocastanum* L., *Ailanthus altissima* (Mill.) Swingle, *Celtis occidentalis* L., *Pinus nigra* (J.F.) Arn, and *Sophora japonica* L. *Ailanthus altissima* (Mill.) Swingle is though considered an invasive tree species, but we have decided to list it as important because of its historical legacy, extraordinary dendrometric parameters and aesthetic qualities. The overall garden composition can be described as irregular and not very systematic, but yet rich in species diversity, which indicates the original owner's passion for collecting tree species.

Green infrastructure as a rural development strategy of the Nitra Region

The strategical aim of rural development in the Nitra Region is its sustainable development in the sense of contemporary development impulses. The sustainability of rural landscapes of the region bases on the implementation of GI. This requires a clear formulation of main goals and specific objectives of rural development. GI is currently one of the investment priorities of the EU. Utilisation of the adaptive capacity and potentials of the common natural capital provides economically efficient tools for climate change mitigation. In the context of the Nitra Region, it means the utilisation of manifold potentials of landscapes and settlements. The countryside is part of this process. Rural development is a crucial condition of the overall vitality of the region. The current state and development capacity of the countryside determines the future of the self-governing region.

The role of education and awareness raising for green infrastructure implementation and development in the Nitra Region

The strategical aims, goals and objectives of rural development in the region are conditioned by a change of thinking of the rural population. This can be

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changed by education and raising of public awareness, aiming at cultural edification and advancement. The countryside needs awareness raising in the field of open space design and GI implementation.

Outlooks

Implementation of the EU Biodiversity Strategy in the Nitra Region has a strong potential in the countryside, mainly Special Areas of Conservation (Habitats Directive Sites) and Special Protection Areas (Birds Directive Sites) within the NATURA 2000 network. Landscape architecture provides a range of tools to preserve and enhance these sites. The Nitra Region has a commitment to form regionally specific, aesthetically and perceptually valuable landscapes in order to preserve the regional landscape character and identity. This requires preservation of valuable landscape elements and features. The enhancement of GI in agricultural landscapes requires conceptual landscape planning and creation of forest and non-forest woodlands.

Discussion

The proposed GI plan for the study area Tvrdošovce presented in figure 10 is based on recommendations by Hrnčiarová et al. (2002) who suggest to increase the share of permanent grasslands and non-forest woody vegetation. They also suggest to maintain existing permanent grasslands and to increase their proportion and distribution, which agrees with our proposal of increasing GI connectivity and its spatial integrity.

The proposed landscape architectural improvements of rural GI through research by design have a strong potential for a sustainable development of local tourism and recreation as suggested by Bihuňová (2008), who argues that the recreational potential of an area is determined by its natural capital, visual qualities and aesthetic values. Moreover, landscape architecture has the potential to enhance the aesthetics of rural settlements and their GI in the region as argued by Kuczman (2015). In this context, research by design appears to be an efficient practice oriented scientific approach.

Development of local GI will be of crucial importance for formulation and priority setting of local policy making, since the issue of greenery, having a wide range of specific features, can develop the civic society as argued by Šimek and Štefl (2014). The outcomes of this scientific monograph can be integrated at the local level in different programmes, strategic and conceptual documents. For instance, the proposed improvements of waterfront GI in built-up areas and open rural landscapes by landscape architecture can help recovering natural resilience of stream or lake ecosystems in rural agricultural landscapes as suggested by Halaj et al. (2015).

The proposed biodiversity enhancement, aesthetic and functional improvement and educational utilisation of GI in school and preschool premises is in accordance with the approach suggested by Bihuňová (2012). A continuous reconstruction of historical gardens and parks proposed in our case studies is necessary for preservation of compositional values and historical legacy for future generations. In reconstruction projects, it is necessary to use the same or similar plant species composition, in order to enhance the natural and cultural legacy of these historical sites as argued by Tóth (2014).

We have found by visual analyses of spatial composition in the landscape that GI has a visual and spatial impact on the perceived landscape, which is in accordance with findings by Rózová et al. (2010, 2013).

The innovativeness of this monograph consists in interlinking of GI with the countryside, rural settlements and rural landscapes, as GI is currently analysed mainly in urban and peri-urban landscapes. The monograph brings to the scene of Slovak scientific publications a new issue, thus definition of GI, its characterisation in the context of Slovak cultural landscapes, of the European Landscape Convention and other European landscape policies, such as the EU Strategy on Green Infrastructure or the EU Biodiversity Strategy to 2020, as well as other directives and strategic documents related to analysis, synthesis, interpretation, evaluation or propositions of GI.

The contribution of this monograph to Slovak research consists in original scientific and research findings gained through field research, territorial and spatial analyses of landscape and settlement structure and its development, as well as research by design applied in the educational process. Results of

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analyses were processed in a scientific synthesis using graphical interpretations, which enabled generalisation of findings. Thus, the monograph contributes to the current state of the art of GI in the context of Slovak rural cultural landscapes, particularly in the Nitra Region.

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Conclusions

This monograph elaborates on the contemporary issue of GI in the context of Slovak rural landscapes. It takes a closer look on rural GI from the perspective of landscape architecture. Ten rural settlements were selected as research samples: Tvrdošovce, Palárikovo, Maňa, Golianovo, Svätoplukovo, Červený Hrádok, Mojmírovce, Žitavany, Nitrianske Hrnčiarovce and Oponice (Nitra Region, Slovakia). The presented research reveals different aspects of historical development, territorial and spatial changes, structural and morphological transformations of rural landscapes and their GI since the 18th century. It highlights strengths, weaknesses, opportunities and threats of current GI in the countryside. At the local level, rural landscapes and their GI as the main object of research is divided into two main groups based on typology and scale: 1/ GI in open rural landscapes, outside the built-up area of rural settlements and 2/ GI in intra-urban areas of rural settlements. The research reveals that GI has a significant visual and spatial impact on the perceived rural landscape. The monograph introduces a GI typology in built-up areas of rural landscapes based on their location, function, spatial, architectural, vegetation and other characteristics. The main GI types, which this monograph deals with are as follows: public green spaces, such as green squares and commons, parks in village and small town centres, green waterfronts, green streetscapes, green spaces in school and pre-school premises and historical gardens. These GI types do not cover all forms of local GI in rural settlements, they rather aim at illustrating the most important types and outlining the typological and functional diversity of local GI. An important contribution of this monograph consists in the application of the research by design approach, which aims at a qualitative improvement of local GI using planning and design tools of landscape architecture. The monograph results in setting up the main strategic guidelines and objectives for rural development in the Nitra Region through GI. This research can be further deepened and extended to other settlements within and beyond the boundaries of the Nitra Region, in order to implement GI in landscape architecture research, planning and design practice.

http://dx.doi.org/10.15414/2016.9788075680082

References

AHERN, J. 2004. Greenways in the USA: Theory, Trends and Prospects. In: Ecological Networks and Greenways – Concept, Design, Implementation. Cambridge: Cambridge University Press, pp. 34-53, ISBN 0-521-53502-6.

AHERN, J. 2010. Sustainability and Cities: A Landscape Planning Approach. In: Proceedings of Fábos Conference on Landscape and Greenway Planning 2010. Budapest July 8-11, Hungary, ISBN 978-963-503-409-3.

ASLA (AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS). 2013. Green Infrastructure [online]. Washington: ASLA, [cit. 2013-08-16]. Available at: https://www.asla.org/greeninfrastructure.aspx

BENEDICT, M.A. – McMAHON, E.T. 2006. Green Infrastructure – Linking Landscapes and Communities. Washington: Island Press, 299 p., ISBN 1-559-63558-4.0.

BIHUŇOVÁ, M. 2008. Porovnanie rekreačnej hodnoty kontaktného územia mesta Nitra a Banská Bystrica na základe prírodného potenciálu [Comparison of the Recreational Value of Contact Zones of Nitra and Banská Bystrica based on their Natural Potential]. In Acta horticulturae et regiotecturae, Vol.11, Special Issue, pp. 55-59. ISSN 1335-2563.

BIHUŇOVÁ, M. 2012. Priestory vyhradenej zelene - základné školy [Special Green Spaces - Primary Schools]. In Komunálna technika : odborný mesačník o komunálnej technike. Vol.4, No.1, pp.24-27. ISSN 1337-9011.

BUCHA, T. et al. 2002. Wood Species Composition of Forests. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environmental Agency, pp. 142-143. ISBN 80-88833-27-2.

COUNCIL OF EUROPE. 2000. European Landscape Convention [online]. European Treaty Series – No. 176. Florence: Council of Europe [cit. 2015-04-07]. Available at: https://rm.coe.int/CoERMPublicCommonSearchServices/DisplayDCTMContent?documentId=09000016800805ce.

DOBRUCKÁ, A. 2009. Metodické prístupy k hodnoteniu vegetačných plôch v urbánnom prostredí [Methodical Approaches to Vegetation Assessment in Urban Environment]: PhD Thesis. Nitra: Slovak University of Agriculture, 103 p.

DUBEN, Z.- ŠVEC, M. 2002. Categories of Forests by their Functions. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 226-227. ISBN 80-88833-27-2.

EGOZ, S. 2012. Landscape as Infrastructure: Asserting the Right to Landscape. In Ignatieva, M. et al. (Eds.): Green Infrastructure: From Global to Local: International Conference Proceedings. Saint-Petersburg: State Polytechnic University Publishing House, pp. 11-12. ISBN 978-5-7422-3540-8.

EUROPEAN COMMISSION. 2010. Green Infrastructure [online]. Brussels: European Commission, VI 2010, 4 p. ISBN 978-92-79-15871-1. [cit. 2013-08-16]. Available at: http://ec.europa.eu/environment/nature/info/pubs/docs/green-infrastructure.pdf.

EUROPEAN COMMISSION. 2011. The EU Biodiversity Strategy to 2020. Luxembourg: Publications Office of the European Union. 28 p. ISBN 978-92-79-20762-4.

EUROPEAN COMMISSION. 2012. The Multifunctionality of Green Infrastructure: Science for Environment Policy - In-depth Report [online]. Brussels: European Commission, III 2012 [cit. 2013-08-16]. Available at: http://ec.europa.eu/environment/nature/ecosystems/docs/Green_Infrastructure.pdf.

EUROPEAN COMMISSION. 2013a. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Green Infrastructure (GI) — Enhancing Europe's Natural Capital [online]. Brussels: EC, 2013-05-06, [cit. 2015-04-07]. Available at:

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0249.

EUROPEAN COMMISSION. 2013b. Building a Green Infrastructure for Europe. Luxembourg: Publications Office of the European Union. 24 p. ISBN 978-92-79-33428-3.

EUROPEAN COMMISSION. 2013c. Communication from the Commission to the European Parliament, the Council, the European Economic and Social

http://dx.doi.org/10.15414/2016.9788075680082

Committee and the Committee of the Regions: An EU Strategy on adaptation to climate change [online]. Brussels: European Commission, 2013-02-16, [cit. 2015-05-05]. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52013DC0216&from=EN.

EUROPEAN COMMISSION. 2013d. The Economic benefit of the Natura 2000 Network. Luxembourg: Publications Office of the European Union. 74p. ISBN 978-92-79-27588-3.

EUROPEAN COMMISSION. 2014. General Union Environment Action Programme to 2020: Living Well, within the Limits of our Planet. Luxembourg: Publications Office of the European Union. 87 p. ISBN 978-92-79-34724-5.

GRANT, L. 2010. Multi-Functional Urban Green Infrastructure. London: Chartered Institution of Water and Environmental Management [online], 47 p. [cit. 2014-01-03], Available at: http://www.ciwem.org/FileGet.ashx?id=1875&library=Public%20Access.

HALAJ, P. et al. 2015. Recovery of Natural Resilience and Resistance Capacity of Stream Ecosystems in Agricultural Land in the Context of Climate Change. In SGEM 2015. Sofia: STEP92 Technology, pp. 531-540. ISBN 978-619-7105-36-0.

HALAJOVÁ, D. 2016. Evaluation of the Accessibility of Public Green Spaces. In SGEM 2016. Sofia: STEP92 Technology, pp. 723-729. ISBN 978-619-7105-69-8.

HALÁSZOVÁ, K. et al. 2015. Stratégia rozvoja vidieka Nitrianskeho samosprávneho kraja 2016-2022: Zelená infraštruktúra - fenomén našej doby [Rural Development Strategy of the Nitra Self-Governing Region from 2016 to 2022: Green Infrastructure – A Phenomenon of our Time]. Nitra: Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture; Office of the Nitra Self-Governing Region. 105 p.

HANÁČEK, J. 1990. Nerastné suroviny [Minerals]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 5, ISBN 80-224-0075-0.

HRAŠKO, J. - ŠURINA, B. 1990. Pôdy [Soils]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 6, ISBN 80-224-0075-0.

HRNČIAROVÁ, T. et al. 2000. Ecological Carrying Capacity of Current Landscape Use Assessed According to Types of Abiotic Complexes. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 318-319. ISBN 80-88833-27-2.

IZAKOVIČOVÁ, Z. 2014. Príspevok Ústavu krajinnej ekológie SAV k implementácii trvalo udržateľného rozvoja [Contribution of the Institute of Landscape Ecology SAS to the Implementation of Sustainable Development]. In The Environment, Vol. 48, No. 3, pp. 174-178. ISSN 0044-4863.

IZAKOVIČOVÁ, Z. - OSZLÁNYI, J. 2014. Ústav krajinnej ekológie SAV - súčasnosť a budúcnosť [Institute of Landscape Ecology SAS - Present and Future]. In The Environment, Vol. 48, No. 3, pp. 137-142. ISSN 0044-4863.

JANČURA, P. 2008. European Landscape Convention in Slovakia. Banská Bystrica: The Slovak Environment Agency, Ministry of Environment of the Slovak Republic. 36 p. ISBN 978-80-88850-78-6.

KABAI, R. 2011. The Role of Green Infrastructure in Mitigating the Visual Impact of New Development. In Supuka, J., Bihuňová, M. (Eds.): Settlement - Park - Landscape V.: Revitalisation of Green Urban Open Spaces with Consideration to Changing Environment. Nitra : Slovak University of Agriculture, pp. 281-286. ISBN 978-80-552-0540-3.

KONČEK, M. 1990. Podnebie [Climate]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 5, ISBN 80-224-0075-0.

KOVAČEVIČOVÁ, S. 1990. Sídla a obydlia [Settlements and Dwelling]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, pp. 50-60. ISBN 80-224-0075-0.

KUCZMAN, G. 2014. Landscape Structure and Biodiversity of Woody Plants in the Cadastral Territory of Kolíňany. In Journal of Environmental Protection, Safety, Education and Management. Vol. 2, No. 4, pp. 25-32. ISSN 1339-5270.

KUCZMAN, G. 2015. Landscape Architecture of Rural Settlements in the Region of Nitra. In Journal on Law, Economy & Management. Vol. 5, No. 2, pp. 52-56. ISSN 2048-4186.

http://dx.doi.org/10.15414/2016.9788075680082

LOSARCOS, L. - ROMERO, L. 2012. Green Infrastructure In-depth Case Analysis - Theme 5: Urban Green Infrastructure [online]. In Green Infrastructure Implementation and Efficiency [cit. 2013-08-16]. Available at: http://ec.europa.eu/environment/nature/ecosystems/docs/implementation.zip.

LUKNIŠ, M. 1990. Bonita pôdy r. 1929 [Soils Quality in 1929]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 6, ISBN 80-224-0075-0.

MAGLOCKÝ, Š. 2002. Potential Natural Vegetation. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 114-115. ISBN 80-88833-27-2.

MAZÚR, E. - LUKNIŠ, M. 1990. Regionálne geomorfologické členenie [Regional Geomorphological Structure]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 4, ISBN 80-224-0075-0.

MAZZA, L. et al. 2011. Green Infrastructure Implementation and Efficiency. Final report for the European Commission, DG Environment on Contract ENV.B.2/SER/2010/0059. Brussels / London : Institute for European Environmental Policy. 266 p.

MELL, C. I. 2008. Green Infrastructure: Concepts and Planning. In Forum Ejournal, Vol. 8, No. 1, pp. 69-80. ISSN 1354-5019.

MELNICHUK, I. - IGNATIEVA, M. 2012. St. Petersburg Green Infrastructure as a Factor for Sustainable Development. In Ignatieva, M. et al. (Eds.): Green Infrastructure: From Global to Local: International Conference Proceedings. Saint-Petersburg : State Polytechnic University Publishing House, pp. 93-94. ISBN 978-5-7422-3540-8.

MIKLÓS, L. et al. 2002. Landscape-Ecological Complexes. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 194-195. ISBN 80-88833-27-2.

MIKLÓS, L. 2014. Prienik krajinnoekologického a environmentálneho výskumu do praxe a politiky [Penetration of Landscape-Ecological and Environmental Research into Practice and Politics]. In The Environment, Vol. 48, No. 3, pp. 147-156. ISSN 0044-4863.

NATURAL ENGLAND. 2009. Green Infrastructure Guidance [online]. Catalogue Code: NE 176. Worcester: Natural England 97 p. [cit. 2015-04-07]. Available at: http://publications.naturalengland.org.uk/file/94026.

NAUMANN, S. et al. 2011. Design, Implementation and Cost Elements of Green Infrastructure Projects: Final Report to the European Commission, DG Environment, Contract No. 070307/2010/577182/ETU/F.1, [online]. Ecologic institute and GHK Consulting, 2011-12-16 [cit. 2013-08-16]. Available at: http://ec.europa.eu/environment/enveco/biodiversity/pdf/GI_DICE_FinalReport.pdf.

PAULEIT, S. 2012. Green Infrastructure for Europe's Growing and Shrinking City Regions. In Ignatieva, M. et al. (Eds.): Green Infrastructure: From Global to Local: International Conference Proceedings. Saint-Petersburg: State Polytechnic University Publishing House, pp. 11-12. ISBN 978-5-7422-3540-8.

PINČÍKOVÁ, Ľ. et al. 2002. Monuments. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 250-251. ISBN 80-88833-27-2.

PODOLÁK, J. et al. 2002. Traditional Way of Land Use and Traditional Culture. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, p. 139, ISBN 80-88833-27-2.

PŠENÁKOVÁ, Z. 2014. Aktuálne trendy v manažmente historických krajinných štruktúr [Contemporary Trends in Management of Historical Landscape Structures] : PhD Thesis. Bratislava: Univerzita Komenského. 265 p.

RÓZOVÁ, Z. et al. 2010. Vizuálna kvalita krajiny [Visual Quality of Landscape]. Edícia Prírodovedec č. 410. Nitra: Constantine the Philosopher University. 109 p. ISBN 978-80-8094-707-1.

RÓZOVÁ, Z. et al. 2013. Environmentálne aspekty urbanizovaného prostredia [Environmental Aspects of Urban Environment]. Nitra: Constantine the Philosopher University, 390 p. ISBN 978-80-558-0388-3.

RUSNÁKOVÁ, Z. 1990. Druhy hraničných znakov chotára [Types of Border Signs of Municipalities]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 64, ISBN 80-224-0075-0.

http://dx.doi.org/10.15414/2016.9788075680082

RUTTKAY, A. 2002. Settlement of the Territory between the 10th and First Half of the 13th Century. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 34-35. ISBN 80-88833-27-2.

RUŽIČKA, M. - MIKLÓS, L. 1979. Teoretické a metodologické základy biologického plánovania krajiny [Theoretical and Methodological Basics of Biological Landscape Planning] : Záverečná správa úlohy VI-35/1. Bratislava: Institute of Experimental Biology and Ecology, Slovak Academy of Sciences, 221 p.

RUŽIČKA, M. - MIKLÓS, L. 1982. Landscape-Ecological Planning (LANDEP) in the Process of Territorial Planning. In Ekológia (ČSSR), Vol. 1, No. 3, pp. 297-312. ISSN 1335-342X.

RUŽIČKA, M. - MIŠOVIČOVÁ, R. 2013. Landscape Ecological Planning LANDEP: System Approach in the Landscape Ecology. Nitra: Constantine the Philosopher University. 128 p. ISBN 978-80-558-0333-3.

SALAŠOVÁ, A. 2006. Metodické možnosti posudzovania krajinného rázu na regionálnej a mikroregionálnej úrovni [Methodical Options of Landscape Character Assessment at the Regional and Micro-Regional Level]. In Ochrana krajinného rázu - třináct let zkušeností, úspěchů i omylů. Prague: Czech Technical University, pp. 91-98. ISBN 80-903206-7-8.

SALAŠOVÁ, A. 2010. Uplatnenie regulačných nástrojov na podporu ochrany a rekonštrukcie historických krajinných štruktúr [Implementation of Regulation Tools for Supporting Protection and Reconstruction of Historical Landscape Structures]. In: Kozová, M. - Pauditšová, E. - Finka, M. et al. (Eds.): Krajinné plánovanie. Bratislava: Slovak University of Technology, 326 p. ISBN 978-80-227-3354-0.

SLOVAK ENVIRONMENT AGENCY. 2002. Landscape Atlas of the Slovak Republic. Bratislava; Banská Bystrica: Slovak Environment Agency, Ministry of Environment of the Slovak Republic. 344 p. ISBN 80-88833-27-2.

STATISTICAL OFFICE OF THE SLOVAK REPUBLIC. 2013. Population on December 31 2013 [online]. [cit. 2016-10-10]. Available at: http://archiv.statistics.sk/files/Sekcie/sek_600/Demografia/Obyvatelstvo/tabulky/pocet_obyvatelov/2013/obce.pdf

SUPUKA, J. 2002. Historical Gardens and Parks, Arboretums, and Botanical Gardens. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 238-239. ISBN 80-88833-27-2.

SUPUKA, J. et al. 2008. Vegetačné štruktúry v sídlach: Parky a záhrady [Vegetation Structures in Settlements: Parks and Gardens]. Nitra: Slovak University of Agriculture, 2008, 504 p. ISBN 978-80-552-0067-5.

SUPUKA, J. 2011. Development of Green Spaces at City Territory with Emphasize to Recreational Utilization. In Supuka, J., Bihuňová, M. (Eds.): Settlement - Park - Landscape V.: Revitalisation of Green Urban Open Spaces with Consideration to Changing Environment. Nitra: Slovak University of Agriculture, pp. 63-70. ISBN 978-80-552-0540-3.

ŠIMEK, P. - ŠTEFL, L. 2014. Systémy zeleně malých měst [Greenery Systems in Small Towns]. In Zahrada, park, krajina, Vol. 24, No. 3, pp. 60-64. ISSN 1211-1678.

TÓTH, A. 2014. Landscape Garden in Palárikovo, Slovakia. In Cultural Garden Heritage Conservation and Tourism. Vienna: University of Natural Resources and Life Sciences, 21 p.

TÓTH, A. 2015. Green Infrastructure of the Rural Settlement and its Surrounding Landscape. PhD Thesis. Slovak University of Agriculture in Nitra. 120 A3 p.

VEREŠÍK, J. et al. 1990. Pôdorysné typy sídiel [Ground Plan Types of Settlements]. In: Etnografický atlas Slovenska [Ethnographic Atlas of Slovakia]. Bratislava: VEDA, Publishing House of the Slovak Academy of Sciences, Slovak Cartography, p. 50, ISBN 80-224-0075-0.

VEREŠOVÁ, M. - SUPUKA, J. 2012. Kultúrno-historické a vizuálno-estetické hodnoty vinohradníckej krajiny [Cultural, Historical, Visual and Aesthetic Values of Vineyard Landscapes]. Nitra: Slovak University of Agriculture, 112 p., ISBN 978-80-552-0867-1.

ŽUDEL, J. 2002. Settlement of the Territory in the Years 1511-1530. In: Landscape Atlas of the Slovak Republic. Bratislava: Ministry of Environment of the Slovak Republic, Banská Bystrica: Slovak Environment Agency, pp. 38-39. ISBN 80-88833-27-2.

http://dx.doi.org/10.15414/2016.9788075680082

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