Interreg CENTRAL EUROPE

European Union
European Regional Development Fund

MaGICLandscapes

Managing Green Infrastructure in Central European Landscapes

Green infrastructure strategies and action plans based on transnational and regional assessments of its benefits and ecological functions

Managing Green Infrastructure in Central European Landscapes – Green infrastructure strategies and action plans based on transnational and regional assessments of its benefits and ecological functions

This E-Book was compiled as Deliverable D.C.6.2 of the Interreg Central Europe Project MaGICLandscapes “Managing Green Infrastructure in Central European Landscapes“ funded by the European Regional Development Fund (ERDF).

Lead Partner

Technische Universität Dresden
Faculty of Environmental Sciences
Chair of Remote Sensing, Prof. Dr. Elmar Csaplovics
Helmholtzstr. 10
01069 Dresden, Germany

Project Partners

Technische Universität Dresden, Germany

Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Czech Republic

The Saxony Foundation for Nature and Environment, Germany

Karkonosze National Park, Poland

Leibniz Institute of Ecological Urban and Regional Development, Germany

The Krkonoše Mountains National Park, Czech Republic

University of Vienna, Austria

Thayatal National Park, Austria

Metropolitan City of Turin, Italy

ENEA - Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Italy

Editors: Anke Hahn, Christopher Marrs
Layout: Anke Hahn
Cover illustration and benefit icons: Anja Maria Eisen

The MaGICLandscapes E-Book is published online: https://www.interreg-central.eu/Content.Node/MaGICLandscapes.html#Outputs

Dresden, October 2020

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Editorial

Elmar Csaplovics, Project Director MaGICLandscapes, Technische Universität Dresden | elmar.csaplovics@tu-dresden.de

Ipsa quoque inmunis rastroque intacta nec ullis
saucia vomeribus per se dabat omnia tellus,
contentique cibis nullo cogente creatis
arbuteos fetus montanaque fraga legebant
cornaque et in duris haerentia mora rubetis
et quae deciderant patula Iovis arbore glandes.

The teeming Earth, yet guiltless of the plough,
And unprovok'd, did fruitful stores allow:
Content with food, which Nature freely bred,
On wildings and on strawberries they fed;
Cornels and bramble-berries gave the rest,
And falling acorns furnish'd out a feast.

Ovid's Metamorphoses, in Fifteen Books, Translated by the Most Eminent Hands [Dryden, Garth, Pope et al.], ed. Sir Samuel Garth. Tonson, London, 1717, Book I (transl. J. Dryden), pp. 101-106

"Europe's landscapes have faced more habitat loss and fragmentation than any other continent. This is a major problem for biodiversity." This concise statement introduces a précis of the threats to green infrastructure and of the efforts of the European Commission to "develop a strategy for an EU-wide Green Infrastructure as part of its post-2010 biodiversity policy" (European Commission 2010, p. 1). Major concerns focussed on safeguarding three essential qualities of (European) green infrastructure understood in its broadest sense as the entirety of green space from core zones of national parks to patches of peri-urban ruderal areas, explicitly connectivity, (landscape) permeability and multi-functionality.

In March 2010 the European Council of Ministers agreed upon a new EU target for the protection of biodiversity in 2020, "The EU intends to halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, restore them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss" (European Commission 2010, p. 4).

It was and is always crucial to verify political announcements in general and in environmental and conservational issues in particular a decade or more after these statements have been published.

When taking into account that - just as an example among many others – based on numbers published by the Austrian Federal Office of Metrology and Surveying (BEV) and Statistics Austria from 1985 to 2018 a population growth of 16 % is confronted with an increase of sealed surfaces of 67 %, with an only marginal flattening of the gradient of increase in the period 2010 to 2018, it becomes evident that efforts to safeguard green infrastructure still significantly lag behind the overall pressure of environmentally-unfriendly economic development. The vulnerability of the soil-vegetation balance is underlined by the fact that the soils of the EU-27 member states store an estimated amount of between 73 and 79 billion tonnes of carbon, equivalent to about 50 times the annual greenhouse gas emissions from the EU, and that ongoing intensification of agricultural production and sealing of high-quality arable soils is inevitably leading to a continuous decline of soil organic (FAO & ITPS (eds) 2015, p. 340).

It is also essential to distinguish between the quantitative term "greenness" as such and the quality of the respectively related green infrastructure. Far too large is the amount of green space in urban and peri-urban areas - and increasingly in rural settlements - due to the fast growing developing areas comprising those ugly standardised plots of monotonous "house gardens", or "suburban lawns" in the two kinds of meanings - which are purely monocultural, dominated by all too frequently mown lawns often fenced in by uniform Thuja hedges, lacking any species-rich spots of at least some biodiversity. Also in the valuable rural cultural landscapes of Central Europe these fringes surrounding the historic hearts of the villages/towns were over centuries covered with meadow orchards and household gardens providing an exhausting biodiversity of grass species, herbs, vegetables and fruit trees and have been/are extensively destroyed by disastrous area zoning plans developed and enforced under the destructive influence of the construction industry. The same danger of misinterpretation holds true for green infrastructure related to "extensive" grazing lands in rural landscapes which are far too often degraded by additional

fertilisation and sowing of fast-growing red clover and the like, thus leaving behind extremely species-poor grasslands blanketing increasingly over-fertilised soils.

It is a matter of fact that apart from the disturbing impact on open landscapes by the steady growth of transport infrastructure construction (landscape fragmentation) it is mainly urbanisation which significantly contributes to both the loss of green infrastructure and soil surfaces by a "decoupled land take". "Since the mid-1950s, the surface area of cities in the EU has increased by 78 %, even though the population has grown by only 33 %." (European Union (ed) 2019, p. 9).

However, positive steps have also been set. It can be argued that by all means important steps towards implementing green infrastructure in European policies have been made, efforts to stimulate programmes and projects which lead the way to a more efficient implementation into planning and management both at regional and national levels have been set, awareness for the values of unspoiled connected and permeable landscapes, of High Nature Value (HNV) areas in rural landscapes, of patchworks of local and sub-regional initiatives to provide multi-functionality in heterogeneous (agricultural and peri-urban) landscapes has been raised. In that light MaGICLandscapes plays a focal role as its (Central) European approach is exactly covering the aforementioned portfolio of issues.

The main objective of MaGICLandscapes is to increase the capacities of institutions to improve the management of the green infrastructure (GI) resource and promote sustainable land-use, both in areas of high biodiversity and surrounding intensively used areas, in order to maximise its multiple socio-economic/ environmental benefits and value for communities such as quality of life & environmental services and for the natural world such as ecological viability.

MaGICLandscapes (application document). TUD, Dresden, 2016, p. 35

It is the enhancement of "the role of (semi)natural landscapes as core areas of Green and Blue Infrastructure in Central Europe" on the one hand and the investigation of the "potential of modified landscapes to support the GI functions of core areas through enhancement of those landscapes" on the other hand which both lay the foundation for significantly increasing "the capacity of institutions to improve the functionality of GI through the provision of tools, training and information and evidence-based actions". It is obvious that besides documentation and spatial as well as thematic analysis of ecological network structures as such and green infrastructure in the overall context the subsequent valorisation of knowledge towards in-situ implementation and - consequently - towards stimulation of a new quality of understanding and appreciation of the values of green infrastructure - from the solitary tree in front of the window to the wilderness of pristine areas – represent a crucial momentum of establishing firmly rooted identification and care of/for nature in its manifold representations. It is also obvious that such holistic initiatives are still underrepresented and their impact beyond the runtime of similar projects in the real-world context is poor.

Mankind is corruptible if it comes to deciding between living in non-reflective irresponsibility (shaped by the misunderstanding of freedom as the "right of unlimited individual consumption") and standing against ecologically/ environmentally harmful behaviours both at the level of the local/regional environment as well as of the sphere of the individual living space, thus taking self-responsibility in protecting nature in general and green infrastructure particularly.

Howsoever, a spontaneous selection of reflections of three most-famous poets and one of the most eminent environmental activists of the 20th century upon human-induced destructive impact on nature during the last two millennia proves that such (often devastating) conflicts were/ are always immanent due to the intrinsic ethical and moral weakness of the human being as such. It is just the fatal misuse of tools of contemporary technologies which make the consequences at all levels much more if not deadly dangerous.

In order not to interrupt and thus disturb the connectedness of both chronological as well as contextual interrelations which span a period from the beginning of the first millennium CE to the end of the second millennium CE the respective text excerpts are arranged consecutively:

1 Publius Ovidius Naso (43 BC–17/18 AD), Roman poet

Metamorphoses (3-8 AD)

[…]
communemque prius ceu lumina solis et auras
cautus humum longo signavit limite mensor.
nec tantum segetes alimentaque debita dives
poscebatur humus, sed itum est in viscera terrae,
quasque recondiderat Stygiisque admoverat umbris,
effodiuntur opes, inritamenta malorum.
iamque nocens ferrum ferroque nocentius aurum
prodierat, prodit bellum, quod pugnat utroque,

[…]

[…]
Then Land-marks limited to each his Right;
For all before was common, as the Light.
Nor was the Ground alone required to bear
Her annual Income to the crooked Share,
But greedy Mortals, rummaging her Store,
Digg'd from her Entrails first the precious Oar;
Which next to Hell, the prudent God had laid;
And that alluring Ill, to fight display'd.
Thus cursed Steel, and more accursed Gold
Gave mischief Birth, and made that mischief bold;

[…]

Ovid's Metamorphoses, in Fifteen Books, Translated by

the Most Eminent Hands [Dryden, Garth, Pope et al.], ed. Sir Samuel Garth. Tonson, London, 1717, Book I (transl. J. Dryden), pp. 135-142

2 Pierre de Ronsard (1524 - 1585), French poet

Contre les Bûcherons de la Forêt de Gâtine (1565)

[...]

Escoute, Bûcheron (arreste un peu le bras)
Ce ne sont pas des bois que tu jettes à bas,
Ne vois-tu pas le sang lequel degoute à force
Des Nymphes qui vivoyent dessous la dure escorce?
Sacrilege meurdrier, si on pend un voleur
Pour piller un butin de bien peu de valeur,
Combien de feux, de fers, de morts, et de destresses
Merites-tu, meschant, pour tuer des Déesses?

[...]

To the Woodsman of Gastine

[...]

Stay, woodsman, stay thy hand awhile, and hark,
It is not trees that thou art laying low!
Dost thou not see the dripping life-blood flow
From Nymphs that lived beneath the rigid bark?
Unholy murderer of our Goddesses,
If for some petty theft a varlet hangs,
What deaths hast thou deserved, what bitter pangs,
What brandings, burnings, tortures, dire distress!

[...]

Songs and Sonnets of Pierre de Ronsard, ed./transl. Curtis Hidden Page. Houghton Mifflin & Company, Boston, 1903, pp. 97-99 (Elegies, Mascarades et Bergerie, par P. De Ronsard Gentilhomme Vandomois. Gabriel Buon, Paris, 1565, Elegie XIV)

3 Robert Burns (1759–1796), Scottish poet and lyricist

Verses On The Destruction Of The Woods Near Drumlanrig (1791)

[...]

"Alas!" quoth I, "what ruefu' chance
Has twin'd ye o' your stately trees?
Has laid your rocky bosom bare-
Has stripped the cleeding o' your braes?
Was it the bitter eastern blast,
That scatters blight in early spring?
Or was't the wil'fire scorch'd their boughs,
Or canker-worm wi' secret sting?"

"Nae eastlin blast," the sprite replied;
It blaws na here sae fierce and fell,
And on my dry and halesome banks
Nae canker-worms get leave to dwell:
Man! cruel man!" the genius sighed-
As through the cliffs he sank him down-
"The worm that gnaw'd my bonie trees,
That reptile wears a ducal crown[1]."

([1]The Duke of Queensbury)

William Ernest Henley, Thomas Finleyson Henderson (eds), The Poetry of Robert Burns, Centenary Edition. Caxton, London, 1897, vol.4, p. 53

4 José Lutzenberger (1926–2002), Brazilian agronomist and environmentalist

Acceptance Speech, Right Livelihood Award (1988)

Today, parks are often the only way of saving certain species or ecosystems. But to me the idea that we have to save parts of Nature against our own destructiveness seems obscene. It is an avowal that something is profoundly wrong with our civilisation. Shouldn't we also try to find out what is wrong with our present culture and how we can re-educate ourselves before it is too late? A healthy, sustainable civilisation can only be one that harmonises with and integrates into the totality of Life, enhancing it not demolishing it.

Modern industrial society has embarked on a course that, if allowed to continue much longer, will, in the end, destroy all higher forms of life on earth. One of the main aspects of how we wrongly deal with the world is reductionism, that is, facing only one issue at a time and thinking in straight lines. Looking for the minimum size of a certain ecosystem and then aiming at preserving only that minimum is a typical example. It completely leaves out the overall view of how those little green spots interact as parts of the whole, the biome and the ecosphere, and what will happen once they are left alone in an ocean of devastation.

José Lutzenberger, Acceptance Speech, Right Livelihood Award, 31 December 1988, Stockholm

Obviously nature as such and green infrastructure as one of its apparent manifestations were and are at the stake all through the history of mankind. But as José Lutzenberger puts it, it is the "industrial society" and the "reductionism" inherent in all kinds of purely profit-oriented and thus profit-maximising socio-economic systems which – sad to say - are rearing their ugly heads again. It is a matter of fact that celebrating the implementation of another patch of protected area under whatever status of protection and forgetting the entireness of our "biomes" and "ecospheres" is a fatal way finally leading into the "ocean of devastation", as Lutzenberger calls it. Bearing in mind that Lutzenberger stressed these facts more than 30 years ago, and being aware that he was then the most eminent leading figure fighting for the protection of the Amazon rainforests and that he was - at least cautiously - optimistic that though "the devastation, for whatever reason, of the worlds tropical rain forests is totally irreversible we will not be able to remedy the unpleasant

consequences, but we might still be able to prevent the continuation of the devastation."

Let us have an eye-opening and thus shocking look at the actual situation with regards to large-scale forest depletion in two extremely endangered large ecosystems, the Amazon rainforest - the largest continuous rainforest ecosystem in the world - and the eastern Carpathians, including the largest primeval beech forest ecosystem in Europe.

In the Amazon basin both green and blue infrastructure are at risk. Rainfall has declined in about 70 % of the forest regions. It is estimated that in 2030 nearly 30 % of the Amazon biome will be treeless if the rate of deforestation does/will not change which - in contrary - obviously happens, though unfortunately in the wrong direction. Researchers claim that the tipping point regarding significant and irreversible change in the forest ecosystems of the Amazon lies at 20-25 % deforestation, and we have already reached 20 %! A process of "savanisation" is activated which will turn rainforest into tropical grasslands, thus leading to a break-down of the climate-regulative function of the vast areas of rainforest, and will devastate ecosystem services related to food, water and energy supply both regionally as well as globally.

Since the outbreak of the COVID-19 virus pandemic and its spread into the Amazon rainforest it is to be feared that the impact on the vulnerable indigenous tribes will be the worst. However, at the same time the protection of reserves in Brazil is weakened and environmentalists and indigenous leaders expect that the pandemic is being used as a pretence for a tremendous increase of illegal logging and mining. Recent numbers refer to more than 6,800 wildfires in the Brazilian Amazon region detected in August 2020 which is the highest number for 13 years. The amount of burnt area has increased for about 50 % compared to the same month last year. To make things even worse dubious interest groups go so far to assassinate indigenous activists opposing their illegal intentions. It is reported that from November 2019 to March 2020 five leaders from the Araribóia Indigenous Territory in Brazil's Amazonian state of Maranhão were purposely killed, all of them somehow involved in the defence of the Arariboia territory against illegal logging (Amazon Watch 2020).

It is disturbing and embarrassing that similar events happen right on our doorstep, explicitly in the remote parts of the last large areas of primeval beech forests in Central Europe, in the easternmost parts of the Carpathians. In 2013 an official investigation In Romania revealed that during the previous ten years about 80 million cubic metres of wood were illegally logged, corresponding to a worth of about 5 billion euros. In 2018, after Romania's second National Forest Inventory had been published, the Romanian NGO Agent Green referred to unpublished information which states that logging per year in the period from 2013 to 2018 amounted to more than double of the legally allowed logging. Based on the forest management plans, the maximum volume of logging in Romania is 18 million cubic metres per year, but the true amount of logging was 38 million cubic metres per year. It is thus obvious that illegal logging in Romania was exploding during the second decade of the 21st century (EuroNature and Agent Green (eds.) 2019, p. 22)

These developments are also - like in the Brazil Amazon rainforests - closely correlated with a significant increase of violence, in this case against forest rangers. In September/ October 2019 two forest rangers were killed by lumber thieves in Northern Romania (Romanian Insider 2019).

Indeed, green infrastructure encompasses wilderness areas, semi-natural and cultural landscapes, High Nature Value (HNV) areas in rural landscapes as well as meadow orchards around villages, peri-urban and urban green space from parks to single trees in intra-urban backyards.

Rewilding is the passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing the human control of landscapes. The opportunity for large-scale rewilding in Europe has been developing over the last few decades through the process of land abandonment, particularly of farmland. Some projections estimate that between 2000 and 2030 as much as 20 million hectares may be released from agricultural use in Europe, an area twice as large as Portugal.

Pereira H.M. and Navarro LM (2015) Rewilding European Landscapes. Springer, Berlin Heidelberg, pp. V-VI.

It seems to be obvious that besides traditional conservation schemes thinking in terms of rewilding European landscapes is a concept worthwhile to be given a serious consideration. However, the concept of ecological rewilding has to take into account that especially in Europe there are complex socio-ecological systems with a continuously increasing impact of human interaction which have to be managed. The focus therefore lies upon ecosystems where it is possible to reduce human impact on ecological processes as much as possible and where non-extractive ecosystem services, e.g. carbon sequestration and recreation potential, the latter providing additional sources of income for the local people, can be provided. This can - at least in the medium term - only be secured under the assumption that the issue is à la longue understood and advocated by the local people themselves!

But is wilderness - in spite of all these constraints - a focal concept which will significantly support the protection and conservation of green infrastructure both globally as well as regionally in the long run? Or does the key for a long-term safeguarding of green infrastructure lie rather in series of small steps towards maintaining and additionally creating patches of green infrastructure in (peri-)urban and rural environments? Evidently both approaches and many more in between these two extrema are needed to ensure for the protection, creation and management of sufficient valuable green infrastructure at all levels of scale.

Taking into account that our societies are facing something like an "environmental generational amnesia" i. e. that each generation - and within it also each specific Kulturkreis - has a different understanding and perception of the term "nature", also depending on the environment shaping the specific living space, however degraded or polluted it may be. It seems to be vital that in the light of a degrading perception of qualitative standards of a healthy environment the people

concerned should not only be motivated to get involved in supporting protection, conservation and/or sustainable management of their landscapes but should also be actively engaged in interacting in and within nature. Urban and peri-urban spaces grow and open spaces shrink and despite that evidence it is "environmental generational amnesia" which allows for an overall unchecked destructive socio-economic development. The increasingly degraded standards of what "nature is" are shaped by the milieu and the age-set of the people concerned. Suggesting the development of a "nature language" which enables the establishment of a relationship with the environment at local to global scales based upon sensitiveness, empathy and appreciation might support a reversal of that "environmental generational amnesia" towards an urgently needed new interpretation of the implications and values of promoting individual self-determination and proactive involvement in safeguarding green infrastructure, from patches of ruderal "weeds" in intra-urban backyards to pristine forests in the last remaining outbacks of wilderness in Europe and worldwide (Kahn & Weiss 2017, pp. 7-24).

Actually perception of and interaction with "nature" in our societies fluctuate between ignorance and deep involvement. There is on the one hand an alarming indifference manifested by an ever-growing misunderstanding of what "nature is" - in suburban and rural settlements people compete for the most monotonous front lawn of their equally looking "little boxes on the hillside" (Seeger 1963) by high-frequency mowing of their putting-green-like treeless Thuja-framed garden plots, thus carefully preventing any possible emergence of spots of potential biodiversity. On the other hand an increasing process of awareness-building and re-interpretation of living in and with nature, mainly carried by urban out-migration but also by local people, takes place - people get involved in organic farming, restoring extensive grazing of semi-natural grasslands and are ready to stand for a proactive involvement in protecting and developing green infrastructure on their doorsteps. Indeed, some of the new settlers in the "lost landscapes" of Central Europe and beyond are even crossing the line and try to resettle under Thoreau-like wilderness conditions (Csaplovics 2012).

MaGICLandscapes has successfully involved the whole potential of people living and working in favour and supportive of maintaining, extending and re-creating green infrastructure in Central European environments. May their impetus and inspiring example steadily grow and embrace an ever-increasing number of people ready to support strategies and action plans for the establishment of green infrastructure as a key indicator in planning guides in order to counteract immanent and even rekindling political and socio-economic interests favouring unrestrained exploitation of resources by purely economically-driven infrastructure.

Deprived of their usual car-washing and lawn-mowing pursuits, the inhabitants of Privet Drive had retreated into the shade of their cool houses. […]

JK Rowling, Harry Potter and the Order of the Phoenix. Bloomsbury, London, 2003, p. 7

I would say that landscape and democracy are very strongly related. Because who can resist the logic of capitalist development for the sake of the landscape? Only the people living in the landscape can defend it.

Gianni Vattimo, in: In armonia con la natura interiore e exteriore/In harmony with the inner and outer nature, a documentary by Lenka Ovcackova. MaGICLandscapes 2020, 5:20 Min.

There are those who cling to the world and never break free; there are those who enter the wilds and never come back.

Xi Kang (223-262AD), Letter to Shan Tao, cp. Hightower, James Robert (transl.) "Hsi K'ang's Letter to Shan T'ao.", in: Cyril Birch, Donald Keene (eds), Anthology of Chinese Literature, Vol.1: From Early Times to the Fourteenth Century. Grove Press, New York, 1965, pp. 162-166 (UNESCO collection of representative works: Chinese series)

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Seeger, P. 1963, Little Boxes. London: Essex Music (Words and Music by Malvina Reynolds) (from the CBS LP "We Shall Overcome")

MaGICLandscapes, Green Infrastructure and a Viral Interruption

Christopher Marrs, Project Manager MaGICLandscapes, Technische Universität Dresden | christopher.marrs@tu-dresden.de

The protection of our environment has become one of the key themes towards the end of the last century and will certainly continue to be so as we embark on this century. This isn't to say that environmental protection wasn't practiced in earlier years, but its importance for us as a society has become a pressing issue as populations increase and resource management becomes more and more important.

In terms of land management, environmental protection has, in the past, concentrated on the preservation of wildlife and natural/semi-natural habitats and preserving natural and cultural landscapes often on a site by site basis and equally as often in isolation from surrounding land uses.

Societies and economies have invested heavily in transport infrastructure, industry and housing, all of which are essential in the modern world and vital to economic and societal stability. Whilst these investments in 'grey' infrastructure provide tangible benefits to society they have somewhat overshadowed the less-tangible, though equally, actually more, important benefits that the environment provides to humans.

In the past this 'other' infrastructure, nestling amongst the more identifiable grey infrastructure of development, has rarely attracted the same level of interest or investment, at least on the strategic level, with local-level investment often concentrating on a site by site basis taking into account recreational needs or the aesthetic requirements of changing development design trends over the years. Understandably, as settlements expand and change, the strategic potential of this 'other' infrastructure has remained a secondary consideration.

Today, our interdependence with the environment is becoming better understood and its value and the benefits it provides for society are the subject of much research and debate. What has become clear is that those spaces or areas outside of protected areas can, and do, provide us with vital services, essential to our health and well-being, economies and cultural identity and indeed also support those protected areas by providing connective networks.

The science of ecosystem services brings with it an opportunity to maximise the benefits that the 'other' infrastructure can provide and adds an extra, more tangible value to our green spaces. However, application of ecosystem services does not necessarily address the strategic imbalance or how or where to plan green and open spaces at the city or regional scale. So we have an inherited situation where our important natural areas are not planned strategically and our urban and peri-urban spaces are rarely planned on a strategic or multifunctional basis.

This 'other' infrastructure is Green Infrastructure. Green Infrastructure is an approach that brings together both the need for strategic planning of green and open spaces and the science of ecosystem services. It promotes the multifunctional nature of space and the benefits that appropriate management approaches can deliver. It recognises the need to plan land use for specific purposes such as farming, nature protection and development but also provides the tool and methods to identify needs and opportunities to enhance the environment and its functions.

Green Infrastructure (GI) is a key strategy in the European landscape policies aimed at reconnecting vital natural areas to urban hubs as well as restoring and improving their functional roles. Thus, GI is an essential planning concept towards protecting Natural Capital and simultaneously enhancing quality of life. This approach needs to be urgently implemented in Central European (CE) landscape planning policies, which seldom consider the ability of land to deliver multiple benefits.

The Interreg Central Europe project Managing Green Infrastructure in Central European Landscapes - MaGICLandscapes worked to operationalise and promote the GI concept in Central Europe. It provided provide land-managers, policy makers and communities the tools and the knowledge, at different spatial levels that they need to ensure the persistence of GI functionality and consequent benefits to society.The MaGICLandscapes project created an assessment approach that deals with all spatial levels across CE landscapes types. It produced tools for GI assessment at the transnational level ensuring cross-border GI is understood in a way that reduces mismatched management approaches. Nine multi-scale and multi-thematic case studies across Austria, Czech Republic, Germany, Italy and Poland provided the testing ground for the trans-disciplinary partner consortium to identify and feedback best practice for assessment, thus creating transnational added value. Outputs include a suite of transferable tools: a series of technical manuals as well as partner-level evidence-based strategies and action plans to direct future actions as well as investment and will enhance the capacities of institutions to better manage our Natural Heritage.

In its final stages the MaGICLandscapes project, along with other Interreg Central Europe projects and the daily life of literally billions of people across the planet was affected by the COVID-19 virus and the restrictive, yet necessary, measures required to control it. Within a very short time MaGICLandscapes' project partners and stakeholders were compelled to work from home, juggling family and professional responsibilities and personal interaction with one another was severely restricted, and at the global level the consequences of this enforced isolation to personal and societal health will likely be the subject of discussion for years to come.

It is interesting that just as our personal interactions with one another had reduced somewhat due to the pandemic, our interaction with the world that surrounds us became more important and its value more apparent.

During the lockdowns seen across Europe when people were unable to travel around freely, our local green spaces became oases, places where human interaction could be carried out safely at a distance.

Those interactions weren't only those between people, they were also between people and nature. The open spaces were a theatre of birdsong, of emerging leaves and flowers, the spectacle of spring itself and thus a stark and welcome contrast to the confines of houses and flats. We walked, we ran, we sat and we enjoyed these spaces with our close families, perhaps more than we would have done under normal circumstances with the 'freedom' to spend the day at work. The outdoors was in itself a distraction from the pandemic and in some respects a cure, not to the virus itself, but perhaps to the secondary symptoms of confinement.

It is certainly no great leap of faith, nor cause for in-depth academic research, to suggest that people with access to green spaces were better off physically, mentally and perhaps spiritually during those times than those with limited access. Sadly, it is also reasonable to assume that when this pandemic has passed and, if the green space distribution remains the same, those with limited access will continue to be worse off.

A wealth of research and evidence already exists demonstrating the clear benefits of green and open spaces to human health and the associated problems of limited access, those problems unfortunately are not just confined to health, there is evidence aplenty that societal and economic deprivation are closely associated with environmental deprivation. Meaning vulnerability can no longer be simply a measure of economic or societal standing, our surrounding environments and lack of green space makes us vulnerable too, and not only to a virus.

The COVID-19 pandemic will not be the last, increasing stress on ecosystems caused by exploitation of natural resources has been responsible for almost half of the emerging zoonoses, pathogens that 'jump' from one species to another. It is safe to assume that continuation along our current and unsustainable trajectory will likely increase the chances of further pandemics. So we have a situation where the destruction of core wilderness areas of green infrastructure is also leaving us vulnerable to further pandemics as well as indiscriminate loss of biodiversity and ecosystem services.

It would appear that the protection we need from future pandemics will need to be more than just wearing a mask and washing hands, relying on a vaccine or having to sit at either end of a garden simply to talk to each other. We also need to reduce the opportunities for pandemics to appear and be better prepared to live with them when they do. We need to recognise that protecting and increasing our green infrastructure resources and enabling access for all will have to be an essential and undeniable part of planning for the future and increasing both our resilience as a society and that of the natural world.

During the pandemic and lockdowns there were hopeful glimpses of what could be with stories from across the world about wildlife reclaiming its rightful realm. Stories such as the return of dolphins in Venice's lagoons and Hong Kong's harbour and the return of Dugongs to Hat Chao Mai National Park in Thailand and even Kashmiri wild goats on the streets of Llandudno in North Wales. It shows that perhaps all is not lost and we do have a chance to improve upon what we still have or could have. However, it is possible the good gardeners of Llandudno may hold a slightly different point of view regarding the goats.

Seizing this chance in a post-COVID world, whenever that is, is surely the challenge we must rise to, it's no longer a question of whether we should or should not, simply a question of how. How to ensure that we commit to equitable world for people and wildlife, how to learn the lessons of the past and finally how to avoid the compounding destruction and plunder of natural resources as nations in competition with each other scramble to rebuild economies and make up for lost time…

It would be folly to over-ride the need to protect the environment for the sake of the rampant capitalism and consumerism that will undoubtedly race to fill the void in economies caused by the pandemic. That our economies were damaged so easily was a clear indication that they were far too fragile in the first place. Not only were they fragile, they were destructive both locally and globally.

It should therefore be seen with some optimism and a positive move, that here in Europe this has been recognised as unsustainable and a return to business as usual is not an option, that a reset is needed and new innovative approaches are necessary. With its Green Deal the European Union is fostering a green, digital and resilient Europe.

Pandemics will come and go, but our need for a healthy and functioning environment will remain, the ensuing threat of climate change is still with us and will be for generations. We have no choice but to ensure resilience of our environment as we are wholly dependent upon it.

Green infrastructure, Nature-based solutions and promoting the multiple benefits of our green spaces and wilderness areas are key actors in creating a resilient environment, society and economy. It is hoped that in some way the MaGICLandscapes project has contributed to the concept of green infrastructure and that the seeds it has sown in the nine case study areas will provide a catalyst for a sustainable and positive change for the better.

CHAPTER 1

Analysing the functions, services and benefits of green infrastructure for a better landscape management in central Europe

Transnational Framework of Green Infrastructure Assessment (Work Package 1)

Marco Neubert & Henriette John, Leibniz Institute for Ecological Urban and Regional Development, Dresden, Germany | m.neubert@ioer.de

1 Introduction and Objectives of Work Package 1

Work Package 1 (WP1) was a fundamental basis for the project work. It provided the framework of the follow-up work packages including definitions, needs and a policy overview as well as the data base for spatial analyses using transnational and regional sources.

There were two main objectives of WP1. The first objective was to design a framework for green infrastructure (GI) assessment that identifies the specific informational needs regrading green infrastructure at the European, regional and local level and how green infrastructure management approaches are supported by European, territorial and local policies and objectives. This was achieved by investigating theoretical approaches of GI assessment towards their success in practical application (state of art) and analysing best-practice examples. Transnational cooperation in the definition of types of GI assessment ensured it meets the informational needs of the partner countries. The related output to this objective is the Handbook of Conceptual and Theoretical Background, Terms and Definitions (Output O.T1.1).

The second objective was to identify the green infrastructure map resources at the transnational scale and using them for GI mapping. A remote sensing-based methodology for transnational assessment of GI and ground-truth the methodology in selected case study areas across the partnership was developed and applied. The re-integration of experiences and empirical findings delivered iterative improvement, ensured validity and that territorially specific needs were recognised in the development process of the transnational assessment methodology. As data bases, remote sensing-based data like High Resolution Layers and CORINE Land Cover data from the European Copernicus programme have been evaluated. Related to this objective, the Manual for Transnational GI Assessment (Output O.T1.2) was elaborated, including a collection of best-practice examples, digital regional maps of GI for each of the participating regions. Due to shortcomings of the transnational data in terms of spatial resolution and compound GI classes all maps on transnational scale have been supplemented by maps using national or regional data. The result is a standard procedure including a transnationally coordinated central Europe-wide classification scheme for green infrastructure that was used for all maps in all case study areas.

2 Conceptual and theoretical background, terms and definitions

The Handbook of Conceptual and Theoretical Background, Terms and Definitions (Output O.T1.1) contains the fundamentals of green infrastructure, which also includes the blue infrastructure. With its three chapters, the handbook covers issues such as definitions of important terms (Chapter A) as well as GI and its relationship to territorial law/policies of the five partner countries (Austria, Czech Republic, Germany, Italy and Poland) and international and EU regulations and programmes (Chapter B) (see Tab. 1 as a key result). Furthermore, it covers the territorial/international needs for a green infrastructure approach and its contribution to sustainable development (Chapter C). It shows, how a green infrastructure approach can address specific territorial and common challenges. The nine multi-scale and multi-thematic case studies of the MaGICLandscape project are introduced too. They offer the testing ground for our trans-disciplinary partner consortium to identify and feedback best practice for assessment, thus creating transnational added value.

The handbook for practice-oriented information is based on a review of GI literature and legislations as well as practical experiences of the project partners and stakeholders. It is expected to be used as a reference for stakeholders and target groups wanting to know more about green infrastructure (GI) but also to aid them in justifying GI related actions and investments. This was done on the one hand by the provision of the policy/legal review for the concerned territories demonstrating how GI relates to multiple sectors. On the other hand it showed, what the needs for a GI assessment are and therefore, where the starting points for actions are. It is expected that the impact will be a greater support for GI as an approach and greater inter-sectoral working to achieve shared objectives that adopting a GI approach can deliver.

The benefit will be an

- increase in together-working and maximizing the public benefit that can be achieved through GI approaches to issues such as health and well-being/recreation;
- mitigating climate change, flooding or loss of pollinators;
- supporting productivity of the land;
- protecting and enhancing our natural capital.

The tool is transferable to other territories despite only having the legal/policy review for the five participating project countries. The introduction, concept and explanation of GI to the reader is not country-dependant and thus transferable

Regulation Topic	Global or regional international regulations	EU	AT	AT, Lower Austria	CZ	DE	DE, Saxony	IT	IT, Pied-mont	PL
Green Infrastructure										
Green Infrastructure		GI	GI	GI	GI	GI				GI
Protection of Nature, Biodiversity and Landscape										
Nature and Biodiversity Protection (in general)				GI	GI	GI	GI			GI
Biodiversity Protection	GI	GI	GI		GI	GI	GI	GI	GI	
Species Protection	GI	GI		GI	GI	GI	GI	GI		GI
Invasive Species Management		F		F	F	F	F	F		F
Protection of areas/habitats	GI	GI		GI	GI	GI	GI	GI	GI	GI
Landscape Protection		GI		GI	GI	GI	GI	GI	GI	GI
Protection of Cultural and Natural Heritage	GI	GI					GI		GI	GI
Environmental Protection										
Prevention of harmful Effects on the Environment (in general)		F		F	F	F GI		F		F
Environmental Liability		F	F	F	F	F		F		F
Environmental Assessment (EIA/SEA)	F	F	F		F	F	F	F	F	
Water Protection	GI	GI F	GI		GI	GI F	GI F	GI F	F	GI
Air and Climate Protection		F	F		F	F	F			F
Soil Protection		F		F	F	F	F	F	F	F
Economy and Sustainable Development										
Agriculture		GI		GI	GI	GI	GI			GI
Forestry		GI	GI	GI	GI	GI	GI	GI	GI	GI
Hunting and Fishing		GI F		GI F	GI F	GI F	GI F	F	GI F	GI F
Tourism and Recreation	GI	GI		GI	GI	GI	GI	GI		
Energy		F	F		F	F	F			F
Sustainable Development		F	F		F	F	F	F		F
Spatial Planning										
Regional and Local Planning		F		F	GI F	GI F	GI F		GI F	GI F
Urban Planning		GI		F	GI	GI	GI	GI	GI	GI
Sectoral Planning		F	GI F	F	F	F	F		GI F	GI F
Access to Information on the Environment and Public Participation	F	F	F	F	F	F	F	F	F	F

Table 1: Protection of green infrastructure (GI) or its functionality (F) by regulations, laws and policies at different levels, for details see John et al. (2019)

outside of the project area and indeed the Central Europe Programme area. This handbook is also provided in country-specific shortened versions in the corresponding national language. They include only policies and legal reviews for the specific country and demonstrate regional examples of GI benefits in more detail. This will also form part of the final output of Work Package 3 regarding the green infrastructure strategy development.

3 Transnational assessment and regional green infrastructure maps of the case study areas

The Manual of Transnational GI Assessment (Output O.T1.2) provides guidance in assessing the structure and types of GI at the transnational level. It demonstrates the process and methods of generating a transnational map of GI. The manual contains an evaluation of available data, for example data provided by the European Copernicus programme, and their suitability for assessing GI in Central Europe. Manifold European datasets are available, but only very few are suitable for a transnational GI mapping. Due to its full coverage and a low amount of misclassifications the CORINE land cover dataset was proved to be the most appropriate dataset. A major added value of the transnational cooperation in this process was the possibility to test the methods together with regional experts of different countries under different circumstances and under consideration of specific biotopes/ land use types not common to all countries to prove the suitability of the data. The CE-wide coordinated GI classification scheme would not have been possible without transnational cooperation.

The manual provides a method for ground-truthing and shows results of the individual ground-truthing carried out by the MaGICLandscapes regional experts in their respective case study areas. Furthermore, a GI classification scheme is presented, that was coordinated between all partners and that is suitable not only for all case study areas but also for Central Europe. This way, also regional specifics could be considered (e.g. poplar plantations in Italy). In addition to the full classification scheme, a simplified three-classes version containing ‘green infrastructure’, ‘green infrastructure under specific circumstances or partly GI’ (depending i.e. on composition, intensity of land use, national/regional characteristics) and ‘not green infrastructure’ is provided.

As a major result of this process the manual provides a GI map on transnational scale for whole Central Europe (see Fig. 1 as a key result) as well as for each of the nine case study areas. Due to some shortcomings regarding transnational data (spatial resolution, accuracy, classified elements) the manual also demonstrates, how to refine maps to national/regional

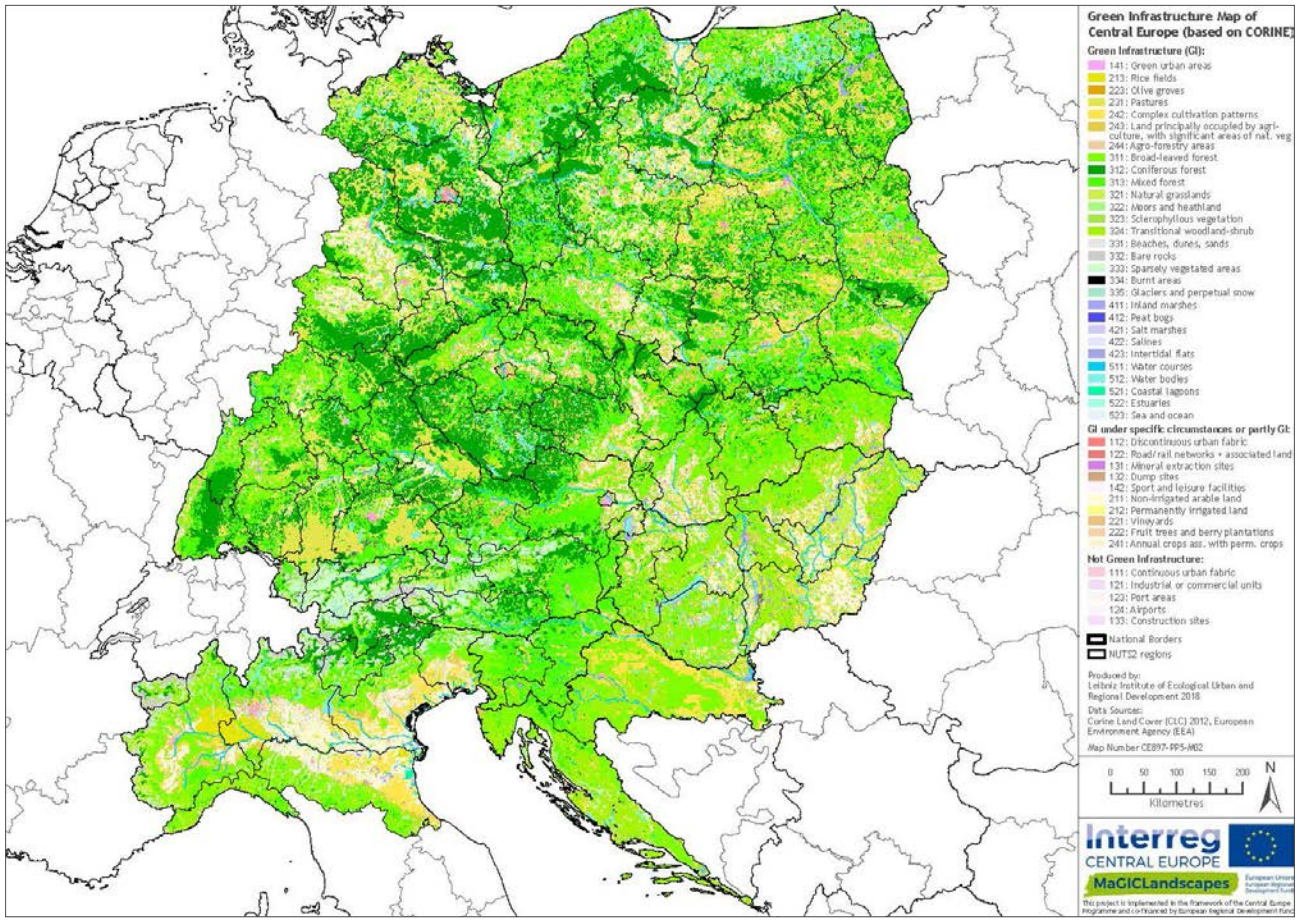

Fig. 1: Map of green infrastructure for the Central Europe programme area based on the transnational legend using CORINE land cover data from 2012, for details see Neubert & John (2019)

level using available detailed data (e.g. biotope or land use maps) and provides a collection of refinement examples from the nine case study areas of the MaGICLandscapes project.

The manual is designed to be a tool that guides the reader through the process of undertaking a large-scale GI assessment at transnational level in Central Europe (CE). It will encourage other institutions for similar realisation and provides decision support to them using examples from the MaGICLandscapes project. The developed mapping process presented by this manual can be considered as a CE-wide applicable approach for the mapping of GI and its constituent elements. It can improve capacities of institutes for conducting GI assessments and monitoring across borders. With the examples demonstrating how to refine maps to national/regional level the manual also provides a useful and informative tool for regional stakeholders of different target groups.

GI maps produced by following the instructions of the manual can be a very helpful basis for further analysis, such as on the provision of ecosystem services, biotope connectivity and functionality etc. The manual is available to the public to be used for other GI mappings and GI planning. Country-specific short versions in four languages are provided, too.

The mapping methodology provided is applicable to different levels/scales depending on the availability of suitable data for the specific scale. This is especially true for other regions within Europe since the transnational datasets used (mainly CORINE Land Cover data) are available for all European countries and similar data is also available beyond. Thus, by design the data and methods mentioned in the manual for transnational GI mapping are transferable to a large extent. With basic knowledge on GIS-software, different stakeholders will be able to use this tool and to apply the methods described.

The availability of the Regional Maps of GI in combination with the Manual of Transnational GI Assessment will stimulate and enable other stakeholders to prepare similar maps and implement them in their region. All maps produced are available to a wide public to use them for further implementation especially in spatial planning. Since the mapping methodology is provided in addition and only freely available or low cost data is used, the obstacles for transferring the regional GI mapping to other territories and stakeholders are minimal.

The conducted regional GI maps show that it is possible to prepare such maps in a comparable layout for the participating Central European regions. Despite regional differences the project team found ways to implement a coordinated approach in all case study areas using regional GI data.

The maps provide a useful tool to inform the following target groups about the status of GI in their region:

- the public, to raise awareness of GI and its benefits to humans,
- the policy decision-makers, to take measures to protect and to enhance the GI Network and
- the planning sector, to implement measures.

4 Conclusions

While developing the handbook we learned, that the term green infrastructure is not well known in the public yet. The same is true for the regional and local planning levels that are important for implementation. The analysis of GI in laws/ policies at EU/national/regional level showed that the topic is differently represented within the EU and its countries. We hope that the WP1 results help to enhance this situation in providing knowledge and guidance.

The transnational cooperation enabled us to perform a coordinated mapping approach using the same database on transnational level and similar data on regional level for all case study areas including a transnationally coordinated legend and colour scheme. Although some regional specifics, the results are comparable across Central Europe to a large extent.

The results of WP1 have been an important base for the subsequent working steps in the project regarding green infrastructure functionality assessment and the development of green infrastructure strategies and action plans.

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Assessing green infrastructure functionality at European, regional and local scale (Work Package 2)

Florian Danzinger, Mita Drius, Stefan Fuchs, & Thomas Wrbka, University of Vienna, Vienna, Austria | florian.danzinger@univie.ac.at

1 Introduction and aim of Work Package 2

The Manual of Green Infrastructure Functionality Assessment is the main output of the Work Package 2 outputs, which were developed as part of the Interreg Central Europe project MaGICLandscapes - Managing Green Infrastructure in Central European Landscapes.

It is designed to be a tool that guides the reader through the process of undertaking a green infrastructure (GI) assessment on a regional and local scale in the central European context. Using practical examples it will demonstrate the main steps for conducting a GI functionality assessment, starting from the regional discrepancies in the definition of GI, then shifting to the description of how and why particular datasets are more useful in conducting such assessments at this level. Finally, it will then show through various spatial analyses how a map of regional and local GI functionality can be created.

The description of the assessment and mapping process presented by this manual is meant to provide decision-support to other users that want to fulfil similar tasks.

The manual describes the general procedure for assessing GI functionality. Besides a short introduction to GI definitions and ambiguities in the terminology at local/regional level, the available spatial data for assessing GI and Blue Infrastructure (BI) in central Europe are presented and discussed. Subsequently, the main methodologies employed to perform the GI functionality assessment are reported. These consist of an integrated synopsis of the results of the connectivity analysis, the field mapping methodology testing and the functionality analysis. In the manual, the general and specific findings of this assessment process are presented. Each step of the functionality assessment is explained by maps from the project's case study areas (CSA). Finally, conclusions are drawn and suggestions about the functionality assessment are provided for the transferability of good practice.

The benefit of assessing and analysing these data is the acquisition of knowledge about spatial distribution and quality of GI on a regional and local level. The findings of the manual help to identify hot spots of GI networks as well as GI with a high functional value or areas with a lack of such elements.

This valuable data, visualised in maps, is the basis for planning further actions. Using these results, concrete measures on different scales for the regions GI can be developed, in order to maintain the present structures as well as the sustainable use of land and to not only expand the network of GI within protected areas but also beyond their borders. Thus, the management of GI not only changes the landscape for the better from an ecological and nature conservation perspective, it also preserves and improves many landscape services from which humans benefit or actually depend on.

2 General procedure of green infrastructure functionality assessment and mapping

Green infrastructure (GI) in spatial planning needs to cover many different policy sectors and its implementation is an on-going process dependent on political willingness. To date, tools for implementing the assessment of the multi-functionality of GI elements are still under progress. Examples of development of toolsets for the assessment of GI multifunctionality include the combination of spatial data with the knowledge of experts and regional and local actors (Kopperoinen et al. 2014), the creation of performance indicators of GI (Pakzad and Osmond 2016), and the use of field questionnaire surveys to explore the perceived benefits (e.g. Qureshi et al. 2010). Nevertheless, a holistic or combined approach to address the functionality assessments is rarely employed to date.

The following steps in the procedure of green infrastructure functionality assessment and mapping are explained in this manual:

1. Definition of Green and Blue Infrastructure elements representing the objects of interest at regional level
2. Data acquisition at the transnational, regional and local level
3. Generating transnational, regional and local maps of GI functionality for the case study areas (CSA)

- Connectivity analysis
- Field mapping methodology
- Functionality analysis

The results can be used to inform the following target groups about the functionality assessment methodology of GI:

- General public (to raise awareness),
- Policy- and decision-makers (to take measures to protect and to enhance the GI Network) and
- Planning sector (to implement measures and to draft Strategies and Action Plans).

3 Generating a regional green infrastructure functionality map

3.1 Definition of green and blue infrastructure elements at regional level

As already described in the MaGICLandscapes 'Green Infrastructure Handbook - Conceptual & Theoretical Background, Terms and Definitions' (John et al. 2019) we suggest the green (and blue) infrastructure definition of the European Commission (2016):

"Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation. This network of green (land) and blue (water) spaces can improve environmental conditions and therefore citizens' health and quality of life. It also supports a green economy, creates job opportunities and enhances biodiversity. The Natura 2000 network constitutes the backbone of the EU green infrastructure" (EC 2016).

In the transnational mapping phase of MaGICLandscapes different datasets able to spatially describe green and blue infrastructure (GI and BI) were explored. From the available dataset sources the standardised land cover classification CORINE Land Cover (CLC 2012) was considered the most adequate (see Manual of Transnational Green Infrastrcuture Assessment, Neubert and John 2019) for further details. According to the CLC classification we could identify 44 CLC classes that either represent GI elements, could contain GI elements under specific circumstances and those that should not be regarded as GI.

Based on the findings of the transnational mapping, we carried out an analysis to define GI at regional level. We chose three categories to distinguish and categorise the CLC classes into GI elements: "GI" for classes belonging to GI, "not GI" for classes not belonging to GI, and "partly GI" for classes which may contain GI elements or could be considered as GI under specific circumstances. Since some of the GI definitions did not fit to the regional landscape characteristics, the project partners were asked to provide their local definition of GI and to indicate which CLC classes are part of GI according to this definition for their respective CSAs. The partners provided their definitions and deviations from the transnational GI based on the features of case study areas located in very diverse landscapes and characterised by different landscape features.

These regional definitions of GI are very dependent on the available spatial and thematic resolution of geodata for technical reasons on the one hand and the current predominant land use, the intensity of management and general landscape characteristics on the other hand.

Despite these differing initial conditions all case study areas were able to perform a highly comparable analysis and to produce consistent results, which shows that the proposed methodology allows for a universal application across varied the landscapes of central Europe.

3.2 Data acquisition at transnational, regional and local level

As with any other mapping approach, high quality geodata regarding spatial and thematic resolution is an essential prerequisite to allow the operationalisation of the GI concept in the first place.

The requirement of incorporating green space elements on the state, regional, community and parcel scales (Benedict and McMahon 2002) emphasises the need for a profound data basis in terms of high spatial and thematic resolution geodata for local implementation of GI. For that reason, data acquisition at transnational, regional and local level is necessary in quite different ways, dependent on the scope and scale of GI implementation.

While the standardised CORINE Land Cover (CLC 2012) database was considered the most adequate (see Neubert and John 2019) for the mapping of GI on a transnational scale, there is no one-size-fits-all solution for the acquisition of suitable geodata at the regional and local level.

Therefore, the best solution to meet these requirements was the compilation of various regional geodata and small-scale field mapping data, ranging from e.g. regional land cover data to forest inventories and digital registration of GI elements from orthophotos.

The use of the highly detailed geodata set revealed differences in the realistic representation of the GI network in the different landscapes. On the one hand, due to the classification and generalisation inherent in CORINE Land Cover, the extent of fragmentation is distinctly under-represented in large continuous areas and small elements of GI, like woodlands or vineyards. On the other hand, apparently, e.g. arable land or urban fabric are often greatly underrated for their provision of GI and landscape features such as hedgerows, ditches, ponds and single trees. Therefore, the regional data set enhanced the evaluation of the GI network in natural and semi-natural areas as well as in rural and urban settings, which allows for the regional operationalisation of the GI concept. The availability and thus comparability in most European countries is still a major benefit of the CORINE Land Cover classification though.

Through the compilation of various forms of local data to produce a regional highly detailed geodata set, the mapping quality of GI can be enhanced for all types of landscapes and constitutes a precondition to develop stakeholder-based strategies and action plans for future actions and investment in GI. It also enables the precise identification of the local GI network for land managers, policy-makers and communities.

3.3 Generating transnational, regional and local maps of green infrastructure functionality

The assessment and mapping of GI functionality carried out in MaGICLandscapes comprised of three main types of sub-analyses:

- the connectivity analysis

- the field mapping methodology
- the functionality analysis itself.

The methodologies were tested in all partner countries of the project: Austria, the Czech Republic, Germany, Italy and Poland. In this section we present each sub-analysis, divided into various steps, and provide examples of their application in the case study areas.

3.3.1 Connectivity analysis

The analyses of connectivity were performed through the software GuidosToolbox (Graphical User Interface for the Description of image Objects and their Shapes). GuidosToolbox is a free software collection by Peter Vogt (Joint Research Centre (JRC) of the European Commission) and offers a variety of modules targeted to investigate several spatial aspects of raster image objects, for example pattern, connectivity, cost, fragmentation, etc.

The GuidosToolbox is freely available at: https://forest.jrc.ec.europa.eu/en/activities/lpa/gtb/.

Besides the Morphological Spatial Pattern Analysis, a Network analysis and the module of Euclidean Distance was performed to illustrate the connectivity of GI.

3.3.2 Field mapping methodology

The key tool for the assessment of green infrastructure at the local level was the on-site inspection of selected test sections within the case study areas. The selection was derived from the results of the map of green infrastructure based on CORINE (2012) as well as the Morphological Spatial Pattern Analysis (MSPA) and the measurement of the Euclidean Distance in order to locate GI that is important for the connectivity on the landscape scale. The aim of the local GI mapping was to deliver a detailed view of the selected sites that shows the high diversity actually hiding behind the more general classes of CORINE or even the regional datasets.

3.3.3 Functionality analysis

The analyses of functionality were performed by plotting capacities of GI elements and all other land use classes to provide landscape services on the above mentioned rationalized geodata stets. Especially when based on participatory approaches, capacity matrices are widely used for assessment of ecosystems services (ESS), perfectly corresponding to MaGICLandscapes' motivation and objectives.

Basically, a capacity matrix is a look-up table that connects land cover types to ecosystem services or landscape services potentially provided. Introduced by Burkhard et al. in 2009 the method has since been developed and applied in an array of case studies (Campagne et al. 2017).

To create a sound matrix of landscape services capacities for the CORINE Land Cover types in central Europe, an existing matrix for the whole of Europe by Stoll et al. (2015) was

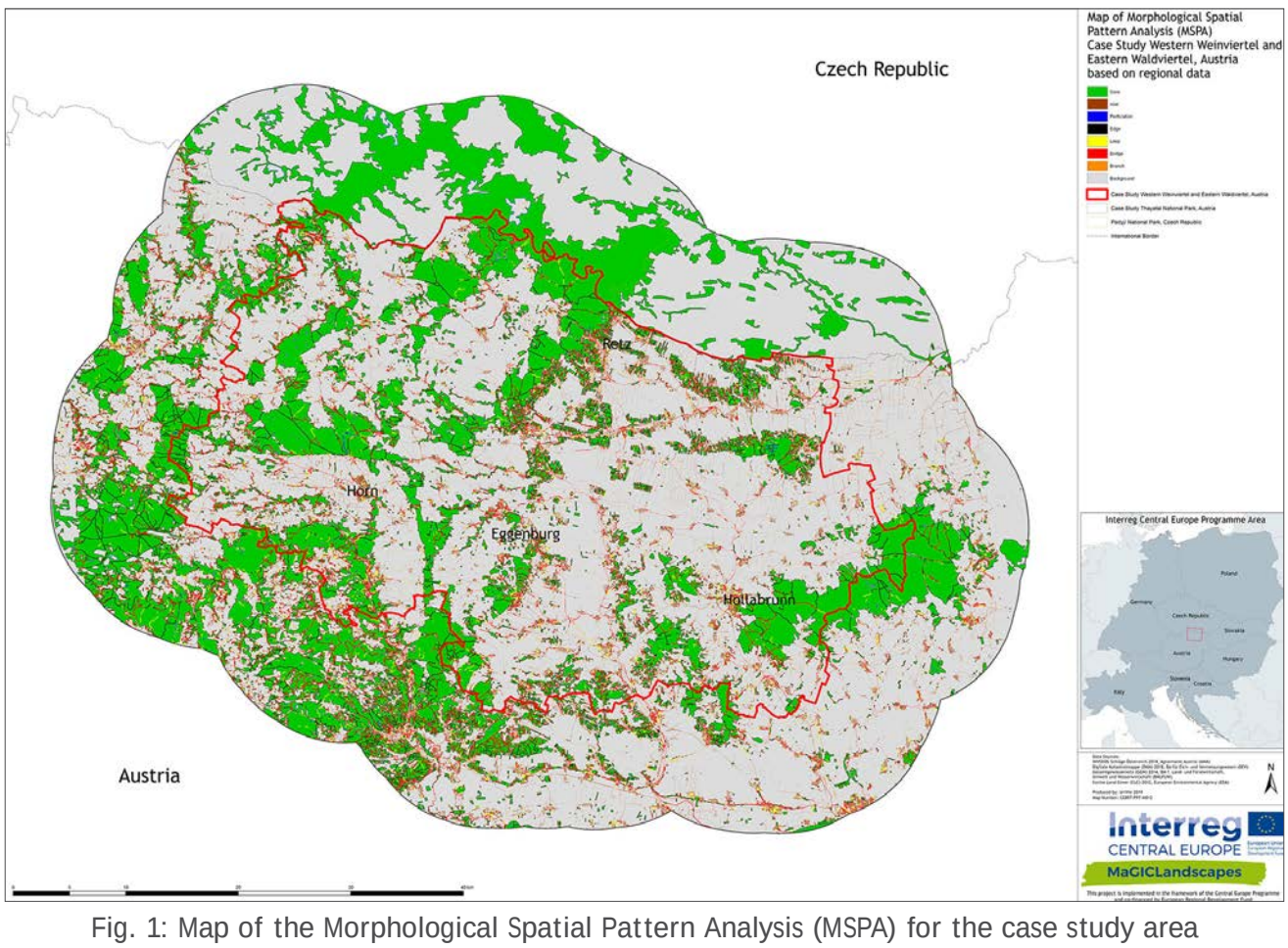

Fig. 1: Map of the Morphological Spatial Pattern Analysis (MSPA) for the case study area "Eastern Waldviertel and Western Weinviertel" based on regional data

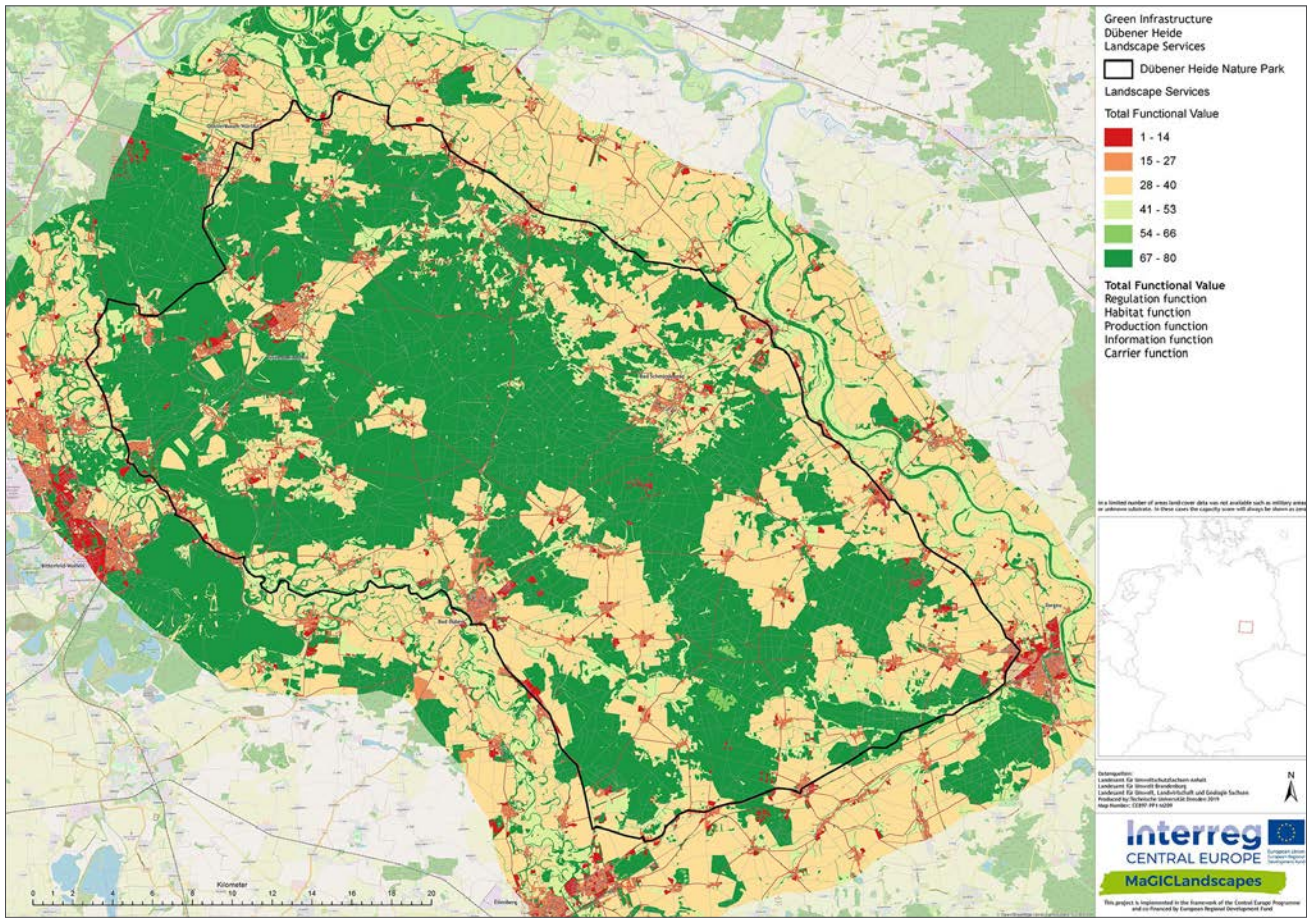

Fig. 2: Green infrastructure functionality map of the case study area "Dübener Heide Nature Park" showing the total value of functions (i.e. regulation, habitat, production, information and carrier functions)

used. It was assigned to the definitions of landscape services by de Groot et al. (2002, 2006 and 2010) and revised by the experts of each project partner. The key tool for the analysis of GI functionality was the resulting final matrix of landscape services, consisting of 30 single ESS in five main services that are aggregated to the total function value for each land cover type.

4 Conclusions on the mapping method and the usability of the methods and maps

Based on the objective to implement green infrastructure in central European planning policies the MaGICLandscapes project aimed to operationalise the GI concept in central Europe as well as in nine case study areas, by using a suite of GIS-based analysis methods, to provide land managers, policy-makers and communities with the adequate tools and knowledge, at different spatial levels.

It was found that the detailed representation of the regional GI network enhances the regional applicability and acceptance of GI initiatives and provides a crucial foundation for assessing GI connectivity and functionality. Based on that, well-founded strategies and action plans can be best developed through an intensive stakeholder involvement to direct future actions and investments in GI.

Therefore, GI assessment methods that focus on functionality in terms of connectivity and provision of landscape services were developed to communicate and facilitate the adoption of those assessment methods by institutions through stakeholder involvement and participatory approaches in order to implement and maintain a viable GI network.

Following the objectives and ideas of MaGICLandscapes, that of an integrated, cross-sectoral approach employing stakeholder involvement and participatory processes, the partner consortium defined an expert-based classification of GI based on CLC classes for the whole Central European Programme Area as a first step, followed by a round of stakeholder validation in the course of workshops in the case study areas to adapt the definitions and classification regionally. The implementation of project activities demonstrated the necessity,as a first step, for a detailed regional GI data basis to allow the realisation of the assessment methods and objectives stated above.

EU-wide available land cover maps, like CORINE (CLC), can help in coarse assessments of GI connectivity and functionality, but they cannot provide exact information about the local network of GI elements. Therefore, this data basis should be supplemented by more detailed available national and regional data. This approach could be adopted all over Europe, owing to the availability of similar kinds of detailed datasets (e.g. agricultural, digital cadastral and hydrographical data). The regional GI map and its various analysis products can be related to a variety of spatial planning measures. It enables politicians, planners, land users/managers and communities to invest in GI by highlighting hot spots of highly fragmented areas or those dominated by well-established networks of GI as well as locating focus areas providing or in need of capacities of certain ecosystem services, influencing the well-being of individuals and communities.

When it comes to interventions or implementation measures at the local level, the ground-truthing through field mapping of selected test sections revealed the need for a local assessment of GI in terms of biodiversity, naturalness and structure in addition to the desk-based GIS analyses. Therefore, the EUNIS habitat classification (2017) provides a characterisation of GI that is comparable at the international level and also transferable to national classification schemes.

In the synopsis of the various products of the assessment and mapping of green infrastructure functionality and connectivity in a certain region, the needs and opportunities for GI become apparent, justifying investments in GI. This inventory of GI regarding its spatial structure, functionality and ecosystem services allows for considering cross-sectoral policy and planning objectives including the GI concept into regional and spatial planning.

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Strategies for intervention at European, regional and local level (Work Package 3)

Gian Luigi Rossi, Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) | gianluigi.rossi@enea.it

1 Inroduction and Objectives of WP3

The objective of WP3 was to show how transnational (Work Package 1), regional (Work Package 2) and local (Work Package 3) green infrastructure assessment can be used to develop strategies and action plans that fit strategically, improve the functionality of green infrastructure and meet specific the local community needs.

As a prerequisite for defining a public benefit assessment procedure in this work package, a third, local, level of assessment has been developed which takes into account specific local needs and identifies threats, strengths, weaknesses and opportunities related to the green infrastructure resource. By jointly developing and testing the public benefit assessment in their nine case study areas in the five regions, in collaboration with local stakeholders and associated partners, the partners identified priority areas and actions and produced green infrastructure strategies and action plans. These green infrastructure strategies and action plans are supported by the results of the evaluation methods used in Work Package 1 and 2 activities. The nine case study areas that are a constant throughout the work packages cover a variety of scales and different types and uses of green infrastructure. Consequently, the strategies/ action plans reflect the different needs and opportunities within these case study areas.

This Work Package produced three key outputs: firstly, the evidence-based strategies and action plans for each of the case study areas; secondly, the Handbook for the Development of Evidence-Based Green Infrastructure Strategies and Action Plans using transnational, regional and local green infrastructure situation analysis and assessment, drafted on the basis of experiences and lessons learned in the development of the strategies and action plans; and thirdly, the launch of training activities related to the methodologies and products developed within the Project.

2 Public Benefit Assessment Tool

Within the scope of the MaGICLandscapes Project, a specific methodological tool, the Public Benefit Assessment Tool, was prepared to guide the assessment of the Public Benefits in the different case study areas.

The Green Infrastructure public benefit assessment tool is aimed at producing an analysis of the Public Benefit situation of GI at the local scale, which can be placed side by side with the results of the analyses at different scales carried out within WP1 and WP2 of the Project, in order to allow the definition of strategies and action plans for Green Infrastructure in the study areas.

Thanks to this integrated approach, strategies and action plans can be based on the evidence of the situation in the targeted areas and respond to specific local and regional needs, mitigate the threats and seize the opportunities for the local stakeholders, maximising multiple benefits from investment in green infrastructure.

The Public Benefit assessment procedure is based on two processes, conducted in parallel, which are scoped to generate two different groups of information, which should be taken into account in the preparation of the strategies.

Process 1

The aim of the first process is to assess the level of availability of public benefits supplied by the territory considered and the relative territorial distribution.

Each benefit from the Public Benefits (PB) list endorsed by the Project was connected to one or more of the Landscape Services (LS)(already used in the WP2), in order to clarify which Public Benefits can be obtained from the landscape we are working on. In the matching process between Benefits and Services, the Services belonging to the “carrier” category are excluded, given their peculiarity and partial redundancy with other Landscape Services.

The compilation of the matrix was guided by the principle of considering the correlations between Landscape Services (provided by the Green Infrastructure network) and Public Benefits guaranteed by these Services. Therefore, general correlations between Public Benefits and Landscape Services were not taken into consideration.

PB-LS matches were established a priori for the entire project in a first general step, but they can be modified based on considerations relating to local situations (which will be declared from time to time). In particular, some connections can be considered or not, depending on the specificity of the local land uses and landscape services.

Subsequently, taking in consideration the matrix defined in WP2, which defines the relations between landscape services and land use typologies, defining their intensity (on a range from 0 to 5). This matrix can be used to produce another matrix that correlates each benefit with each type of land use, expressing a value, calculated as the average of the values attributed to each considered landscape service. To simplify the comparison between the different values, the result is expressed in a scale from 0 to 3. In this way, it is possible to assign, to each land use category, an intensity value of each benefit provided.

On this basis, it is possible to produce a series of maps presenting the distribution of the provision of each benefit in the analysed area from the existing Green Infrastructure network, working on land use maps already used in WP1 and WP2, and the extension of GI as defined in the WP1 maps. Before maps are drawn up, the role of land cover types defined as "GI according to specific circumstances" must be resolved, possibly by preparing two different sets of maps. The mapping of information also makes it possible to evaluate quantitative aspects relating to the entire area as a whole or to specific portions of the territory. Lastly, it is also possible to draw up a map of the so-called "Global Benefits", understood as the combination of all the Public Benefits considered.

It is important to underline that, while for many Public Benefits it is possible to produce maps that express the distribution of the different levels of supply across the territory, for others (such as low carbon transport and energy or investment and employment) the maps are not as effective.

These maps can be combined with other drafted using the matrix connecting Land Cover Types and Landscape Services, dependant on the results of the activities of process 2 of Public Benefit Assessment Tool. In this case, it is necessary to take into account the difference between public Landscape Services (provided to whole society) and private Landscape Services, whose benefits are provided to specific stakeholders (land owners, farmers, quarry owners…).

The use of other, different source datasets, such as reports, regional databases, statistics etc., useful in the assessment of the Benefit availability provided by the GI in a territory, can be put in place in order to integrate this land use-based evaluation. In fact those benefits that cannot be easily described through land use data analysis, can often be better identified using these other data sources.

Process 2

The aim of the second process is to collect the information needed to identify the existing needs and prospects regarding the implementation of the Green Infrastructure network in the area considered, and as much data as possible from the territory and institutional stakeholders on the benefits supplied by the existing Green Infrastructure (in addition to that identified by process 1).

The consultation of the stakeholders identified for the project in each study area, joined in groups according to the best interaction methods (meetings, questionnaires, interviews, etc.) should be planned.

The consultation may cover two topics, discussed separately in two groups.

The purpose of the first group is to gather from institutional stakeholders (mayors, public administrators, officials, others) information about the benefit needs required by the territory. Moreover, information must be collected about the development perspectives of the Green Infrastructure network, on projects or scenarios already formalised and on the expectations for increases in the supply of public benefits (e.g.: the mayor of "Village A" declares the project of creation of a new wooded area on a public property; the Province administration reports the need to increase biodiversity in the agricultural area…etc.).

This assessment can be carried out through the different consultation channels and also through the identification of the main regional and local policies or strategies that directly address the various public benefits or can indirectly determine their implementation (e.g.: a measure of the Rural Development Program targets the realisation of hedges in agricultural areas)

Another way to identify local needs can be based, as discussed before, on spatial/demographic data that also identifies needs, e.g. floodplain data, areas of deprivation, poor air quality mapping, surface sealing rates, tree cover, etc. This kind of data can be used as a basis for the consultations with institutional stakeholders, besides being considered a direct source of information.

The second group aims at gathering information on the presence and location of elements of Green Infrastructure and the relative Public Benefits ("which benefits from which infrastructure"), interacting with both institutional stakeholders and with organisations or with single or associated citizens (e.g.: the Park Authority reports about a network of small wetlands managed for the conservation of a amphibian species; an association signals a pathway useful for teaching activities…etc.).

The information deriving from this type of consultation will constitute an integration of the results obtained from the activities of land use analysis conducted by the Partners, also within the framework of the results of WP2 functionality assessment.

The purpose for this collection of information is, on the one hand, integrating the knowledge of the local existing network of Green Infrastructure, and on the other hand to understand the ways in which green infrastructure and the relative public benefits are considered by local stakeholders.

3 Drafting the Strategy

The strategy must refer to all the results collected in the various phases:

- Transnational mapping (WP1)
- Policy and strategy review (WP1)
- National and Regional mapping (WP1-WP2)
- Field mapping (WP2)
- Naturalness, connectedness and functionality assessment (WP2)
- Public Benefit Assessment (WP3)

In the case study areas of the MaGICLandscapes Project, each group of results was used, though sometimes in different ways.

Transnational mapping and Policy and strategy review

The transnational cartography represented, for all the experiences, a framework tool for large-scale analysis, whose limited detail, however, did not allow the partners to operationally use it in the process of drafting the Strategy.

The analysis of regulatory, planning and strategic tools at EU, National, regional and local level, on the other hand, has been a tool of fundamental importance, allowing partners to frame the strategic guidelines at local level in the context of existing planning at different levels, and to make the best use of the tools and guidelines provided by existing legislation, which vareid greatly between different areas. In some cases, the Green Infrastructure Strategy has to be part of an articulated and complex architecture of planning tools, while in other situations the absence or limited presence of an strong planning for the area made it possible (and necessary) to proceed with greater freedom in the definition of objectives.

National and Regional mapping and Field mapping

In all the case studies, the analysis of the existing situation was based on a regional land use map, significantly more detailed than that provided by Corine Land Cover (CLC) (available at the transnational scale), which allowed the analysis of the territory and the return of information in a more appropriate way. The use of the CLC legend for the definition of the types of land use to be considered as Green Infrastructure did however make it possible to create maps and, more generally, congruent and comparable analyses.

The field mapping, on the other hand, experimented by all the project partners, was not used in strategic planning. In fact, it has been verified that the extent of the field activity necessary for the detailed survey of land use at a very small scale makes this activity suitable for the design of specific interventions, rather than as a tool for large territorial analysis and planning.

Naturalness, connectivity and functionality assessment

The analyses of naturalness and functionality conducted within the project were of fundamental importance for the drafting of the Strategies. In fact, they identified the spatial distribution of the network of existing Green Infrastructure, also taking into account the level of provision of landscape services by current types of land use. This method of analysis also provided tools of great utility, for different partners, in the interaction with stakeholders, with whom it has been possible to work on the basis of clear and objective data.

Finally, the evaluation of connectivity, carried out through the use of GuidosToolbox, provided further evidence of the needs and possibilities of reconnecting the green infrastructure network in the considered territories.

On the basis of the data collected, it is possible to proceed with the zoning process, through the definition of different areas, to be considered in planning. The area subject to planning can be mapped out in different ways, but the identification of the different territorial areas must be functional to the identification of the detailed objectives and, above all, to the location of the corresponding actions.

Public Benefit Assessment

The Public Benefit Assessment process, conducted according to the procedures described in the PBA Tool above, or in other ways depending on the needs and peculiarities of each area of study, made it possible to obtain a clear geographical representation of the availability of public benefits provided to citizens by existing green infrastructure. This information, together with the assessment of the availability of landscape services, enables the evaluation of the existing situation and to identify the needs of the territory.

First of all, the Benefits can be listed in a scale of intervention priorities. Subsequently, a list of actual availability can also be drafted.

For the benefits identified in the first list, the planning and/or strategic tools at a regional or local scale have to be identified. They must be taken into account in the design of the GIs on a local scale, jointly with the National rules.

The MaGICLandscapes Project's activities in all study areas led to the identification of priority benefits, reported below in the order of frequency.

Conservation Benefits	8
Tourism and Recreation	8
Health and well-being	6
Disaster prevention	5
Land and soil management	5
Education	4
Climate change mitigation and adaptation	4
Water management	4
Agriculture and forestry	4
Investment and employment	2

The benefits which were considered as a priority in the study areas of the project are "Conservation benefits" and "Tourism and recreation". It is interesting to note that "Conservation benefits" were identified in the majority of cases at the top of the priority list. This identification must be considered in relation to the type of areas examined (mainly natural or rural areas, with the presence of protected areas, in some cases also of national interest), but it is not secondary to consider that often priority was given to the implementation of natural areas, believing that in this way it is possible to increase the potential of the territory also for other types of benefits.

The target of the strategy: general and detailed objectives

The benefit priorities identified through the consultation activities with the stakeholders, must be taken into consideration in the definition of the General Objectives. Similarly, information on the location and quantification of actual benefits must also be taken into account.

All the different sources can be taken into consideration for the identification of general and detailed objectives

- the analysis of existing planning tools
- the evidence resulting from the environmental analysis
- the expression of preferences/priorities in terms of Public Benefits by the territory

The strategy can be hierarchically organised into general objectives and detailed objectives, differentiated (if necessary) for the different areas defined in the mapping, but a matrix approach has also been used within the Project, to highlight the multiple interactions of each detailed objective with the general objectives defined.

The drafting of a map of the Strategy is a very useful tool, both as a document for disseminating and sharing the strategic choices made, and for summarising information.

The Action Plan

The Action Plan is the implementation of the Strategy: the method used to implement the objectives defined within it. One or more actions represent the implementation of a detailed objective.

To draft the Action Plan, we can define a list of action types that have a correlation with a specific benefit. Whenever possible, it should prioritise win-win actions, defined as actions that respond to different objectives (and are associated with different benefits).

In the Action plan one should insert only the actions for which the principal actor(s) can be defined so that it can be realised, where is the best location and what are the existing and potential sources of funding. This means that you probably can't insert all the objectives defined in the Strategy in the Action Plan, but the Action Plan can be implemented when some actions become feasible. New action plans can always be created as new funding opporutnities arise, thus furhter objectives can be met.

In order to provide a guide for the formalisation and description of the detailed objectives and corresponding actions each identified action should be compiled into a form, containing all the information needed to describe and plan the action. If it isn't possible to fill all the fields, you must reconsider if the action is really feasible under the current conditions.

Lastly, though equally as important as the other steps in the process, is the need to promote the Strategy and Action Plan(s) and keep up the momentum built from stakeholder involvement in the development process.

CHAPTER 2

Green Infrastrcuture Strategies in MaGICLandscapes' case study areas

KYJOVSKO

South Moravia, Czech Republic

Description of the area

Kyjovsko is a region in South-Moravian, Czech Republic. It is an administrative district of municipality with extended competence, named by its administrative centre - city of Kyjov. The region covers an area of 470 km^2 and has about 55,000 inhabitants living in 42 municipalities. It is situated in the lowlands and is characterised by undulating terrain. Most of the region is intensively used, especially for agriculture, resulting in very large, impermeable blocks of arable fields that suffer from wind and water erosion. Due to its warm and dry climate (and the terrain), the region is known for its vineyards, and to a lesser extent for its orchards, which are unfortunately gradually disappearing. Green infrastructure is mainly represented by large woodland complexes in the north and south, some remnants of dry grasslands and the unique but quickly disappearing mosaic of smallholdings. Approximately 20 % of the region is covered by protected areas in the form of NATURA 2000 sites, significant landscape elements or small protected areas.

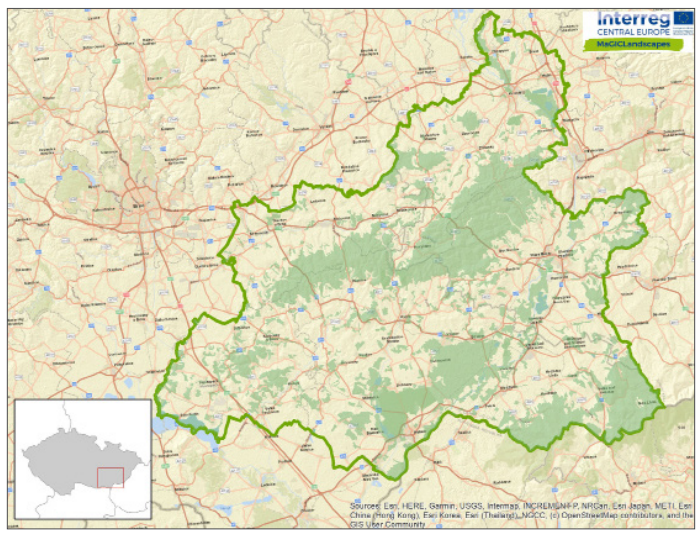


Fig. 1: Map of Kyjovsko case study area

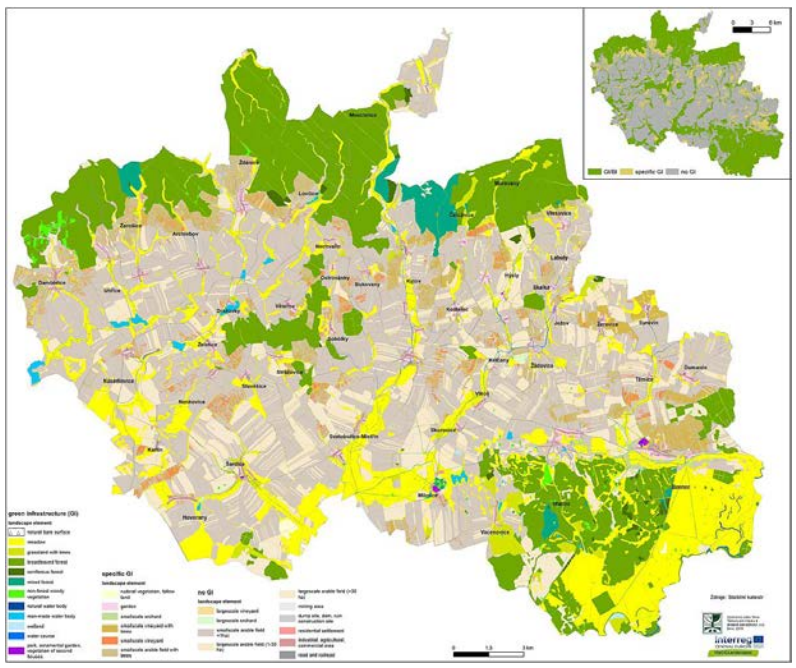
Issues and challenges

Kyjovsko, like other parts of the Czech Republic, was affected by socialist collective agriculture, which manifested itself among other things in land consolidation resulting in destruction of the fine harmonious cultural landscape mosaic. This consolidation dramatically decreased the number of field roads, grasslands and woody strips, woodlots and groups of trees. This has significantly reduced the permeability of the landscape not only for humans but also for wildlife. Another consequence of socialist and contemporary intensive agriculture, and also of ongoing change in climate, is increased soil erosion and the reduced water retention ability of the landscape. The reduced retention function has been perceptibly worsened by agricultural ameliorations (e.g. efforts to accelerate water drainage, watercourse straightening/canalisation and draining of wetlands). There are several challenges related to implementing GI in the region and in order to combat the aforementioned issues. The most pressing one is the fact that the majority of municipalities lack complex land consolidations that allow for implementation of GI. This is often due to the land owners' reluctance to agree with these consolidations and lack of money. Another challenge is to persuade some farmers to implement anti-erosion measures. Last but not least, spatial planning and environmental protection lack complete documentation related to green infrastructure, such as a digital layer of the Territorial System of Ecological Stability (TSES). The TSES is a planned (though not completely realised) network of natural and semi-natural ecosystems that incorporates existing ecosystems and identifies where creating new ones would improve its network function. This includes connectivity, providing habitats to support species survival and increasing the positive effect of natural ecosystems on their less stable surroundings.

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

Based on consultation with local stakeholders, three main priorities were identified within the work packages. Firstly, to identify how to improve permeability of the landscape, secondly, to upgrade data about GI and thirdly to identify gaps in existing GI in order to tackle soil erosion and worsened water retention. Two main maps were created – the map of



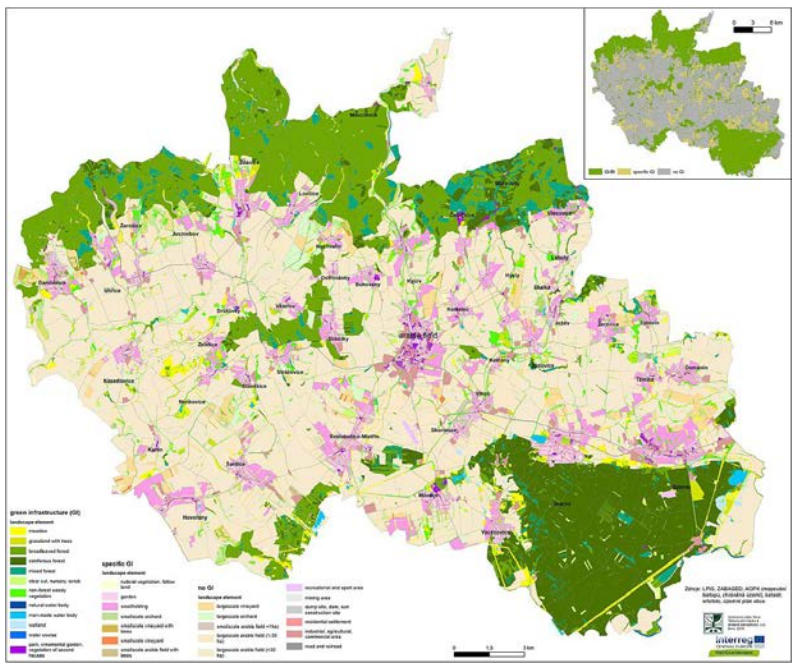


Fig. 2 and 3: Historical (left) and current green infrastructure in the Kyjovsko region

current landscape structure that shows areas with lack of GI and map of historical landscape structure that can serve as an inspiration for restoring GI in these gaps. The map of current landscape structure was based on combination of several sources of regional data and manual digitising, while the map of historical landscape structure was based on stable cadastre.

Stage 2 – Functionality assessment

The Functionality Assessment predominantly focused on identifying areas with low connectivity and permeability. Connectivity can be enhanced by full implementation of the TSES. With regard to the challenges identified, a digital layer of TSES for the whole case study was created and used in a further functionality assessment. It was based on computing Euclidian distances and morphological spatial pattern analysis (MSPA). Maps of Euclidian distances showed mostly areas of large arable fields with low permeability. Further analyses of historical landscape structures revealed where the missing GI elements used to be and could be restored to increase current landscape permeability. MSPA analyses then identified which non-existing elements from TSES would help in increasing connectivity, if realised.

Stage 3 – Assessment of public benefit

Two separate actions were undertaken in order to assess priorities/ areas and benefits. One element dealt with meetings with stakeholders and discussing their needs, the other focused on the assessment of existing strategic documents. Meetings were held with mayors from the region's municipalities as well as the interested public. Both groups of stakeholders identified several areas where GI implementation would help in improving landscape permeability, retention and connectivity. With regards to strategic documents, 27 documents were assessed, with a focus on GI related themes and their relation to benefits. These themes can be grouped to infrastructure (e.g. cycle paths, nature trails, field roads), concepts (e.g. land consolidation, erosion control measures, education), water (e.g. ponds, flood control measures, renaturalisation of streams and rivers), and planting greenery (e.g. village greenery, greenery outside villages, afforestation). Each

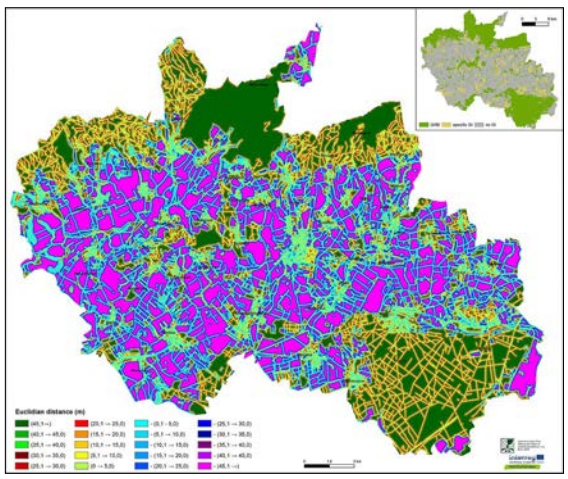


Fig. 4 (left): Map of Euclidian distance (left) revealing localities with impermeable landscape (purple)
Fig. 5: Currently unrealised TSES bio-corridor that would help increase green infrastructure connectivity

GI BENEFIT	STRATEGIC TOOLS/POLICIES	PARTNERS
Land & Soil Management	Community Local development Strategy for Kyjovské Slovácko region Strategic plan, Development Programme/ Strategy for 33 municipalities	Municipalities, MAS Kyjovské Slovácko v pohybu (Local Action Group), Kyjovsko region
Tourism & Recreation		
Education		
Climate change mitigation & Adaptation		
Health & Well-being		
Water management		

Table 1: Strategic tools, policies and partners supporting which green infrastructure benefit group

theme was associated to the several benefits it can produce.

Outline of key topics for the Strategy and Action Plan

Based on the identified needs and problems and other analyses, three main objectives were suggested: better landscape permeability, increase of water retention ability and reduction of soil erosion. These objectives are also, to some degree, included in strategic documents of the region and individual municipalities. They can be subdivided to diversifying landscape mosaic, connecting existing road/ path network (with accompanying GI), enhancing organism migration, creating educational trails, creating/restoring water ecosystems and other GI elements. Their realisation would contribute to benefits stated in the table below. Measures that can help in fulfilling these goals are, for example, the realisation of planned but non-existing TSES elements, planting grassland belts (with and without trees) in erosion prone localities, building cycling paths, restoration of field roads, surveys and mapping of interesting/unique GI elements, building/restoration of wetlands and water bodies, and the renaturalisation of streams and rivers. Historical maps helped in identifying where the previous GI elements as well as where roads used to be and could be restored to help fulfil the goals. The combination of functionality assessment with other sources then enabled the prioritisation of which of the TSES elements should be realised first in order to fulfil the goals.

Fig. 6 and 7: Discussion with stakeholders about identifying localities that would benefit the most GI implementation

Key actors

The key player and main supporter in the delivery of the strategy is the Municipality of Kyjov, Department of Environment and Territorial Planning, who is also an associated partner in the project. They will have all data and outputs from the project and will be able to distribute them in the region. Some outputs will be incorporated into the development/territorial plan of the region. Other actors using the strategy and outputs will be the municipalities who can base their investment plans for GI intervention on the project's outputs.

Expected benefits

Implementing at least some parts of the strategy will help in reducing the current problems that occur in the Kyjovsko region. The benefits resulting from implementations are; improved land and soil management/less soil erosion, an increased water retention ability of the landscape/enhanced water management, better connectivity leading to a higher resilience of the landscape/ecosystems. This implementation will also to provide more recreational opportunities and subsequently better health and well-being of local communities.

Contact

Silva Taraouca Research Institute for Landscape and Horticulture, Brno, Czech Republic
Hana Skokanová
hanka@skokan.net
Website

The regional Green Infrastructure Strategy & Action Plan will be distributed by

Municipal Authority Kyjov
Department of Environment and Territorial Planning
Masarykovo náměstí 30/1
69701 Kyjov
urad@mujkyjov.cz
https://www.vukoz.cz/index.php/en

Fig. 8: View of Bohuslavice village in the Kyjovsko region

DÜBENER HEIDE NATURE PARK

Saxony and Saxony-Anhalt, Germany

Description of the area

The Dübener Heide is a cross-border landscape area on the southern edge of the North German lowlands between the northern Saxony and southern part of Saxony-Anhalt. Key elements are the river valleys of the Elbe and Mulde in the west, north and east. In the north, the Dübener Heide is characterised by the post-mining landscapes, a legacy of the historic extraction of brown coal. The central core of the park is mixed woodland, the largest in Germany

The landscape of heath, bog, marshland, woodland, waterways, ponds, grassland and agriculture is home to a wide range of species including cranes, otters, ospreys and the beaver, the park's symbol. It is also home to people with scattered small settlements and larger towns such as Bad Düben and Schmeideberg. The park is a popular destination for residents and visitors alike. Cultural attractions and events add to the multifunctional attraction of the park. The park is a National Nature Reserve and a Special Protection area.

The Dübener Heide is highly valued by local communities and their contribution to its conservation is both impressive and considerable. With almost 400 members the Verein Dübener Heide e. V. (Dübener Heide Association) is organised into nine local groups. The association has demonstrated the effectiveness of community involvement and ownership of conservation activities in the park and is the perfect example of professional bottom up conservation efforts supported by established and effective funding mechanisms.

Issues and challenges

Although in principle the area offers a well-preserved and diverse green infrastructure, it is important to continue to protect, continuously expand and secure it for future generations, especially so for a tourist recreation area like the Dübener Heide.

There is a partial lack of grey infrastructure that encourages small and medium-sized enterprises to settle in the region (e.g. lack of rail connections). The expansion of broadband and digitalisation as well as the development of cycle paths and other tourism developments are currently ongoing

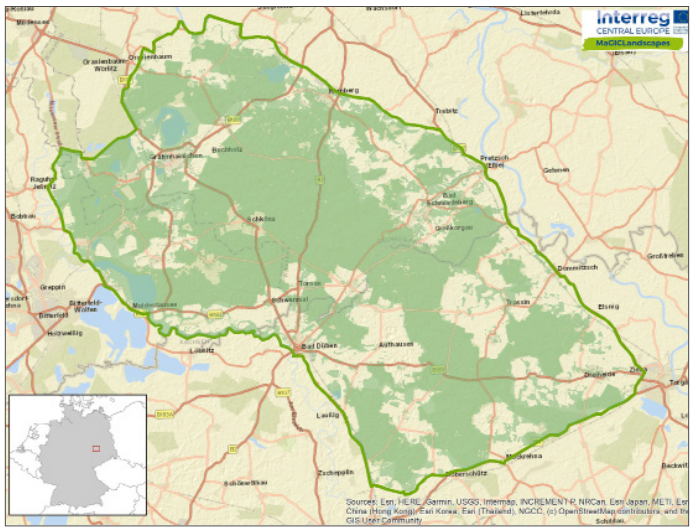


Fig. 1: Map of the case study area Dübener Heide Nature Park

and these plans and developments must be evaluated and possibly adapted with regard to their impact on the existing and future green infrastructure.

The Dübener Heide region is subject to relatively strong demographic changes and migration processes. A lack of perception, identification and access to green infrastructure has also been identified. There are also many challenges posed by climate change such as increasing drought, falling water levels in the bogs, calamities, heavy rainfall events. Through the evaluation of the public benefits for GI and through the workshops and consultations with local actors and associated partners during the project, a deficit was identified in the perception and appreciation of existing and exceptional green structures and elements as well as in the communication and identification with the Dübener Heide Nature Park and the region.

For many of these challenges, the concept of green infrastructure can offer solutions. An analysis of existing guidelines, planning instruments and political strategies showed that a large number of these documents for the Dübener Heide region referenced the elements and benefits of green infrastructure. However, the term or strategic concept of green infrastructure is almost unknown or

applied. Several planning and strategy documents were revised and updated (e.g. the maintenance and development concept for the nature park). This created the opportunity to anchor the concept of green infrastructure, methods and tools developed and tested in the MaGICLandscapes project in planning and contribute directly to the improvement of green infrastructure. The perception and communication of the advantages of the green infrastructure concept is also a challenge and if there is no adequate appreciation, the benefits for people will only unfold to a limited extent and currently communication of the nature park so far only reaches the target groups to a limited extent.

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

The transnational cartographic survey was the first step towards gaining an understanding of land use in the Dübener Heide. The CORINE (Coordination of information on the environment) land cover dataset (CLC) was used for this purpose. It was shown that a large part of the Dübener Heide consists of green infrastructure in the form of woodland (coniferous, mixed and deciduous), meadows, pastures, floodplains, post-mining lakes, rivers, and bogs. Many urban and village structures are interspersed within the green infrastructure and agricultural areas.

At this level of analysis it was already apparent that there was a specific need for networking and connecting the green infrastructure elements, both with each other and the settlement areas.

In a second step, the production of maps with more detailed regional data from Saxony (BTLNK – 2005), Saxony-Anhalt (BTNT - 2009) and Brandenburg (BTLN - 2009) showed a more heterogenic mosaic of land uses and biotopes in the area.

Stage 2 – Functionality assessment

Using the Guidos Toolbox, various connectivity and functional assessments for GI were carried out. Areas of green infrastructure were defined as core areas and their connections, networks, corridors and their location relative to each other were presented as “bridges”, “branches”, “loops” or “islands”. Using this information so-called focus areas were selected for further investigation and mapping and analysis. The Dübener Heide with its near-natural and structure-rich forest core areas, moorlands and many lakes, rivers and streams has good to very good natural connectivity, but these are highly influenced by anthropogenic activities. In addition, many re-naturalisation processes are currently taking place. Nevertheless, the potential for improvements of the green infrastructure was identified in some areas. For example, rows of trees, hedges and shrubs could be created along local roads connecting the core areas of the green infrastructure. The agricultural landscape could also be adapted to help connectivity, as well as other ecosystem services. The floodplain areas along the rivers Elbe and Mulde and the numerous streams also represent important habitats and habitats that perform a wide range of ecosystem services

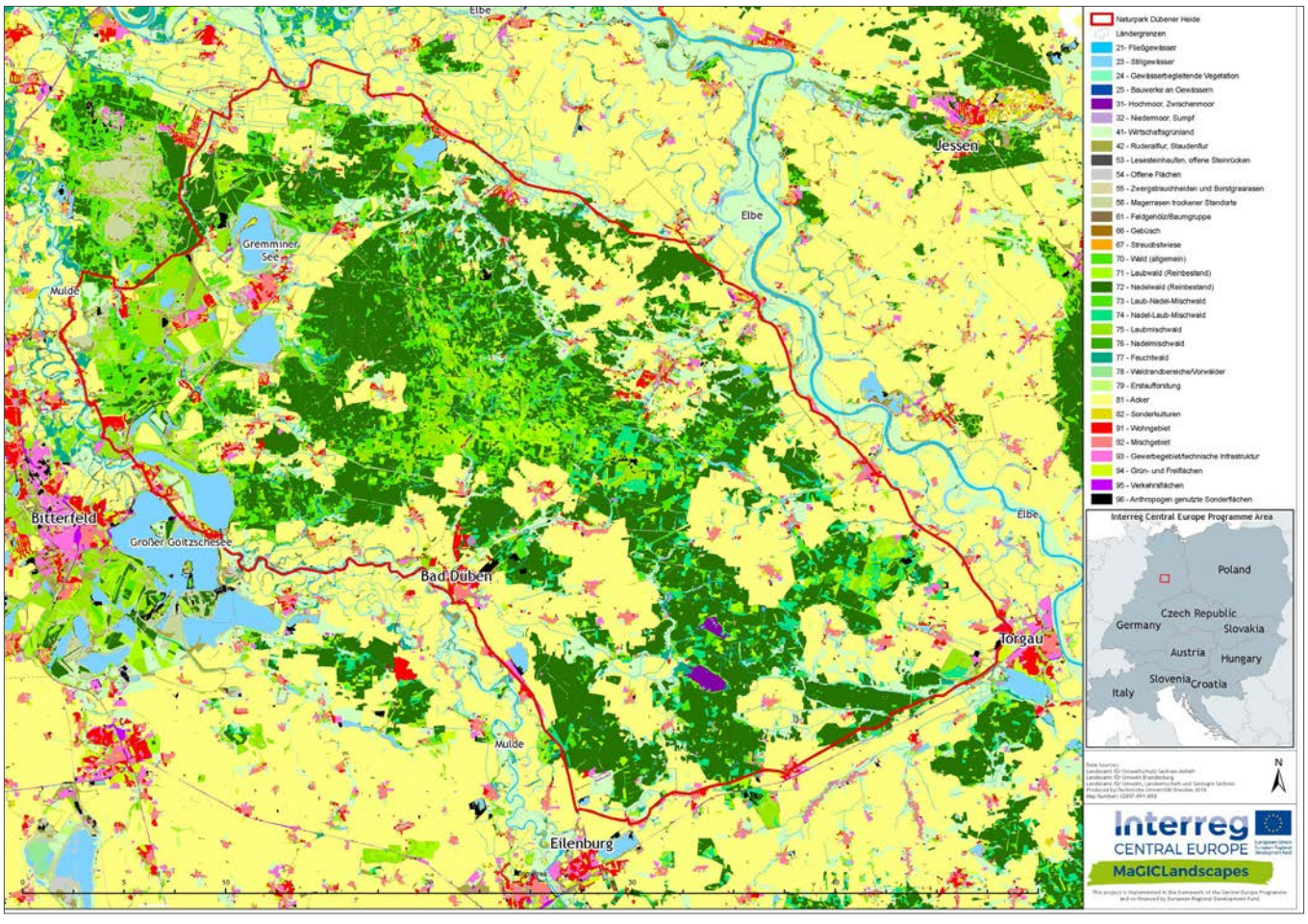


Fig. 2: Regional green infrastructure map of Dübener Heide Nature Park and surroundings

and could be improved and protected. Another important aspect is the creation and maintenance of near-natural green spaces in settlement areas and the connection of urban areas with the immediate surroundings and core areas of green infrastructure.

Stage 3 – Assessment of public benefit

Two workshops were held with local stakeholders including the nature park administration, regional management, regional planning associations and landscape conservation associations. In addition many consultations and discussions with associated partners took place on site. During these meetings the strengths, needs, risks and opportunities for the expansion and improvement of GI were specifically identified and demonstrated (e.g. by thematic mapping on large-scale maps of the Dübener Heide).

Current and future projects, development perspectives and various scenarios were also discussed as were expectations of increasing the supply of public services. Information on where valuable elements of green infrastructure are located and how the respective public benefits are currently assessed, as well as the process of updating the nature park plan, also played an important role in the discussions. During discussions it became apparent that there is a particular deficit in communication, perception and identification with GI in the Dübener Heide Nature Park and surrounding areas.

At the end of the first process of the PBA tool it was possible to produce a series of maps showing the geographical distribution of the public services provided by the GI network and the benefits derived from them.

Outline of key topics for the Strategy and Action Plan

As a result of the processes carried out, five main themes were defined for the strategy and action plans for the expansion and improvement of green infrastructure in the Dübener Heide Nature Park. Firstly, involving and informing residents about the benefits of GI and connecting people with nature (in terms of health and well-being and tourism and recreation). Secondly, improving the perception and value creation as well as the communication and identification with GI in the region. These first two themes were addressed through the development of the Communication Concept “Increasing the perception of the advantages and functions of green infrastructure in the Dübener Heide Nature Park”). With this concept, target groups that have not yet been reached are specifically addressed and the advantages of green infrastructure can be communicated. In addition to an analysis of the current situation (SWOT), the concept provides strategic recommendations and proposals, on the basis of which concrete Projects and measures on the Social media channels from the nature park administration can be implemented.

A third theme is access to, and connection with the existing green infrastructure. A further focus is education for sustainable development and the topic of expanding and

Fig. 3 (above): Discussing with stakeholders potential actions how to enhance the existing GI network
Fig. 4: Green infrastructure along cycle routes in the Nature Park

improving elements of GI. Finally, adapting and reacting to climate change is also a major theme.

Spatially, the cities and settlements in the Dübener Heide and their connection to the surrounding core areas of green infrastructure are of particular importance. A key role is played by the management of the nature park. As a result, the following table was compiled, which reflects the advantages of GI according to priority and the strategies and partners involved for the Dübener Heide.

Key actors

The main actor for the implementation and execution of the strategy and action plans for the expansion and improvement of green infrastructure in the Dübener Heide nature park is the nature park administration. In cooperation with the two planning offices (Saxony and Sachsen-Anhalt), which are responsible for the creation of the Maintenance and Development Concept, many contents of this strategy as well as the concept of the GI could be included and serve as guidelines and orientation for further planning and projects for the next 10 years. In the same way, participating landscape management associations, the regional planning associations and the nature conservation authorities will be able to use parts and findings of this strategy for their future work.

GI BENEFIT	STRATEGIC TOOLS/POLICIES	PARTNERS
Health & Well-being	Regional Plan Leipzig-Western Saxony Networked mobility Dübener Heide District Development Concept 2030 North Saxony LEADER Development Strategy (LES) Dübener Heide Maintenance and Development Concept for Dübener Heide Nature Park (PEK) Location Marketing Concept Dübener Heide	Dübener Heide Nature Park Cities and municipalities Regional Management Dübener Heide Heath Spa
Climate change mitigation & adaptation	German Strategy for Adaptation to Climate Change Regional Plan Leipzig-Western Saxony Integrated Climate Protection Concept Integrated Urban Development Concept (InSEK) LEADER Development Strategy (LES) Dübener Heide Maintenance and Development Concept for Dübener Heide Nature Park (PEK)	Dübener Heide Nature Park Cities and municipalities Regional Management Dübener Heide Nature conservation authorities
Tourism & Recreation	Cycle Traffic Concept of the district of North Saxony Networked mobility Dübener Heide LEADER Development Strategy (LES) Dübener Heide Maintenance and Development Concept for Dübener Heide Nature Park (PEK) Location Marketing Concept Dübener Heide	Dübener Heide Nature Park Cities and municipalities Regional Management Dübener Heide Tourism managers
Conservation benefits	Biotope Network Saxony (Biotopverbund) Biodiversity Saxony 2020 Maintenance and Development Concept for Dübener Heide Nature Park (PEK)	Dübener Heide Nature Park Cities and municipalities Regional Management Dübener Heide Nature conservation authorities Landscape conservation associations Nature protection NGOs (NABU, BUND)
Disaster prevention	River Development Concept North Saxony Regional Plan Leipzig-Western Saxony Maintenance and Development Concept for Dübener Heide Nature Park (PEK)	Dübener Heide Nature Park Cities and municipalities Regional Management Dübener Heide Water management bodies
Education	Education for Sustainable Development (ESD) Maintenance and Development Concept for Dübener Heide Nature Park (PEK)	Dübener Heide Nature Park Cities and municipalities Regional Management Dübener Heide Nature Park schools

Table 1: Strategic tools, policies and partners supporting which green infrastructure benefit group

Expected benefits

The strategy for green infrastructure in the Dübener Heide Nature Park and the associated action plans will make an important contribution to improving future living conditions in the region. In addition to the benefits for health, quality of life and recreation, tourism in the region will also be promoted by improving the accessibility and access to GI. The diverse and valuable flora and fauna will be protected by the implementation of the GI concept as well as the inhabitants of the Dübener Heide from reduced vulnerability to natural disasters such as floods or the negative effects of climate change. Moderation processes between nature conservationists, agriculture and forestry can also be initiated to find sustainable solutions for a sustainable region, also in the sense of education for sustainable development.

Contact

Academy of the Saxony State Foundation for Nature and the Environment, Dresden, Germany
Sven Riedl
sven.riedl@lanu.sachsen.de
https://www.lanu.de

Naturpark Dübener Heide e. V.
Thomas Klepel

t.klepel@naturpark-duebener-heide.de
https://naturpark-duebener-heide.de

Fig. 5: Characteristic landscape of Dübener Heide Nature Park

KARKONOSZE NATIONAL PARK AND JELENIA GÓRA BASIN

Lower Silesia, Poland

Description of the area

The Jelenia Góra Basin, together with the surrounding Karkonosze, Rudawy Janowickie and Kaczawskie Mountains, is a special landscape, beautiful and valuable both from the natural and cultural point of view. The turbulent history of this region, changes in the national identity and related influences of different nations and customs has resulted in a diverse cultural landscape, shaped in an area of above average natural value. Towns and villages nestle among a natural mosaic, consisting of mountains and valleys, forests and fields as well as marshes and ponds. The largest city in the valley - Jelenia Gora (about 75,000 inhabitants), forms an agglomeration with cities lying at the foot of the Karkonosze Mts. (Kowary, Karpacz, Piechowice and Szklarska Poreba - between 5,000-10,000 inhabitants) and also with villages of very different sizes. The green areas are well preserved and varied, which is of great importance for the protection of biodiversity and landscape. They include elements both strongly shaped by man: urban parks, squares, allotment gardens, as well as economic forests, agricultural areas, and semi-natural and natural ecosystems in the highest parts of the mountains. The most valuable areas have been included in the Natura 2000 network, including the Karkonosze National Park - the area with the largest nature protection regime in Poland. The area of the Jelenia Góra basin is also known as the "The Valley of Gardens and Palaces". - with palace and park complexes of the highest historical and cultural values. The most important factor in the development of the area has become tourism, the intensity of which can be observed in the area of the Karkonosze (Karpacz, Podgórzyn, and Szklarska Poręba). In Jelenia Góra, the main city in the area, industrial zones and service centres are more important.

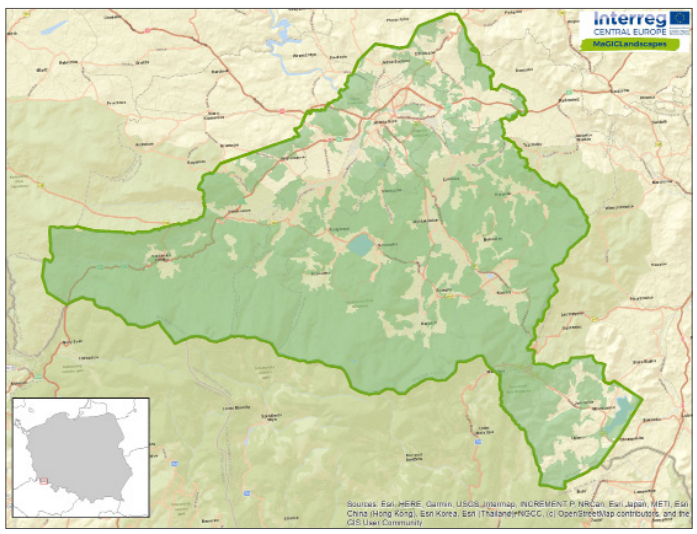


Fig. 1: Map of the case study area Karkonosze National Park and Jelenia Góra Basin

Issues and challenges

The intensive development of tourism, seen during the economic transformation of the 1990's as a basis for development for the region, has recently been recognised as a threat for local nature. It is estimated that the region is visited by about 4 million tourists per year, of which the Karkonosze Mountains alone attract over 2.5 million. The Karkonosze National Park has the highest density of hiking trails of all of the Polish national parks and some of the most attractive places, such as the highest peak of Sniezka (1,603 m), which at the same time the highest natural value. The most valuable ecosystems and unique species are relatively easily accessible and subject to tourist pressure practically all year round, both in summer (hiking) and in winter (skiing). Negative influence is connected with constant presence of people, trampling places off the trails, litter and also with inefficiency of water and sewage management in mountain hostels. A consequence of the tourist pressure is also the expansion of sub-montane areas, especially large buildings: hotels and apartments. The ease of transforming agricultural land, especially mountain meadows, which, as a result of the withdrawal of agriculture, are used for building development, results not only in the impoverishment of habitats, but also in the fracturing of local ecological corridors. In the areas abandoned by agriculture, invasive vegetation appears. More and more frequent periods of drought combined with intensive water uptake from the mountain results in a lack of natural flow. Regulated rivers, especially in urban areas, increase the speed of the outflow of water. There is less and less retention due to the development and drying-out of

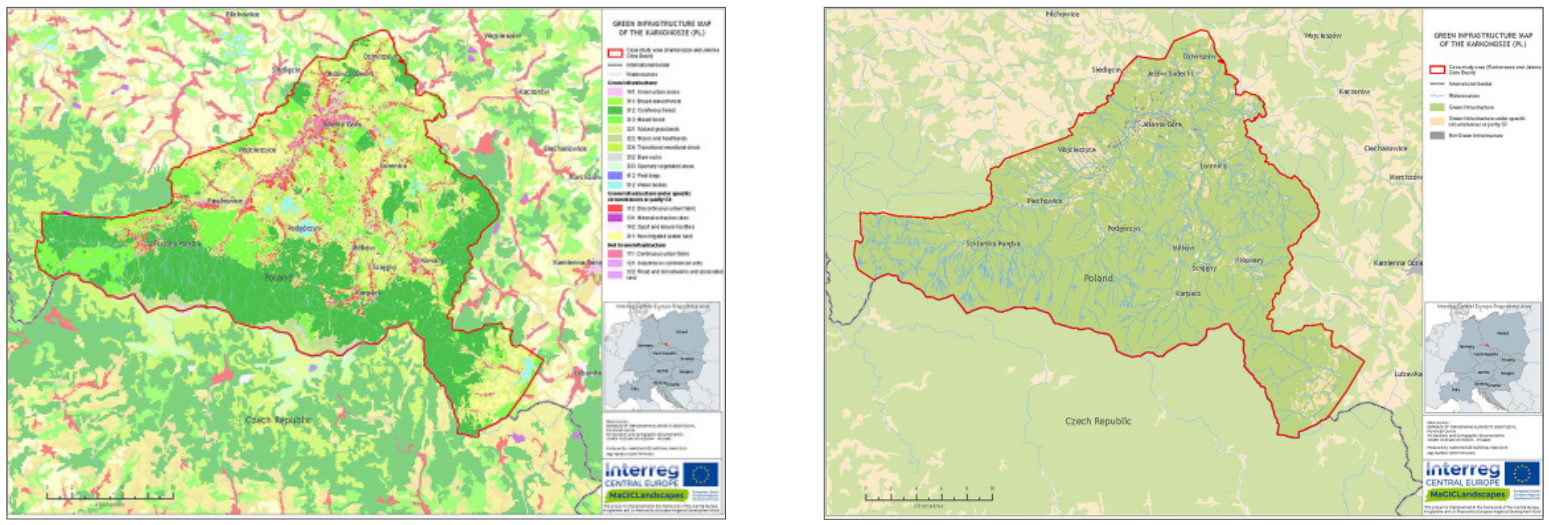


Fig. 1 (left): Regional green infrastructure map of the case study area based on regional biotope data
Fig. 2 (right): Green infrastructure map regarding GI (green), no GI (grey) and GI under specific circumstances (beige)

wetlands, drainage of land and drainage of rainwater directly into storm channels.

A big challenge for the development of green infrastructure is its popularisation and implementation in the spatial planning process. Due to the lack of legal rights for green infrastructure, this challenge is mainly related to its promotion both among the region's authorities, investors and residents. The challenge is to convince everyone how many benefits are delivered by the creation of sustainable investment concepts and local plans, which, in addition to the grey infrastructure, preserve or create multifunctional elements of the GI, secure compensatory actions or landscape values. The challenge in areas where greenery is relatively abundant and accessible is to preserve it by setting boundaries for sustainable landscape use. Sometimes it is much easier to gain support for costly implementations based on green infrastructure than to maintain elements of already existing natural greenery. The challenge is also to introduce GI topics, ecosystem services, into education that, in addition to knowledge of the benefits of GI, would create a sense of spatial order and explain the role of public participation in the spatial planning process.

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

This stage was the first step to understand the idea of green infrastructure, an opportunity to check if and how it functions in Polish law and policies developed in the region. This stage also included the identification of the GI network in the area of Karkonosze and Jelenia Góra Basin. On the basis of available GIS data maps were produced, which show the spatial distribution of GI elements and places where GI is missing. For this purpose, the publicly available data of CORINE area coverage and topographic data 1:10 000 were used. For the mesoregion of the Karkonosze Mts. an additional detailed ecosystem map was created, for which the European classification system EUNIS (level 3) was applied. For this area, elements of green infrastructure such as linear woods, marshes, field borders, buffer zones along streams were also mapped. The knowledge on the ecological functions of these small GI elements is still too low. It was increased during workshops, where local governments and institutions responsible for shaping the GI in our region met. One of the main conclusions of the workshop was that it is necessary to implement the idea of GI in spatial planning as soon as possible in order to maintain ecological connnectivity, to protect functionally important elements of GI and – what is important in the mountains - landscape values. Additionally, during consultations with stakeholders, the need to develop a strategy how to keep meadow habitats located in lower locations of the Karkonosze, within the Natura 2000 area, was stressed.

Stage 2 – Functionality Assessment

The essence of green infrastructure, which also comes from its definition, is to shape the GI as a network. The links are important both for the migration of animals and plants (ecological corridors), but also for man (potential for marking out green routes: bicycle paths, walking routes). The analyses made in the GUIDOS program illustrated the condition of the GI network in the area and indicated areas important for maintaining connectivity e.g. between Natura 2000 areas. Additionally, planning documents from all municipalities were analysed in order to assess potential threats to connectivity in the case of implementation of planning records. In some places it may be completely interrupted or significantly reduced by new developments. Appropriate legal implementation is needed to protect these strategic connectivity sites. The functionality of green infrastructure based on landscape services has also been assessed. Due to the fact that the GI areas occupy about 70 % of the CSA and a significant proportion of them are forest areas, and high values of landscape services have been recorded in a relatively large area. Places where it is advisable to take measures to strengthen e.g. regulatory services mainly concern dense urban development or industrial and commercial areas.

Stage 3 – Assessment of public benefit

Fig. 3 (left): Developing cycling routes as “green routes” is one of the main needs of the area
Fig. 4 (right): Mountain meadows as habitats and part of ecological corridors used by deer

The services provided by ecosystems are human benefits. Therefore, it is very important to show the value of green areas through the prism of specific benefits. The associated partners of the project in the framework of the consultations indicated the following priorities: clean air, prevention of natural disasters, and improvement of water management and preservation of the aesthetic features of the landscape. Nature protection institutions also mentioned the need to maintain and shape ecological connectivity as a condition for biodiversity. A survey was also conducted among the inhabitants of Karkonosze towns and cities. In this group, air quality, the influence of greenery on the harmony and beauty of the landscape, water retention and purity were also repeated. There were also proposals for actions that support these benefits: revitalisation of existing parks, squares, planting of trees, e.g. species characteristic for the village. Some of the tasks can be carried out within the commune, in cooperation with active communities, the others require inter-communal cooperation with many institutions or landowners, e.g. planning a network of bicycle paths or protecting ecological connectivity.

Outline of key topics for the Strategy and Action Plan

One of the key benefits of the project itself and the beginning of one of the strategy’s objectives was the creation of a cross-sectoral forum where the needs of shaping green infrastructure were discussed in the form of workshops. In the region of the Karkonosze and Jelenia Góra Basin the GI areas are quite well preserved and are largely under area protection, so most of the proposed actions focus on how to preserve the GI in the face of pressure from tourism, buildings or climate change. These are quite difficult topics, as they are usually related to the introduction of restrictions and the need to define the boundaries for maintaining healthy ecosystems and functioning networks. These topics are close to institutions responsible for nature protection, but also more and more often to local associations, which care about preserving the natural and landscape values of the places where they live. The plans of local governments are primarily related to the maintenance, revitalisation or creation of urban green areas and thus adaptation to climate change. Therefore, the most important goals of the Strategy include: shaping ecological connectivity and improving the state of biodiversity, improving water management, implementing the GI concept in improving local spatial planning and building partnerships for the GI in the region.

Fig. 5 and 6: Local stakeholders participating in the workshops for creating an enhanced green infrastructure network

GI BENEFIT	STRATEGIC TOOLS/POLICIES	PARTNERS
Conservation benefits	Plany ochrony parku Narodowego, parków krajobrazowych, obszarów Natura 2000	Regionalna Dyrekcja Ochrony Środowiska Dolnośląski Zespół Parków Krajobrazowych Karkonoski Park Narodowy
Health & Well-being	Strategia rozwoju Miasta Jeleniej Góry na lata 2014-2025 Lokalny Program Rewitalizacji Gminy Podgórzyn na lata 2016-2023 Gminny program rewitalizacji dla Szklarskiej Poręby 2016-2023 Lokalny program rewitalizacji gminy Karpacz na lata 2016-2020 Program Ochrony Środowiska Gminy Miejskiej Kowary	Miasto Jelenia Góra Gmina Podgórzyn Gmina Szklarska Poręba Gmina Karpacz Gmina Kowary Gmina Piechowice Lokalna Grupa Działania Partnerstwo Ducha Gór
Water management	Kompleksowy projekt adaptacji lasów i leśnictwa do zmian klimatu – mała retencja oraz przeciwdziałanie erozji wodnej na terenach górskich	PGLLP Nadleśnictwo Szklarska Poręba, Śnieżka PGW Wody Polskie Zarząd Zlewni w Lwówku Śląskim
Education	Statut Towarzystwa Statut Stowarzyszenia Sołecka Strategia Rowoju Wsi, Statut	Zachodniosudeckie Towarzystwo Przyrodnicze Stowarzyszenie Ochrony Krajobrazu i Architektury Sudeckiej Stowarzyszenie Karkonoskie Zachełmie

Table 1: Strategic tools, policies and partners supporting which green infrastructure benefit group

Key actors

Many of the key institutions and local governments in the Karkonosze and Jelenia Góra Basin have been involved in the preparation of strategies and action plans. In addition to the associated partners defined in the project, it was possible to involve active residents - members of associations that implement many projects supporting the GI. The GI Strategy is the first study on green infrastructure in the region, which as well as providing general directions for the future also demonstrates specific implementation ideas. We hope that they will become a mutual inspiration for further actions, help in updating the planning documents and elaboration of plans e.g. city climate change adaptation plans, in which green infrastructure is one of the most important tools.

Expected Benefits

The implementation of strategies and action plans will allow us to maintain the attractiveness of the landscape and natural resources of the region. Maintaining green links and open areas not only enables the migration of animals, but also shapes the spatial order, preventing the dispersion of buildings, which burdens additional costs on local governments. Any measure improving landscape retention may prove to be a priority for the difficult to predict effects of climate change. The benefit in regulating the urban climate can be gained by revitalising and increasing the area of green spaces in cities, which will also improve the quality of life of residents. Cross-sectoral partnership, the promotion of public participation and the expansion of education on the functions and benefits of GI can result in further projects to improve GI and will indirectly also strengthen local identity for residents.

Contact

Karkonosze National Park, Jelenia Góra, Poland
Dorota Wojnarowicz
dorota.wojnarowicz@kpnmab.pl
https://kpnmab.pl

KRKONOŠE MOUNTAINS NATIONAL PARK AND SURROUNDING AREA

Liberec Region and Hradec Králové Region, Czech Republic

Description of the area

Krkonoše Mts. National Park (KRNAP) is oldest National Park in the Czech Republic. This mountainous, unique and valuable protected area encompasses a wide variety ecosystems and landscapes. Those landscapes include the lowlands of villages, fields and pastures, mountain mixed and spruce forests containing highly biodiverse meadows and arcto-alpine tundra characterised by natural grasslands with dwarf pine shrubs on the upper slopes and sparsely vegetated areas on the highest peaks.

The main purpose for the park's designation is its geo-biodiversity, variability of the landscape and many species including those endemic to KRNAP such as the IUCN Red List Campanula bohemica and glacial relicts such as the Bluethroat (*Luscinia svecica svecica*). KRNAP has also been listed as a UNESCO Biosphere Reserve, Special Protection Area, and Site of Community Importance and is under the Ramsar Convention.

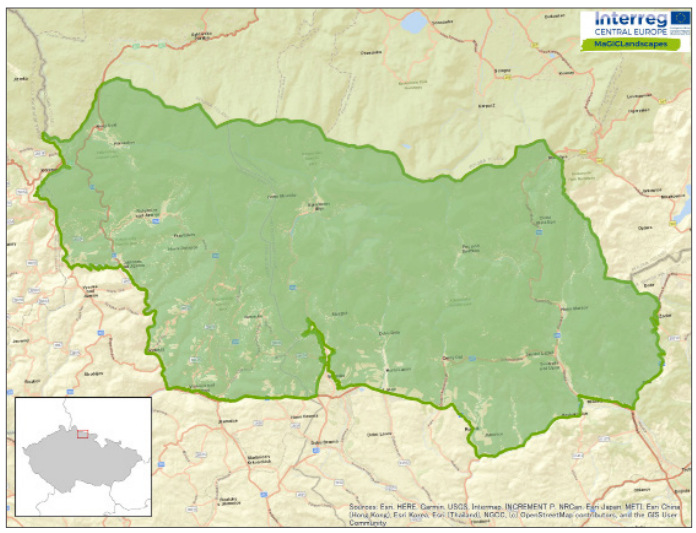


Fig. 1: Map of the case study area Krkonoše Mountains National Park and surrounding area

Issues and challenges

Despite the valuable biodiversity and many protected species, KRNAP has been declared by the IUCN as a one of the most endangered national parks. Air pollution was a significant issue in the past decades. Nowadays there are problems connected with development pressure (housing, hotels, ski centres), heavy tourism and climate change, with many valuable ecosystems and species exposed to the threat of drought. The advancing treeline is also increasing pressure on the fragile tundra ecosystem. Increasing tourism and the associated infrastructure (transportation, ski lifts and slopes etc.) have led to further landscape fragmentation and created barriers, reducing the ability of large mammals to move through the landscape.

Krkonoše Mts. National Park faces a number of challenges. A key challenge lies in finding a common approach for all stakeholders (National Park and Protected areas Administrations, municipalities, etc.) in the park and its surroundings. Secondly it is necessary to improve connectivity and the functionality of green infrastructure in the whole region. The cross-border (Czech and Poland) location of the park means bilateral implementation and financing of mutual projects between municipalities, Parks Administrations and municipalities on both sides of the border is fundamental. Last but not least it still remains a challenge to persuade some stakeholders of the benefits of green infrastructure, especially those benefits which are not obvious to stakeholders or associated with their roles and responsibilities.

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

A series of discussions with local (municipalities, businesses, ski centres), regional (regional and districts administrations) and national (Ministry of Environment, universities and research institutions) stakeholders identified key priorities for GI of KRNAP case study area. They include preserving biodiversity, reducing fragmentation without reducing the recreation functions of the landscape, improving water management in the landscape and mitigation against climate change.

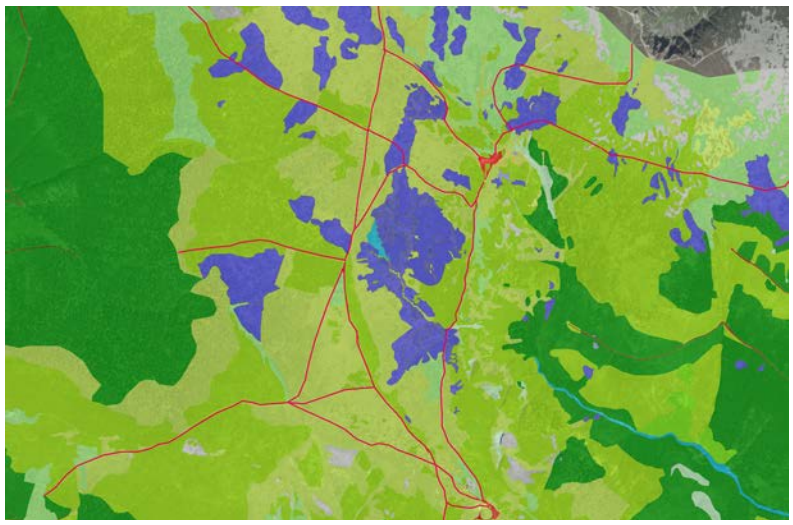


Fig. 2 (left): Peat bogs are an important habitat, seen here in purple among the Arctic-alpine tundra of grassland and dwarf pines in green, and are heavily fragmented by a dense network of tourist paths shown in red.
Fig. 3: Landscape structure of lower parts of the case study area. The thin strips of woodland shown here help to connect habitats for key species.

These discussions were supported by fundamental legal and strategic documents investigated in the policy review including Acts No. 114/1992 Coll., on the conservation of nature and landscape and No. 289/1995 Coll., on forests and on amendments to some acts (the Forest Act) and the Plan for Maintaining the Krkonoše National Park and its Buffer Zone. Regional and local maps of GI based on various geographical data created in the transnational assessment also supported discussions and included the consolidated layer of ecosystems of the Czech Republic (KVES ČR) perhaps one of the most important of background information sources.

Stage 2 – Functionality Assessment

The next stage was to analyse the landscape functionality using the outputs of Work Package 1 (mapping) and simple to use software. Using the results of the GI functionality analyses, specifically connectivity, habitat function and fragmentation indexes, key landscape services were identified as well as locations characterised by a reduced functional value, which in turn provided focus areas.

Although KRNAP appears on the surface to have high values for most landscape services, there is a risk of this decreasing due to high level of landscape fragmentation in the lower areas, those surrounding the main tourism centres. The habitat and refugium functions are most at risk. It necessary to keep original landscape structure (formed by strips of woodland – see Fig. 2) in the lower parts to connect areas with other protected areas in the region.

Stage 3 – Assessment of Public Benefit

The assessment of public benefits was helped by the existing long-term cooperation between KRNAP Administration, the most important authority regarding nature conservation in the park, and others local and regional stakeholders.

The key topics of green infrastructure were discussed during regular meetings with the mayors of municipalities and the representatives of the KRNAP Administration in Vrchlabí.

The most important issues surrounding GI have been incorporated into the production of statutory strategic documents for which the KRNAP Administration is responsible.

This was necessary because nature conservation authorities prioritise “environmental” benefits (conservation and biodiversity, water management), while most municipalities and others (e.g. ski centres) favour those GI functions and benefits associated with recreation and tourism.

The identification of the significant benefits of GI was supported by the outputs of Work Package 2 (functional landscape analyses) and other research and preceding long-term monitoring results arising from many internal and external projects. This research also helped identify GI elements and locations with the largest intersection of multi-sector of benefits were to be found. Field trips with local authorities proved to be very useful tool in explaining the benefits and functions of green infrastructure (Fig. 3).

Outline of key topics for the Strategy and Action Plan

Based on the previous stages and assessments the key themes and priorities of the green infrastructure strategy were identified. One of those key themes is Preserving Biodiversity and Nature Conservation to maintain the natural value of area and the various endemic and relic species. To fulfil this goal the management of key ecosystems and refuges will be necessary. In valuable arcto-alpine tundra ecosystem the park will fell the Pinus mugo shrubs (planted during last centuries) to support other protected floral and faunal species. The second planned action for this habitat is tourism management. During the nesting period in spring some selected trails will be closed and visitors will be directed to other tracks and locations. Additional measures such as projects that realise the renewal of grazing and appropriate mowing regimes will also ensure the perseverance of the mountain meadows and their biodiversity interest.

GI BENEFIT	STRATEGIC TOOLS/POLICIES	PARTNERS
Conservation benefits	Plán péče o Krkonošská národní park 2010 – 2020 (Zásady péče 2021 – 2040) Zásady územního rozvoje a Strategie Královéhradeckého a Libereckého kraje NATURA 2000 ÚSES a ÚP obcí na území KRNAP Zákon 114/1992 Sb.	Krkonoše Mountains National Park Administration Hradec Králové Regional Authority Liberec Regional Authority Trutnov, Jilemnice, Vrchlabí, Semily, Tanvald Municipalities with extended powers Czech Ministry of the Environment Other municipalities
Tourism & Recreation	Plán péče o Krkonošská národní park 2010 – 2020 (Zásady péče 2021 – 2040) Integrovaná strategie rozvoje regionu Krkonoše 2014 – 2020 (s výhledem do roku 2030) Strategie rozvoje Královéhradeckého a Libereckého kraje	Krkonoše Mountains National Park Administration Krkonoše – Alliance of towns and municipalities Municipalities Hradec Králové Regional Authority Liberec Regional Authority
Water management	Plán péče o Krkonošská národní park 2010 – 2020 (Zásady péče 2021 – 2040) Strategie rozvoje Královéhradeckého a Libereckého kraje	Krkonoše Mountains National Park Administration Czech Ministry of the Environment Municipalities
Health & well-being	Integrovaná strategie rozvoje regionu Krkonoše 2014 – 2020 (s výhledem do roku 2030) Strategie rozvoje Královéhradeckého a Libereckého kraje	Krkonoše Mountains National Park Administration Krkonoše – Alliance of towns and municipalities Municipalities Hradec Králové Regional Authority Liberec Regional Authority

Table 1: Strategic tools, policies and partners supporting which green infrastructure benefit group

The second, though equally important, theme is landscape fragmentation and increasing connectivity. Krkonoše Mts. National Park is a one of the most visited protected areas in Europe, placing significant pressure on valuable ecosystems (i. e. arcto-alpine tundra) and is causing the fragmentation of protected key species habitats, such as those for Eurasian Lynx (*Lynx lynx*) and Black Grouse (*Tetrao tetrix*) for example. The KRNAP Administration are preparing (together with municipalities and district authorities) a new Territorial System of Ecological Stability to help migration for many species and for habitat creation. The creation of new black grouse habitats is another action to help reach this objective.

Fig. 4: Field trip with stakeholders to discuss public benefits and landscape services of key GI elements, in this case a forest meadow in Sklenářovice.

KRNAP provides many educational benefits, such as how nature and GI can help us and provide us with many services and benefits. Management of sustainable tourism based on field education is one way how we can protect the most valuable parts of the area. The construction of new education trails with views and other attractions and the reconstruction of current paths will support this objective.

Last, but not least, the themes connected with climate change and mitigation are a pressing issue and actions to water retention support were identified by all key stakeholders in the case study area. One key action to be undertaken is to address this is the building of small dams in aquatic ecosystems (springs, peat bogs). The list of the key benefits and priorities is shown in the Table 1.

Key actors

The selected goals of the Strategy have been incorporated into the fundamental strategic and statutory document of Krkonoše Mts. National Park – Plan for Maintaining the Krkonoše National Park 2021-2040. This is statutory document for all municipalities and other stakeholders in the case study area. The strategic plan for connectivity support (TSES) was adopted by the responsible authority of municipalities with extended powers (Trutnov, Jilemnice, Vrchlabí, Semily,

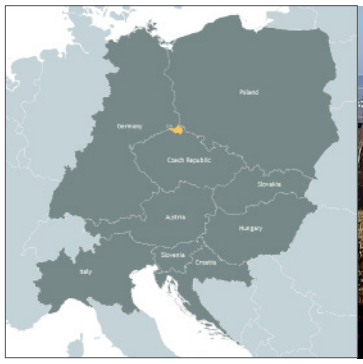
Tanvald). Most of municipalities committed to implement TSES for habitat and landscape connectivity support into their territorial planning.

Expected benefits

By implementing the strategy the connectivity of landscape and habitats of key species will increase helping to preserve some threatened species through the defragmentation of the landscape. The landscape will become more resistant to drought and climate changes. Importantly the negative impacts of tourism and recreation will be reduced and the role of the park as an education resource will be enhanced.

Contact

Krkonoše National Park Administration, Vrchlabí, Czech Republic
Martin Erlebach
merlebach@krnap.cz
https://www.krnap.cz



TRI-BORDER REGION CZECH REPUBLIC – GERMANY – POLAND

Liberec Region, Czech Republic, Saxony, Germany, and Lower Silesia, Poland

Description of the area

The case study area of the three-border region Czech Republic-Germany-Poland stretches from Bohemian Switzerland in the west through the Zittau and Lusatian Mountains to the Iser Mountains in the east. An important landscape feature is the River Neisse and its tributaries. This network of waterways connects the three countries and passes through mountainous areas with forests, peat bogs, rocky areas and mountain meadows and the lowlands with their settlements (e.g. Zittau and Liberec) and agricultural areas. Open cast lignite mining still impacts this landscape, with the Turów mine being the largest.

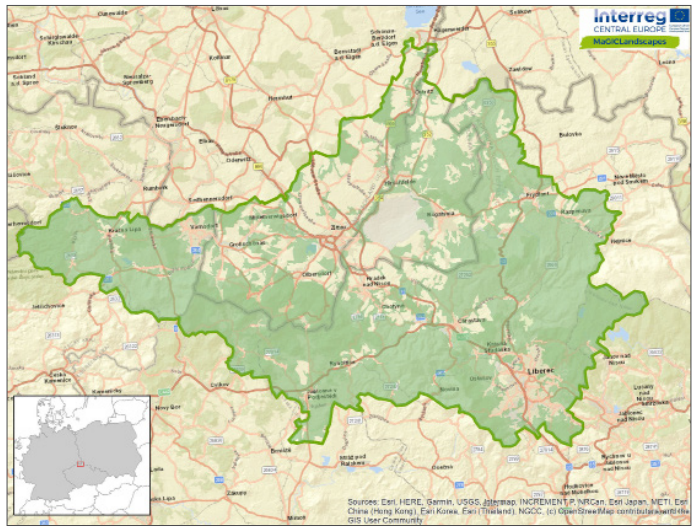


Fig. 1: Map of the case study area Tri-border region Czech Republic-Germany-Poland

Issues and challenges

The region is an important ecological corridor between the national park regions of Saxon-Bohemian Switzerland and the Giant Mountains. However, between the Zittau/ Lusatian Mountains and the Jizera Mountains, elements of green infrastructure (GI) are often not sufficiently connected. Urban and peri-urban areas are characterised by a lack of green spaces and contain abandoned or unused areas offering very few benefits. The area has a lot of straightened or channelised rivers that can increase the risk of flooding for downstream areas and the floodplains have limited biodiversity and/or multifunctionality.

A key challenge surrounds the issue that the term GI and concept is understood very differently by different actors or is even unknown to some stakeholders in the case study area. In addition, all three countries have their own biotope network system, individual formal planning systems, each with different legal basis, and various geodata on land use, often differing in projection and content. All this currently makes cross-border planning of GI difficult. Informal planning instruments have a high potential to implement GI, but their establishment in the case study area is a further challenge.

How was the strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

Analyses of the legal and strategic framework showed where aspects of GI are already being considered. The EU directives on the Natura 2000 network as the backbone of GI have been transposed into national law. In addition, there are GI concepts (e.g. DE: Bundeskonzept Grüne Infrastruktur/ German Federal Green Infrastructure concept), strategy documents (e.g. CZ: Politika architektury a stavební kultury České republiky/Policy of Architecture and Building Culture of the Czech Republic) or the term is already anchored in regional development plans (e.g. PL: Plan Zagospodarowania Przestrzennego Województwa Dolnośląskiego/Spatial Development Plan of Lower Silesian Voivodeship).

The GI mapping was carried out on the basis of full-cover regional geodata on land cover/land use. Gaps in the GI network are mainly found between the Zittau/Lusatian Mountains and the Jizera Mountains, which are due to settlements, transport infrastructure, open-cast mining and

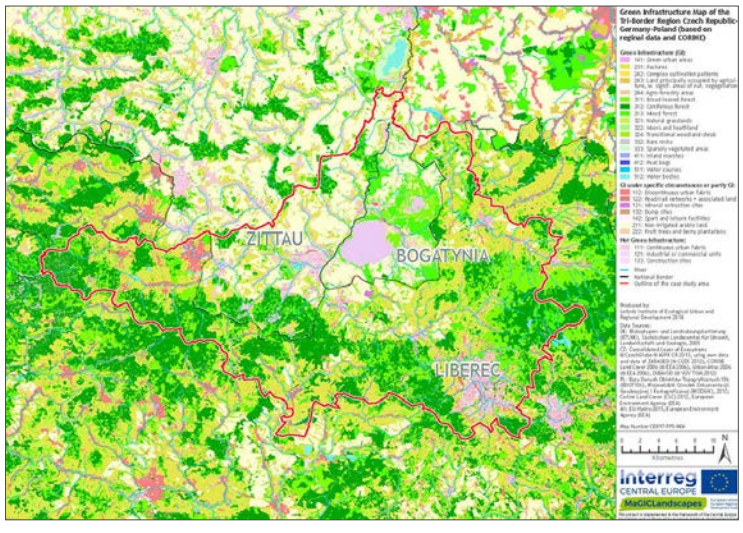


Fig. 2: Green infrastructure map of the Tri-border region Czech Republic-Germany-Poland based on regional biotope and land use data

intensive agricultural use. The three largest cities Liberec (CZ), Zittau (DE) and Bogatynia (PL) have a limited amount of green space, especially in the centres. Regional stakeholders confirmed these gaps and limitations and helped prioritise activities to address them (see Step 3).

Step 2 – Functionality assessment

An analysis of the networking and spatial patterns of the GI elements revealed several areas within the cities and their surroundings where there is a lack of green spaces and where green routes could link smaller urban green spaces with larger green spaces in the surrounding area. On-site mapping of selected areas showed how differently certain green spaces can be characterised and how their functionality may differ. The maps of the provision of different landscape services proved to be an important basis for integrated development concepts, especially for the cities in the case study area such as Zittau. On this basis, it was possible to identify areas where new GI should be created (e.g. urban gardens) or existing GI should be enhanced (e.g. river restoration).

Step 3 – Assessment of the public benefit

Over the course of several workshops, thematic mapping was carried out together with regional stakeholders. The participants represented various target groups (including NGOs, universities/research institutions, local public administrations/authorities, sectoral agencies and planning offices). The thematic mapping identified the strengths of and threats to existing GI as well as the needs and opportunities for the creation of new GI. The issues mentioned by the stakeholders were assigned to GI benefits that could be achieved by implementing appropriate measures. Those benefits that were often identified by stakeholders as being significant became those prioritised in the strategy.

Key themes, priorities and direction for the strategy and action plans

Two fields of action determine the direction of the strategy

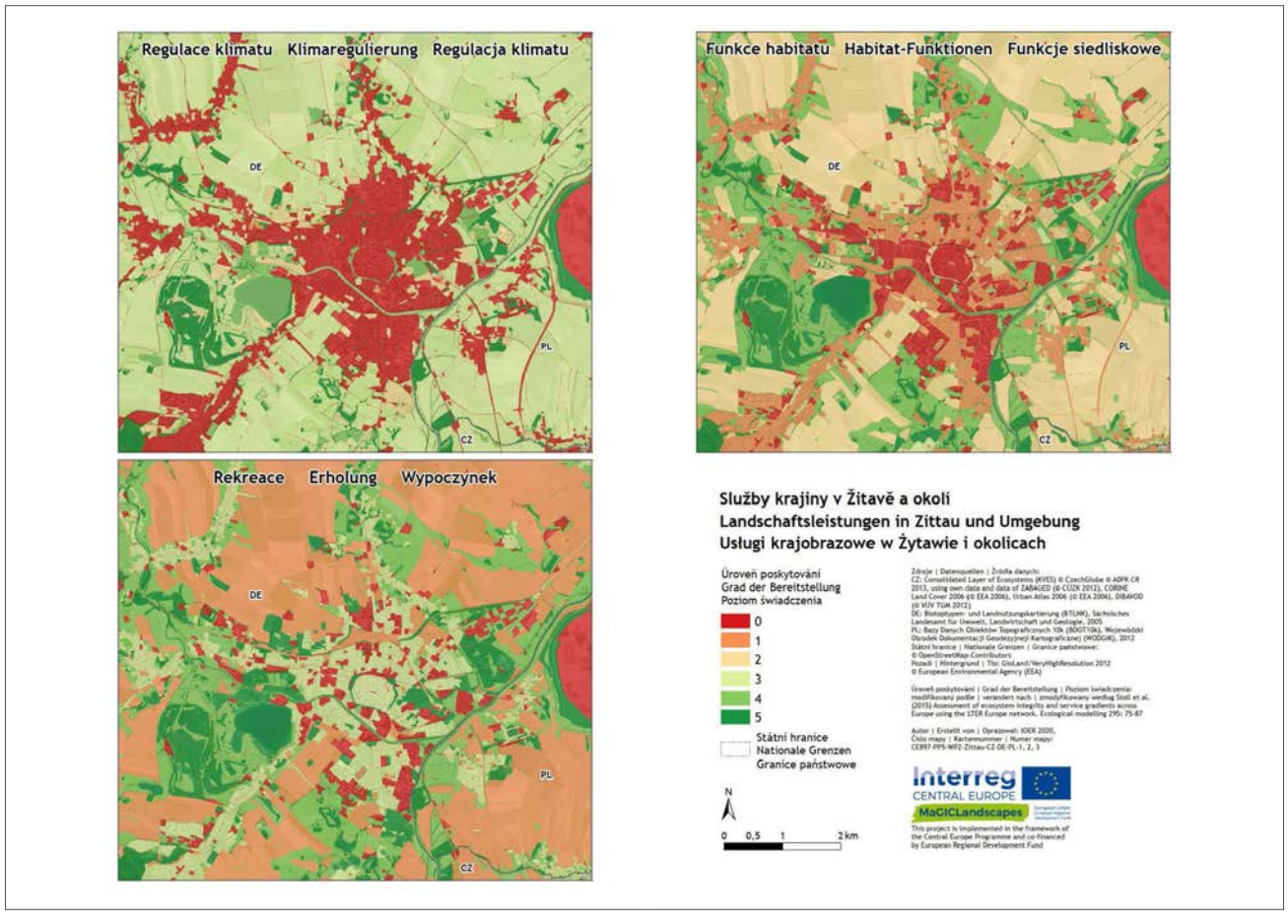


Fig. 3: Landscapes services climate regulation, habitat function and recreation in and around the city of Zittau (red = no service; dark green: good service)

GI BENEFIT	STRATEGIC TOOLS/POLICIES	PARTNERS
Health & Well-being	Integrated urban development concept (INSEK) Zittau Elaboration of a common development concept for the Liberec-Zittau region	Zittau Urban Development Corporation (Zittauer Stadtentwicklungsgesellschaft mbH) Interreg SN-CZ Project 'ALiZi'
Education	Urban Gardening Initiatives Special training measures of the Employment office (motivation workshop 2.0)	"Amaliengarten" Zittau, University of Applied Sciences Zittau Görlitz (HSZG); City of Bogatynia bao GmbH - Service provider for education, work and orientation
Tourism & Recreation	Tourism concepts Application of the City of Zittau for the European Capital of Culture 2025	International University Institute, TU Dresden (IHI) Tourism Centre Zittauer Gebirge Nature Park 6-City Association, City of Zittau, City of Liberec
Conservation benefits	Biotope network systems/Natura 2000	Czech Nature Protection Agency (AOPK) (CZ) Regionalna Dyrekcja Ochrony Środowiska we Wrocławiu - RDÓS (PL) Saxon State Ministry for Energy, Climate Protection, Environment and the Economy (SMEKUL) (DE) Lower Nature Protection Agency of the District of Görlitz (DE)
Land & Soil management	Participation procedure for the second comprehensive update "Regional Plan Upper Lausitz - Lower Silesia" Central network grassland-management for the promotion of biodiversity in the southern District of Görlitz RAINMAN Toolbox	Zittau Mountains & Foreland Landscape Conservation Association (Landschaftspflegeverband Zittauer Gebirge & Vorland e.V.) Interreg Central Europe project RAINMAN
Agriculture & Forestry	EPLR project 'Forest restructuring outside protected areas' Programme for sustainable forest management	Czech Forest Agency (Lesy České republiky)
Climate change mitigation & Adaptation	European Green Leaf Award of the European Commission	Zittau Urban Development Corporation (Zittauer Stadtentwicklungsgesellschaft mbH)
Disaster prevention	Cross-border cooperation of Saxony and the Czech Republic in flood risk management	Interreg SN-CZ Project STRIMA II

Table 1: Strategic tools, policies and partners supporting which green infrastructure benefit group

for the tri-border region. They are:

• Creation and enhancement of urban green spaces

• Restoration of watercourses, floodplains and catchment areas

All action plans are assigned to these two fields of action. Each action offers several benefits. Priority GI benefits identified for the tri-border region are 'Health & well-being', 'Education' and 'Tourism & recreation'. Key actions for these three benefits focus on the creation and improvement of green spaces in urban and rural areas. Other priority benefits include:

• the 'conservation benefits, e.g. by increasing biodiversity in the cities,

• 'land & soil management' and 'agriculture and forestry', with emphasis of actions on improved erosion control and resilient forestry, and

• 'climate change mitigation & adaptation' and 'disaster prevention', e.g. to achieve improved flood protection through the restoration of rivers and floodplains.

Key actors

One of the main actors in the tri-border region is the Zittauer Stadtentwicklungsgesellschaft mbH (Zittau Urban Development Corporation), which is incorporating the GI concept into the Integrated Urban Development Concept (INSEK) for the Municipality of Zittau (DE). In addition, the

Fig. 4: Discussing the benefits of green infrastructure at the stakeholder workshop in Liberec/CZ

institution is currently working with the City of Liberec (CZ) on a joint development concept for the Liberec-Zittau region as part of the project ALiZi, in which the results of MaGICLandscapes are also to be taken into account. The bao GmbH is another important partner in Zittau in the design of public open spaces, e.g. within the scope of special training measures of the employment office. The City of Bogatynia (PL) is already planning a number of measures that will deliver the three top priority benefits. The nature conservation authorities of all three countries (see table above) are working on the biotope network and the Natura 2000 network of protected areas.

The University of Applied Sciences Zittau-Görlitz (HSZG) as well as the International University Institute of the TU Dresden (IHI) increasingly integrate GI and its achievements into teaching and support student activities in this field, as in the case of the HSZG the urban gardening project "Amaliengarten" in Zittau. Networking with other ongoing (research) projects (e.g. RAINMAN, STRIMA II) is equally important in order to exchange and harmonize proposed measures for the region and thus to promote their implementation.

Regional representatives of the German Green party (Bündnis 90/Die Grünen) act as multipliers of the GI concept in the region. In addition, a number of funding programmes are available which can support the implementation of the GI concepts in the region. One example are the small project funds, administered by the Euroregion Neisse-Nisa-Nysa, which support cross-border projects between Saxony and Poland as well as Saxony and the Czech Republic.

Expected benefits

The strategy and action plans cover two main fields of action. The field of action "Creation and enhancement of urban green spaces" aims to improve the quality of life of city dwellers and to create recreational areas and environmental education opportunities. At the same time, this is expected to increase biodiversity and improve the adaptation of cities to climate change. The field of action "Restoration of watercourses, floodplains and catchment areas" is intended to prevent future heavy flooding, reduce soil erosion in the catchment areas and increase the biodiversity of the floodplains.

Contact

Leibniz Institute for Ecological and Regional Development
Marco Neubert
m.neubert@ioer.de
https://www.ioer.de

EASTERN WALDVIERTEL AND WESTERN WEINVIERTEL

Lower Austria, Austria

Description of the area

The Lower Austrian case study area of MaGICLandscapes project covers the districts of Horn and Hollabrunn and is a transition area between two landscapes, the Waldviertel in the west and the Weinviertel in the east. The Waldviertel is shaped by the highlands of a shallow gneiss landscape. The River Thaya partially marks the northern border to the Czech Republic and gives its name to the trans-boundary Thayatal National Park /Podyjí National Park, recognised as an outstanding biodiversity hot spot. The Weinviertel is characterised by wide open valleys and rolling hills. The area is one of the driest parts of Austria and lacks distinctive river networks. There are more meadows and less wetlands compared to the Eastern Waldviertel and due to the Pannonian climate and the loess soil it is Austria's largest wine growing region. River regulation and drainage associated with arable farming means many wet meadows and waterlogged habitats have been lost. On steeper hillsides and knolls the landscape becomes more varied with viticulture interspersed by patches of dry and xeric grassland as well as heath. At slightly higher elevations warm temperate oak forest can be found. The vegetation in this area is unique, home not only to Pannonian species but also species normally found much further to the east such as the European ground squirrel (Spermophilus citellus). Due to its high biodiversity large areas of the case study area are part of the Natura 2000 Network.

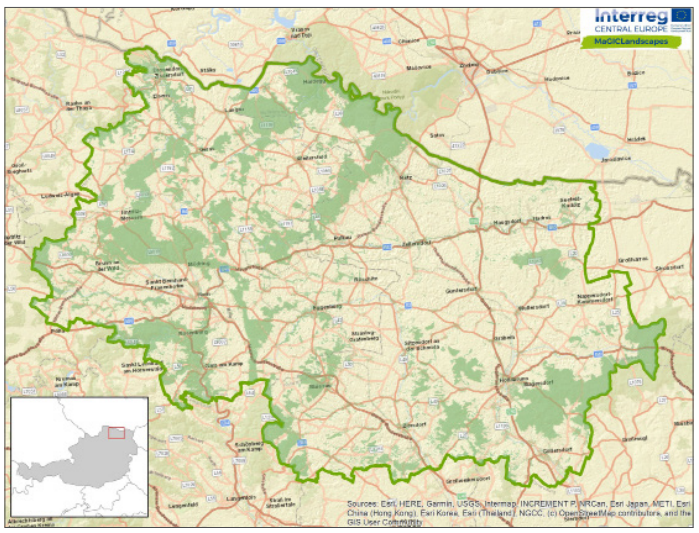


Fig. 1: Map of the case study area
Eastern Waldviertel and Western Weinviertel

Issues and challenges

The landscape of the case study area is typically characterised by narrow partitioned strips of farmland with many field margins and boundary ridges. Due to changes in agriculture, increasing intensive cultivation and abandonment of small and unattractive sites, parts of the landscape nowadays are pretty much cleared and featureless.

Existing migration axes and gaps in the GI-network have to be identified and several disconnected Natura 2000 areas should be linked. A main issue is the need to recreate ecologically relevant landscape elements taking into account of the private economic interests of local land managers. Grasslands and streams in the Waldviertel and dry and xeric grasslands in the Weinviertel have been identified as priorities for action. The large-scale spread of the invasive False Acacia (Robinia pseudoacacia) on abandoned meadows, dry and xeric grassland, woodlots and hedges seriously affects the quality and functionality of GI elements in the region. In the more wooded western part of the case study area, the Waldviertel, monotone species-poor plantations of spruce dominate extensive parts of the landscape.

Due to the rural character of the region, containing 44 municipalities with just 4 larger cities and covering a relatively large area of nearly 1,800 km², a major challenge is the absence of an overarching instrument for spatial and in particular landscape planning. Thereby the broad scope of tasks for small municipal administrations seldom allows for an intensive involvement in side issues like green infrastructure (GI) or nature conservation at the local level. Providing an easy to use inventory of GI regarding its spatial structure, functionality and ecosystem services on regional and local level can supply decision-support for politicians, planners, land users/managers and communities to invest in GI and will support the further implementation of GI.

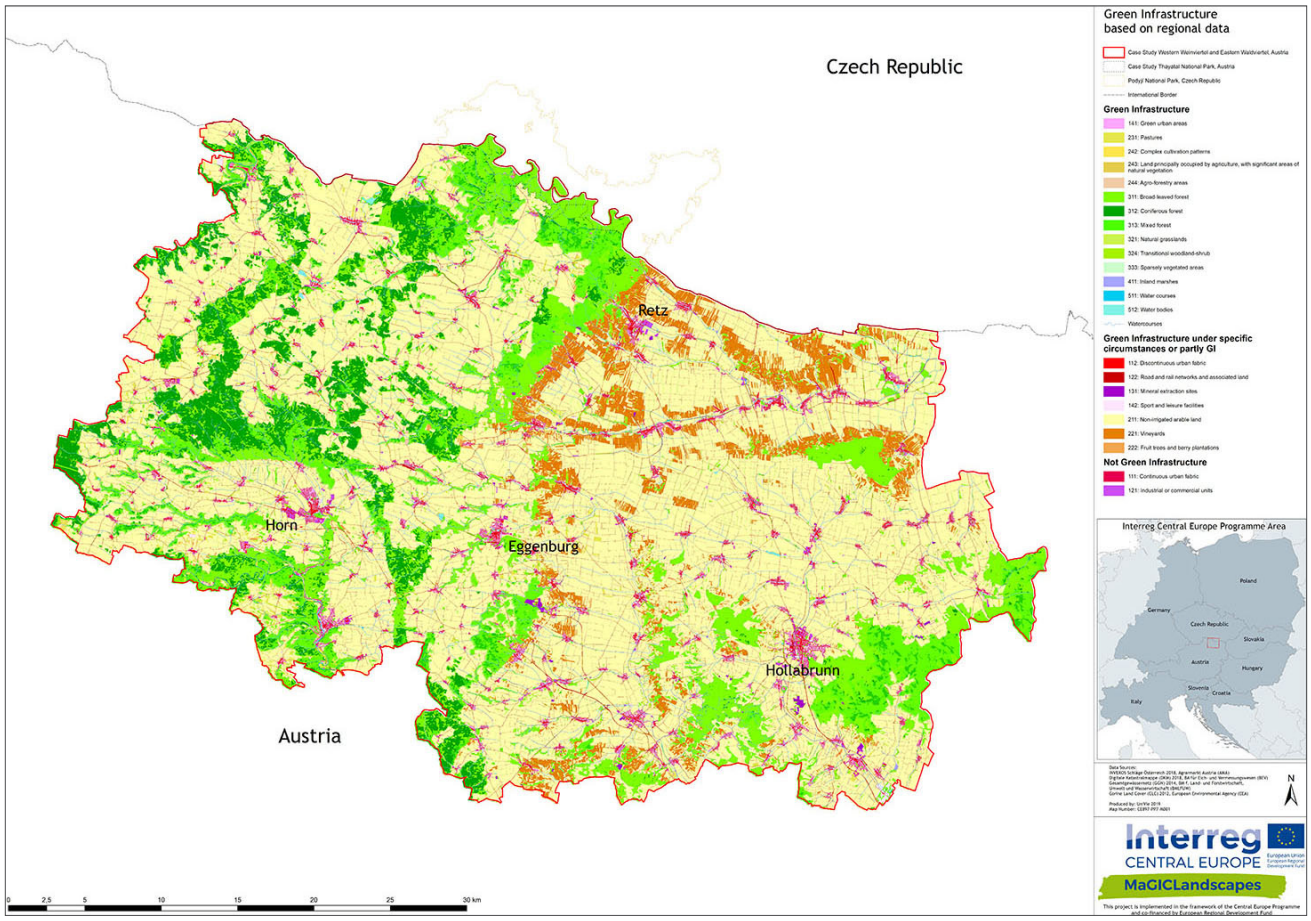


Fig. 2: Map of green infrastructure of the case study area based on regional geodata

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

Starting from the common, comparable data base of CORINE Land Classification (CLC), MaGICLandscapes partners supplemented individual geographic information system (GIS) projects using available national and regional data. For the compound Austrian case studies this was obtained by compiling the following data sets:

- Copernicus High Resolution Layers (HRLs): High Resolution Layer - Forest Types
- Agricultural data of the Integrated Administration and Control System (IACS) and Land Parcel Identification System (LPIS)
- Digital cadastral data
- Regional waterways network

The data sets were aggregated and reclassified according to CORINE and, using various GIS-based tools, sequenced according to their thematic coverage to obtain an accurate description of land cover.

Over several workshops and meetings stakeholders identified the following issues;

- Further intensification of land use and therefore loss of valuable extensively used habitats of the cultural landscape (orchards, meadows, pastures), irrigation
- Building development, infrastructure projects, urban sprawl, land consolidation and spatial planning
- River regulation and drainage
- Disposal of waste and residual materials
- Loss of small biotopes and extensively used habitats of the cultural landscape

Rural agricultural landscapes are the dominant type of landscape in the area (Fig. 2), and face major challenges in implementing a connected and functional GI network. In these intensively farmed areas elements of GI are very often limited to linear structures, and as such, important linking elements crucial to the GI network. At the same time, GI improves the overall environmental resilience of farmed landscapes towards climate change and extreme environmental events.

Green Infrastructure as a concept has not yet been established in Austrian legislation. Nonetheless, legal matter referring to elements of green infrastructure appears in different national and regional legislation. In Austria most of the legislation regarding nature and landscape conservation, etc. lies within the responsibility of the federal states. The only documents directly referring to GI are the Austrian Biodiversity Strategy 2020+ (Biodiversitäts-Strategie Österreich 2020+) and the Lower Austrian Nature Protection Concept (Naturschutzkonzept Niederösterreich).

GI BENEFIT GROUP	KEY BENEFITS TO ENHANCE	PARTNERS
Conservation benefits	Maintaining/enhancing existence value of habitat, species and genetic diversity Maintaining/enhancing bequest and altruist value of habitat, species and genetic diversity for future generations	Thayatal National Park Lower Austrian network of protected areas Lower Austrian League for Nature Conservation Biologists, NGOs & nature conservationists
Tourism & Recreation	Increase in tourist attractiveness of the territory Expansion of range and capacity for recreational opportunities	State and municipalities Tourism associations
Disaster prevention	Enhancing erosion control capacity Reduction of the risk of forest fires Flood hazard reduction	State and municipalities Water Board Climate Change Adaptation Model Regions
Land & Soil management	Reduction of soil erosion Maintaining/enhancing soil's organic matter Increasing soil fertility and productivity Mitigating land take, fragmentation and soil sealing Improving land quality and making land more attractive Higher property values	State and municipalities District agricultural authorities Chamber of Agriculture Winegrowers' Association Federal Ministry of Agriculture, Regions and Tourism Climate Change Adaptation Model Regions
Agriculture & Forestry	Enhancing multifunctionality and resilience of agriculture and forestry Enhancing pollination Enhancing pest control	State and municipalities District agricultural authorities Chamber of Agriculture Winegrowers' Association Austrian Federal Forests Federal Ministry of Agriculture, Regions and Tourism Climate Change Adaptation Model Regions
Investment & Employment	Better image More investment More employment Increase in labour productivity	State and municipalities Tourism associations Chamber of Agriculture Climate Change Adaptation Model Regions

Table 1: Prioritisation of GI benefits for the case study area and representative stakeholders

Stage 2 – Functionality assessment

The use of detailed regionalised GI geodata revealed specific details of the landscapes' structure and fragmentation as well as land use patterns and landscape features. Furthermore, this dataset provided an ideal basis to enhance the specific analyses of connectivity, by an additional assessment of functionality in terms of provision of landscape services. The synopsis of the results of the connectivity and functionality analysis, including sample field mapping surveys, helped greatly to identify hot spots of GI networks as well as GI with a high functional value and areas lacking such elements. Throughout the case study area the predominant agricultural landscape shows many rather featureless areas. These areas represent one of the most important target regions for the establishment of new elements of GI, like small woodlots, copses, hedges, riparian woods and strips as well as field trees (Fig. 3).

Stage 3 – Assessment of public benefit

To enhance the data driven approach of the functionality assessment in stage 2 a broad stakeholder process was implemented to integrate local needs and priorities to establish a comprehensive strategy document. By using a dual system to include stakeholder's opinion, firstly a direct consultation of experts and institutions was conducted, to explore problems, priorities and interests, and secondly a series of more open public workshop events took place, where also individuals from various sectors could add their views. A tool for the assessment of public benefit for both of these stakeholder groups served to identify target areas as well as to prioritise GI benefits.

Outline of key topics for the Strategy and Action Plan

As a result of stakeholder involvement and application of various tools to assess the public benefit of GI, a prioritisation of the key aspects of local GI (Table 1) was achieved and provided the basis for the coordinated development of strategies and action plans for the Eastern Waldviertel and Western Weinviertel.

According to this prioritisation and the data driven analysis, the following actions and areas for intervention were identified as most urgent:

Action Plan 1: Enhancement of the cleared, arable dominated cultural landscape by re-cultivating it with landscape

Fig. 3 (left): Typical aspect of the agricultural landscape of the Eastern Waldviertel and Western Weinviertel
Fig. 4: Stakeholder involvement to highlight and prioritise green infrastructure benefits and locations

elements such as hedges, field margins or flower strips

Action Plan 2: Climate-friendly forest conversion of spruce plantations with tree species appropriate to the location and designation of natural forest reserves

Action Plan 3: Creation of retention and buffer areas, widening of water bodies, promotion of small water bodies and increase of structural diversity in river beds and bank areas of water bodies and wetland habitats for ecological upgrading, raising of the groundwater level and improvement of flood protection

Action Plan 4: Securing and improving green infrastructure in areas of fruit and wine growing complexes by preserving and returning to the traditional small-scale cultural landscape and its numerous intermediate structures such as slopes, rows of trees and individual trees.

Action Plan 5: Targeted maintenance and resumption of traditional forms of use such as mowing and grazing of the remaining dry grasslands, meadows and pastures which, as scattered residual areas within the intensively used cultural landscape.

Action Plan 6: Improvement measures for green areas close to settlements, such as home gardens and parks as well as accompanying areas of road and rail infrastructure offer the possibility to improve the environmental conditions in the villages and towns and to increase the quality of life of the people.

Action Plan 7: Securing and establishing habitat corridors to re-connect protected areas, improve an effective biotope network and increase the connectivity of the landscape.

Key actors

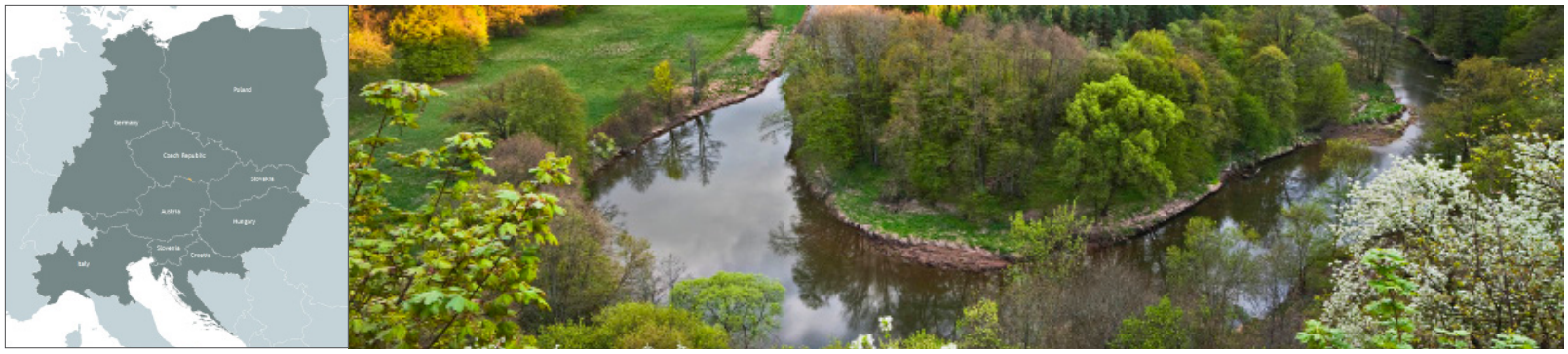
The strategy and action plans are supported by institutions, individuals and municipalities in the case study area and the findings, recommendations of the project will be used to ensure that policy-making and decisions improve the GI resource. Local land owners and managers and nature conservation bodies are encouraged to use the findings to safeguard and improve the functionality of the existing and planned GI network.

Expected benefits

The implementation of concrete measures of the developed action plan will contribute positively to the safeguarding of and, ideally, expansion of the provision of GI benefits regarding, amongst others, conservation, tourism and recreation, disaster prevention, land and soil management, agriculture and forestry as well as investment and employment greatly. By promoting and improving green infrastructure associated with the agricultural landscape, forests and woods, watercourses, still waters and wetlands, fruit and wine growing complexes, dry grasslands, meadows and pastures as well as urban and rural settlements the multifunctional role of these areas providing a wide range of benefits could be further increased to serve human well-being. In addition, though cross-linking and the re-connection of the fragmented GI network, migration and dispersal possibilities of wildlife will be improved, helping to protect ecological fitness, genetic variability and biodiversity.

Contact

University of Vienna
Division of Conservation Biology, Vegetation Ecology and Landscape Ecology
magiclandscapes.cvl@univie.ac.at
https://cvl.univie.ac.at



THAYATAL NATIONAL PARK

Lower Austria, Austria

Description of the area

The Thayatal National Park in the north of Austria was founded in 1999 to protect the high biodiversity of the meandering River Thaya valley. It plays an important role in the landscape protection in the border region between Austria and the Czech Republic. With over 90 % of the park being woodland, the Thayatal National Park is a true forest national park and a core area of the regional green infrastructure. The National Park is a biodiversity hotspot and is home to a large number of rare animal and plant species. This biodiversity can only be maintained and enhanced, if there is a sufficient network of suitable habitats, as otherwise there is a risk of genetic decline. Green infrastructure is of particular importance in the region so that the Thayatal National Park does not become an isolated island. Forest and meadow areas in particular represent occasional interruptions to the monotonous agricultural activities that need to be protected and enhanced.

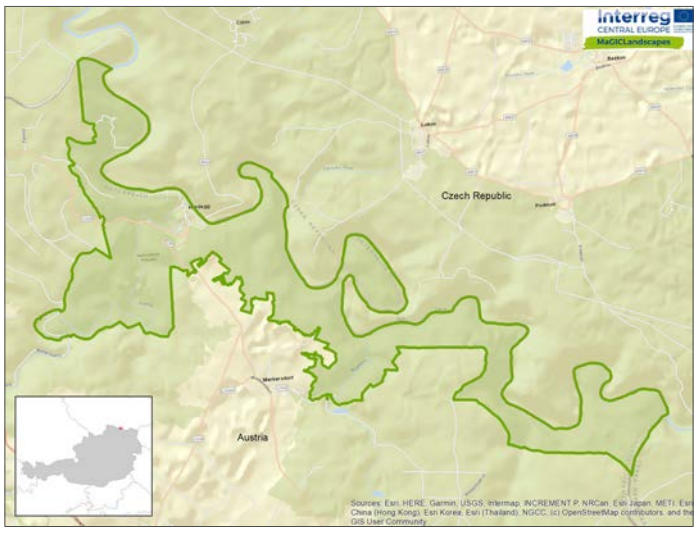


Fig. 1: Map of the case study area Thayatal National Park

Issues and challenges

The National Park provides a refuge for rare and endangered species which otherwise would not be able find a suitable habitat in an agricultural landscape. In order to maintain and improve the biodiversity of the National Park, green infrastructure is a key factor in sustaining the park. Many species struggle to find migration corridors through the agricultural land, which for the most part surrounds the National Park. For example, the rare European wildcat (Felis silvestris), which was believed extinct in Austria, found its way back into the country. Sightings in the Thayatal National Park were confirmed on several occasions using DNA-analyses. For the preservation of a healthy wildcat population an exchange of genetic material must be ensured.

Without sufficient green infrastructure many species would suffer of genetic depletion. The role of such protected nature sites in Central Europe, which are often surrounded by agricultural land, is very important for the preservation of a functioning natural environment. It allows the natural vegetation to adopt to climate change and therefore protects biodiversity for generations to come. In order to secure the continuance of the functionality of the natural protection sites, green infrastructure is indispensable in keeping the landscapes and its people healthy. Therefore, it is of high interest for the Thayatal National Park to improve its connectedness to other natural habitats and protected sites throughout Central Europe.

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

Starting from the common, comparable data base of CORINE Land Classification (CLC), MaGICLandscapes partners supplemented this with available national and regional data. For the compound Austrian case studies this was obtained by compiling the following data sets:

- Copernicus High Resolution Layers (HRLs): High Resolution Layer - Forest Types
- Agricultural data of the Integrated Administration and Control System (IACS) and Land Parcel Identification System (LPIS)
- Digital cadastral data

• Regional waterways network

The data sets were aggregated and reclassified according to CORINE and, using various GIS-based tools, sequenced according to their thematic coverage to obtain an accurate description of land cover.

Over several workshops and meetings stakeholders identified the following issues in the surroundings of the Thayatal National Park;

• Further intensification of land use and therefore loss of valuable extensively used habitats of the cultural landscape (orchards, meadows, pastures), irrigation

• Building development, infrastructure projects, urban sprawl, land consolidation and spatial planning

• River regulation and drainage

• Disposal of waste and residual materials

• Loss of small biotopes

Mixed deciduous forest is the dominant type of landscape in the area (Fig. 2), which is surrounded mostly by agricultural land. To keep the National Park and the inhabitants of the region healthy, the surrounding region faces major challenges in implementing a connected and functional GI network. In the intensively farmed areas elements of GI are very often limited to just linear structures, and as such, important linking elements crucial to the GI network. At the same time, GI improves the overall environmental resilience of farmed landscapes towards climate change and extreme environmental events.

Green Infrastructure as a concept has not yet been established in Austrian legislation. Nonetheless, legal matter referring to elements of green infrastructure appears in different national and regional legislation. In Austria most of the legislation regarding nature and landscape conservation, etc. lies within the responsibility of the federal states. The only documents directly referring to GI are the Austrian Biodiversity Strategy 2020+ (Biodiversitäts-Strategie Österreich 2020+) and the Lower Austrian Nature Protection Concept (Naturschutzkonzept Niederösterreich).

Stage 2 – Functionality Assessment

The use of detailed regionalised GI geodata revealed specific details of the landscapes' structure and fragmentation as well as land use patterns and landscape features. Furthermore, this dataset provided an ideal basis to enhance the specific analyses of connectivity, by an additional assessment of functionality in terms of provision of landscape services. The synopsis of the results of the connectivity and functionality analysis, including sample field mapping surveys, helped greatly to identify hot spots of GI networks as well as GI with a high functional value and areas lacking such elements.

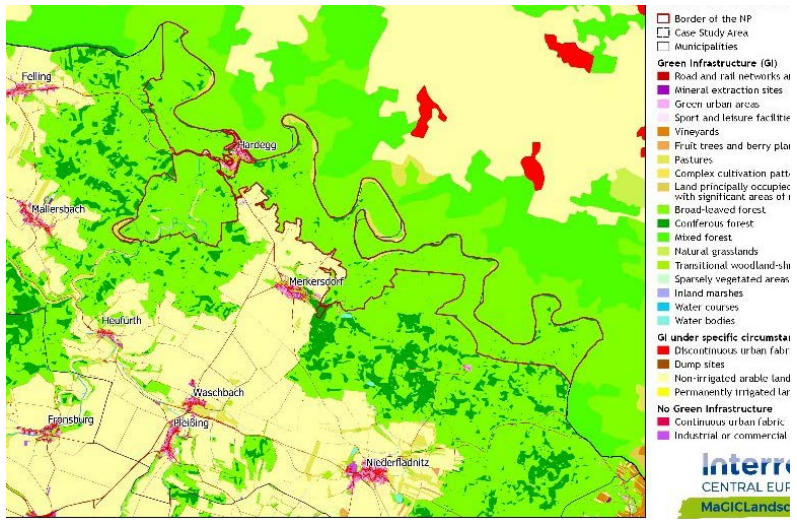


Fig. 2 (above): Map of green infrastructure of the case study area based on regional data

Fig. 3: Stakeholder involvement to highlight and prioritise green infrastructure benefits and locations

Stage 3 – Assessment of public benefit

To enhance the data driven approach of the functionality assessment in Stage 2 a broad stakeholder process was implemented to integrate local needs and priorities to establish a comprehensive strategy document. By using a dual system to include stakeholder's opinion, firstly a direct consultation of experts and institutions was conducted, to explore problems, priorities and interests, and secondly a series of more open public workshop events took place, where also individuals from various sectors could add their views. A tool for the assessment of public benefit for both of these stakeholder groups served to identify target areas as well as to prioritise GI benefits.

Outline of key topics for the Strategy and Action Plan

As a result of stakeholder involvement and application of various tools to assess the public benefit of GI, a prioritisation of the key aspects of local GI (Table 1) was achieved and provided the basis for the coordinated development of strategies and action plans for the Thayatal National Park.

According to this prioritisation and the data driven analysis, the following actions and areas for intervention were

GI BENEFIT GROUP	KEY BENEFITS TO ENHANCE	PARTNERS
Conservation benefits	Maintaining/enhancing existence value of habitat, species and genetic diversity Maintaining/enhancing bequest and altruist value of habitat, species and genetic diversity for future generations	Thayatal National Park Lower Austrian network of protected areas Lower Austrian League for Nature Conservation Biologists, NGOs & nature conservationists
Tourism & Recreation	Increase in tourist attractiveness of the territory Expansion of range and capacity for recreational opportunities	State and municipalities Tourism associations
Disaster prevention	Enhancing erosion control capacity Reduction of the risk of forest fires Flood hazard reduction	State and municipalities Water Board Climate Change Adaptation Model Regions
Land & Soil management	Reduction of soil erosion Maintaining/enhancing soil's organic matter Increasing soil fertility and productivity Mitigating land take, fragmentation and soil sealing Improving land quality and making land more attractive Higher property values	State and municipalities District agricultural authorities Chamber of Agriculture Winegrowers' Association Federal Ministry of Agriculture, Regions and Tourism Climate Change Adaptation Model Regions
Agriculture & Forestry	Enhancing multifunctionality and resilience of agriculture and forestry Enhancing pollination Enhancing pest control	State and municipalities District agricultural authorities Chamber of Agriculture Winegrowers' Association Austrian Federal Forests Federal Ministry of Agriculture, Regions and Tourism Climate Change Adaptation Model Regions
Investment & Employment	Better image More investment More employment Increase in labour productivity	State and municipalities Tourism associations Chamber of Agriculture Climate Change Adaptation Model Regions

Table 1: Prioritisation of GI benefits for the case study area and representative stakeholders

identified as most urgent:

Action Plan 1: Communication activities to the public

The importance as well as the possibilities for improving green infrastructure are identified and spatially located. Together with the municipalities and other institutions, the elements of the green infrastructure, their maintenance and promotion in the region are being discussed.

Action Plan 2: Meadow and dry grass management

Whilst the region has a high proportion of forest, other open but extremely important ecological locations such as meadows, dry grassland and heathlands are of great importance for the biodiversity in the region. In order to maintain a structurally rich and diverse habitat, however, maintenance and care measures are essential.

Action Plan 3: Environmental education and recreation

The diverse elements of the green infrastructure also serve for recreation and environmental education of the public. This is particularly possible if the visitor infrastructure is in harmony with the elements of the green infrastructure. For this reason, new visitor infrastructure is being created in the region, which on the one hand makes the space more diverse, on the other hand allows natural elements to be experienced and thus helps to raise awareness in the region.

Action Plan 4: Display garden

A display garden at the location of the National Park Centre is intended to bring the regional population and visitors closer to nature-oriented gardening and to show what an important element of the green infrastructure gardens in urban areas are, even in a national park region. Visitors are shown which species thrive particularly well in this region, are native here and adapted to the climate.

Action Plan 5: Habitat networking

The network of habitats plays a very important role in maintaining the high biodiversity that the Thayatal National Park is currently home to. In order to avoid a genetic impoverishment of this diversity, there must be regular exchanges with species from other populations. However, if a habitat is very isolated or not networked with other habitats, this exchange cannot take place and species diversity would ultimately decline. Therefore, the National Park supports actions and implementations of green infrastructure in the region, which supports the connectivity of the protected

area with the region and other habitats.

Key actors

The strategy and action plans are supported by institutions, individuals and municipalities in the case study area and the findings, recommendations of the project will be used to ensure that policy-making and decisions improve the GI resource. Local land owners and managers and nature conservation bodies are encouraged to use the findings to safeguard and improve the functionality of the existing and planned GI network.

Expected benefits

The implementation of concrete measures of the developed action plan will contribute positively to the safeguard and, ideally, expand the provision of GI benefits regarding, amongst others, conservation, tourism and recreation, disaster prevention, land and soil management, agriculture and forestry as well as investment and employment greatly. By promoting and improving Green Infrastructure associated with the agricultural landscape, forests and woods, watercourses, still waters and wetlands, fruit and wine growing complexes, dry grasslands, meadows and pastures as well as urban and rural settlements the multifunctional role of these areas providing a wide range of benefits could be increased strongly to serve human well-being. In addition, though cross-linking and re-connection of the fragmented GI network, migration and dispersal possibilities of living beings will be improved to protect ecological fitness, genetic variability and biodiversity.

Contact

Nationalpark Thayatal GmbH
David Freudl
david.freudl@np-thayatal.at
https://www.np-thayatal.at

Fig. 4: Typical landscape aspect of Thayatal National Park

PO HILLS AROUND CHIERI

Piedmont Region, Italy

Description of the area

The Case Study Area (CSA) includes Turin, one of Italy's main cities, and the surrounding peri-urban areas located on the plain near the hills to the east of Turin. Italy's longest river the River Po also flows through the area. The Turin hills to the east are covered with woodlands and vineyards. There are many Special Areas of Conservation (SAC), both on the hills and on the plain, along the River Po. To the south of the area there is the Altopiano di Poirino and a wide plain, where the woodlands were replaced by agriculture. The area has a significant naturalistic-environmental and landscape value.

Issues and challenges

The problems in the area are manifold and include landscape deterioration (urban and peri-urban areas particularly), urban expansion and sprawl in the plains and in the hills along the main transport routes. The loss of biodiversity and reduced environmental connectivity caused by soil consumption and sealing, and spread of exotic species is also an issue. The landscape has been transformed due to cereal crops and arboriculture (especially on Altopiano di Poirino) and hydro-geological fragility results in many landslides and flooding is also an issue particularly in the southern sector. In agricultural areas and in the urban/peri-urban contexts there is a shortage of GI benefits and reduced biodiversity and connectivity.

Key challenges are the planning, management and increase of woodlands, increasing riparian/perifluvial vegetation along the hydrological network and promoting the appropriate soil and water management in agricultural, urban and peri-urban contexts to reduce soil erosion, particularly in areas of slope instability. A further challenge is the re-connection and increase in area of natural and semi-natural areas such as hedgerows, isolated woodlands and small wetlands and the rehabilitation of brownfield areas in urban and peri-urban areas.

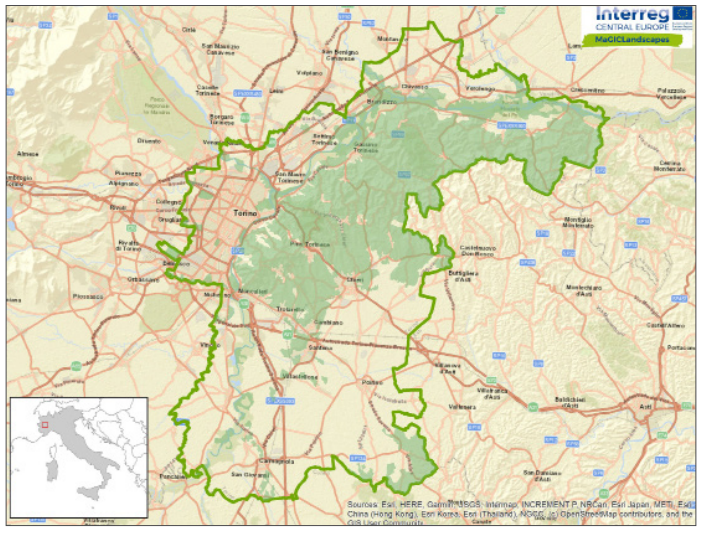


Fig. 1: Map of the case study area Po Hills around Chieri

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

The CSA map of green infrastructure (GI) at the transnational level, based on CORINE Land Cover data showed a large amount of non-irrigated arable lands in the south-eastern part of the CSA. The GI shown on the map corresponds mainly to the large wooded areas on the hills and to the main rivers (Po and Stura). In the plain there are settlements and transport infrastructure. The priorities were identified through a consultation with the project's Associated Partners (Po Park, Piedmont Region and Chieri Municipality). The Po Park Management Body proposed to update the Park Plan and to draft a Plan (Operational Territorial Project) which includes the Po, Superga and Bosco del Vaj parks and to link the hills to lowlands in the west and to the south of the CSA. The main expectation is the development of an analysis model and the design/management of GI which is both understandable and easily used by local administrations.

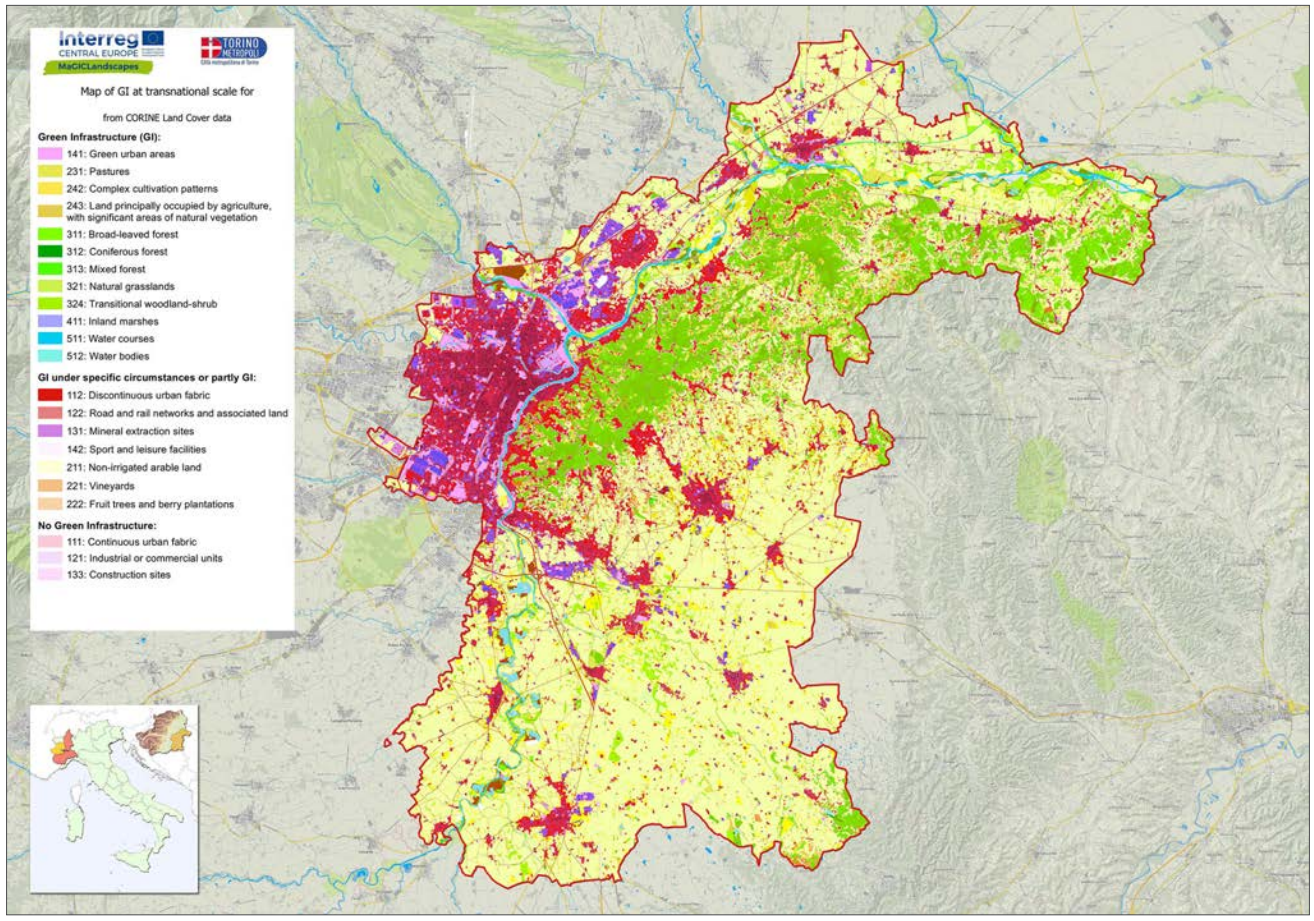


Fig. 2: Map of green infrastructure of the case study area based on regional data

Stage 2 – Functionality assessment

As a first stage the Piedmont Land Use Land Cover (2010) was used and then integrated the LCP with more detailed and recent data to create GI maps. Using GUIDOS toolbox, a map was then produced the showing core areas, islets, bridges and loops. The MSPA (Morphological Spatial Pattern Analysis) map correctly recognised that the core areas are restricted almost exclusively to the most extensive and the most intact hilly wooded areas. The rest of the hilly woods areas are classified as corridors (red), since they are extremely fragmented. The other core areas are located in the flood plain correspond with the Natura 2000 network sites.

The Landscape Services and Benefit analysis confirms previous assessments.

Stage 3 – Assessment of public benefit

Stages of Assessment are: evaluation of territory critical issues, weaknesses and threats and their general representation on a map; strategies analysis (an in-depth analysis of the work done in WP1); localisation of specific objectives to be pursued in the various areas of the CSA. Then we held a stakeholder consultation including institutional stakeholders and associated organisations/associations). During the workshop we gave each participant a questionnaire containing the list of benefits/effects provided by GI and we asked them: a) to select the 5 effects/benefits produced by GI which they consider most important; b) to localise the benefits (whole area or a specific location); c) to briefly describe which instruments/plans or actions could be used to achieve the objectives identified. In this way we integrated our previous analyses and studies and prioritised benefits.

Outline of key topics for the Strategy and Action Plan

Through the analysis of workshop results we identified the final locations of the objectives to be pursued with the enhancement/implementation of GI; the planning instruments and strategies to achieve these objectives and the actors in charge of drawing up the plans / strategies (Public Institutions) and implementing them (Public Institutions, private citizens, organisations, associations …). Below is an extract of the table.

The final products were: a map with the location of the objectives to be reached (sector/areas), and a brief description of critical issues and strategies for each area/ sector; a document that collects the planning instruments / strategies useful to achieve the objectives and improve public benefits and the actors responsible for their implementation. The document provides, for each type of actor (Metropolitan City, Municipalities, private citizens ...), concrete indications regarding the tools to be used to pursue the enhancement of GI. For the Action Plan the steps are the same, but the evaluations are much more detailed and aimed at enhancing Arignano Lake and its surroundings from an environmental and touristic point of view.

Key actors

The following actors are supporting the implementation of the strategy and action plan; municipalities through the

GI BENEFIT GROUP	KEY BENEFITS TO ENHANCE	RESPONSIBLE INSTITUTIONS
Land & Soil management Soil productivity and fertility	Agricultural areas: Piano di Sviluppo Rurale (PSR) [Rural Development Plan (regional)]; Piano d'Azione MAB "Collina Po" [Action Plan of UNESCO Man and Biosphere Reserve "Collina Po"] Periurban/degraded areas: Linee Guida sulle Aree Agricole Periurbane (LGAP) [Guidelines about periurban agricultural areas], Piano Compensazioni [Compensation Plan]	Piedmont Region: PSR Metropolitan City of Turin (CMTo): LGA, Piano Compensazioni, PTGM Municipalities: Piano Regolatore Generale Comunale (PRGC) [Municipal General Plan]; Piani del Verde Urbano
Land & Soil management Ability to mitigate the effects of soil consumption (sealing, fragmentation, impove rishment)	Ban on new land use: Piano Territoriale Generale Metropolitano (PTGM) [General Territorial Metropolitan Plan]; PRGC Recovery/Restoration of abandoned areas: Mosaico Verde; Piani del Verde Urbano Urban forestry/Creation of green areas: Mosaico Verde, Climate Decree	Piedmont Region: Regional law about land consumption; Projects and Strategic Plans referred to the article 44 Piano Paesaggistico Regionale (PPR) [Regional Landscape Plan] CMTo: PTGM Municipalities: PRGC; Piani del Verde Urban
Conservation benefits Variety level of flora and fauna and habitat connectivity	Case study area: Linee Guida sulla Rete Ecologica Provinciale (LGREP) [Guidelines on Provincial Ecological Network], PTGM Periurban/Urban areas: Linee Guida sulle aree agricole periurbane	CMTo: LGREP; PTGM; Piano d'azione del Lago di Arignano [Action Plan] Municipalities: PRGC, Piani del verde SIC and parks management bodies: Piani Di Gestione (PdG) [Management Plans] SIC [Natura 2000 Areas] e Piani Area; progetti per Mosaico Verde
Health & Well-Being Air quality and environmental quality	Case study area: Piano Regionale della Qualità dell'Aria (PRQA) [Regional Air Quality Plan]; Piano Regionale Mobilità e Trasporti; PUMS; PRG dei Comuni	Piedmont Region: PRQA; PR Mobilità e Trasporti; CMTo: Piano Urbano della Mobilità Sostenibile (PUMS) [Urban Sustainable Mobility Plan] Municipalities: PRGC; Piano sulla mobilità ciclabile [Bike Mobility Plan]
Tourism & Recreation	Case study area: PUMS (Coordination and enhancement of cycling and hiking routes)	Piedmont Region: Coordination and enhancement of cycling and hiking routes CMTo: PUMS Municipalities: PUMS Transposition in PRG

Table 1: Prioritisation of GI benefits for the case study area and representative stakeholders

drafting and implementation of the rules of the PRGC and Urban Green Plans or Regulations, Po Park Management Body through the drafting and implementation of Plans/ Programmes (Management Plans of the of Natura 2000 Sites; PTO; Program of the Piedmontese Po shared forest; update of Park Plan). The Metropolitan City of Turin will include the strategy in its Strategic and Territorial Plan and in other documents like Guidelines). For the Action Plan the key actors are the 4 municipalities in the area (Arignano, Andezeno, Marentino and Chieri) and a cultural/environmental association (Arignano Lake conservation committee).

Expected benefits

The inclusion of rules and regulations in the various territorial and urban planning tools will help to protect and implement GI and their benefits such as: prevention and mitigation of soil erosion/instability, ability to mitigate the effects of soil consumption (waterproofing, fragmentation, impoverishment), improvement of air quality and environmental quality; the Action Plan is aimed at the environmental and touristic enhancement of Lake Arignano area; it will consist of concrete actions.

Contact

Metropolitan City of Turin
Gabriele Bovo
gabriele.bovo@cittametropolitana.torino.it
http://www.cittametropolitana.torino.it

Fig. 3: Shrubby and arboreal hedgerows in agricultural areas contrasts the removal of fertile soil (windbreak)

UPPER PO PLAIN

Piedmont Region, Italy

Description of the area

The case study area corresponds to the Tourist Area of the Po River Park - Vercelli-Alessandria stretch and includes, in addition to Regional Nature Reserves, several Natura 2000 Network sites. The area is characterised by the presence of the river corridor, which runs through the territory for about 90 km. This corridor consists of the riverbed, the riparian vegetation strips and marginal areas such as oxbows, side branches and wetlands.

On the left bank of the Po, the landscape consists of an expanse of paddy fields, within which the minor hydrographic network is very important. In addition to allowing the distribution of the water needed for agriculture, it is in itself a significant component of the green infrastructure network. In monoculture there are several areas, more or less large, which host strips of lowland forest that represent the residue of the original land cover. The largest area is the Bosco della Partecipanza di Trino, located in the northernmost part of the study area.

On the right bank of the river corridor, in the western area the hills are characterized by the presence of a discontinuous but widespread forest cover, alternating with more or less extensive forms of agriculture. The eastern, flat area is occupied by intensive forms of agriculture (maize, cereals), within which the natural areas, with the exception of those connected to the hydrographic network, are very scarce.

Issues and challenges

The study area is affected by an extremely intense agricultural activity, which over time has been reducing more and more the spaces of naturalness, although small, that existed previously (rows, hedges, vegetated banks). The territory, so trivialized, reduced its capacity to preserve significant levels of biodiversity and ecological connectivity. As regards the main hydrographic network (the Po River and its main tributaries) and the secondary one (the minor hydrographic network), this trivialisation has led to a reduction in resilience capacity in the face of flood events that have been more frequent in recent decades.

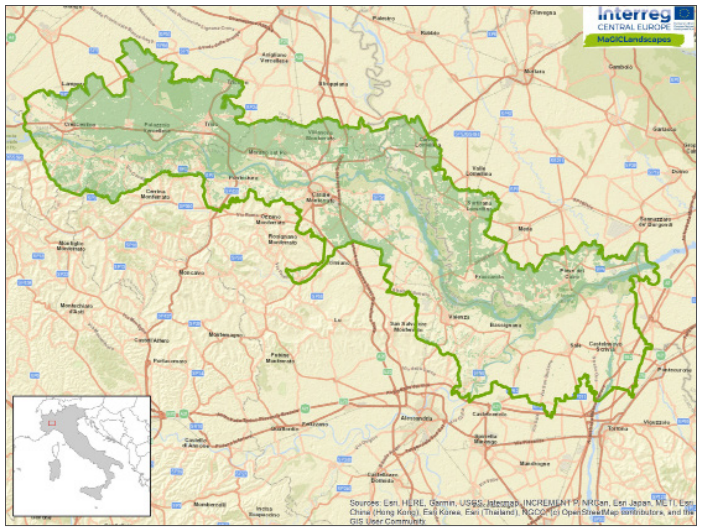


Fig. 1: Map of the case study area Upper Po Plain

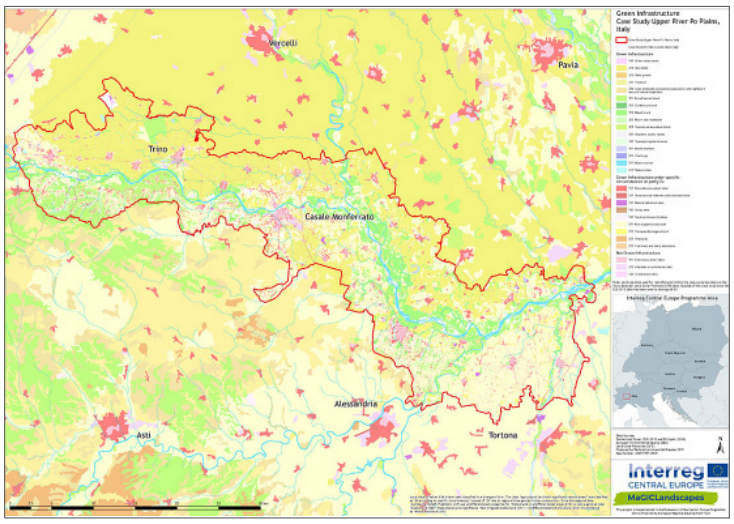
The main challenges to which the case study area is subject are first and foremost those concerning agricultural activity: identifying production methods that, while meeting the needs of financial sustainability, guarantee environmental sustainability in the short, medium and long term. The application of the “Green Deal” principles to regional rural development programming will make it possible to achieve these objectives, also by allocating a portion of the agricultural area to the creation of new natural nuclei.

At the same time, the promotion of ways of fruition of a territory which, in the collective imagination, doesn’t present a tourist attraction but which actually hosts values of great naturalistic, historical and landscape interest, can determine the creation of new flows (both of people and of economic resources deriving from them).

How was the Strategy developed?

Stage 1 – Transnational green infrastructure assessment and identification of priorities

From the analysis of the Green Infrastructure Map, it emerges that the areas in which there are green infrastructures, not considering rice fields which in any case play a significant



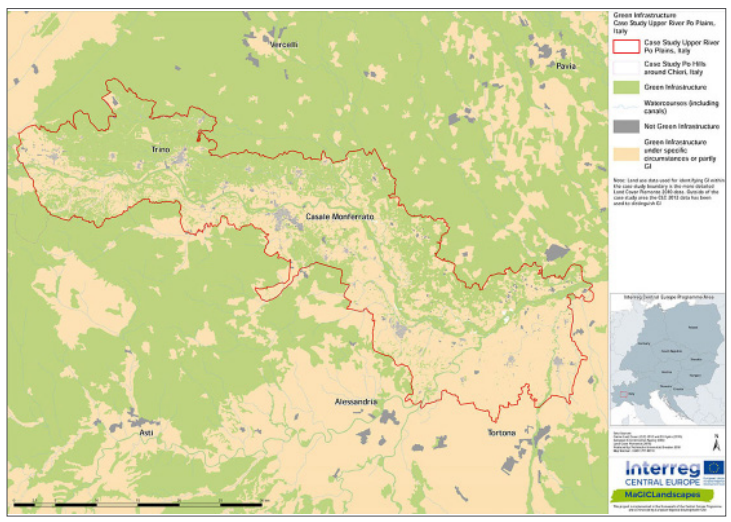


Fig. 2 (left): Regional green infrastructure map of the case study area based on regional data
Fig. 3: Green infrastructure map regarding GI (green), no GI (grey) and GI under specific circumstances (beige) based on regional data

role, are limited to a fairly continuous river belt, to a widespread and frayed mosaic placed in the hilly belt and to a single point mosaic in the plain areas of both Vercelli and Alessandria. There are also some important areas such as the Bosco della Partecipanza di Trino, the area around the abandoned power plant of Leri Cavour and, of smaller size, the natural areas included in the SACs of Palude di San Genuario and Fontana Gigante.

The analysis of the planning tools made it possible to identify a series of common thematic areas that are suitable for increasing the functionality of the Green Infrastructure network in the area under examination:

- Protecting and improving the existing natural formations/ elements (from the most important core areas to the linear and punctual elements).
- Improving the quality of aquatic ecosystems and increase the naturalness of the river territory (to increase biodiversity and to protect against hydrogeological risk).
- Protecting the landscape
- Promoting the development of highly sustainable economic activities

Stage 2 – Functionality assessment

The connectivity analysis underlined how the river corridors and, at a higher level of detail, the minor hydrographic network, constitute the fundamental structure of connectivity in the case study area, and the ambit of possible expansion of the green infrastructure network at local scale.

The Total Function Value Map, which provides information on the multifunctionality of the territory, drawn up considering the four considered families of landscape services (Regulation, Habitat, Production, Information) highlights, even more, the fundamental role assumed by the river territory and forest formations. The highest value is reached by spontaneous tree formations, while the river corridor is characterized by a slightly lower level.

Stage 3 – Assessment of public benefit

The maps drawn up using the methodology of Public Benefit Assessment developed within the Project make it possible to represent the level of provision of each benefit by the territory under consideration, based on the land use cartography. These maps, although each referring to a different "family" of benefits, connected to the provision of a different list of Landscape Services, do not appear, from a general point of view, significantly different: in almost all cases the fundamental role to be attributed to the river corridor and the wooded areas present in the territory is highlighted.

Public Benefits that were identified in the interaction activities with local stakeholders as priorities for the drafting of the strategy are:

- Conservation benefits
- Disaster prevention
- Climate change mitigation and adaptation
- Agriculture and forestry
- Water management
- Tourism and recreation

It should be noted that, at the scale of the entire territory, there is ample room for possible intensification in the provision of individual benefits, through an action to improve functionality and ecological connectivity. In addition, it is highlighted the importance of the conservation of all the existing natural areas (wooded areas, wetlands, river areas), which currently ensure the availability of benefits for all users of the territory of the Po Park and its touristic Area.

GI BENEFIT GROUP	KEY BENEFITS TO ENHANCE	PARTNERS
Conservation benefits	Piano d'Area del Parco fluviale del Po Piano di Gestione della ZPS Fiume Po – Tratto Vercellese Alessandrino IT1180028 Piano di Gestione della ZSC Palude di San Genuario IT1120007 Piano di Gestione della ZSC/ZPS Bosco della Partecipanza di Trino IT1120002 Piano di Gestione della ZSC/ZPS Fontana Gigante IT1120008 Piano Paesaggistico Regionale del Piemonte Piano Forestale Aziendale del Parco del Po vercellese-alessandrino Piani Forestali di Area per le aree "coinvolte" Piano Regionale delle Attività Estrattive	Ente di Gestione del Parco del Po Regione Piemonte Provincia di Vercelli
Disaster prevention	Piano di Gestione del Rischio di Alluvioni del Bacino del Po Piano di Gestione di Distretto del Bacino del Po Piano di Tutela delle Acque della Regione Piemonte	Ente di Gestione del Parco del Po Regione Piemonte Autorità di Bacino Distrettuale del Fiume Po
Climate change mitigation & Adaptation	Strategia Regionale sui Cambiamenti Climatici (in preparazione)	Regione Piemonte
Agriculture & Forestry	Piano di Sviluppo Rurale	Regione Piemonte
Water management	Piano di Gestione del Rischio di Alluvioni del Bacino del Po Piano di Gestione di Distretto del Bacino del Po Piano di Tutela delle Acque della Regione Piemonte	Ente di Gestione del Parco del Po Regione Piemonte Autorità di Bacino Distrettuale del Fiume Po
Tourism & Recreation	Piano Paesaggistico Regionale del Piemonte Piano Territoriale di coordinamento della Provincia di Vercelli Piano Territoriale di coordinamento della Provincia di Alessandria Progetto VENTO. – ciclovia Venezia-Torino	Ente di Gestione del Parco del Po Agenzia di promozione Turistica

Table 1: Prioritisation of GI benefits for the case study area and representative stakeholders

Outline of key topics for the Strategy and Action Plan

The activities carried out by the Project made it possible to identify the following list as Public Benefits on which to operate primarily in the study area:

Based on interactions with local stakeholders, some priorities were defined:

• the connection through natural elements of the core areas; the connection axes that seem most relevant are those that would allow the connection between Bosco della Partecipanza and Palude di San Genuario, and those that would connect these ZSC with the river corridor;

• the recovery and strengthening of minor roads for the realization of cycle and pedestrian tourist routes;

• improving the integrity of the irrigation network.

Key actors

The strategy was drawn up in collaboration with the Po Park Authority, associated partner of the Project, which is interested in achieving the defined objectives, through the implementation of specific actions. The Province of Vercelli, which has been carrying out for years activities aimed at increasing biodiversity on a territorial scale in the rice sector through direct interventions and promotion of good practices, will also be a key player in the implementation of the strategy.

Expected benefits

The implementation of the actions identified under the Strategy will allow the improvement of ecological connectivity, in particular in the rice sector, which can lead to increased biodiversity and the conservation of species and habitats that are of specific value to the case study area. It is also expected to reduce the risk of flood damage and increase the potential for sustainable use of the territory

Contact

Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)
Gian Luigi Rossi
gianluigi.rossi@enea.it
https://www.enea.it

Protected Areas Po Vercellese-Alessandrino
Dario Zocco
parcodelpo-vcal@pec.it

CHAPTER 3

Green infrastructure planning and management in central Europe

Green infrastructure as an opportunity, Green infrastructure as a threat?

Michael Hošek, DHP Conservation Ltd., Prague, Czech Republic | hosek@dhpconservation.com

'TO THINK always means to think differently'.
Miroslav Petříček, Czech philosopher

The fast development of society is resulting in overuse and deterioration of natural resources. The Green Infrastructure (GI) concept was developed as a response to that. To help understanding of what has been happening with ecosystems and how they should look like in well-balanced world. Let me share a few thoughts about what is or can be good and bad about GI. I will also use three countries with different conditions to demonstrate how the GI concept can work there: Czechia, Georgia, and Montenegro. It will identify opportunities and bottlenecks for the implementation of the GI concept in general as well as the specific countries' conditions.

1 The purpose of this article

In Europe, we do not need for another technical article repeating the advantages of the GI concept and how that addresses recent needs. We have already sufficient background – enough information to understand that GI can really help if appropriately implemented of course. One could even say that there is a huge disbalance between the massive amount of research on GI and the weak implementation on the ground. Therefore, let me be a bit provocative here and share with you how someone from the nature conservation community could see GI based on the personal experience and raises doubts that GI is strong enough to be more successful than its predecessors. Of course, GI is an opportunity, but to take advantage of that we need to learn from previous failures which means being honest with ourselves about where we are and what we actually want to achieve.

2 What is green infrastructure?

It is needless to repeat the definition and specificities about GI as defined by the European Commission in 2013. Detailed technical guides have been available, some of them also developed under the MaGICLandscapes project. Nonetheless, although the GI concept looks like a brand new idea, this is not the case. It is possible to translate GI as an ecological network concept. These concepts have been around since the 1980s, led by the Netherlands and followed by the former Yugoslavian countries. The Pan-European networks were also developed at that time. If we compare these 'older' concepts with the GI concept, the main difference is the inclusion of protected areas (PAs). While the older concepts were developed as complementary to national PAs network, GI includes them in automatically. In that sense, GI is larger and more inclusive, but that also means more general. GI also covers another, totally new aspect – ecosystem services valuation as proof of its positive contribution to the society and the economy. So, when we talk about the GI, we have to consider not just purely ecological values, but also the social and economic benefits as well.

3 Technical background for establishment of green infrastructure

When one reads technical guides for the development of the original ecological networks, they will recognise that those concepts were technically sound with no significant gaps (from the perspective of the knowledge at that time). So why we do try reinventing the wheel by promoting GI now and as new concept? The answer is simple: except for a few countries successful in the legal and practical establishment of ecological networks, the vast majority of plans were unsuccessful and remain as an exercise on paper. Green infrastructure tries to reopen the issue of the ecological connectivity again at the strategic level, and because we are talking about the EU territory, the concept is EU-wide and general in order to suit to basic conditions and circumstances in all EU countries. As mentioned above, there is a new aspect in this, too – an attempt to include ecosystem services valuation as a link to social and economic benefits and our dependency on a favourable state of the environment.

For an expert being aware of historical consequences, GI could look like a step back from a reasonably precise technical background to broader (and potentially shallower) concept. Nonetheless, the GI concept is a logical step in a time of the existence of Natura 2000, and contemporary lack of any EU-wide legal tool supporting an ecological coherence of unprotected EU landscapes.

4 Common understanding of the ecological connectivity concept

Ecological connectivity concept is not only a theory, it is a vital part of our paradigm. It is believed that for species populations as well as for ecosystem units a spatial connectivity is a must in ensuring their existence, and hopefully we are correct in this. However, when we delve deeper into the concept, ideas about how such connectivity should look like differ somewhat. Disputes emerge about precisely how wide an eco-corridor should be, or how long, or if we allow natural processes with dominating invasive species as a consequence, or do we plan to manage areas in

order to ‘create’ a desired ecosystem type, etc.

So far, so good. More challenging discussions start when linking the ecological connectivity concept (and thus the GI) with ecosystem services valuation. The GI is often promoted also as a vehicle for the sustainable ecosystem services provision. While ecological connectivity is quite easy to understand, the ecosystem services assessment process is still (!) difficult to comprehend for many of us. An example of total misunderstanding can be found in the Montenegrin Law on National Parks. Their ‘ecosystem services’ definition is quoted below.

With GI, we substituted a purely ecological approach by one based on ecosystem services valuation, moreover a monetary valuation. The idea behind was to present the economic value to our decision makers and thus to have stronger arguments for environmental protection. The effect is often the opposite. Ecosystem services valuation is still challenging when it comes to our ability to provide proper and accurate assessments. Besides, biodiversity values are not those that can be simply translated to monetary or even social benefits due to their intrinsic value. So, the impact of the ecosystem services valuation to the practice is poor. That does not make a life of GI easier. So far, majority of EU states have not been able to carry out country-wide quality ecosystem services evaluation.

5 Practical challenges for implementation in the field

Reality has endowed the nature conservation sector with lack of capacities since its birth. Simply, the nature conservation sector is usually established by countries or societies rich enough to afford its financing with the majority of nature conservation activities in developing countries and regions being paid for by international donors. Every economic crisis, irrespective of what triggers it, puts our sector in a difficult position of being one where we can save money fast, because there is no direct impact to society, living standards, employment rates, etc.

With this in mind, we need to prioritise in order to use our current capacities carefully. GI was introduced in a world in which we are already busy with other long-term tasks: protected areas management (including the Natura 2000), species protection, ecosystems management, etc. By doing so, we can hardly switch to GI implementation. GI requires significant additional capacities, because it is immensely demanding when it comes to:

a) Political willingness;

b) Robust technical capacities both at strategic and even more at the field level;

c) Sufficient budget for planning and incentives for stakeholders – not project based, but as continued funding allowing for long-term sustainability of the system.

In addition, we also need strong cooperation with our partners who are in fact the main stakeholders in the process: forestry, agriculture, water management, and spatial planning. A significant part of the task should be taken up by them, so far that is not the reality. Still, we are persuading the majority of stakeholders about why the GI concept is important. Their reaction is often hesitant and sometimes even outright refusal.

To conclude, it is impossible to implement the GI concept with only the current capacities available in our sector. If we do not increase them, we will need to cooperate with stakeholders that can share their resources. None of those options has happened so far, and there is no indication that it will happen any time soon.

6 Czechia, Georgia, and Montenegro – similarities and differences

Czechia has been a member of the EU for 16 years now, Montenegro is an EU candidate country, and Georgia an EU associated one. These levels important to distinguish. The EU promotes its policies in all of them, albeit to varying degrees of influence. While Czechia should transpose and implement EU environmental legislation, Montenegro is in the process of transposition, and Georgia is only asked (based on the EU Association Agreement) to implement selected elements. Those differences are irrelevant when it comes to GI which is not legally binding in any of those countries. The whole concept is mainly on a voluntary basis. Only ‘the core’ part of the GI, the Natura 2000 network, must be established in EU and EU candidate

DEFINITION OF ECOSYSTEM SERVICES IN MONTENEGRIN LEGISLATION ON NATIONAL PARKS

‘…Ecosystem services are additional actions and activities related to the protection of certain ecosystems in order to create direct or indirect economic benefits for users of national parks. Ecosystem services can be performed by legal and natural persons performing projects and activities in national parks. Ecosystem services are performed only on the basis of the concluded contract with the company.

The contract referred to … shall contain in particular:

- a description of the projects and activities to be carried out within the framework of ecosystem services;
- assessment of the ecosystem service that is the subject of the contract;
- technology to be used in the realization of ecosystem services;
- the amount of financial assets or other kind of benefits realized using the assets of the national parks that the user of those goods provides to the company;
- deadline for realization of ecosystem services;
- the obligation of the company to direct the funds received from the users of the national park’s goods to the protection and improvement of the assets of national parks…’

Law on National Parks (Official Gazette No56/09 and 28/2014)

countries, and based on the agreement, partially in Georgia. Czechia is one of the most industrialised countries in the EU. The side effect of that is densely populated landscapes with high level of ecological fragmentation. This resulted in attempts to establish an ecological network in the country in late 1980s. This was simply because of the need to improve the environment, because it was in very bad state and was even one of the main drivers that triggered the Velvet revolution in 1989. Whilst air pollution was the main driver, water quality, erosion and the state of the countryside in terms of ecology were also recognised as being poor. Those attempts were successful at the legal level and since 1992, Czechia has a strong legal tool – the territorial system of ecological stability. The rule is simple – the more damaged the environment is, the higher priority it is given to improve it.

Both Georgia and Montenegro are countries with quite small industrial sectors, underdeveloped infrastructure, and as a consequence, well preserved nature. In other words, the ecological connectivity is generally not a problem in either country except for minor parts of their territories. This results in a position that ecological coherence is not a priority, which from the pragmatic point of view, is correct. They have recently had other priorities more important than that.

The challenge is not the current state of the environment, but rapid development mostly supported by international donors. Examples include hydroelectric installations, rapid construction of transport infrastructure with insufficient environmental impact assessments, uncontrolled urban sprawl on sea shores due to lack of spatial planning, etc. Unfortunately, none of those trends are currently recognised as problems by decision makers (by the time they do it will be too late). In fact the opposite is true: both Georgia and Montenegro promote themselves as 'green countries' hoping that the attractiveness of their environment will attract tourists and they consider tourism as one of their most important future economies.

It is interesting to compare who leads discussion about the environment and thus also about GI (potential) implementation in all three countries:

1) Czechia already has the legal tool that is at least partially implemented. The state administration is active in this issue with support from academic institutions and environmental NGOs. Ecological connectivity, though still insufficiently implemented, is a perceived as an important aspect. GI is not considered as something new, rather it is translated as already existing tools implemented well in the country.

2) Georgia still has the task to build sufficient capacity within the state administration sector. There is a lack of technical knowledge as well as human capacity and also financial resources. The majority of funds in nature conservation and other sectors is provided by international donors and not by the state budget. This causes unsustainability in the long-term and a lack of strategic planning that cannot be provided via short-term disconnected projects with no sufficient coordination by country authorities.

3) Montenegro has a weak state administration and does not have the capacity to work on GI in a systematic way. Therefore, the process is mainly led by NGOs operating at the country level and by the EU Delegation supporting the EU accession process. As is the case in Georgia, GI or the ecological connectivity is neither considered as a problem nor opportunity, thanks to the current favourable state of the landscape.

As highlighted above in the case of the Montenegrin legislation on national parks, understanding of often basic technical principals or paradigms is a challenge. The GI concept is in some ways included within the policies of all three countries, but competent authorities do not always have a clear idea about what the GI aim is and what the implementation process should look like. The only rule is: the bigger the problem with the state of ecological coherence in a country is, the more competent bodies are interested to solve the problem. In the example of Czechia, the country spends a lot of capital restoring what has already been damaged (mainly from the state budget). In much the same way as Czechia in the past, those countries with a relatively intact environment are going to deteriorate the state of the landscape to a point at which only then will they feel strong enough pressure caused by the unfavourable state of the environment and only then will they start with restoration activities (for higher costs) instead of the cheaper conservation activities of maintaining the current favourable condition.

7 Conclusions

Let's go back to the title of the article. GI as an opportunity, if that was recognised and implemented by at least the majority of the EU countries as a real task and not only as a theoretical concept which is still the case, then it can be an opportunity. To ensure a proper implementation, it would need appropriate legal establishment and practical management taking into account a country's ecological conditions. One of the lessons learnt is that a voluntarily based approach does not work in this case. In addition, we need to reconsider if the ecosystem services valuation as a part of the concept is rather beneficial or aggravating, i.e., making the implementation process too challenging and not comprehensible for stakeholders[1].

The threat linked to the GI concept is that if we fail with its implementation, it will be just another term in long list of many others, developed just for the sake of 'innovation' or simply because older ideas were unsuccessful. If that happened, the result will be a weaker position of the competent bodies in the environment sector compared to those who are really deciding about land use. In reality and in the majority of countries we do go this direction. Stakeholders still do not properly understand what is behind the GI concept. While some ignore its existence (our partners from other sectors), some others overuse the GI term in a wrong way[2].

To think means always to think differently. The meaning behind that quotation is to use thinking processes consciously, and not just repackage existing concepts. I am a little bit afraid that we do this more than thinking differently with

regards to GI. Since 2013, GI is increasingly recognised by experts in Europe, but it is difficult find its solid base in the minds of other stakeholders. In my view, the only tool that could guarantee successful implementation would be a stronger legal basis for GI both at the EU as well as at the EU countries level[3]. Real enforcement instead of a voluntarily based approach that so far has been unsuccessful.

It is almost impossible to implement GI if the main driver is solely pressure from the environmental protection sector. The only successful approach must be based on strong societal recognition of the importance of GI. To do that we need an extensive and professional campaigns led by professional PR experts[4] rather than multiply technical guides. This is what other sectors do, so why should we reinvent the wheel here as well.

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[1] Countries with somehow successfully established ecological networks prefer to work with them not only because of tradition, but also due to the fact that it is much easier to understand them and thus implement.

[2] E.g., architects promoting mitigation measures with almost no adaptation impact to the climate change or the ecological state of target areas. Or did you recognized how much the GI is quoted by landscape architects when presenting quite artificial projects on improvement of the landscape aesthetical characteristics? In my experience, much more than spatial planners and competent bodies.

[3] As it has been with Natura 2000 as the most successful piece of the EU nature conservation. Its success is determined by its legal obligatory effect.

[4] Possible also as the EU to compliment the legal obligations and its strategic goals.

Green Infrastructure

Potentials for urban development in Dresden and Chemnitz

Christiane Eberts, Rehwaldt Landscape Architects, Dresden, Germany | christiane.eberts@rehwaldt.de

1 Urban challenges

It's getting crowded in the cities. In view of increasing densification, the effects of climate change and the dramatic decrease in biodiversity, a great deal of effort has been put into developing concepts, funding frameworks and technical solutions based on the idea of a green infrastructure in recent years. Green infrastructure (GI) is 'en vogue' and has become a code word for sustainable urban development.

But what potential does this concept actually hold for the complex challenges in cities? In 2013, the European Commission defined GI as a planned network of land and environmental elements with the objective of protecting biodiversity and providing the widest possible range of ecosystem services. Ecosystem services stand for a new approach to the assessment of natural resources, based on the consideration of the performance of ecosystems and the balance of nature. In this way, nature and natural resources were promised a realistic attribution of value and an improved position in the political decision-making process.

This perspective on "green" performance has contributed significantly to establishing a net-like GI as a promising concept for the development of urban spaces. In 2017, for example, the Federal Agency for Nature Conservation (Bundesamt für Naturschutz - BfN) named this as an essential factor for "good living in cities" in its guideline "Urban Green Infrastructure". The Federal Government's White Paper on Urban Greening (2017) emphasises the importance of green infrastructure for quality of life and services of general interest, including health protection and the quality of life in the city. If this approach is considered further, it is obvious that the improvement of open space in the city also leads to effects that can be measured in monetary terms. Open areas that serve flood protection and climate regulation reduce risks and the resulting costs. But also the quantification of savings through open spaces, which serve health care, environmental education, the equalisation of social conflicts and, as latest analyses suggest, also the containment of epidemics, is already within the realm of possibility and could give a clear impulse to the discussion about the development of cities.

The idea of an urban green network that takes over ecological functions and at the same time benefits everyone's health and quality of life seems obvious and at the same time ambitious. With the existing green spaces alone, such a multi-functional network can hardly be realized so far, and it would also quickly overwhelm historical parks or sensitive biotopes, for example. However, parks, city squares, cemeteries, allotments and avenues can form the nodes and major connections of the network. Many cities have had a green system in place for a long time.

Nevertheless, attention must now also be paid to the subordinate connections. They are multifaceted and often only visible as green infrastructure at second sight. They consist of species-rich greenery, roadside trees, areas with coverings that are capable of infiltration, schoolyards, green roofs and facades, but also structures of the "grey" infrastructure, such as roads, parking lots and the numerous altered watercourses running waters in the city, which must be appropriately qualified (e.g. unsealing, greening, rainwater utilisation).

Now, it would not be a new approach to use existing green spaces in a multifunctional way. However, the concept of green infrastructure turns the focus around: to think of areas that so far have served mostly grey infrastructure functions such as traffic, media supply, drainage or disposal as components of a green network is now urban green infrastructure. Squares, streets and roofs are no longer evaluated and developed in the usual mono-functional way, but with a focus on their potential in terms of climate mitigation, climate adaptation, biodiversity, social balance and health care.

2 Green infrastructure in object planning

The approach of GI requires the participation of several disciplines and makes it a cross-sectoral task of urban development. In the future, existing planning instruments may have to be adapted, more suitable communication formats developed and some technical regulations expanded.

However, there is already a great pressure on local authorities to create living space and at the same time climate-friendly, attractive open spaces. A relaxation of the situation is not in sight. Due to the pressure to act, the GI approach to urban open spaces is already being addressed in many places at the object planning level. Green infrastructure is already a regular part of the current task. It is important that it is not an end in itself. It is part of the inherent character of the GI (infrastructure - originally from the military, lat. infra means something existing below/above, in the sense of a serving structure) that it is subordinate to higher objectives, such as sense of place, mobility or the appearance of a place, and allows the overlapping of different functions.

The rich potential of overlapping aspects of use is therefore increasingly the basis for spatial and design decisions. In detailed planning, this requires solutions that are tailored to the location and its requirements. Traffic areas should be critically reduced to a necessary level. Depending on the

situation, the use of infiltration-capable pavements is to be preferred. Urban trees provide shade and evaporation and should be integrated into the urban space wherever possible. Here it is important to have better organisation of the space for utility infrastructure and street trees in favour of the trees in the future. For trees and plantations, climate-resilient species that can withstand heat and drought should be used. Species-rich, height-adjusted plantings provide habitats for birds and small animals. On paved areas, rainwater can be dammed up and infiltrated so that wet areas are created which generate evaporation cooling and in which amphibians can live. For existing material that originates on site, a new use can often be found. This saves transport and recycling costs. Demolition material can be collected and piled up to provide a habitat for insects and lizards.

3 Example of green infrastructure in Chemnitz: Brook & Bikes – Kappelbach green corridor

Chemnitz is characterised by its location between different mountain ranges, which are separated by river valleys. Along these rivers, a diverse range of watercourses developed in the 19th century and nationally important industry with extensive facilities and building complexes. Chemnitz is characterised by its location between different mountain ranges, which are separated by river valleys. Along these rivers a diverse and nationally important industry with extensive facilities and building complexes developed in the 19th century. One of these industrial sites was located on the Kappelbach Kappel Brook), near the city centre. After it was abandoned, the city of Chemnitz seized the opportunity to renaturalise the Kappelbach floodplain and connect it with other green spaces. In addition, the river floodplain was to be made accessible to the citizens and a comfortable connection was to be created with cycle and footpaths between the city centre and the western districts. To achieve this, part of the land had to be purchased from private owners. The municipal green space authority took the lead in the following planning. Since 2005, several stages of implementation have been undertaken to unseal the areas, create paths and give the water and its riverbanks a comprehensive ecological upgrade.

Until the beginning of the first measures, the Kappelbach was still surrounded by bank walls, the river bed was fixed and the river profile partially covered. The stream was not visible in the city landscape. Today, changing slope inclinations and flow velocities allow natural sediment dynamics to be restored. Crossing thresholds in the watercourse enrich the water with oxygen and ensure self-purification of the watercourse. Numerous species of insects, amphibians and small animals benefit from the shadowed wetland areas along the banks, which are covered with tall shrubs and provide valuable retreat areas during hot seasons. Shrubs and trees typical of riparian areas have been planted on the embankments to shade the meadows and regulate the microclimate. The demolished bank walls made of rubble stone, bricks and concrete provided the material for the distinctive dry stone walls, which were aligned transversely to the stream and on which wooden sitting platforms were installed. At the same time a habitat was created for insects and lizards, who find shelter in the joints.

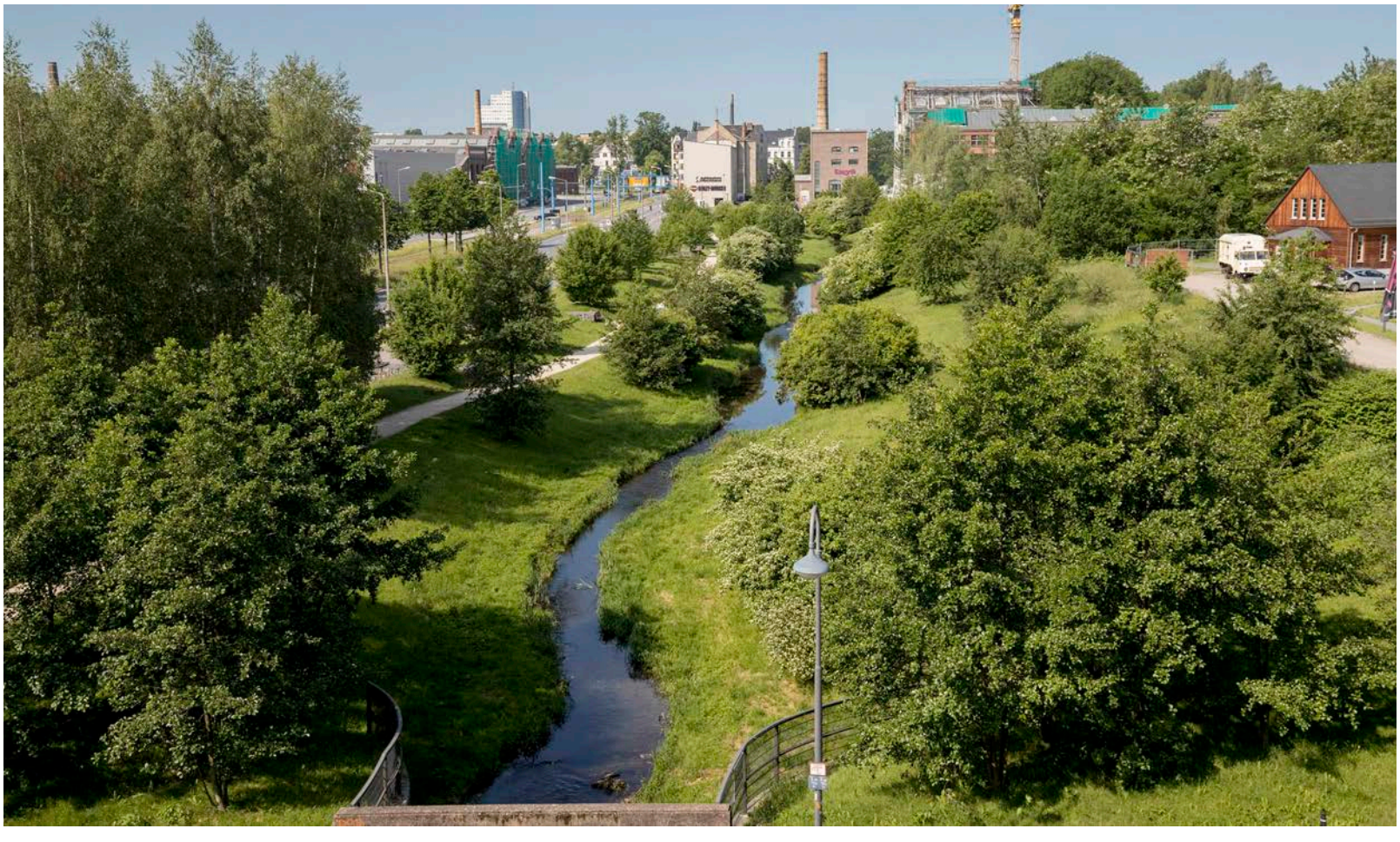

Fig. 1: Kappelbach green corridor in Chemnitz/Germany

Fig. 2 (left): Before the start of the first reconstruction works in 2005
Fig. 3: Opportunity for new mobility, popular cycle path connection along the Kappelbach

In addition to the newly developed ecosystem, urban life benefits from the new green corridor. The sitting platforms in the meadows invite people to rest and play. A citizens' association has taken the newly created green city artery as an opportunity to plant more trees in the neighbouring meadows. After the redevelopment, several gastronomy businesses have settled on the neighbouring properties and have set up coffee or beer gardens with a view of the meadows. The cycle and footpaths along the river on both sides are very well accepted. For the rush hour traffic that flows in and out of the streets every day, they offer safe and fast routes for bicycles, skaters and e-bikes, thus strengthening environmentally friendly mobility behaviour. For Chemnitz, with its waterway axes and old industrial areas leading radially into the surrounding area, the Kappelbach floodplain is a green infrastructure with model character, as it could also be created along other watercourses.

4 Example of green infrastructure in school buildings: school at Lehmberg in Dresden – sustainable open space creation

In the district of Briesnitz in Dresden, the school on the Lehmberg was newly built. In order to implement a concept that is as sustainable as possible, the Sustainable Building Rating System (Bewertungssystem Nachhaltiges Bauen, BNB), which is already mandatory for federal buildings, was used for the first time in Dresden for the planning and construction of the school buildings and outdoor areas. It includes the ecological, economic and socio-cultural evaluation of the entire life span of buildings and outdoor facilities using a transparent, objective evaluation system.

The school's outdoor facilities include sports areas with a playing field and running track, a school garden and areas for breaks and after-school care. The break and after-school care areas include both robust, paved and spacious "green" areas. Thus, in collaboration with the school and the after-school care teachers, a large landscaped area with meadows, flowering wild shrubs and willow bushes was created next to the actual yard, which fulfils a variety of climatic, ecological and educational functions.

A large portion of the rainwater collected on the paved areas is channelled into this landscape through an artificial stream. The temporary watercourse is designed as a playable "little brook" with a loose stone bed and plants. The target of the rainwater are several troughs which fill up in the rainfall and can absorb the necessary drainage volume. Instead of being returned to the sewerage system as quickly as possible, a considerable amount of water can evaporate through the accumulation and be returned to the natural water cycle. If the water rises to the edge of the trough, it flows through an overflow into the municipal sewer system. This flood protection is important, but it can be seen that the basins have always been able to withstand the sometimes heavy rainfall.

In the depressions, flowering wild shrubs thrive, such as *Filipendula* (meadowsweet), *Lythrum salicaria* (purple loosestrife) and *Myosotis scorpioides* (true forget-me-not) who can tolerate the temporary waterlogging. The shrubs and woody plants, including species important for bees and native butterfly populations, such as *Salix purpurea* (purple willow), *Salix repens* (creeping willow) and *Betula nana* (dwarf birch), do not require any additional watering in the humid locations. At the same time, diverse habitats are created, which provide a play and nature experience area for the students. During class time and after-school care, the natural space is used for research projects on various scientific topics. Honey bees are kept in a protected area, the honey benefits from the flowery environment. There is also a reading garden in the school's break area. Hedge plantings and trees of native species provide shade for the area and ensure a balanced microclimate. In this way, the school grounds become an open space knot with various functions in the city's green network.

Fig. 4: School at the Lehmberg – native woody plants shape the open spaces

Fig. 5: First rainwater inflow into the depressions shortly after planting

Mapping green infrastructure and assessing its connectivity in an agricultural region of Kyjovsko, Czech Republic

Hana Skokanová, Tomáš Slach, Pavla Pokorná, Marek Havlíček, Silva Tarouca Research Institute for Landscape and Horticulture, Brno, Czech Republic | hanka@skokan.net

Introduction

The concept of green infrastructure (GI) has gained in popularity in recent years, especially with the EU Green Infrastructure Strategy published in 2013. The development and conservation of GI elements is listed as one of the priorities in several key EU policies (e.g. the EU Climate Change Strategy) (Skokanová et al. 2020). However, the concept is not yet fully integrated into actual planning strategies, usually due to lack of guidelines how to identify and map GI using available sources.

Spatial delineation of GI elements has often been based on a re-classification of available land cover data combined with information about the natural values of each cover class (Liquete et al. 2015). The existing data sources often do not fulfil the requirements for thematic coverage, resolution or accuracy, leading to inadequate results concerning not only real occurrence of GI but also its multifunctionality and connectivity. GI elements are often part of usually complex categories, e.g. settlements, resulting in their inadequate representation, especially at regional and local level. Methods for mapping GI include visual interpretation of aerial imagery and fieldwork (Rosina and Kopecká 2016) or using very high resolution (VHR) satellite remote sensing systems, which can significantly improve capturing GI elements within complex categories. However, the use of VHR imagery and remote sensing for mapping GI involves sophisticated software and procedures. Therefore, they are not always suitable for regional or local planners when forming the territorial planning strategy (Skokanová et al. 2020).

GI is researched mainly in urban areas (e.g. Gradinaru and Hersperger 2019, Hansen et al. 2019), where it can connect greenspace (Davies and Lafortezza 2017), help mitigate climate change manifestations (De la Sota et al. 2019) or even control urban sprawl (Gavrilidis et al. 2019). In rural landscapes, GI is usually studied in the framework of ecological networks. Indeed, existing ecological networks, usually in the form of protected areas, are considered by many as a stepping stone in mapping GI, especially its connectivity (e.g. Liquete et al. 2015). The concept of ecological networks stems from the principle that intensively used landscapes are balanced by natural zones that function as a coherent self-regulating whole (Bennett and Mulongoy 2006).

GI is defined according to European Commission (European Commission 2013a) as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings. Unlike ecological networks, GI can be understood in a broader sense, since it includes "other environmental features" (such as urban parks, green roofs, roadside vegetation) and is designed with humans as the main focus (in ecological networks, the main focus is wildlife). Still, these two concepts are interlinked and this fact can be taken advantage of because there are countries where the concept of ecological networks is already integrated into legislation while the concept of green infrastructure seems to be a "new term" (Skokanová and Slach 2020). One such country is the Czech Republic, where the legislation operates with a concept based on ecological networks called the Territorial System of Ecological Stability (TSES). TSES is defined as an "interconnected system of natural as well as modified semi-natural ecosystems keeping the natural balance". It is integrated not only in environmental legislation but also in the planning, which to some degree fulfils some of the main terms in GI definition (Skokanová and Slach 2020). TSES consists of three main groups: bio-centres, bio-corridors and interactive elements. While bio-centres represent habitats or systems of habitats ensuring permanent existence of natural or semi-natural ecosystems, bio-corridors are areas enabling the movement of organisms between bio-centres. Both bio-centres and bio-corridors have predefined minimum parameters ensuring their functionality. Interactive elements are usually spatially isolated, delivering favourable conditions for the permanent existence of organisms with limited territorial requirements, creating stepping stones (Skokanová et al. 2020). There are three levels of TSES – supra-regional, regional and local. Supra-regional and regional TSES consists only of bio-centres and bio-corridors while the local TSES includes also interactive elements.

Connectivity is one of the main goals of a well-established GI network. It can be either physical/structural (areas are physically connected with other areas via corridors) or functional (actual connectivity from a specie's perspective). Within the spatial planning, structural connectivity of GI is preferred since it is more obvious and can be planned in the actual landscape. There are many tools to assess GI connectivity, one of them being GUIDOS Toolbox, developed by researchers from Joint Research Centre of the European Commission. It offers a variety of modules targeted to investigate spatial aspects of GI, for example, pattern, connectivity, cost, fragmentation, etc. (Danzinger et al. 2020) and is freely available. Results from this software can provide an important insight on the different focal points of regional management plans, therefore providing exact areas targeted for GI investments.

The aim of this contribution is to compare existing data suitable for mapping GI on regional level in the Czech Republic, highlight their strengths and weaknesses and using the most detailed GI map to show how connectivity of GI can be affected by including TSES and how the results can be used in GI planning.

1 Case study area

Kyjovsko is a lowland region situated in the southeast of the Czech Republic, in South Moravia (Fig. 1). This region covers 470 km2, containing 42 municipalities. Most of the region is intensively used, especially for agriculture, resulting in very large, impermeable blocks of arable fields that suffer from wind and water erosion. Due to its warm and dry climate (average annual temperature is around 9 °C and average annual precipitation around 450-500 mm), the region is known for its vineyards and to a lesser extent also for its orchards, which are, however, quickly disappearing. Larger forest complexes cover 29 % of the whole territory and can be found in the north (mostly deciduous, dominated by oak and hornbeam) and in the south of Kyjovsko (predominantly coniferous – pine forests on sandy soils). There are also some remnants of dry grasslands and other types of grassland with scattered trees. One of the unique but rapidly disappearing features of the landscape is the mosaic of smallholdings – a mixture of vineyards, orchards, arable fields and grasslands, usually connected with settlements.

2 Materials and methods

2.1 Data sources

There are several databases on land cover/land use currently available in the Czech Republic. They include sources freely available, on request or for a fee. Freely available data are cadastre data from the Czech State Administration of Land Surveying and Cadastre (ČÚZK) and data from the Land Parcel Information System (LPIS) from the Ministry of Agriculture. Free data on request are biotope data and Consolidated Layer of Ecosystems of the Czech Republic (CLE) from the Czech Nature Conservation Agency (AOPK ČR). Data available for a fee are data containing forest types from Forest Management Institute (UHUL) and data from the Fundamental Base of Geographic Data of the Czech Republic (ZABAGED) from ČÚZK. More detail about these data can be found in Skokanová et al. (2020).

There are also several sources for acquiring information about TSES, dependant of hierarchical level. Bio-centres on supra-regional level can be obtained in a digital vector form from AOPK ČR. TSES on supra-regional and regional level in digital vector form can be obtained also from regional administrations. Data on the local TSES are an integral part of municipal spatial plans. They can be found in a digital vector form as a separate layer, however, they are often only in a digital raster format as a part of the whole plan and therefore have to be extracted (Skokanová and Slach 2020). Ortophotos are also available from the ČÚZK in the wms format and can be useful for verification.

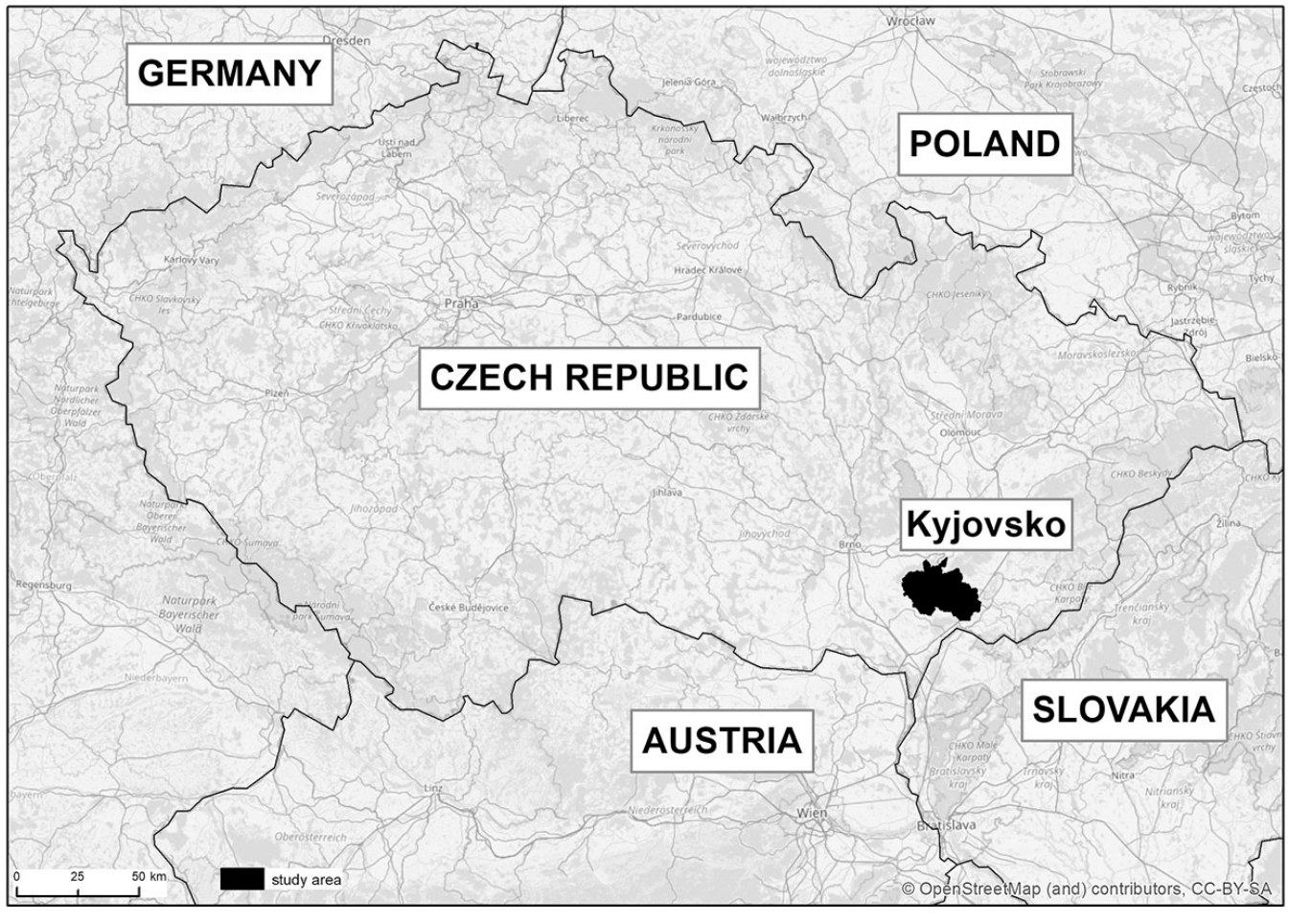

Fig. 1: Location of the Kyjovsko case study area in the Czech Republic

2.2 Green infrastructure identification and classification

The GI identification was based on the definition from the European Commission (2013). Thus, every green or blue element in the landscape whether natural, semi-natural or anthropogenic that may provide ecosystem services, was considered Green/Blue infrastructure and integrated into the map.

The GI classification scheme is based on CORINE Land Cover (CLC), as was agreed within the MaGICLandscapes project (Ed. 2019). For the regional mapping level, it has been adjusted in order to capture level of naturalness. Therefore, the GI classes in narrow sense included only natural or semi-natural ecosystems: broad-leaved, coniferous and mixed forests, natural grasslands, transitional woodland-shrub, inland marshes, water courses and water bodies. GI under specific circumstances (or specific GI) were represented by ecosystems created and regularly managed by human activities. Without them, these ecosystems would cease to exist. They included green urban areas, vineyards, fruit trees and berry plantations, pastures, complex cultivation patterns (smallholdings), land principally occupied by agriculture with significant areas of natural vegetation (further mentioned as agricultural land with natural vegetation) and agro-forestry areas. No GI/BI included continuous and discontinuous urban fabric, industrial or commercial units, road and rail networks and associated land, mineral extraction and construction sites, sport and leisure facilities and non-irrigated arable land. From this group, discontinuous urban fabric included only impervious surfaces, such as buildings or parking spaces while green elements were assigned either to green urban areas or smallholdings/gardens. Non-irrigated arable land did not include woody or grassland strips, which were part of agricultural land with natural vegetation, and road and rail networks and associated land included only paved/unpaved roads and railways. Therefore these categories were defined in a narrower sense than the original CLC categories.

2.3 Green infrastructure mapping

GI mapping was conducted for regional level and the data were processed and classified using ESRI ArcGIS Desktop 10.3 – 10.5 software. We produced two GI maps. The first map was based on the existing CLE layer, while the second map was a combination of several land cover data sources and manual vectorisation with the help of current orthophoto.

The CLE layer combines biotope layer, ZABAGED, Digital Base of Water Management Data, Copernicus Land Monitoring Service (Urban Atlas) and CLC, i.e. data with different spatial and thematic resolutions. It was produced in 2012-2013. It divides the landscape into 41 main categories of ecosystems, which were reclassified and rendered into the CLC classification. The GI map was then derived by dividing existing classes into three groups: GI, specific GI and not GI/BI according to the above mentioned definitions.

The second GI map (detailed regional GI map) was also based on the combination of existing data. Some of the GI classes were directly represented by certain categories comprised in the datasets, such as forests, inland marshes, water courses (as a buffer) and water bodies. Other GI classes were a combination of several sources and had to be manually adjusted according to orthophoto. These were mainly transitional woodland-shrub, complex cultivation patterns and green urban areas. Still other classes were not captured by existing sources at all and had to be manually vectorised. These belonged mainly to agricultural land with natural vegetation. In some unclear cases, verification in the field was necessary. Subsequently, all layers were overlaid. This overlay revealed gaps that needed to be filled in manually, again using the 2017-2018 orthophoto. The gaps were usually linear features of GI that were not captured in the existing databases. Finally, individual classes were assigned into the three groups and a GI map was derived.

2.4 Territorial System of Ecological Stability

For the Kyjovsko case study region, we obtained TSES elements at supra-regional and regional level as a digital vector layer from the regional administration in Kyjov. Concerning the local TSES, only six municipalities had separate digital vector layers for TSES. For verification purposes, each vector layer was compared with the main spatial plan. Spatial plans for the other municipalities had to be georeferenced and the TSES layer had to be manually extracted/digitised. Based on the visual interpretation of orthophotos, TSES elements were divided into three categories: a) existing (element is as described in the municipality plan and at the same time can be seen in orthophoto), b) partly existing (element is present in the orthophoto to some degree but doesn't fulfil all the required criteria, e.g. a bio-centre that has been planted on half of its intended area, a line of trees in a grassland strip in an intended bio-corridor), and c) non-existent (element is planned in a municipality plan but is not present in the orthophoto). The same analysis was done also for regional and supra-regional TSES.

2.5 Connectivity

Connectivity is considered as one of key principles of GI (Skokanová and Slach 2020). Connectivity in this case was understood as physical connectedness of GI elements and was therefore calculated using Morphological Spatial Pattern Analysis (MSPA), which was carried out in GUIDOS Toolbox, version 2.7 (Vogt and Riitters 2017). MSPA distinguishes seven feature classes: cores, islets, bridges, loops, branches, edges and perforations. While cores enable broad movement of organisms, islets are isolated patches that do not directly affect degree of connectivity but can be considered as stepping stones. Bridges and loops are connectors; branches facilitate movement outside cores and can be considered as potential features for extension and subsequently transformation into connecting elements – bridges or loops. Edges and perforation represent outer and inner boundaries.

For calculating connectivity, we considered only classes that were included into the GI group.

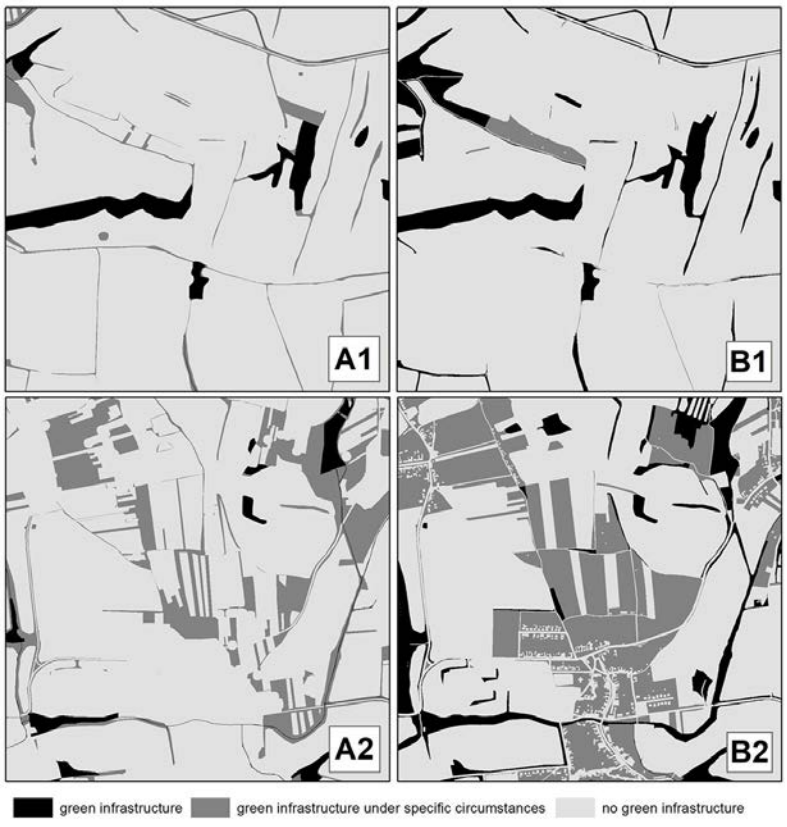

Fig. 2: Comparison of Consolidated layer of Ecosystems (CLE) Green infrastructure map (A) and detail regional Green Infrastructure map (B) in open landscape (1) and urban settings (2)

Since MSPA uses only a binary raster, both GI and TSES layers were converted to this format. The pixel size was set to 2 m. MSPA settings were set to foreground connectivity 8 (all neighbouring pixels are connected), and the edge width defining the width/thickness of the non-core classes in pixels was set to 10, i.e. 20 m.

Connectivity based on MSPA results was assessed within the framework of graph theory (Saura and Rubio 2010). Cores were considered as nodes and bridges served as links. With the help of GUIDOS software, we calculated an Equivalent Connected Area (ECA) which represents a summary of overall connectivity. It is defined as the size that a single habitat patch should have in order to provide maximum connection (Saura et al. 2011).

To find out how TSES implementation can affect overall connectivity, we conducted MSPA and calculated ECA separately for the GI layer and combined GI and TSES layer.

3 Results

3.1 Green infrastructure maps – comparison between Consolidated Layer of Ecosystems and detailed regional maps

Comparison of the overall coverage of GI revealed that the detailed regional GI map shows larger area (48 %) of GI in comparison to the CLE GI map (46 %) as well as higher number of GI elements (19,139 vs 14,565). This might be largely attributed to the fact that the CLE GI map does not recognise GI elements integrated in urban areas, especially gardens, leading to underrepresentation of GI in these settings (Fig. 2). This feature is the main disadvantage of the CLE GI map.

There are other differences between the two datasets, stemming mainly from the sources used for depicting individual GI classes but also from the date of used sources. The biggest difference was identified for meadows and pastures: the CLE GI map significantly overestimates area of this category (9 % coverage compared to 1 % coverage in the detailed regional GI map) due to the fact that it includes also complex cultivation pattern as well as agricultural land with natural vegetation. These two categories are then completely missing from the CLE GI map.

Smaller differences in the area can be also seen for broad-leaved and coniferous forests and vineyards (overestimation in the CLE GI map), and natural grasslands, mixed forests, transitional woodland-shrub and orchards (underestimation in the CLE GI map). The differences are around 1 %, with the exception of vineyards (around 2 %).

The CLE GI map used primarily biotope layer for identifying natural forests and a mixture of biotope layer, ZABAGED and CLC for identifying managed forests, while the forests identification in the detailed regional GI map was based on the accurate dataset on forest composition provided by UHUL.

Natural grasslands in the CLE GI map were covered only by data within the biotope layer; in the detailed regional map, also LPIS and ZABAGED were used for delimitation of this class and orthophoto for their verification. Although this approach can result in classifying also commercially used grassland plots as natural, the overall difference between the two maps is about 1 %. One of the reasons is the time lag – many plots classified in the CLE GI map as natural grassland have been overgrown by woody vegetation and therefore should be classified as transitional woodland-shrub.

Overestimation of vineyards on one hand and underestimation of orchards on the other could be attributed to the time lag between CLE GI map (from 2012) and detailed regional GI map (from 2018) but also to the level of detail. Indeed, quite a lot of plots identified in the CLE GI map as vineyards were in the detailed regional GI map classified as complex cultivation patterns. Similar reasons are also behind underestimation of transitional woodland-shrub.

3.2 Territorial System of Ecological Stability and green infrastructure connectivity

The existence of TSES in the Kyjovsko region is quite good. All supra-regional TSES elements are present in the landscape, this is because at this level is usually planned in order to include already existing habitats. There are some parts of one forest bio-centre that cover a narrow valley, which is dominated by arable land. Because there is no major road going through the valley, this circumstance does not represent a problem for forest species to reach forest on the other side. At the regional level, there are several missing bio-corridors or their parts delineated in the agricultural landscape with dominant

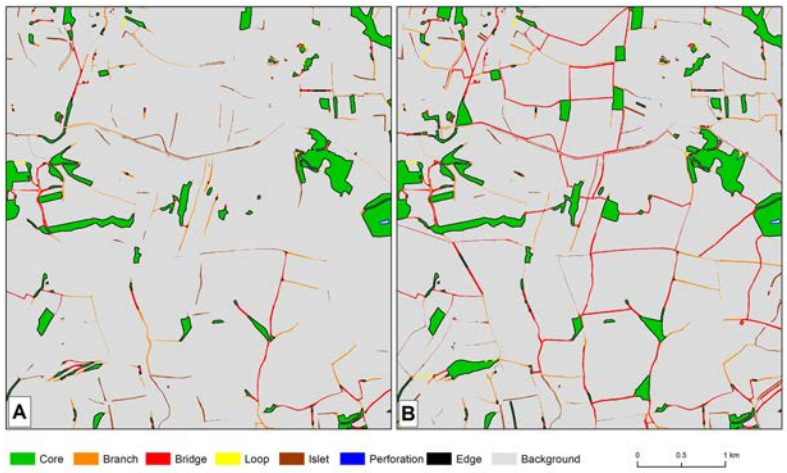

Fig. 3: Subset of the resulting Morphological Spatial Pattern Analysis (MSPA) of green infrastructure (GI) without adding elements of Territorial System of Ecological Stability (A) and with added elements (B) in the Kyjovsko region (from Skokanová and Slach 2020)

large arable fields. These bio-corridors are supposed to connect local bio-centres; therefore, their realisation should be a priority.

In case of local TSES, one third of delineated elements does not exist. Even though they cover only 21 % of the total TSES area, they are usually situated inside or at the edges of large arable fields. Therefore, their realisation would help in reducing soil erosion. In the main, local bio-corridors and interactive elements already exist. If we consider presence of local TSES in individual categories, it is predominantly bio-centres where the situation is quite good: 75 % of bio-centres exist fully or in part; in the case of bio-corridors, this is true for 67 %, and in case of interactive elements, 64 % exist fully or partially (Skokanová and Slach 2020).

Morphological spatial pattern analysis revealed quite a high fragmentation of GI (Fig. 3A). It was expressed by high numbers of branches, cores and islets and smaller numbers of bridges and loops. Equivalent Connected Area (ECA) was calculated as 150 ha of GI being fully connected. Adding the TSES layer resulted in a significant increase of connectivity (Fig. 3B), expressed by increase in ECA (1,239 ha). This is mainly a result of an increase in number of bridges (from 1,466 to 2,071) and in the area of cores (from 28 % to 31 %).

Based on the connectivity analysis, we were able to identify which TSES elements should have the highest priority to be realised in order to increase overall GI connectivity in the Kyjovsko region (Fig. 4). As the Fig. 4 shows, it is mainly bio-corridors and

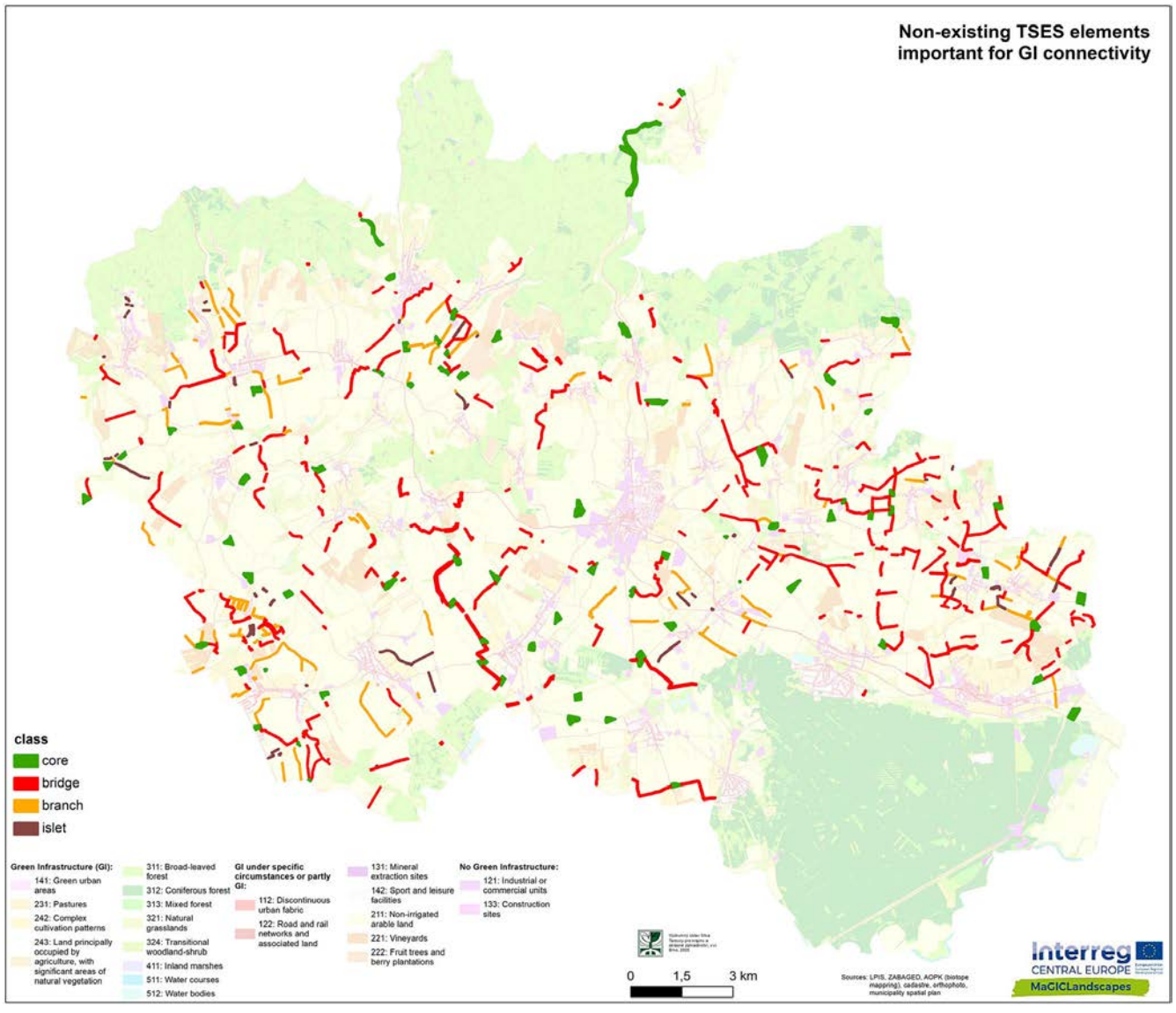

Fig. 4 Identified non-existing Territorial System of Ecological Stability (TSES) elements divided into Morphological Spatial Pattern Analysis (MSPA) classes that are important for increasing green infrastructure (GI) connectivity

interactive elements in the form of bridges or branches.

4 Discussion and conclusions

Unlike (trans)-national GI mapping, the regional GI mapping requires higher accuracy and detail. The Czech sources that are available can provide such detail but have to be carefully combined and up-to-date data should be used. If we do not differentiate GI into individual classes but work with GI as such, the CLE database, when updated, is a very good source for GI identification, especially in the rural settings. In the urban setting, this database lacks sufficient detail as can be seen Fig. 2 and therefore should be adjusted. This could be done with incorporating some classes from the ZABAGED database, such as "ornamental garden, public park" and "fruit orchard, garden". The second class is a bit more problematic since it combines gardens with orchards. However, the layer can be clipped by an urban mask and combined with information from cadastre data. The urban mask can be created following the rules described in the CLE database (AOPK 2013), i.e. combining existing layers and buffer. Another approach how to capture urban GI can be based on semi-automatic extraction from Sentinel data and classification of the extracted polygons based on visual interpretation of aerial orthophotos, leading to the minimisation of manual editing while maintaining a high level of accuracy (Kopecká et al. 2017). Using high-resolution data from Copernicus programme, especially the layer of small woody features, might be another option to obtain information about GI in settlements and also in open agricultural land.

A detailed regional map resulting from combination of existing data and manual editing can be a good basis for the local level mapping. Manual delineation of smaller elements and refining of existing features based on time-consuming but necessary fieldwork is desirable in order to allow a proper GI assessment and planning at such scale (Skokanová et al. 2020). It can also serve as a basis for further multifunctional analysis where each GI element is assigned with respective landscape service according to e.g. the manual created within the MaGICLandscapes project (Danzinger et al. 2020).

TSES as a mandatory part of the spatial plans can be considered as an important source for GI mapping from national to local scale. However, we should be aware of the fact that not all TSES elements captured in the spatial plan actually exist in the real world as was demonstrated by our analysis in the Kyjovsko region. Still, the situation with TSES implementation is much better than expected and this can be attributed to massive effort of some municipalities to make landscape in their regions more resilient. It is mainly TSES elements with clearly defined parameters regarding their size, shape, etc. that are realised (Skokanová and Slach 2020). This fact shows that clear rules for TSES elements such as bio-centres and bio-corridors are preferred while ambiguity associated with interactive elements can lead to unwillingness in their implementation. On the other hand, this lack of rules might make their implementation easier, since they can be realised on land with less suitable size parameters.

Full implementation of TSES will lead into increase of GI's connectivity as was shown in Fig. 3, making the landscape more resilient, less fragmented and offering more ecosystem services and resulting benefits, as described in Technical information on Green Infrastructure (European Commission 2013b).

Using MSPA provides clear picture about which parts of GI are core areas, which are connecting elements and which can be used as stepping stones for increasing GI connectivity. Therefore, it is a useful tool for landscape planners and managers as well as municipal authorities, especially when deciding priority of implementation of TSES elements as illustrated in Fig. 4.

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Green infrastructure and valorization of the landscape around Karpacz/Poland

Janusz Korzeń, architect and town planner, Karpniki, Poland | janusz_korzen@o2.pl

As part of the MaGICLandscapes project, special analyses were carried out for the town of Karpacz, the main tourist and holiday resort in the Polish Karkonosze region. In recent years, in its spatial development, tendencies have appeared, associated with excessive urbanisation that are dangerous for the preservation of its natural and landscape values. Therefore, work has been undertaken to update the town's spatial policy and to develop ways to mitigate those tendencies. The analysis of the green infrastructure network and its improvement as well as the resulting recommendations for improving the functioning of the town's natural system and living conditions as well as for rest and recreation became part of this mitigation process.

1 Basic elements of the town's green infrastructure

According to the 2013 European Union, the green infrastructure network is a strategically planned network of natural and semi-natural areas, managed to provide a wide range of ecosystem services.

The elements of this network are formed by the following systems:

• The blue infrastructure network, identified as a basis for the functioning of the "green" network (including elements such as: water bodies and main watercourses, as well as springs, wetlands and peat lands);

• The green infrastructure network (including elements such as coniferous, mixed and deciduous forests, mid-field and coppice areas, in the high parts of the mountains - dwarf pine scrub, as well as locations within built-up areas such as town parks and cemeteries, areas of meadows and pastures, as well as allotment gardens and larger orchards).

The most important of the above mentioned elements are presented in Fig. 3 that also shows the division of the town's area into 3 basic landscape units, shaped by culminations and local ridges, which limit the valleys of rivers and streams such as: Łomnica, Łomniczka and Płomnica and Skałka and Malina. These are naturally shaped "interiors" with special, individual features and arrangements, resulting mainly from local geomorphological conditions.

Individual elements of the green infrastructure network, occurring in the area of the town, are subject to protection and management by the Karkonosze National Park (KPN) within its borders and in part within the area of its buffer zone, as well as within the Natura 2000 Special Areas of Conservation (SAC) and Special Protection Areas (SPA). The forests outside the Park's borders are managed by the State Forest (Lasy Państwowe), and the waters are managed by the National Water Management Authority, and in a comprehensive approach, the elements of the discussed network are subject to management by the local government.

An important element of the discussed analyses was to carry out the valorisation of the basic elements of the blue and green infrastructure, as a result of which it was possible to indicate, among others, the following:

• Core areas of particular importance for the town's natural system (a compact complex of forests surrounding urbanised areas of the town, as well as dwarf pine, mid-forest and high-mountain meadows were considered as such);

Fig. 1 (left): Karpacz is the main tourist and holiday resort in the Polish Karkonosze mountains.
Fig. 2: Mountain meadows are of particular importance for the town's natural system.

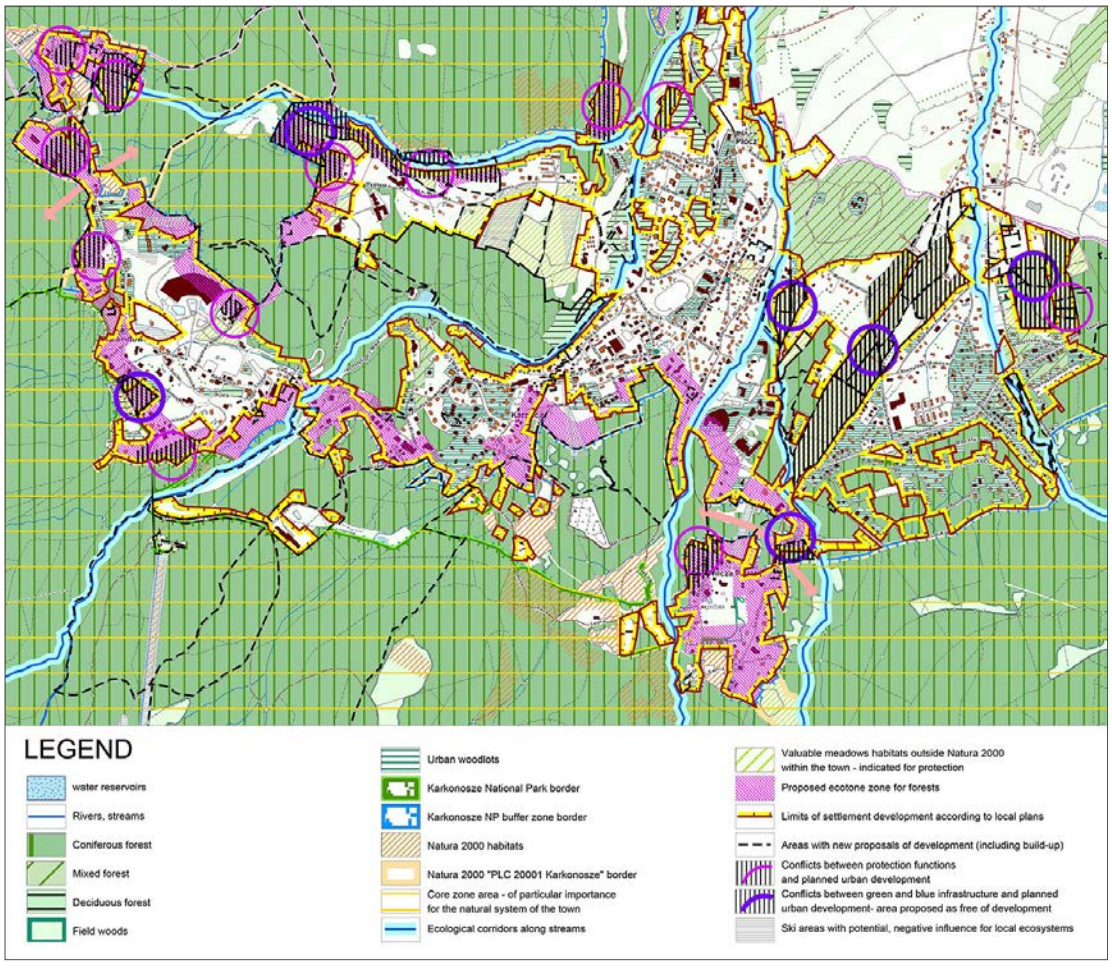


Fig. 3: Green infrastructure network in and around the city of Karpacz

- Terrestrial and aquatic ecological corridors;
- Areas with valuable Natura 2000 habitats in meadow communities, located on the outskirts of areas already designated and indicated for protection;
- The proposed external eco-tone zone for forests in the KPN area and its buffer zone.

2 Threats to green infrastructure

By comparing the spatial layout of the most valuable elements of the blue and green infrastructure with the location of the applications for the currently being prepared update of the municipal study and concerning the postulated changes of land use, including those related to construction purposes, it was possible to indicate the places of conflict between the protective functions and the planned development of urbanisation, including those predestined for the ban on the introduction of buildings. Conclusions resulting from the discussed analysis are of a general nature and indicate potential threats that could hinder or prevent the protection of the town's blue and green infrastructure systems. This required the development of appropriate solutions, in particular, they should concern the prohibition of building development in open areas, located below Księża Górka on the Skalne district, in the upper part of the Dziki Potok valley, and three other places in the town area (indicated in the figure of the Green Infrastructure System). Other conflicts between the GI and local plans were identified and the findings should be acknowledged so as to limit as much as possible the threats to the natural environment and at the same time ensure better quality of life for the residents.

3 Structure of the town landscape elements of its exposure and threats

The blue and green infrastructure networks presented above are the basic elements of the town's land cover and thus build its local landscape. It is defined in various ways and by combining its definitions, contained in the glossaries of applicable laws on spatial planning and development and on protection and care of monuments, it can be said that it is a space perceived by people, containing natural elements and products of civilisation, historically shaped as a result of natural factors and human activity.

Taking into account such an understanding of landscape, the following two sets of its basic elements can be indicated in the area of the town (shown next to it in the picture Landscape Valorisation and principles of its protection against the background of the existing system of nature and landscape protection):

- Natural – including the relief of the terrain, the bottoms of the valleys of the main streams and water reservoirs, areas of forests and thickets of dwarf pine, mountain halls and meadows;
- Cultural - covering urban settlement areas with historically shaped cultural and natural landscape, historic buildings and selected engineering objects indicated for protection;

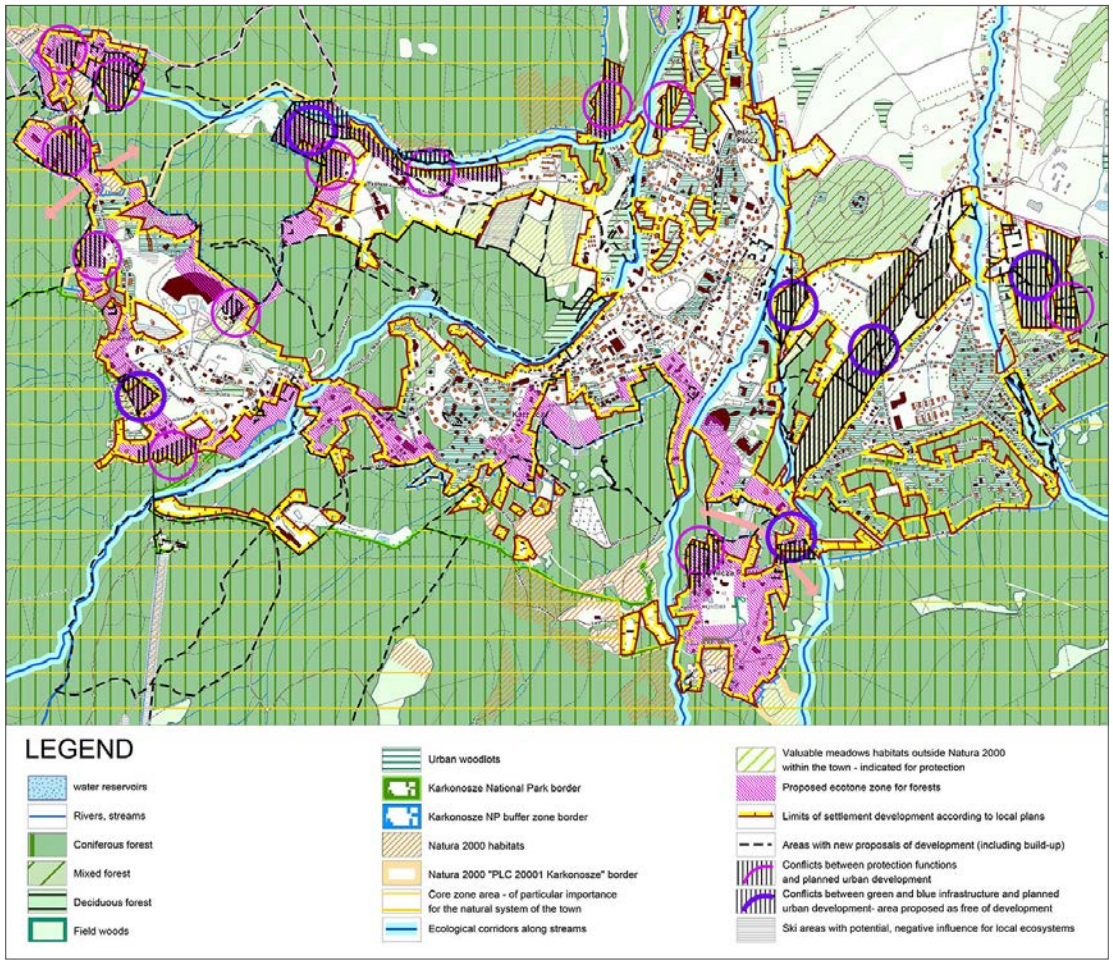


Fig. 4: Map of the potential threats for the town's blue and green infrastructure systems

The town's landscape is also valued, which allows to indicate areas within its area;

• of unique natural values (the highest parts of the Karkonosze Mountains, with its postglacial cirques and ponds, and the Śnieżka culmination, were recognized as such);

• of outstanding natural values (forest complexes surrounding urbanized areas of the town and located on the northern slopes of the above mentioned massif, within the formed valleys of the main watercourses were recognized as such);

• of outstanding cultural values (this is the religious complex of the Wang Church with a cemetery and the development complex surrounding the main pedestrian route in the town centre with Konstytucji 3 Maja Street as its axis).

The most valuable elements of the town's landscape are exposed from many points and viewing routes, from which the panorama of the Karkonosze massif and its main culmination stretches. On the above mentioned drawing they are also indicated outside of them:

• main view axes, directed at Śnieżka;

• more important natural and cultural dominants;

• zones of distant and close insights from the main roads and hiking trails.

Within the framework of the analysis of the threats to the integrity of the landscape, complimenting the analysis for the state of green infrastructure - the locations of conflict between selected elements of landscape and the urban development planned for the update the municipal study and the implementation of the local plan were identified. They concern the already mentioned areas located below Księża Górka and areas in Karpacz Górny.

4 Summary

The presented results of the analyses created within the framework of the MaGICLandscapes project, including the indication of threats to the condition of the green infrastructure network and the landscape of the town, resulting from, among others, the applied and anticipated directions of spatial development of Karpacz, have been used in a comprehensive update of conditions and the future direction of spatial development, adhering to the principles of protection of its natural environment and landscape.

HARMONISATION OF GREY AND GREEN INFRASTRUCTURES – EXAMPLES FROM LOWER AUSTRIA

Jacob Seilern, Anja Manoutschehri, Judith Scherrer, University of Vienna

In their masters three students from the University of Vienna investigated the potential of green infrastructure (GI) enhancement in different areas of Lower Austria. How suitable are, for example, high-voltage power lines as place for new green infrastructure elements? What is the potential for more GI along and close to railways or cycle paths? Besides the need for a better harmonisation of grey and green infrastructure the students who attend the university's Department of Botany and Biodiversity Research also explored the quality of vineyards and shelter belts/wind breaks with regards to their ecological functionality as green infrastructure elements.

Power lines and their importance as part of green infrastructure, using the example of sections of the 380 kV high-voltage line between Dürnrohr (AT) – Slavětice (CZ)

Jacob Seilern, University of Vienna | seilernjacob@gmail.com

This master thesis shows the current condition of the 380 kV high-voltage power line Dürnrohr (AT)- Slavětice (CZ). It points out possible threats, names management measures and checks the suitability as part of the green infrastructure (GI) in the Western Weinviertel. The landscape structure and biotopes were documented and indicators for the GI suitability were determined by means of an empirical field data collection. In summary, the power line has a positive effect on the intensive agricultural landscape and increases the nature conservation-value. However, in view of the functionality and the requirements, the effect size is currently too small to be a completely effective part of the green infrastructure. The establishment of a sustainable route management plan in the agricultural and forest-dominated landscapes would probably lead to a significant increase of the nature conservation value along the entire high-voltage line. Minor measures, such as the creation of structures, scrub encroachment around power pylons or selective neophyte control have a high positive effect and provide a significant contribution to the regional green infrastructure.

Introduction

To stop the progressive loss of plant and animal species and their habitats, it is necessary to examine all areas of the rural landscape and check their suitability for nature conservation purposes. With the help of a conservation oriented management plan, a power line could act as part of the green infrastructure with positive effects on the environment and serve as part of an ecological network system.

1 Methods

A stratified random selection of power pylon areas and their subdivision into three circular zones ensures the representativeness of the study. The core zone has a radius of 69 m and is centred around the power pylons. Surrounding this is the buffer zone with a radius of 98 m, followed by the outer zone with a radius of 120 m.

A total of 30 power pylons in the intensive agricultural landscape and 24 power pylons in the heterogeneous landscape (structured permanent crops, forests and heterogeneous open areas) were analysed. Based on an area-wide landscape mapping and a selective biotope mapping (following Wrbka et al. 1997) relevant landscape parameters were collected and processed by using a geographic information system. Subsequently, the Nature Conservation-Value (NCV) and the suitability as part of the GI was determined using landscape ecology and nature conservation evaluation methods.

The Nature Conservation-Value (NCV) developed here is a multi-factorial approach that allows a good comparison of the current landscape values. It contains four important landscape ecological indices, based on the green infrastructure requirements. The Shannon Diversity Index captures the richness and diversity of the landscape (Lausch 2000) and the Edge Density captures the structuredness (McGarigal et al., 2002b). The Hemeroby reflects naturalness (Sukopp

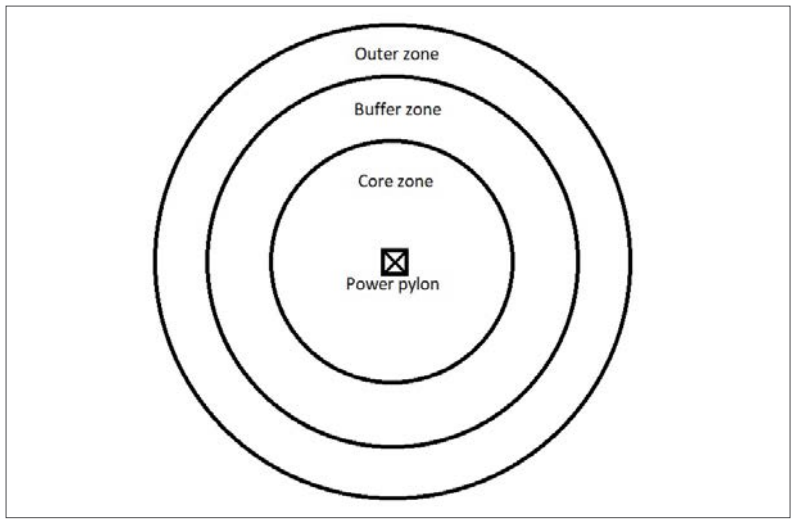
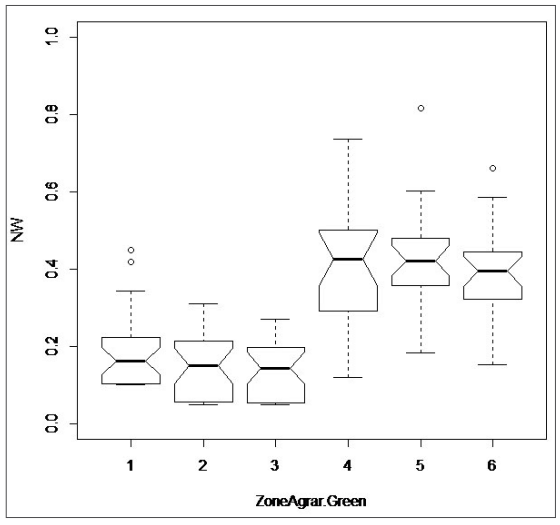


Fig. 1 (left): Example of power pylon zones
Fig. 2 (right): Green infrastructure in the core zone of a power pylon



1 = Core zone agric.
2 = Buffer zone agric.
3 = Outer zone agric.
4 = Core zone GI
5 = Buffer zone GI
6 = Outer zone GI

Fig. 3: 380 kV high-voltage power line Dürnrohr (AT) – Slavětice (CZ)
Fig. 4: Boxplot Nature Conservation Value (NCV) in six zones: 1 = Core zone agric., 2 = Buffer zone agric., 3 = Outer zone agric., 4 = Core zone GI, 5 = Buffer zone GI, 6 = Outer zone GI

1972) and the Biotope Value contains important enhancing landscape functions, such as protection and connectivity properties. The combination of these important indices is intended to take up key factors, compare them, reflect a conservation value and show the suitability as part of the GI.

2 Results

The power pylons (core zone) differ, in terms of the Nature Conservation Value (NCV), from the surrounding intensive agricultural landscape (outer zone) with a significance of p = 0.065. The NCV is higher in the affected core zone (NCV = 0.19) than in the unaffected outer zone (NCV = 0.14).

Considering the heterogeneous landscape, no significant difference between power line (core zone) and the surrounding areas (buffer cone and outer zone) could be observed. However, power pylons within the heterogeneous open landscape have a significantly higher Nature Conservation Value than the surrounding area (p-Value = 0.04).

3 Discussion

The high-voltage line faces two main problems in the Western Weinviertel. On the one hand the strong neophyte pressure due to Solidago gigantea and Robinia pseudoacacia in the southern and northern parts of the line route respectively and on the other hand the general negative edge effects of intensive agriculture. In the course of a sustainable route management plan, the focus should be on the creation of structures, the re-connection of habitats, the upgrading of biotopes and neophyte control. The power pylons increase the structural richness of the intensive agricultural landscape, but the negative edge effects of agriculture such eutrophication and biocides lead to species-poor ruderal societies.

The potential GI area along the power line can be divided into two landscape types. A heterogeneous open landscape and a forest-dominated landscape. In the heterogeneous open landscape, the power pylon zones have significantly higher nature conservation values than the unaffected outer zone. Due to the increased number of small structures and composite elements, there are more edge and corner positions of the power pylons. The footprint increases and is connected with neighbouring biotopes. Power lines and their pylons have a great potential as part of the green infrastructure.

4 Acknowledgments

At this point I would like to express my thanks to all those who have supported me in the creation of this work.

Special thanks go to Ass.-Prof. Dr. Thomas Wrbka and MSc. BSc Florian Danzinger for supervising the work, for inviting me to various MaGICLandscapes conferences and workshops, as well as for mediating with Dipl.-HLFL-Ing. Sven Aberle MSc and Austrian Power Grid AG.

In this context I would like to thank Sven for his support and the opportunity to take another step towards sustainable electricity supply in the Western Weinviertel.

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Railway tracks as green infrastructure – biotope assessments on five train lines in Lower Austria

Anja Manoutschehri, University of Vienna | manoutschehrianja@gmail.com

1 Introduction

Facilitating the network of green infrastructure (GI) is beneficial for biodiversity as well as for humans. It enables species migration, mitigates the negative effects of climate change and serves recreational, health, and touristic purposes (EK 2013). As the railway tracks form a tight trans regional system and include accompanying habitats, they could act as a corridor and therefore, have a great potential for nature conservation. Previous studies assessed vegetation types alongside tracks within the same study region and developed guidelines for maintenance measures (Schmitzberger 2005; Mastalir 2013). The main aim of this work is to investigate the potential use as green infrastructure. Additionally, the following hypotheses are tested: habitats directly adjacent to railway tracks are in a better condition than other habitats due to intensive use of the surrounding cultural landscape; habitats of individual train lines differ in quality due to varying traffic intensity and maintenance measures; and spreading of invasive species might be facilitated.

2 Method

Therefore, five train lines within the districts of Horn and Hollabrunn in Lower Austria are evaluated: two highly frequented passenger train lines, namely Franz-Josefs-Bahn and Nordwestbahn, the non-electrified and lesser frequented Kamptalbahn, as well as Reblausexpress, which offers tourist trips at weekends, and the Western part of Pulkautalbahn, which has been abandoned for over thirty years. Fifty study plots (ten on each train line) with a width of 500 m and a length of 100 m are selected via random stratified sampling to take the types of cultural landscapes into account (forests, grasslands, vineyards, highly structured fields and poorly structured fields).

At first, biotope mapping and landscape structure mapping are performed, and common invasive species observed. Therefore, the following parameters are obtained: biotope type, land use type and intensity, Hemeroby, linearity, attributes of conservation value, structural characteristics, current and potential threats.

To analyse the data in regard to the hypotheses, two indices

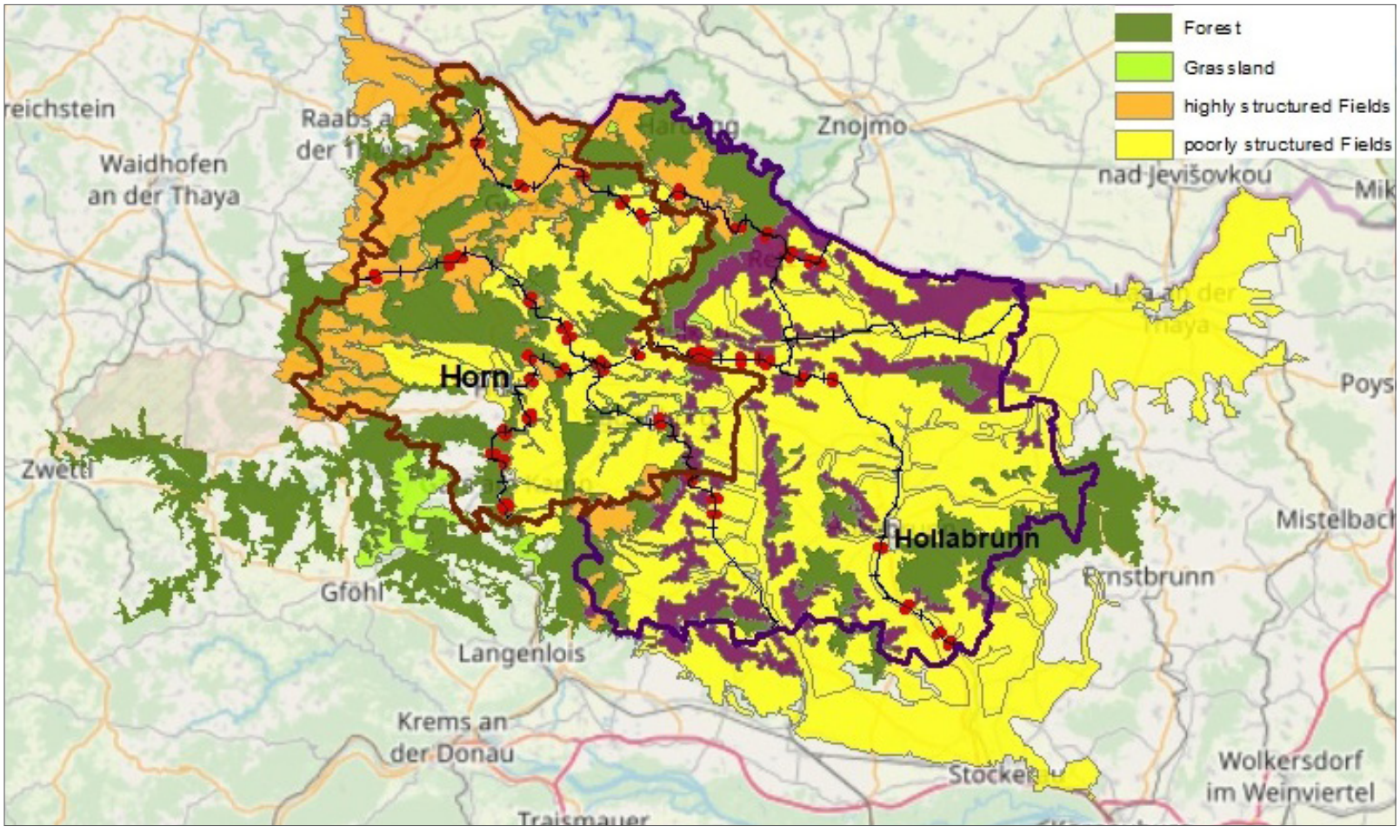

Fig. 1: Cultural landscape and railway system in the study area – the districts Horn and Hollabrunn in Lower Austria

Fig. 2 (left): The abandoned part of Pulkautalbahn

Fig. 3: Railway tracks with accompanying habitats

are calculated. The biotope value provides information about the conservation value of a habitat, whereas Shannon's Diversity Index describes the biotope diversity and distribution (McGarigal and Marks 1994). Furthermore, a Morphological Spatial Pattern Analysis (MSPA) is performed in GUIDOS Toolbox (Vogt 2016) to visualise landscape patterns and investigate the progress of fragmentation. Additionally, the proportions of potential GI elements are evaluated. Generalised linear mixed models are used to compare adjacent to distant habitats.

Shannon's Diversity Index (SHDI) *The higher, the more patch types/ more equitable the proportional distribution of area among patch types ≥ 0.*	**SHDI= - Σ (P_i*lnP_i)** *P_i=proportion of landscape occupied by patch type i*
Biotope Value (BV) *The higher, the more valuable the biotope for nature conservation ≥ 0.*	**BV = v_{hem} + [(n_{AC}+n_{SC}) - n_t]** *v_{hem} = Hemeroby value* *n_{AC} = Number of attributes of conservation value* *n_{SC} = Number of structural characteristics* *n_t = Number of current threats*

Fig. 4: Land use along a railway track in Lower Austria

3 Results and discussion

It is shown that the study area is considerably fragmented and two thirds of it are covered by intensively used crop land. Therefore, naturalness is reduced. However, the study area is known to be dominated by intensive grain cultivation (Wrbka et al 2005). Furthermore, the majority of plots have a medium diversity of biotopes, as well as a low to medium biotope value. This suggests that the study area is rather well appointed in comparison to similar landscapes in other studies (Kropik 2014; Herbst 2007). It has to be noted that, calculating a biotope value is not a common and consistent approach as a few other studies use a slightly different method (Pöll et al 2015; Hermann and Wrbka 2009). However, together with Shannon's Diversity Index it provides comprehensive information about a landscape.

Invasive species are found in only ten percent of all patches, being mostly Robinia pseudoacacia. Therefore, the hypothesis regarding the facilitating effect of railway tracks on the spreading of invasive species can not be confirmed. A vegetation survey is suggested for more detailed results.

The train lines do indeed differ in number and distribution of biotopes and land use types due to varying land use intensity, climate and geography. Within the study area there is sandstone and loess, as well as granite and gneiss (Schnabl 2002). Additionally, both Pannonian and continental climates prevail (Auer et al 2012). Traffic intensity does not seem to have a great impact as a comparison between main lines and secondary lines leads to a minimal difference.

Adjacent habitats have a significantly higher conservation value and naturalness, as well as a significantly larger proportion of potential GI elements than distant ones. This might be caused by the less likely occurrences of streets and crop land in the direct vicinity of tracks. However, distant habitats have a significantly higher biotope diversity. But both results could be biased by the considerably smaller amount of adjacent patches.

It is concluded that habitats alongside railway tracks might be valuable, specifically within regions, where hardly any GI is left, e.g. within the Eastern Part of the study area.

However, to maintain them, Hemeroby and fragmentation should be decreased through continued specific maintenance measures as Schmitzberger stated in 2005. Additionally, more sustainable agriculture and forestry is necessary.

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Green infrastructure along bicycle routes: a benefit for cycling tourism and nature conservation

Judith Scherrer, University of Vienna | mail@judith-scherrer.at

Abstract

With the study I aimed to contribute to the development of sustainable bicycle tourism projects by delivering a scientific background for stakeholders and decision-makers to create nature-friendly bicycle routes. Although building new grey infrastructure can increase access to nature and the experience of nature for tourists, it is almost always at the expense of Green Infrastructure. With my approach I propose an investment in existing Green Infrastructure to enhance it and make it more valuable for both nature conservation and experiencing nature. A nature-themed bicycle route can be designed as an upgrade to an existing bicycle route. In this way stepping stone areas can be created and the tourism value of the bicycle route is increased.

In the study area of Western Weinviertel in Austria I demonstrated a method of evaluating a landscape on a regional scale, based on multiple factors and considering multiple perspectives. I assessed the Green Infrastructure along four bicycle routes applying newly developed formulas to compute three overall values for each sampling circle; the 'Natural Value' described the perspective of nature conservation, the 'Cycling Tourism Value' represented the extent of experience of nature for cycling tourists and to calculate the 'Land Use Value' I adopted the perspective of intensive land use. I analysed how the three overall values correspond, to determine correlations and conflicts between them. Additionally I developed the separately computed value 'Suitability for Multifunctional Development, SMD'.

The demonstrated methods performed well and delivered distinctive results. The findings showed, that an enhancement of Green Infrastructure for both nature conservation and the experience of nature for cycling tourists is possible as these perspectives have a high correlation and few conflicts are to be expected. The intensive land use will have to recede suitably to implement that.

1 Introduction

The concept of Green Infrastructure (GI) describes a holistic

Fig. 1: Development of sustainable bicycle tourism in the Western Weinviertel

approach to preserve and restore a functional network which provides benefits to both nature in general and also to mankind. Human society depends on the benefits provided by nature (European Commission 2013). Local actions deliver positive outcomes, but it is important to intensify the implementation of measures across all the targets of the EU (European Union) 2020 Biodiversity Strategy (European Commission 2015). There is a need to develop, preserve and enhance healthy Green Infrastructure and by increasing the scale, coherence and connectivity of its network the greater the benefits will be (European Commission 2020). The patterns of land cover and the degree of fragmentation of natural habitats will also influence the ability of ecological systems to respond to a changing climate (Dale et al. 2000). Green Infrastructure should become an integral part of spatial planning as it can contribute to grey infrastructure solutions or offer even better alternatives (European Commission 2020). Investing in Green Infrastructure could bring benefits in medium and long-term perspectives and is already recognised as contributing to sustainable growth in Europe (European Commission 2011). Moreover, there is usually a high return on Green Infrastructure investments (European Commission 2013).

There is a need to integrate the protection of natural resources into ordinary territorial planning (Cassatella 2013). Dale et al. (2000) recommends that decision-makers and citizens should include ecological perspectives in choices on how land is used and managed. He also calls on scientists to develop the science that is needed by land managers. Ahern (2005) describes the trans-disciplinary model where planning may become even more integrated with research, and states that 'the trend towards inter-disciplinarity and trans-disciplinarity is central to sustainable planning'.

This is exactly in line with the objectives of the Interreg Central Europe Programme project 'MaGICLandscapes - Managing Green Infrastructure in Central European Landscapes' with which my study was connected to.

Apart from more general planning approaches I could not find any previous research where the specific topic of nature conservation in connection to cycling tourism was analysed in any detail. However, many studies indicate, that the preferences of bicycle tourists are related to the aims of nature conservation in the study area.

Ode et al. (2009) found that landscape indicators associated with naturalness are important in the formation of preference. The findings of De Valck et al. (2017) show that cyclists seem to prefer natural, semi-natural and diverse landscapes. They enjoy crossing landscapes that offer a good mix of features. Van Berkel & Verburg (2014) found that landscape change due to rewilding is not considered a problem. Additional information about nature along the bicycle routes could enhance the experience of nature for cycling tourists even more, as Gobster (1999) determined that ecological knowledge changes how people look at nature and also what is considered to be aesthetic. Therefore it could help resolve conflicts between aesthetic and sustainability values.

Those findings indicate, that a nature-themed bicycle route would be appealing to cyclists. This could be described as a variant of ecotourism in a cultural landscape as the International Ecotourism Society defines ecotourism as 'responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education'. (TIES 2015)

Nature conservation has to be embedded in the landscape where it has to exist alongside other users that have different needs and demands. What might be considered as natural and appealing to bicycle tourists is not necessarily the same as the objectives of nature conservation. On the other hand attractive areas could be overused which leads to pressure and a decreasing quality of nature. Therefore the compatibility of the ecological and the touristic point of view had to be determined. In addition, I assessed the perspective of land use as it is a main factor in the study area and had to be considered too. By comparing these three perspectives I assessed correlations and possible conflicts. I focused on the experience of nature for cycling tourists, but related aspects such as 'Points of Interest' and the type of path surface were also considered.

2 Method

In the study I demonstrated a method of evaluating a landscape on a regional scale based on multiple factors and considering multiple perspectives. I aimed to provide a scientific background for enhancing both nature conservation and the experience of that nature for cycling tourists. To create a nature-themed bicycle route as an upgrade to an existing bicycle route, I proposed an investment in existing Green Infrastructure. Therefore the main research question was: What is the contribution of the Green Infrastructure along the bicycle routes to both nature conservation and the experience of nature for cycling tourists and where are possibilities to enhance both?

I assessed the Green Infrastructure along four bicycle routes in the study area of Western Weinviertel. For the study I chose the bicycle routes 'Chardonnay', 'Weinviertel DAC', 'Riesling' and 'Rivaner' which are all designed for circular day trips. They were built on existing paths, mostly farm tracks and small roads with little traffic. Thanks to the cooperation of Weinviertel Tourismus GmbH I was also able to take into account which bicycle routes are interesting for potential follow-up projects with regards cycling tourism. Fig. 2 shows the location of the four bicycle routes.

For all spatial information about the bicycle routes on my project, I used the KML-data downloaded from www.weinviertel.at and the 'Radkarte Weinviertel', a map of bicycle routes in Weinviertel (Weinviertel Tourismus GmbH 2017).

I generated sampling circles and applied a stratified sampling design to represent the spectrum of possible landscape sections in the study area. I created three different strata, one of them with four sub-strata. The selection criteria were based on the 'Central European Habitat Map' (Kuttner et al. 2017) and on the presence or absence of special features,

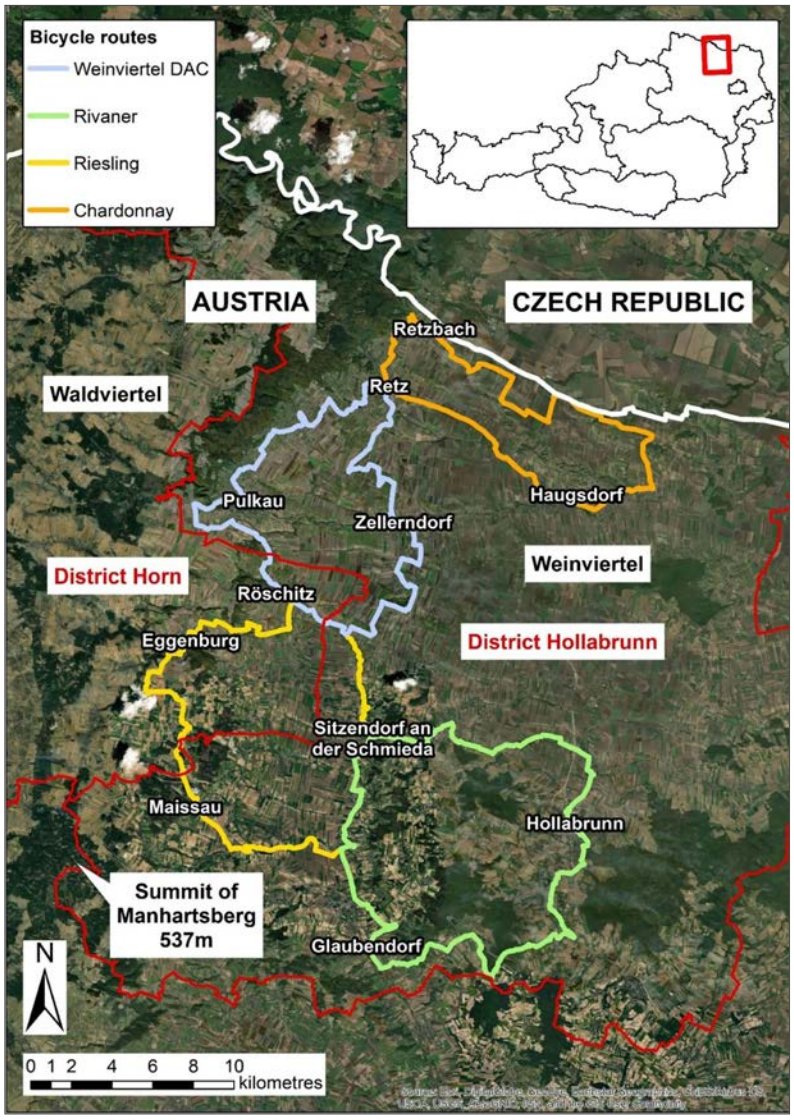

Fig. 2: Location of the selected bicycle routes, landscape structure and political districts

that are especially interesting for the study, such as nature protection areas, natural monuments, 'Kellergassen' (rows of buildings used to store wine) and 'Points of Interest'. I categorised the habitat classes of the 'Central European Habitat Map' (Kuttner et al. 2015) according to the requirements of the study and for the surveyed landscape into 'Agriculture/Forestry', 'Potential' and 'Urban'. 'Potential' included all habitat classes that might contain ecologically valuable habitats. 'Urban' comprised all built up areas, roads and railways. In the surveyed sampling circles all characteristics of the landscape in my study area were represented. However, highly urban areas were excluded because the study was about the experience of nature for cycling tourists, consequently the focus was on non-urban landscape. For an overview of all strata and sampling criteria see Table 1.

In spring 2018 I carried out the field research on site and mapped 2,567 polygons in 70 sampling circles. I conducted a landscape structure survey (based on Wrbka et al. (2015)) for each polygon and collected additional data for the bicycle route itself and for focus habitats (based on Wrbka (2015)).

After data entry and digitalisation I determined additional spatial data. I then applied a newly developed method based on the approach of Pöll et al. (2016) to compute a composite biotope value. I calculated rescaled values for 28 landscape variables per sampling circle from the mapping and the collected data and used them as criteria to compute three overall values for each sampling circle. Each of the overall values expresses a different point of view and therefore the three formulas use different criteria that contribute to the particular perception. The 'Natural Value' describes the perspective of nature conservation, the 'Cycling Tourism Value' represents the extent of experience of nature for cycling tourists and to calculate the 'Land Use Value' I adopted the perspective of intensive land use. The yielded values were rescaled to range from 0 to 1. Therefore, the overall values are comparative and enabled analyses within the spectrum of landscape sections in the study area. By connecting and comparing the data, I assessed the value of the bicycle routes as an element of regional Green Infrastructure and detected correlations and conflicts between the three different perspectives.

Additionally I developed the separately computed value 'Suitability for Multifunctional Development, SMD' which I used for comparison with the results. It is based on expert knowledge and represents the suitability of the sampling circle for development that benefits both nature conservation and the experience of nature for cycling tourists. Furthermore I compared the results to the strata I used in the sampling design.

Stratum/ Sub-Stratum	Nature Protection area or natural monument	'Kellergasse'	Point of Interest (POI)	Potentially interesting habitats*	Urban area < 20 %	Amount of sampling circles
Stratum 1: Sampling circles with special features						22
1.1	+	+ or POI	+ or 'Kellergasse'	~	+	(6)
1.2	+	-	-	~	+	(6)
1.3	-	+	-	~	~	(4)
1.4	-	-	+	~	+	(6)
Stratum 2: Sampling circles with potentially interesting habitats						24
	~	~	~	+	+	(24)
Stratum 3: Sampling circles without potentially interesting habitats						24
	~	~	~	-	+	(24)
Total						70

Table 1: Selection criteria for the surveyed sampling circles +/green: included, -/red: excluded, ~/yellow: not considered * Preselected Categories from the 'Central European Habitat Map' (Kuttner et al. 2015).

3 Results and discussion

The strong positive correlation between the 'Natural Value' and the 'Cycling Tourism Value' and their strong negative correlation to the 'Land Use Value' is very distinct (see the correlogram in Fig. 3 and 3D scatter plot in Fig. 4). The conflict between nature conservation and intensive land use is obvious. However, valuable areas for nature conservation provide also a high level of experience of nature for cycling tourists and in turn the latter has only little negative impact

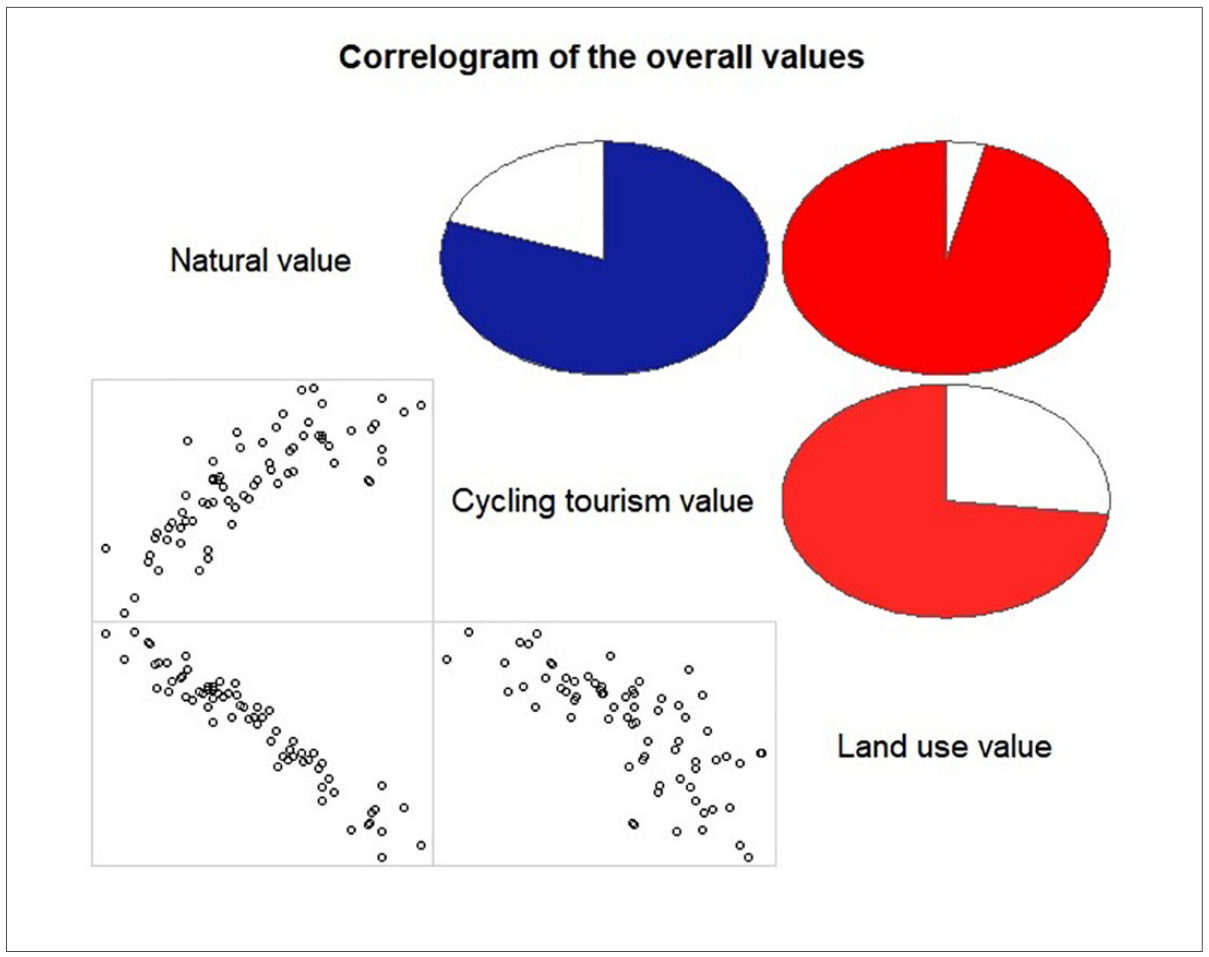

Fig. 3: Correlogram of the overall values 'Natural Value', 'Cycling Tourism Value' and 'Land Use Value'
Each of the three combinations shows a very strong correlation, pictured in pie charts in the upper right panels and in scatter plots in the lower left panels.

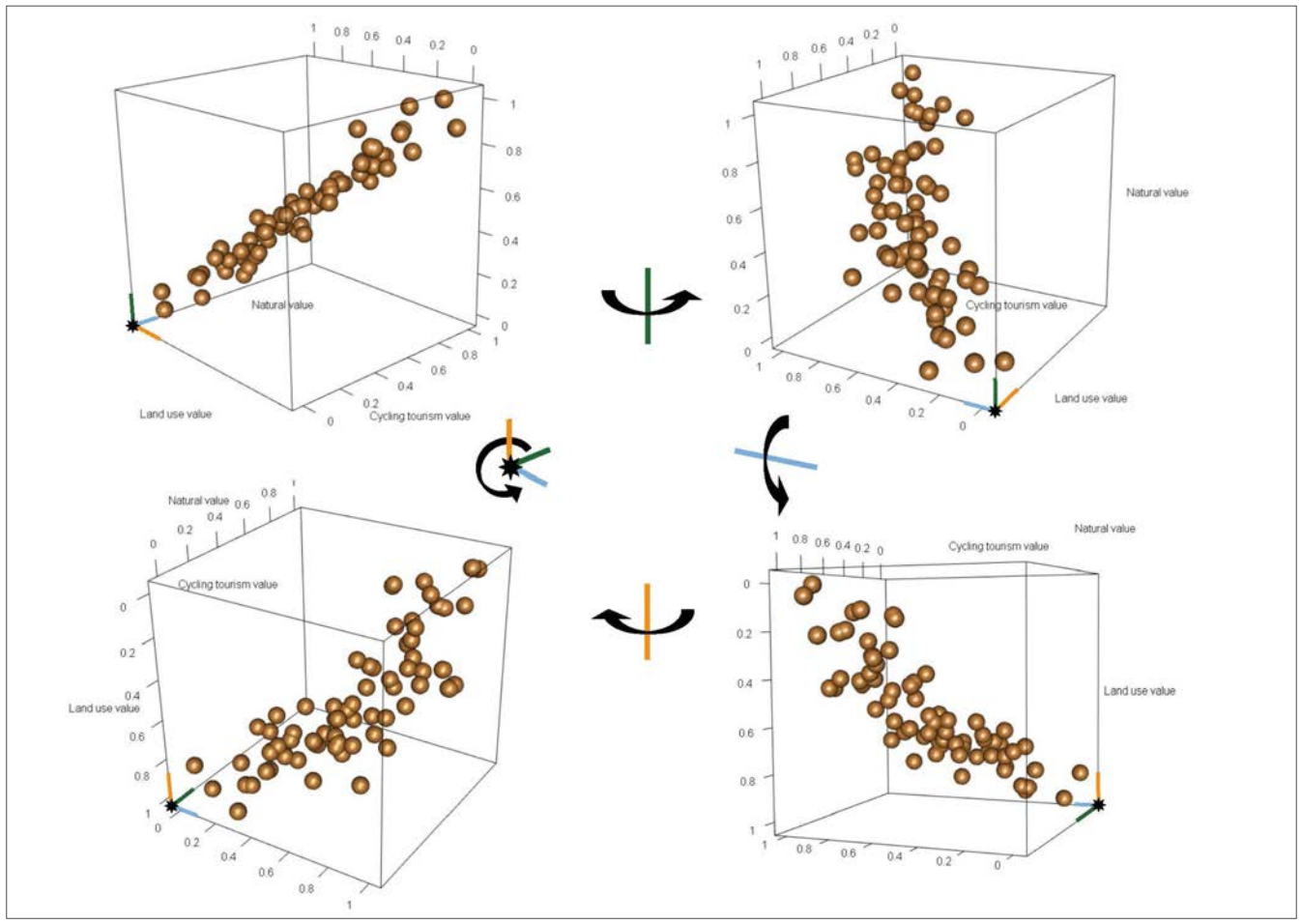

Fig. 4: 3D scatter plot of the 'Natural Value', the 'Cycling Tourism Value' and the 'Land Use Value'

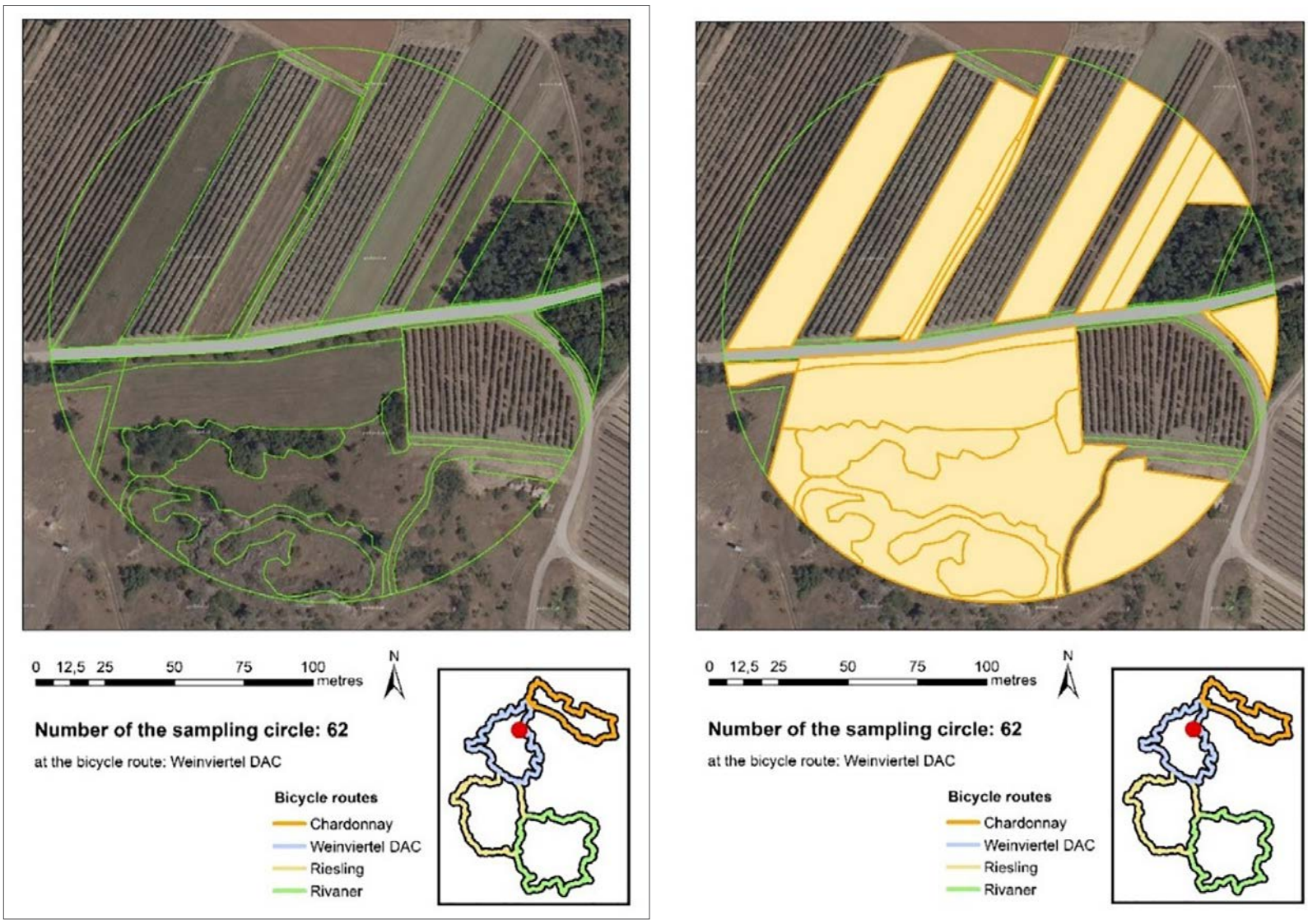

Fig. 5: The sampling circle with the highest 'SMD'. In the right map all focus habitats are marked in light yellow.

on the 'Natural Value'. Therefore an enhancement of Green Infrastructure for both nature conservation and the experience of nature for cycling tourists is possible as these perspectives are highly correlating and few conflicts are to be expected.

A high specialisation on land use is at the expense of nature as well as on the experience of nature for cycling tourists and therefore the touristic value of the bicycle route. But there are good prospects to enhance both, with a slight reduction of intensive land use as high sums of all three overall values are possible even with intermediate 'Land Use Values'.

In another analysis I compared the results to the strata. The sampling circles that were selected based on the favoured habitat classes from the 'Central European Habitat Map' (CEH), show a clear trend according to the overall values. Therefore the CEH is proved to be very useful to detect potential areas for the multipurpose use of nature conservation and the experience of nature for cycling tourists.

There is potential to enhance the experience of nature for cycling tourists regarding nature protection areas and natural monuments. Combined with the results of the strata based on the CEH, this shows that by investing in Green Infrastructure on the areas between these special features and the bicycle routes, not only the experience of nature for cycling tourists will benefit but also nature conservation.

The results of 'Suitability for Multifunctional Development, SMD' correspond highly to the pattern of the three overall values which makes it a promising approach and an efficient tool. They have a very high correlation to 'Natural Value' and 'Cycling Tourism Value' and a high negative correlation to 'Land Use Value'. Sampling circle 62 has the highest 'Suitability for Multifunctional Development, SMD' value and also ranked third at both the 'Natural Value' and the 'Cycling Tourism Value' and last at the 'Land Use Value'. It is presented in Fig. 5.

This method needs expert knowledge to determine the potential of a patch for both nature conservation and the experience of nature for cycling tourists. This provided, it is possible to map a large route section quickly and accurately regarding the specific question. That again can be a basis to find the most suitable areas to enhance the Green Infrastructure along the bicycle route, to make it more valuable for both nature conservation and experiencing nature. As the method for 'Suitability for Multifunctional Development, SMD' is in an early stage of development it should be analysed and tested more closely in further studies before it is applied on a broad scale. I recommend the refinement of the method, including the development of guidelines, an exact definition of the grades and its components and a manual.

I need to stress that the approach to compute values for landscape services is always an abstraction of the complexity of natural systems and needs to be used very carefully. It makes it possible to conduct distinct analyses but it is also important to be aware that there might be values that cannot be expressed in numbers. Therefore I did not attempt to determine the overall worth of the surveyed areas but rather focused on specific perspectives to compare them to each other. I aimed for a comprehensive representation of each perspective by taking a multitude of specific criteria into account. The values I yielded from the formulas are comparative and enabled analyses within the spectrum of landscape sections in the study area, regarding the research questions of this study.

The substantial dataset I generated during the study opens up many more possibilities for further analyses.

The demonstrated method of evaluating a landscape on a regional scale, based on multiple factors and considering multiple perspectives, performed well. The newly developed formulas proved their effective operation. Furthermore the robustness of the method could be confirmed. Also the 'Suitability for Multifunctional Development, SMD' is a promising approach. All methods developed for the study could also be transferred to other study areas and even to other research questions, but would have to be adapted. As they are in an early stage of development, further analyses and refinement is recommended.

The study delivered distinctive results and can be a foundation for developing strategies for both nature friendly and visually appealing bicycle routes. Enhancing the Green infrastructure along bicycle routes is a valuable contribution to the recovery of natural habitats. It also increases the experience of nature for cycling tourists and therefore the touristic value of the area. The next steps could be to adopt a trans-disciplinary approach to develop practical steps towards the implementation of a nature-themed bicycle route.

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Green Infrastructure for better living: The LOS_DAMA!* project approach

Maria Quarta, Piedmont Region, Turin, Italy | maria.quarta@regione.piemonte.it

** The LOS_DAMA! Project was funded by the Interreg Alpine Space Programme 2014-2020.*

1 Introduction

The EU Interreg project LOS_DAMA! (Landscape and Open Space Development in Alpine Metropolitan Areas)1, investigated approaches to better protecting, enhancing and developing green and open spaces and thus improving the quality of life in peri-urban landscapes. This goal was achieved by developing a networked and multifunctional peri-urban green infrastructure as well as by networking actors over the entire Alpine region. The practice-oriented LOS_ DAMA! project focused on seven pilot projects in the urban regions of Grenoble, Ljubljana, Munich, Piedmont, Salzburg, Trento and Vienna.

In the pilot projects, green infrastructure was developed further or improved with innovative planning approaches involving local and regional actors, e.g. inter-municipal associations. New multifunctional and participatory approaches were applied. Likewise, more emphasis was placed on cooperation at the various planning levels.

2 The Piedmont Region pilot project

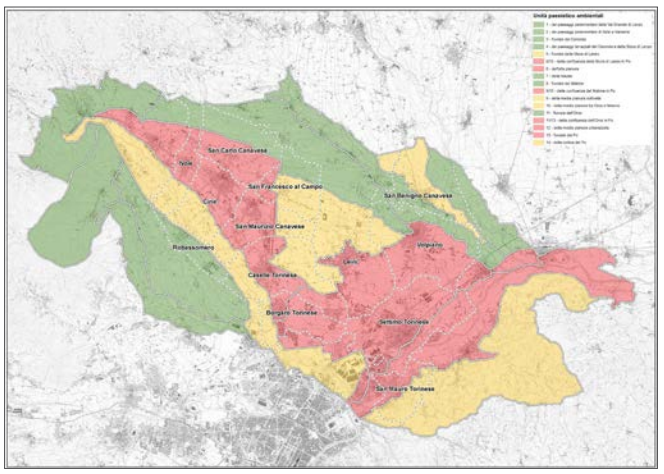
The Piedmont Region has identified in the Turin metropolitan area a location on which to develop the LOS_DAMA! Pilot project, an area influenced by the Corona Verde Project since the end of the 1990s. The project involves approximately 90 municipalities with an area of almost 1,650 km^2 and a population of approximately 1,800,000 inhabitants.

The Piedmont Region intended to capitalise on the experience of territorial governance gained over a decade of cooperation with local stakeholders in the Corona Verde project and, at the same time, implement the most recent concepts of green infrastructure, ecosystem services and climate change highlighted by the recent cultural and scientific debate. European and national policies and strategies were also examined, as well as experimenting with innovative approaches in planning and sustainable management of the territory and landscape.

The general objective of the pilot project of the Piedmont Region was to define and test effective methods and tools for sustainable territorial development, through the planning and design of effective green and blue Infrastructure.

Through the LOS_DAMA! project a new spatial planning model was developed that is able to face the challenges of climate and societal change.

The tool is the recognition of the value, including economic, of the multiple benefits that the green and blue infrastructure provide to the territories, both urban and peri-urban, and to their inhabitants using a multi-scalar and multidisciplinary approach, developed by a team composed of landscape architects, landscape ecologists, planners, economists and industry experts.



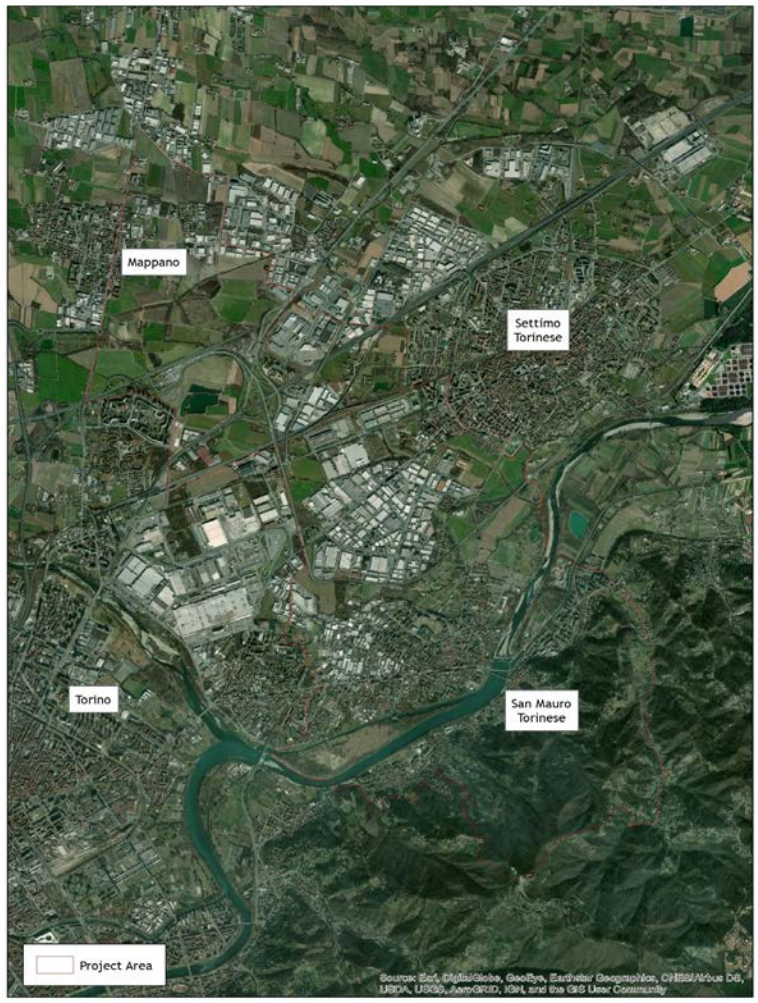


Fig. 1 (above): Pilot area “River Stura di Lanzo Basin”

The landscape-environmental investigations were carried out with a multi-scale approach, taking as a large-scale reference the entire territory of the Corona Verde and a smaller study area (the River Stura di Lanzo Basin) to compare and further deepen the analyses; the latter was in turn further divided into areas with their own specific landscape characteristics.

3 The method

A multi-scale method was chosen for the green and blue Infrastructure (GBI) analysis and valuation aimed at integrating landscape dimensions, ecosystem services (ES), green infrastructure and Nature Based Solutions (NBS) into planning policies. The method, applies an ecosystem services approach and makes visible the multiple functions of GBI and their added value to society and the strong interplay between social and ecological systems. The project considered the following steps:

1. The preliminary evaluation of the landscape vulnerability of the Corona Verde area and its components. The evaluation of vulnerability was developed with suitable indicators;

2. A socio-economic analysis of the pilot area, including the mapping of ecosystem services, their providers and beneficiaries, and the identification of governance tools fitting with the enhancement of ecosystem services;

3. The identification of the ecosystem services able to reduce the main vulnerabilities, for each land unit/component: this phase enabled the definition of the existing ecosystem services delivered by each land unit/component;

4. The assessment of the scarcity and abundance of the ecosystem services able to reduce those vulnerabilities;

5. The economic evaluation of the green and blue infrastructure in the pilot area. This step was developed using the contingent valuation methodology, able to capture non-use and indirect values in a Total Economic Value (TEV) framework;

6. The choice of the Nature Based Solutions able to deliver the ecosystem services needed from each land unit.

4 Stakeholder analysis

Given the growing interest in the Ecosystem Services Paradigm, the analysis of the stakeholder interests in ecosystem services became more and more crucial. Indeed, the ES approach asks not only for assessing goods and services that the ecosystems can provide, but also for understanding who can have a stake in such services, and why and where. The governance, management and use of ecosystem services involves a wide range of stakeholders with distinctly different but often interrelated stakes, which need to be taken into account.

Stakeholder analysis enables the systematic identification of these stakeholders, the assessment of their particular sets of interests, roles and powers, as well the consideration of the

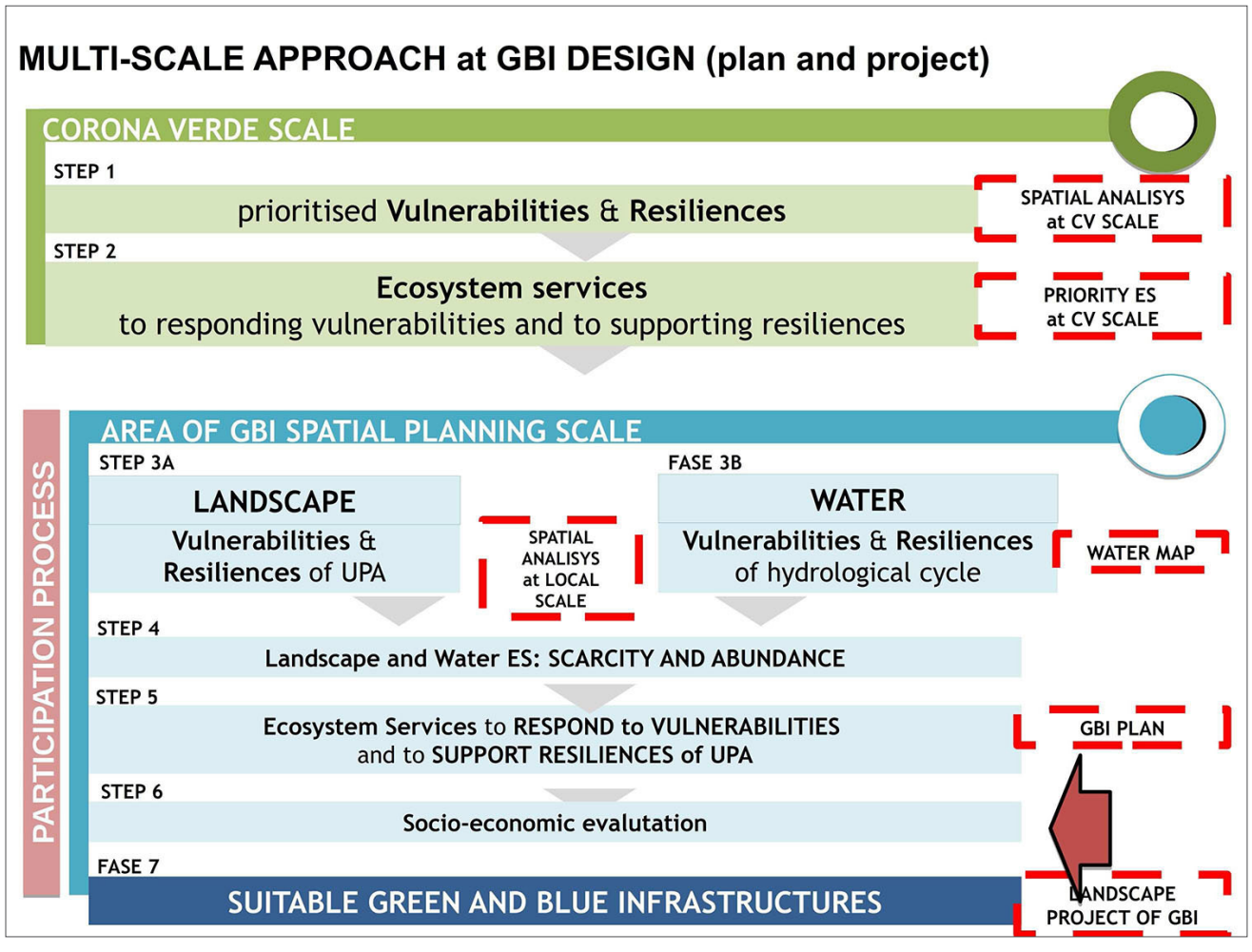
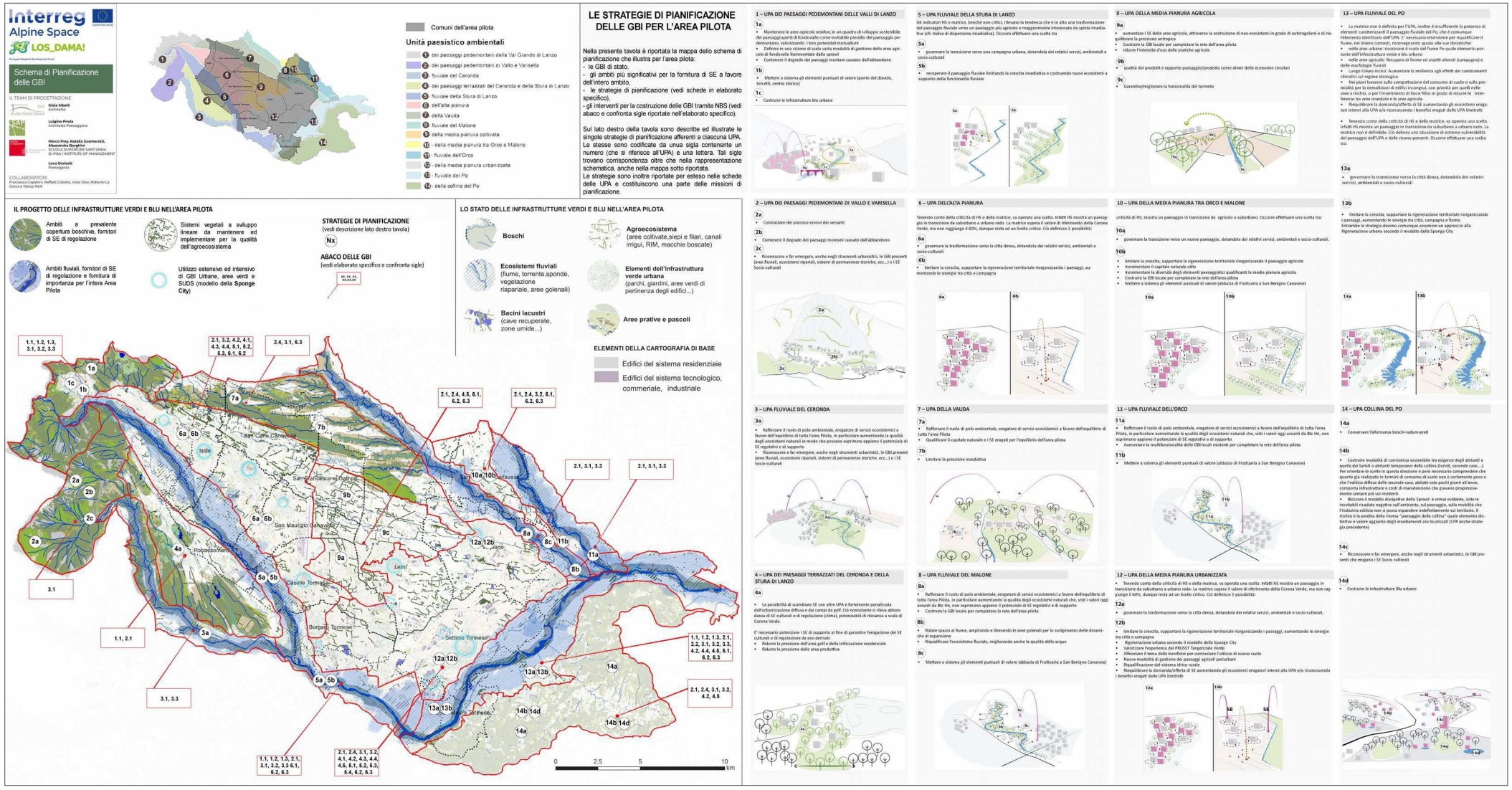


Fig. 3: Scheme of multi-scale approach

Fig. 3: Green and blue infrastructure planning and management



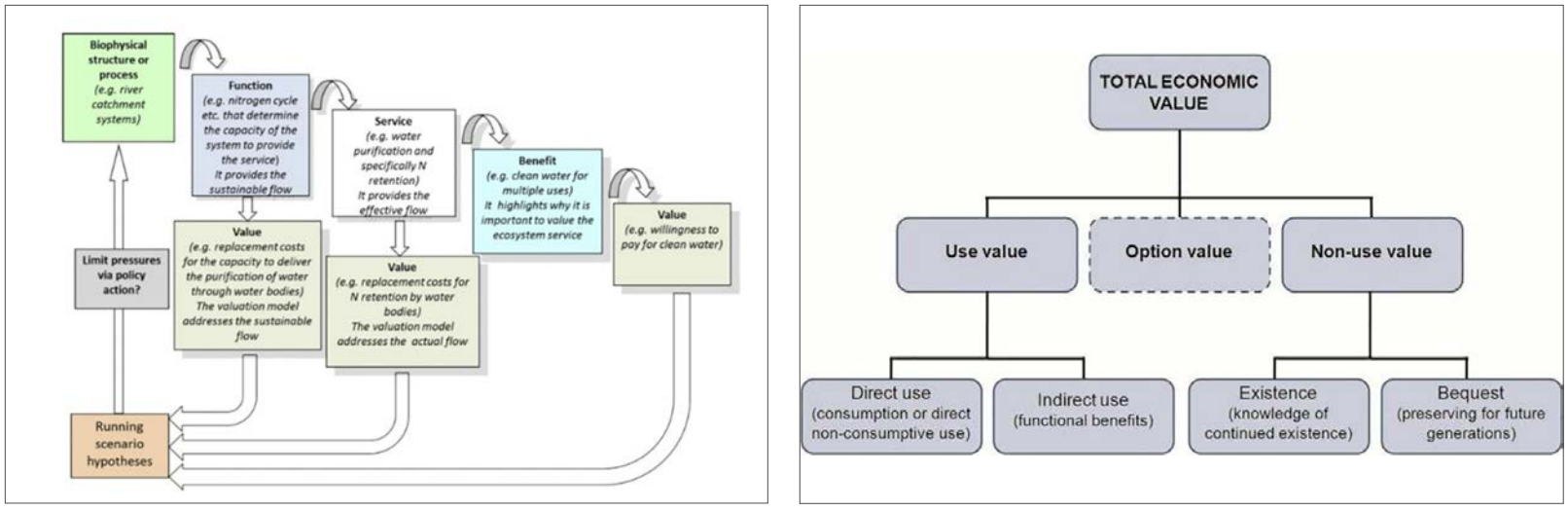


Fig. 4: Ecosystem approach and Economic evaluation Scheme

relationships among them, including possible conflicts.

The stakeholder analysis combine a desk and in-the-field approach, according to the following steps:

1. Stakeholder identification

2. Stakeholder categorisation

3. Fine-tuning of the stakeholder identification

Stakeholder's participation was a key trait of the LOS DAMA approach. Indeed, in LOS DAMA the stakeholder participation is twofold: on the one hand, the stakeholders enabled the inclusion of local knowledge in developing the project activities and – on the other hand – the involvement made them more aware about the ecosystem services and the benefits they provide to society.

Stakeholders were actively involved in the following activities:

5 Participatory mapping of ecosystem services

It consisted of assessing the spatial distribution of ecosystem services according to the perceptions and knowledge of stakeholders. It encompasses different approaches including Participatory GIS (Geographic Information Systems) and Public Participation GIS.

For the project purposes, the methodology was used in order to include local stakeholders perception about the distribution of ecosystem services (cultural ones and others that will established according to the partnership). The involvement of the relevant stakeholders was achieved through different approaches, including web-based surveys, face to face interviews and workshops.

6 Multi-criteria decision analysis (MCDA)

MCDA is an "umbrella term to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter".

MCDA methods can be used to address trade-offs between multiple ecosystem services because they allow comparison of ecological objectives with socio-cultural and economic ones in a structured and shared framework. They can incorporate ecological criteria such as carbon sequestration and water quality; economic criteria such as costs and economic impacts of alternative courses of action; and socio-cultural criteria such as cultural heritage and aesthetic values.

7 Cost-benefit analysis

The traditional cost-benefit analysis is a quantitative analysis in which costs related to a certain investment are quantified and compared to total benefit derived from that investment. The Participatory Cost-Benefit Analysis (PCBA) is a tool that helps prioritise potential actions by comparing the benefits and costs of those various proposed actions. The PCBA can be either qualitative or quantitative and is aimed at capturing information that is often unavailable from traditional data sources. It ensures that financial, social, and environmental benefits and costs of an action are identified. In LOS DAMA, through PCBA, a group of stakeholders was involved in comparing the costs and benefits of several identified natural based solutions in the pilot area.

8 Economic assessment

This phase consisted of the valuation in economic terms of the benefits derived from green infrastructure. To this end, various methods were used for estimating economic values for ecosystem services, such as stated preference methods using contingent valuation and choice modelling revealed preference methods such as travel cost method or hedonic pricing methods.

The methodology chosen for the economic evaluation of some ecosystem services concerns the verification of the willingness to pay (WTP) by local communities in the face of the increased benefits offered by green infrastructure.

The method consists of 3 logical steps:

1. Establish and characterise the sample.

2. Create a hypothetical market: starting from the description of the current state of the asset and the hypothetical change in the status of the asset, the methods of use and payment of the asset were established.

3. Request for WTP and subsequent statistical processing.

An appropriate measure of the economic value of an environmental good should take into account all the components of the Total Economic Value.

The indirect use value and the existence value are difficult to measure. In any case, the general principle underlying economic evaluation is looking for some expression of individual preferences for that environmental good, that is, utility they obtain from that good in whatever form (actual use of future use). According with conventional consumer theory, such preferences reveal themselves in the form of demand (or willingness to pay) for that environmental good.

The Contingent Valuation Method (CVM) aims at making the individuals' preferences on the environmental good explicit. This is obtained through the creation of a hypothetical market.

9 Methods: questionnaire design and testing

The survey was structured to enable respondents to thing broadly about the role that GBI plays in the pilot area and the benefits it provides and about the risk of losing those benefits.

The WTP questions asked participants to express their willingness to pay to ensure that those investments in NBS are actually provided (i. e. how much they are willing to pay to not lose the benefits provided by the GI).

An increase in the water bill was considered the most appropriate payment vehicle because most respondents are familiar with it and it is the most popular one used in similar studies.

The WTP elicitation question was complemented by contextual questions allowing the survey to establish a deeper understanding of reason underpinning the possible zero WTP and positive WTP.

10 The value of green and blue infrastructure

After econometric analysis of the individual responses, we needed to address the aggregation issue in order to estimate the economic value of the GBI in the pilot area, the mean was chosen as the representative value. Considering that the payment vehicle was an increase in the water bill, the aggregation criterion chosen was the number of families living in the area. Multiplying the number of families by the chosen WTP value, we discerned that the annual value of the benefits from GBI in pilot area is about 36 million euros in Scenario 1 and 30 million euros in Scenario 2 (Fig. 5).

11 Conclusive remarks

In the frame of LOS_DAMA! project, the multidisciplinary team developed and applied a methodological approach that was able to provide public administrations with guidelines for integrating GBI and ES into municipality and inter-municipality planning.

The economic evaluation is a very relevant part of the information for public administrations. Every decision is preceded by a weighing-up of values among different alternatives. The rationale behind ecosystem valuation is to disclose the intimate relationship between socio-economic and ecological systems, make explicit how human decisions would affect ecosystem service values, and to express these value changes in units that can be easily understood (i. e. monetary). Survey research techniques – such as the

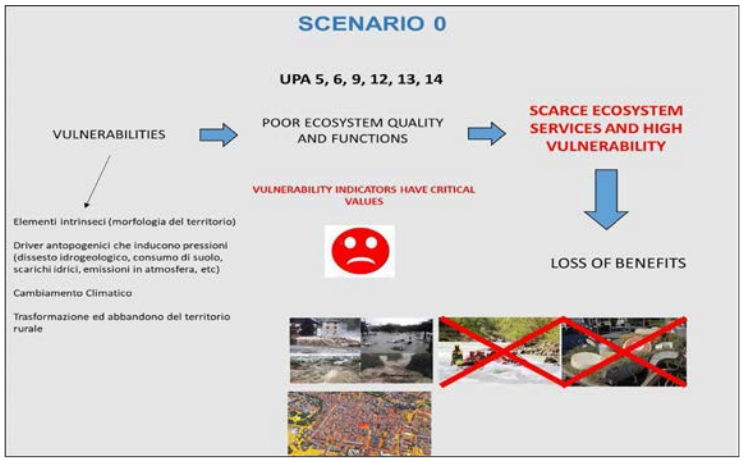


Fig. 5: Scenarios of GBI implementations and willingness to pay by stakeholders

contingent valuation method - complement the flow of relevant information to support decision-making in this field and make explicit the social and economic value of GBI to society.

Our experience reveals that people understand the multifunctionality of the GBI and they are willing to support GBI development, taking into account multiple benefits such as climatic, aesthetic, recreational, etc. People assign a great value to GBI, a value that can exceed the cost of investment in and management of nature based solutions.

We advise public administrations to create public support by not only making people aware about impacts, climate change for example, but also by providing information on the multiple benefits of GBI.

Finally, it's important to understand motives behind valuations, including ethical positions, environmental attitudes and social norms. These multiple motives can be seen as offering greater insight into how individuals perceive the environment and as a result how policy should be designed.

Communicating green infrastructure: the Italian experience of RETICULA

Serena d'Ambrogi, Italian Institute for Environmental Protection and Research (ISPRA), Rome, Italy | serena.dambrogi@isprambiente.it

RETICULA Journal on the web

The frequent environmental emergencies and their related challenges require thoughtful and coordinated responses to enhance environmental resilience. The integration of Natural Capital conservation into spatial planning tools, is one of the strategies for the achievement of EU and national targets to recover and restore degraded ecosystems, to improve ecological connectivity and to reduce soil artificialisation and sealing. Moreover, such integration would effectively enhance the resilience and environmental quality in terms of landscapes and community life, counteracting densification trends, especially in the urbanised areas.

A planning and territorial development approach, based on an integrated and strategically planned system of natural and semi-natural areas, should consider the close relationship between the loss/preservation of biodiversity and landscape functionality. This approach is important in order to preserve a stock of adequate and multifunctional resources (also in terms of strategies and organisational, operational, and management skills) to respond to the different vulnerabilities and to enhance the resilience of the territory. The implementation of land transformation management policies is pursued by the reinforcing of knowledge, the promotion and the sharing of actions aimed at environmental restoration, reduction of soil consumption and ecosystem fragmentation, by using options that are in harmony with nature such as Nature Based Solutions (NBS) and green infrastructure (GI) (EC, 2013) as opposed to grey infrastructure (Comitato per il Capitale Naturale, 2018).

The ecological network concept has been proposed as a useful means to integrate biodiversity conservation into sustainable landscape development (Opdam, 2006). To be ecologically sustainable, landscape elements should support ecological processes and flows required to enable landscapes to deliver ecosystem services to present and future generations. The regulating principle of ecological networks originates from one of the fundamental principles of Landscape Ecology, where the configuration of ecosystems influences processes and flows that occur in landscapes and, in particular, the biotic flows that define the biodiversity of a landscape (Todaro, 2010). Ecological networks therefore aim to recover and maintain functional ecological connectivity and environmental continuity of regions and landscapes at different scales, and can be understood as a spatial expression of landscape connectivity (Jongman et al., 2004). This network of features and functions is planned and designed to achieve multiple goals, such as improving landscape quality and diversity, enhancing territorial resilience, and enabling adaptation to climate change. This acts as a multifunctional ecological network, aiming to connect ecosystems and regions (Malcevschi, 2010) within a multi-purpose ecosystem

Fig. 1: RETICULA (from the Latin for small network) was born in 2012 as newsletter of the National Working Group 'Reti Ecologiche e Green Infrastructure'

scenario to support sustainable territorial development (Guccione & Peano, 2003).

The multifunctional ecological network then becomes a supporting infrastructure that provides more than one service/function within a wide area, combining global sustainability needs with local sensitivities and vocations (Malcevschi, 2010). Such structure combines ecological requirements (biodiversity protection and ecosystem structures rebalancing) with territorial demands and needs to increase overall system resilience.

GI, as a multifunctional ecological network, brings together both the need for strategic planning of green and open spaces with ecosystem services approach. It promotes the multifunctional nature of spaces and the benefits that appropriate management approaches can deliver. In addition, it recognises the need to plan land uses for specific purposes such as farming, nature protection, and development, while also providing tools and methods to identify needs and opportunities to enhance the value of environment and its functions (John et al 2019). The role of GI is increasingly significant as a vital means to promote environmental restoration of mainly urban and peri-urban environments in connection with natural and semi-natural ecosystems. This may also be achieved through the implementation of the ecosystem-based adaptation solution (ecosystem-based approaches and NBS), which aims at strengthening resilience and reducing the vulnerability of territories to environmental emergencies, and addresses related challenges through integrated actions.

A multifunctional ecological network is therefore conceived as an intersectoral operation and as a general resource and reference to promote ecological and landscape requalification

to which all the territorial stakeholders are called upon to collaborate with. The improvement of communication, awareness and involvement of all stakeholders as well as the dissemination of information about innovative landscape planning solutions designed to address key territorial management issues, can enhance the territorial resilience.

For the national dissemination related to implementing ecological networks and GI at both regional and provincial levels, the Italian Institute for Environmental Protection and Research (ISPRA) has developed a communication and dissemination program that has successfully promoted ecological network considerations in the Italian regional and provincial spatial and landscape planning tools. This program is further supported by RETICULA, an online technical-scientific journal, with the aim to promote a knowledge exchange involving all the stakeholders dealing with ecological connectivity issues, GI, ecosystem services, NBS, and environmental governance connected to an eco-sustainable land use and landscape planning.

RETICULA (from the Latin for small network) was born in 2012 as newsletter of the National Working Group Reti Ecologiche e Green Infrastructure, promoted by ISPRA and formed by representatives of local administrations, regional environmental agencies and park authorities, but also universities, research institutes and freelancers who, for professional reasons, research or institutional competence deal with the topic of the connectivity, the ecological networks within spatial and landscape planning, consistent with the commitments related to the Habitats Directive and the new biodiversity protection policies of the European Union.

The National Agency for the Evaluation of the University System and Research has recently classified RETICULA among the Italian scientific journal list and earned RETICULA the role of technical-scientific journal. RETICULA represent, then, a consolidated tool for the transmission of knowledge, to enhance the information and encourage innovation of approaches, accelerating access to specific knowledge, experiences and good practices.

Fig. 2: The contribution of RETICULA journal is to support and foster synergies between the academic world and planning and design practice

This will also increase over time the quantity and, of course, the quality of projects and experiences throughout the national territory in continuity with similar cross-border experiences. The current 1,600 subscribers to the journal with their different roles in research, public administrations and freelancer activities, represent the protagonists of future planning, project and management of territorial actions.

The challenge RETICULA wants to address is the promotion of an active and conscious participation of all stakeholders in order to feed a dialogue that will lead to the definition of effective and shared approaches and spatial planning methodologies to increase the landscape resilience to face 21st century global challenges. The innovative characteristics of the journal are both an openness and active involvement of different professional fields and the availability in open access that surely improves the knowledge exchange.

The contribution of RETICULA is to support and foster synergies between the academic world and the know-how of planning and design practices that involve both administrations and the professional world, through sharing and dissemination. This includes the refinement of the on-going discussion on how and what to do in order to refer to the concept of ecological network as an appropriate conservative strategy, without underestimating the possibility of a revision and innovation of the models, adapting them to the new needs of its evolution according to the changed needs that have emerged in recent years. However, the original idea of ISPRA's activity still needs to be maintained: to speak of ecological network not only at the scale of territorial systems, but at the scale of its effects, in other words, the local dimension: researching globally, engaging locally.

The journal maintains unchanged in its vocation as tool of sharing among those who, for different reasons, deal with the issue of connectivity aiming to assume more and more a primary role of reference within the national scene as a tool of communication and sharing of issues. This is not only related to ecological connectivity, both in its now mature paradigm of ecological network and in its most recent incarnation as GI, but also to environmental governance connected to a proper eco-planning of large areas.

The articles show the results of the activities of local government, especially provinces (Varese, Pordenone, Pisa, Rome, Potenza, Barletta - Andria – Trani, Vercelli, Lodi, Fermo, Parma, Macerata) and regions (Piedmont, Sicily, Trento, Lombardy, Tuscany, Friuli Venezia) but also municipalities (L'Aquila, Cagliari, Pavia, Turin, Novara) and presents the updating of planning, management and regulatory practices regarding ecological networks and GI. The journal also collects contributions from the world of research and from pilot projects that identify and apply innovative good practices, as well as articles describing activities of the 21 Italian Regional Environment Agencies (ARPA/ APPA) on the issues of ecological connectivity as element of biodiversity protection and conservation. In addition, the magazine has a large section (Reticula News) where information on publications, events and projects is given in a short and interactive form.

The monographic issues of the journal collected, among others, the theme of adaptation to climate change (RETICULA n. 4) and soil consumption (RETICULA n. 7). Both monographs show the role that green areas play in strategies and actions in order to address these topics especially in urban and peri-urban contexts. The monographic issue of 2019 (RETICULA n. 22) on the River Contracts, presents experiences and reflections on integrated management of rivers as blue infrastructure that, especially in the most densely populated contexts, can represent areas of regeneration and implementation of urban ecosystem resilience.

The convergence between ecological networks and participatory and negotiated planning methodologies, as observed in Italy, also offers an intriguing perspective. The River Contract, an instrument already well known in this field, should assume a form specifically dedicated to ecological networks (Ecological Network Contract). This kind of agreement could lead, in the short term, to a more widespread recognition of the value and need for multifunctional ecological network planning, and could increase implementation opportunities, with the direct involvement of local stakeholders helping to guarantee the efficacy and sustainability of these actions over time.

Whilst the actual balance of the journal is undoubtedly positive some improvements will be carried on to ensure a wider participation (authors as well as subscribers) of professions and geographical areas which so far have had a marginal role. The RETICULA commitment therefore, will be to stimulate more and more the debate on sustainable spatial planning and to act as a vehicle of knowledge and dissemination of best practices, case studies and approaches. RETICULA will promote the integration into spatial planning tools those new solutions that are able to meet the challenges that the environment, the economy and civil society are facing. The responses to these challenges must be effective and multifunctional and this can only happen if those responses are shared by all stakeholders: from researchers to citizens, from local administrators to the private sector.

RETICULA, therefore, wants to be more and more at the national level and, in the future also at the European level, a meeting and sharing platform of good practices on ecological networks and GI in spatial and landscape planning. To promote the consideration of these tools as determinants for the inclusion of biodiversity issues in other areas of intervention (agriculture, forestry, water, maritime and fish resources, regional and cohesion policies, climate change mitigation and adaptation strategies, recreational, tourism and cultural activities, mobility and transport policies, green economy and energy opportunities) in line with the European Strategy for Green Infrastructure. In fact, the Commission Communication COM (2013)249 states that one of the cornerstones of the EU Strategy for the promotion of GI is to improve information, consolidate the knowledge base and stimulate innovation.

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Chapter 1: Analysing the functions, services and benefits of green infrastructure for a better landscape management in central Europe

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Chapter 2: Where and how best invest into green infrastructure in the MaGICLandscapes case study areas?

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Chapter 3: Green infrastructure planning and management in central Europe

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