Managing Environmental Goods under the Global Change

Approaches and Methods

Tatiana Kluvankova, Urban Kovac ed.

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reviewed by:
Assoc. Prof. Lenka Slavikova, University of J. E. Purkyne Usti nad Labem, Czech Republic
Prof. A. Udovc, University of Ljublana, Slovenia

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Foreword

In recent decades, human activities have moved beyond the range of natural variability, resulting in a rapid increase of complexity, approaching critical tipping points that may lead to irreversible changes to the Earth's systems, such as the disequilibrium of the Earth's energy balance, a rise in greenhouse gas concentrations, increasing ocean temperatures, declining biodiversity, and other factors. Studying and managing complex social and biophysical systems is a tremendous challenge for human society in an increasingly globalized world.

Global change represents a broad range of biophysical and socio-economic transformations, significantly interrelated with human activity, especially in the form of greenhouse gasses efflux, transportation systems and changes in land use.

The dynamcis of socio-ecological processes increases the vulnerability of social and biophysical systems. The vulnerability of regions is among the challenges reflected in the Territorial Agenda 2020. In this context, the crucial question is how to increase the adaptive capacity of biophysical systems against global change when such systems are faced by increased complexity and uncertainty, and how to protect their sustainable development.

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Managing the Resilience of Socio-Ecological Systems after the Disturbances

Tatiana Kluvánková, Veronika Gezik, Mari Shioya
Institute of Forest Ecology, SPECTRA Centre of Excellence,
Slovak Academy of Sciences, Vazovova 5, 81243 Bratislava, Slovak Republic;
and Cetip Network, Prague 10, 100 00, Czech Republic;
e-mail: *tana@cetip.sk*

1. Introduction

The human dependence on the capacity of ecosystems to generate essential services, and the vast importance of ecological feedbacks for societal development, calls for a more comprehensive and dynamic approach. The Socio-Ecological System (SES) concept represents such an interconnection. SES include societal (human) and ecological (biophysical) subsystems in mutual interactions (Gallopin, 1991). The SES concept places humans within nature, and focuses on the way in which interconnections between people and their biophysical contexts produce complex adaptive systems. The vulnerability and stability of SES against external natural and social disturbances is thus understood as the function of socio-ecological dynamics (Adger, 2006). A resilient ecosystem has the capacity to withstand shocks and surprises and, if damaged, to rebuild itself. In a resilient socio-ecological system, the process of rebuilding after disturbance promotes renewal and innovation. Without resilience, ecosystems become vulnerable to the effects of disturbance that could previously be absorbed. The concept of resilience, originally used by ecologists in their analysis of the population ecology of lands and animals and in the study of managing ecosystems (Holling, 1973), has been extended in order to understand the dynamics of SES (Folke, 2006). The capacity to absorb shocks while maintaining function is innovative, and provides components for renewal, reorganisation and innovation following disturbance (such as climate change or financial crises), and sustains the capacity for adaptation and learning (Carpenter et al., 2001; Folke, 2006; Holling, 1973).

In a global world, the diversity of actors and scales, and their power and interest in natural system resources and the dynamics of economic, social and natural processes, increases the vulnerability of social and biophysical systems to disturbances such as floods, droughts, earthquakes, forest fires, and overpopulation. Such systems can become adjusted to some types of disturbances, and in so doing may become vulnerable to the regime changes caused by many contemporary social-economic processes (Janssen et al., 2007a). This situation can lead to the unavoidable collapse of traditional systems. Disturbances in our study are understood as any short term (shocks) and long term (stresses) events that affect the functions and structure of the system (Leach et al., 2010).

In our paper we argue that the flexibility of rules in use, efficient use of local knowledge, self-organisation and legitimacy of an increased number of decision-making actors increase trust, create the conditions for renewal, and increase their adaptive ability to external disturbances. Moreover, we argue that adaptability implies establishing compatibility between ecosystems and social systems by creating efficient social norms and rules that are capable of managing systems in an effective and sustainable way. We analyse and demonstrate the effect of these processes in two examples of social ecological systems that are diverse in geopolitical history and socio-ecological values. These examples are the High Tatras (Slovakia) and Shiretoko (Japan) national parks.

To assess the impact on SES after the disturbance, semi-structured interviews were conducted in the High Tatras (2009) and Shiretoko (2010). The total number of interview respondents was 45, including employees in central government, municipalities, local park authorities, and tourism associations both in Slovakia and Japan, as well as local fishermen and indigenous people in the Shiretoko area.

The concept of resilience for human-nature relationships and the management of disturbances represent a theoretical framework to address the adaptive governance of social ecological systems that is presented in Section 2. The evolution of the adaptation cycle in the High Tatras and Shiretoko national parks is in Section 3. Section 4 concentrates on the management of resilience in particular adaptive tools and system robustness using analysis design principles. We conclude with suggestions as to how our analysis may be applied to improve local management and governance in promoting resilient social-ecological systems.

2. Understanding resilience as a concept for the management of disturbances

The resilience-based approach has emerged as a new paradigm to deal with the increasingly uncertain changes in forestry management, and the relationship between the social and ecological components of forest SES

(Rist and Moen, 2013). Understanding resilience requires describing the system via the construction of a conceptual model, which includes resources, stakeholders, and institutions (Resilience Alliance, 2010).

Any particular approach acts as a lens through which problems are viewed, and can have a major influence on how emerging challenges are conceptualized and confronted (Rist and Moen, 2013). Thus, the resilience approach will assist in assessing forest system dynamics and the interactions between its components.

Managing resilience involves improving actors' capacity in a system to adapt to changes and successfully avoid critical thresholds (Berkes, 2007). There is abundant evidence of traditional local SES that have persisted for a long time, retaining their resilience by adapting their institutions to natural and social disturbances (Berkes and Folke, 1998), as well as to the broader economic, political and social systems in which such SES are located (Janssen et al., 2007a, 2007b; Young, 2002; Howlett, 2009; Gatzweiler and Hagedorn, 2002). This adaptation can be described as an adaptive cycle whereby the dynamics of SES pass through four stages (Holling, 1973; Folke 2006): growth and exploitation phase (r), merging into a conservative phase (K), followed by chaotic collapse and release phase (Ω), finally giving way to a reorganization phase (α). The cycle occurs at a number of scales, and SES exist as 'panarchies' interacting across multiple scales. These different stages of SES dynamics are the key cycles of SES resilience analysis. Many systems appear to move through these four phases, whereas some variation in the adaptive cycle may occur. Because of cross-scale interaction, system resilience will depend on the influence of states and dynamics at scales both above and below (Walker et al., 2004). For example, global climate change, political changes or market shifts can trigger local institutional changes or regime shifts.

Characterized by self-organization, transfer of knowledge, resources and institutions across the scales, SES may form a set of independent local self-governed systems with high trust and social capital (Ostrom, 1998; Berkes and Folke, 1998; Poteete et al., 2010, Hurlbert, Gupta, 2015) with overlapping competences, and co-operative and competitive relations. Globalisation introduces a dimension of scale into local SES that affects their vulnerability to external disturbances. In particular, traditional durable institutions are challenged by global market actors that are not embedded in local institutional arenas thus negatively effect trust. The resilience approach is particularly prominent, with adaptive cycles, and transformation that recognise cross-scale interactions (panarchies) and emergent properties. It emphasizes non-equilibrium dynamics where instabilities can flip a system into another stage and regime of behaviour (Rist and Moen, 2013., Young et al., 2006).

Whilst there is increasing interest in resilience thinking, there has been little conceptual elaboration as to how these ideas might be operationalized in the management of SES (Rist and Moen, 2013). We employ resilience concepts to understand the processes of change and to describe the ability of the system to deal with disturbances during a certain time period. Following our main arguments that the resilience of SES are enhanced by the durability of institutions, legitimacy of new actors and local knowledge of ecosystem dynamics, we evaluate the institutions and governance against the design principles set out by Ostrom (1990). The key idea is that the final synthesis of the findings from the construction of the system's conceptual model, along with an evaluation governance, will reveal factors that may be eroding or enhancing the system's resilience (Urgenson et al., 2010).

3. Evolution of resilience in the socio-ecological systems of the High Tatras and Shiretoko

Our analysis contains two cases that in more recent times have been struggling to deal with natural or unique socioeconomic disturbances: in particular wind storms and timber markets in the High Tatras (Slovakia) and Shiretoko (Japan) national parks.

3.1 Natural and social values – current system state

High Tatras NP

The High Tatras mountains are one of the smallest alpine ranges in the world (covering 738 sq km), and the only alpine system mountain range in the Slovak Republic and Poland over 2000 m. The landscape is formed of 25 granite peaks with numerous side mountain ridges lined by valleys, with mountain streams and lakes formed by previous glacial activities. The natural ecosystems in the High Tatras are characterised by the 'elevational gradation', with the last remnants of virgin mountain forests. With over 1,300 recorded plant species, and large European predators such as bears, foxes, lynxes, marten wild cats and wolves, the High Tatras is an important centre of biodiversity. In contrast, the dominant part of the forest in the High Tatras mountains comprises numerous large tracts of even-aged, spruce (Piceaabies) that were artificially planted after recurrent natural disasters at the beginning of the twentieth century (Crofts et al., 2005) (Vyskot et al., 2007), but which influence the vulnerability of ecosystems.

The unique ecosystems of the High Tatras are protected as a cross-border national park. Tatransky Narodny Park (TANAP) has been recognised in the Slovak Republic since 1948, and Tatranski Park Narodowy in Poland since 1954. UNESCO acknowledged the uniqueness of the Tatras as part of international biosphere reserves in 1993. The two most important natural reserves – the Ticha and Koprova valleys – represent piscine forest and natural ecosystems the protection of which predates the park's establishment. Such reserves are core areas of European importance, designated as NATURA 2000 sites and part of the Pan-European Ecological Network under the Council of Europe's Pan-European Biological and Landscape Diversity Strategy (Crofts et al., 2005).

Shiretoko NP

Shiretoko is located on Hokkaido, a northern Japanese island comprising a volcano mountain range and coastal area. The total area of 56,100 ha represents a core area of 34,000 ha and a buffer area of 22,100 ha.

The Shiretoko National Park was established in 1964 as the twenty-third national park in Japan; at 38,633 ha it is renowned for diverse wildlife and unique landscape (UNEP, WCMC., 2005, 2011). The designation of the park was initiated bottom up, and granted based on its tourism promotion activities. At that time, Japan was in the midst of a resort development boom accompanied by rapid economic development, hence some land left behind by Shiretoko farmers underwent real estate industry development.

3.2 The growth and exploitation phase (r) in the High Tatras NP

Historically the High Tatras concentrated on forestry and agriculture. The High Tatra played an important role at the start of the twentieth century as an alpine respiratory health resort, subsequently an attractive place for recreation and sports that often expanded into the core natural ecosystem. The years of human interaction with nature in the High Tatras have left visible footprints on the original natural ecosystems, increasing their vulnerability. The unique combination of natural values with outstanding cultural heritage in the High Tatras attracts over 3 million visitors a year, offering opportunities for all-season activities. The increased number of visitors has put pressure on the development and expansion of tourist infrastructure, with subsequent considerable pressure on the natural and cultural values of the High Tatras.

Human settlements are located in the buffer zone of the national park in several municipalities distant from each other. In 1999, the City of High Tatras was legally established, which concentrated all municipalities under a formal governance structure with one centre. However, centralisation and the remote character of the city resulted in inefficiencies and a mis-coordination of power (Fig 1) such as public transport, shopping and schools, adversely affecting the well-being of locals as well as visitors. As the City of High Tatras comprises several municipalities, a coordination of competences is required to maintain the efficiency of public services. However, the failure to ensure this coordination has resulted in the City of High Tatras losing authority with municipalities, a process of fragmentation that continues. Process is described in Figure 1 in the annex. Cycle I exhibits loose connections within national, regional and local governance. Cycle II starts in 2004 after the wind storm, where additional hidden problems were revealed at local level. This developed into uncontrolled pressure on the park, such as intensive recreation and illegal logging. Cycle III represents the misfit of two sectoral approaches to the management of the park and the absence of local population.

In addition to the territorial governance of the City of High Tatras, park governance is subordinated to two state agencies: Nature Conservancy and the State Forest Company. These two state actors are guided by different management plans, with forest classification coming from a dual regulatory system. The discordance of two sectoral regulations has been causing additional difficulties and coordination problems in the management of the High Tatras. Most critical is the incompatibility of protection regimes. Forestry management is based on practices that are contrary to the ecosystem approach of conservationists that allow for natural renewal as well as dead wood being left in the ecosystem. Contrasting positions regarding the type of management and competences in decision-making escalated into open conflicts and communication failures.

The participation of non-state actors in planning and decision-making is also a challenge, because the absence of an accountability mechanism and practice for non-representative participation is prevalent (Kluvánková-Oravská et al., 2013). The involvement of land owners and land-users of protected land in decision-making and the protection of ecosystems and natural disaster prevention strategies is lacking.

An exception is the collective forest ownership regime constituted as a self-governing historical common pool resource since the 18th century. These systems co-evolved over the centuries as formal and informal norms and standards, respecting the economic interests of shareholders as well as social equity and ecosystem dynamics. Such appropriation and provision rules are derived from historical traditional practices, self-monitoring, gradual sanctioning, collective choice arrangements and conflict resolution, with decision-making divided between an annual assembly of owners and a management board. The rights and responsibilities of individual members accord with their respective property shares. Currently these regimes are nested within the national forest governance structure, representing 25.5 % of forest land at the national level, currently regulated by the Slovak Law on Land Associations (No. 181/1995, respectively 97/2013). However they power in local decision making is limited to local property maintenance.

Hokkaido was formerly called “Ezo-chi”, which means uncultivated or unexplored place. In prehistoric times, the indigenous Ainu lived there. Their culture mixed with Okhotsk culture, whereby they engaged in the small scale hunting and collecting of nuts and shells.

From the early to the mid-20th century, part of the Shiretoko Peninsula was pioneered by dairy farmers and crop farmers by the Japanese Government’s land reclamation scheme to Hokkaido. Those new settlers were from poor farming areas in Honshu, the main Japanese island, coming to seek new opportunities. But by the 1970s the farmers had abandoned their homesteads due to the severe weather, poor land, hardship, and changes in the national government’s priorities.

The main economic activity there has traditionally been fishing and farming. Fishing developments for herring and squid were established in Shiretoko, and agricultural development began on the peninsula. Today, 96,000 tons of fish including salmon and walleye Pollack are brought into Shari and Rausu (Hokkaido Government, 2006). Although the agricultural land on the peninsula produces crops valued at 6.2 billion yen annually, there are only 850 ha of cropland and pastures on the peninsula, and no agricultural or forestry activities within the National Park. Tourism is also an important part of the economy, with 2 million annual visitors to Shiretoko National Park.

This period began with an economic boom in the Shiretoko area in the late 1970s. In response to the rapid speed of development, in 1977 the Shiretoko 100m^2 Movement started in Shari Town as a pioneering project in the Japanese National Trust. Under this initiative, public funds were used to purchase abandoned farmlands so that their forests could be restored to their original grandeur. This process increased connections between the local population and the national authorities (Fig 2).

Cycle I exhibits the increased connections within the local population and the national scale. Cycle II displays the system after the rapid economic development that continued into the 1990s. Strong local social pressure has a direct impact on national policy legislation developing from exploitation into conservation. Cycle III begins in 1998 with recognition as a World Heritage Site and the establishment of the Scientific Committee and Regional Council that increase connection between national and regional scales. Connection with the local scale was increased due to the participation of local residents in regional councils

In February 1980, the zoning of this area was revised, and the area in the vicinity of Mt. Onnebetsu was designated a Wilderness Area, which warrants stringent conservation and management. With the opening of the Shiretoko Cross Road in 1980, the number of visitors to the park increased to approximately 2.2 million per year, and it has become a popular natural site for tourists. Visitor facilities have been set up at various tourist attractions. These include the hidden mystical Shiretoko Five Lakes, which form the group of lakes on the Iwaobetsu Tableland; the Horobetsu park land, where a centre for providing information on the natural surroundings of Shiretoko has been established; Shiretoko Path, which has a view of Mt. Rausu and Kunashiri Island; and the Rausu hot spring facility complex (Shiretoko Data Center, 2010).

3.3 Disturbances – Chaotic collapse and release phase (Ω)

Natural disaster as a driver of recovery strategies in the High Tatras

On November 19th, 2004, the High Tatras mountains were hit by a storm with winds reaching up to 173 km/hour. The storm completely destroyed 13,000 hectares of forest between 700 m to 1350 m above sea level. Approximately 3 million cubic meters of soft wood were damaged (Toma, 2009), comprising mostly commercial forest but also some pristine forest in Natura 2000 sites.

After this event, many additional problems were revealed, mainly in tourist centres and settlements, such as illegal waste disposals, poorly maintained buildings and infrastructural facilities, illegally rebuilt buildings and devastated green areas. Thus the wind storm as a short term disturbance to the environment of the Tatras expanded into a social disturbance – uncontrolled recreation and vacation housing. The storm created opportunities for a reorganisation phase, such as a discussion regarding future Tatras policies and sustainable economic activities. On the other hand, investors hoped to expand residential and recreational areas instead of aid forest recovery, a move that would lead to another collapse phase.

Social shock in Shiretoko

After WW II, Japan started to focus on timber production along with people's new need to rebuild the country under the rapid economic development. Fast growing trees were planted in order to have quick production, leading to the forest losing its biodiversity. The speed of logging increasingly accelerated throughout the 1950s and '60s. The Shiretoko logging battle took place under such circumstances. This battle became the trigger to change Japan's forestry policy, as it drew attention throughout society. Due to this social pressure, the National Forestry Agency changed their policy from exploitation to conservation. Other areas of Shiretoko were gradually designated a Wildlife Protection Area (1982) and a Shiretoko Forestry Biodiversity Protection Area (1990).

Prior to such designation, Shiretoko was declared a National Park in 1964 and protected by Natural Environmental Conservation law since 1980; Shari and Rausu town municipality initiated a World Heritage Site (WHS) Project in 1998 to have higher protection enforcement through higher visibility, as well as to attract local and international tourists. It was officially registered as a World Natural Heritage Site in July 2005 after consultation with IUCN. Soon after, the park started receiving huge numbers of national and international visitors (2.5 million per year), which affected the socio-ecological system in numerous ways. Firstly, it caused the reduced quality of service and environment of the park, as it could no longer maintain the previous level under the higher pressure of visitor numbers. Secondly, other changes due to intense tourism included the reshaping of the demography, economic and political structure of the area. This will be further explained in section 4.4.

4. Management of Resilience – Phase of reorganization (α)?

Following our arguments in the previous chapters and Urgenson et al., (2010), we will now explain the evolution of resilience and adaptive processes in both areas, in particular the possible phase of reorganization after a disturbance process.

4.1 Dilemma over land use management in the High Tatras post- storm

Forest management

The windstorm re-opened discussions on the division of competencies and future strategic plans for the management of the High Tatras. The key issue became the type of forest regime and the revitalization of forest ecosystems in the High Tatras region (Jankovič, J. 2007, Toma, 2009). By a decision of the intergovernmental committee for the Renewal and Development of the High Tatras, replanting was performed for three zones. A recreational zone and core park zone replanted with native species, and two nature reserves and NATURA 2000 sites protected under the EU Habitat Directive (Tichá and Kôprová valleys) were left for natural evolution, with no management activities (such as the collecting of deadwood or pesticide treatment against insects).

The management regime of those two reserves became a source of conflict: the forest authority – in order to prevent insect outbreaks from the reserve to neighbouring forest – violated the joint decision and initiated the collection of deadwood in reserves. The risk of bark beetle was considered higher than the potential damage to ecosystems by collecting deadwood, as such ecosystems had been seriously affected by the storm. In contrast, nature conservation authority followed the decision and international treaties and the EU Habitat Directive, arguing that no interventions should be taken against bark beetles in natural ecosystems as such were already in the process of consolidation due to natural succession. This position was also supported by the ***International Union for the Conservation of Nature*** (IUCN), the World Wildlife Fund (WWF), and subsequently by the Director General of the Environment of the European Commission (DG Environment) who indicated that the management activities planned for Ticha valley were incompliant with NATURA 2000 principles. Hence the EU initiated infringement proceedings against the Slovak government.

The attempt to harmonise the contradictory legal regulations and management practices for forestry and nature conservation in protected forest has not been successful. The consequence of this conflict between the two parties responsible for forest management in the High Tatras National Park created a barrier to the co-evolution of the two existing regimes and their adaptation to the post-disaster situation.

Intense or Sustainable land use?

The windstorm also initiated discussions about new land-use documentation for the High Tatras that dated from 1999. This discussion process is heavily influenced by the land developers that hope to get approval for extending built-up area boundaries beyond the current limits, as well as the nature conservation community aiming to confirm the park's zoning – a process that has been under public and professional discussion/ negotiation for several years. The City of High Tatras, where land use planning decision-making is based, has failed to act as a powerful actor. Hence neither zonation nor land use plan are in effect.

To sum up, in the absence of clear authority for the park and zonation of the park, the development of a comprehensive land use strategy is jeopardised.

The misfit of two sectoral approaches to the management of the park and the absence of an indigenous population can be considered key factors behind the unsustainable development as well as the failure of involved parties to use the natural storm for the revitalisation of social systems to increase resilience.

4.2 Recovery of Shiretoko after social shock

Logging battle

In 1986, the National Forestry Agency decided to clear the part of the national forestry area inside the national park to help regenerate the forest. The plan was to clear 1700ha of old woodland area in 10 years with the aim of revitalisation. Whilst it is legal to fell trees inside national parks, there was some concern from the Shari municipality that this process could harm the habitat of rare bird species such as Blakiston's fish-owl (Bubo blakistoni) in the virgin forest. This was published in several newspapers, stimulating argument throughout Japan, publicly supported by one million people.

This conflict between the economic interests of the Japanese government and ecological protection interests heavily supported by the public and the media was an iconic event for public participation in Japan, as well as for Japanese forestry policy. Public protests in Shiretoko rapidly re-directed the forest management policy and practices of the National Forestry Agency, which is under the control of the Ministry of Agriculture, Forestry and Fisheries for timber production, sustainable forestry, and conservation. As a consequence, the Shiretoko area was established as a Forestry Biodiversity Protection Area in 1990.

World Heritage Site

Accession to the WHS brought intense tourism that reshaped the demography, economic and political structure. Similarly to the High Tatras National Park after the storm, it created a platform for the rapid development and intensification of commercial activities such as new bus lines and travel tours that increased employment but put pressure on ecosystems and the subsequent degradation of visitor experience.

The setting up of the Scientific Committee and Regional Council was a response to such social shocks by institutional change. Scientists, researchers and experts are given the scope to express influential opinions on wildlife management. Without the Scientific Committee's agreement the authorities cannot proceed with issues, and the local community can also participate in the decision-making process by joining the regional council. All stakeholders can contribute to any topic. Both Committee and Council have thematic working groups that facilitate work on each topic with both institutions.

The extension of sea defences, limiting tourist numbers, and management of wildlife (such as deer, bears and foxes) are all matters firstly discussed by the Scientific Committee and Regional Council. Upon the agreement of both parties, the government can issue a legal change in the respective area. Thus it can be said that the emergence of a bottom-up and cross-scale mechanism is happening in Shiretoko under the conditions of globalization (international visitors, IUCN policy suggestions).

4.3 Enhancing resilience

In our study, the socio-ecological systems of two national parks were affected by disturbances. A wind storm in the High Tatras and development demand in Shiretoko both increased the vulnerability of social and natural systems. In the following we will assess the adaptability of SES to external disturbances and the effect on resilience by analysing institutional maturity, in particular the quality of self-organisation and rules in use, cross-scale interplays, and the fit between social and ecological systems using Ostrom's (1990, 2008) eight design principles. Table 1 demonstrates the comparative analyses of the High Tatras and Shiretoko SESs.

Measure of resilience	NP High Tatras	NP Shiretoko
System boundaries	Hierarchy of the city	Park hierarchy and community networks
Congruence with local conditions: Ecology – Culture – Cost/benefits	 Ecosystem/technology in conflict – Absence of local community in the park – Local costs-global benefits	 Ecology-society fit emerging – Indigenous and local community – Local costs, local/global benefits
Collective choice	Centralised governance, exclusion of non-state actors	Multilevel polycentric governance
Monitoring	National, EU	International (IUCN)
Gradual Sanctioning	External with low enforcement	Informal social exclusion
Conflict resolution	Formal laws only	Participatory mechanism and public awareness
Upper level recognition	By law	By multilevel structure
Nested enterprises	In formal system	Formal and polycentric

Table 1: Management of resilience in Shiretoko and the High Tatras.

Physical ***boundaries*** in both cases are clearly defined by laws governing national parks. However, in the High Tatras the top-down organization and remote character of settlement makes this structure ineffective in addressing regional needs and coordinating responsibilities, such as adequate responses to external disturbances. Thus some actors dominate in their right to use resources. In Shiretoko the original top-down system has been adapting by extending the influence and diversity of local networks, which enable the development of more effective user systems.

In terms of ***congruence*** with local rules, in the High Tatras the conflicting forest management practices, domination of large scale investors over the resource, misfit of sectoral policies, and the absence of local community within the park accelerates conflicts of forest management and violate this principle. In Shiretoko a compatibility between ecosystems and social systems is emerging from the cooperation of local actors and respective authorities. The pace and scale of institutions are congruent with traditional decision-making processes.

Collective choice in the High Tatras is halved by a top-down territorial governance structure that prevents the evolution of rules in use and adaptive mechanisms towards multilevel governance. Only powerful actors can participate in decision-making. In Shiretoko the multilevel governance structure and participatory action of stakeholders appears at a diverse level. New actors have been legitimised by the public and authorised by the Scientific Committee and Regional Council – the new bodies established to coordinate local action. There is no internal ***monitoring and self-sanctioning*** mechanism in place in the High Tatras governance, except for those practiced by non-state forest owners (see also Kluvankova, 2013). Those mechanisms imposed by legal regulations suffer from low compliance. In Shiretoko the monitoring of environmental quality is mainly conducted by IUCN and respected state authorities. Although there is no formal sanction system, external investors are rarely invited to local networks.

Conflict resolution in the High Tatras has been organized top-down or is fragmented to individual practices and habits. In Shiretoko, growing public involvement at various levels of decision-making enables the evolution of participatory low-cost and effective conflict-resolution mechanisms.

Functional and creative efforts by local appropriators to create effective stewardship mechanisms for local resources recognised by upper levels are absent in the High Tatras. In Shiretoko, the multilevel governance structure enables local institutions to be recognized at the regional and national scales.

In both cases, socio-ecological systems are ***nested*** in formal legal systems, however in Shiretoko the polycentric structure is in evolution. This may link governance and ecology across the scales.

5. Conclusions

In our paper the concept of socio-ecological resilience is used to understand the dynamics of social–ecological systems exposed to external disturbances, and how such dynamics interact across temporal and spatial scales. Our arguments build on the role of self-organisation and socio-ecological fit in rebuilding the social-ecological system after disturbances, and promoting the innovative and adaptive capacity of such systems.

We conducted empirical analyses to demonstrate the effect of these processes in two examples of social-ecological systems recently exposed to disturbances that are diverse in geopolitical history and socio-ecological values. These are the High Tatras (Slovakia) and Shiretoko (Japan) national parks. A panarchy adaptive cycle has been created to analyse the vulnerability of both socio-ecological systems. Using Ostrom's eight design principles, institutional maturity, in particular the quality of self-organisation, rules and fit between social and ecological systems determined the adaptive capacity and survival of both SES. Both parks were established by legal regulation as a response to increased pressure on their unique natural ecosystems, but failed to develop adequate institutional systems to maintain sustainability. Disturbances to which the parks were exposed increased vulnerability, but also opened opportunities for renewal and new trajectories.

In the High Tatras a misfit of sectoral policies and an absence of local community has created a barrier to the evolution of a self-governing system, and has accelerated conflicts between forest management and the character of development that has resulted in a misfit of ecological and social systems. The current top-down centralised territorial governance structure is inefficient, as it fails to maintain the legacy of the park under emerging market pressure, and also prevents the evolution of rules in use and adaptive mechanisms to multilevel governance.

In Shiretoko the disturbances have been successfully managed and the system has been adapted by a novel multilevel governance structure and the participatory action of stakeholders at a diverse level. New actors have been legitimised by the public at diverse scale. The compatibility between ecosystems and social systems has been evolving by cooperation between the local actors and respective authorities. The polycentric structure has been evolving as an adaptation of Shiretoko's socio-ecological system to today's conditions.

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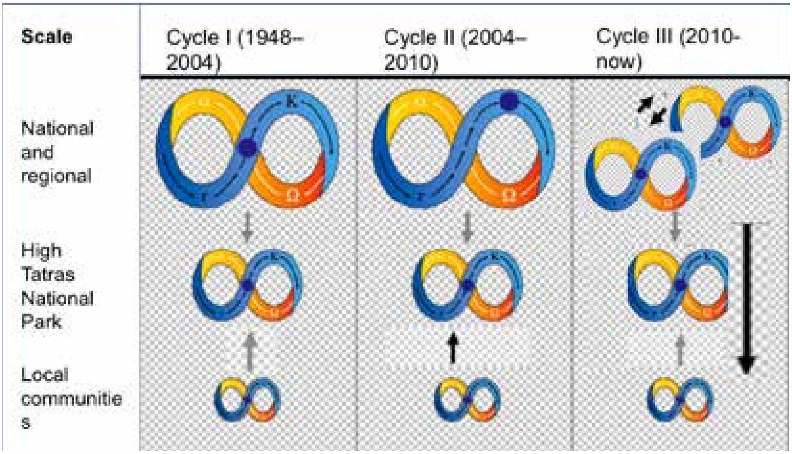


Fig 1: The panarchy system illustrates the dynamics and cross-scale interactions in Tatra National Park over time. The illustration shows scales above (national and regional) and below (local population) the system of interest (national park).

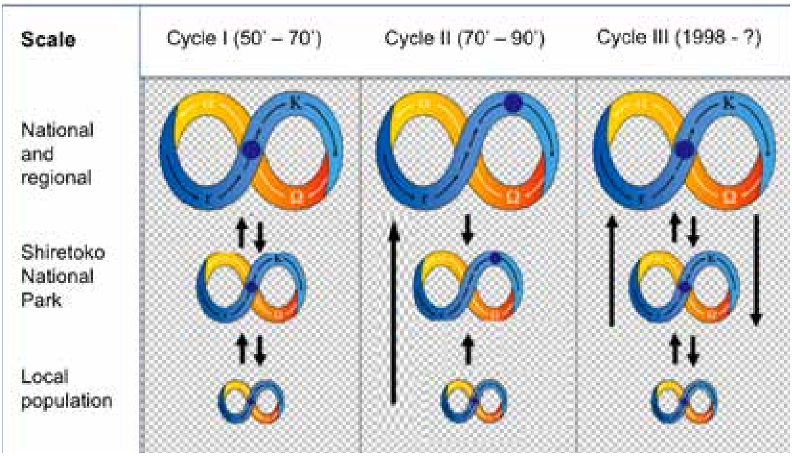


Fig 2: The panarchy system illustrates the dynamics and cross-scale interactions in Shiretoko over time. The illustration shows the scales above (national and regional) and below (local population) the system of interest (national park).

ECOSYSTEM SERVICE GOVERNANCE: Cultural Ecosystem Services to Promote Ecosystem Values and Management under the Rapid Change

Eva Streberová[1], **Tatiana Kluvánková**[1], **Patrik Zoľák**[2]

CE SPECTRA 2Institute of Management of Slovak University of Technology and 1Institute of Forest Ecology, SAS ´

1. Introduction

Natural ecosystems provide almost unlimited opportunities for spiritual enrichment, mental development and leisure (de Groot, et al., 2002). Because, the longest period of human evolution took place within the context of undomesticated habitat, the craving of the human brain for gathering information and a sense of well-being are very strongly tied to the experience of natural landscapes and species diversity. Human beings possess the mental capacity to be perceive the nature and its processes through prism of spirituality, and have been equipped with sense of wonder, curiosity and instincts to explore nature. Nature is, therefore, a vital source of inspiration for art, science and culture. Additionally natural environments provide many opportunities for education and research. Natural provides a highly inspirational and educative form of re-creative experience, with opportunities for reflection, spiritual enrichment, cognitive development and recreation.

Actual approaches to conservation of natural resources targeting at habitat and species protection overlook ecosystem functioning and resilience of complex biophysical systems. Major gaps exist in addressing the importance of ecosystem services and their effects on well-being in related policies. The quality of these services results – among other things – from individuals' decisions and how they as well as from how decisions are regulated by norms and formal governance schemes, legislations, policies and various forms of economic incentives operating at and across the scale. As ecosystem services are primarily public or common goods, in a global environment asymmetric and imperfect information between ecosystem service provides and user accros governance scale requires change from individual to cooperative strategies to decision making to maintain sustainability under the increasing pressure of global market.

In particular urban ecosystem services are facing increased pressure. Concentration of economic activities and increase of urban population has rapidly influenced demand for urban ecosystem services. Urban systems represent complex, socio-biophysical systems interacting far away behind their administrative borders. Functional interactions and global partnerships are effecting their performance, in the same time strong interdependences of urban systems on local resources remains. This leads to the growing vulnerability of urban systems to external shocks, such as climate change effects, often appearing locally but affecting the whole system. While most of economic activities are individual and private, urban resources remains public or common, characterised by costly exclusion of beneficiaries through physical and institutional means and high subtractability of resource units available to others, thus facing social dilemmas in which individual short-term interests are in conflict with long-term society interest. Vulnerability of ecosystem services in urban public spaces rapidly increased due to multilevel factor, in particular while ecosystem services are local, distant users operates across governance scale and with diverse interpersonal and social interest often ignoring sustainability and carrying capacity of local ecosystems. Furthermore, traditional governance modes based on territorial belonging challenges legitimacy of representative democracy resulting from the growing scale individualism of human existential space and overlapping action spaces of particular activities. Ecosystem services in urban areas are thus seen as promising concept to promote urban sustainability via supporting users awareness and interest in producing and maintaining ecological values in the city.

2. Taxanomy of cultural ecosystem services

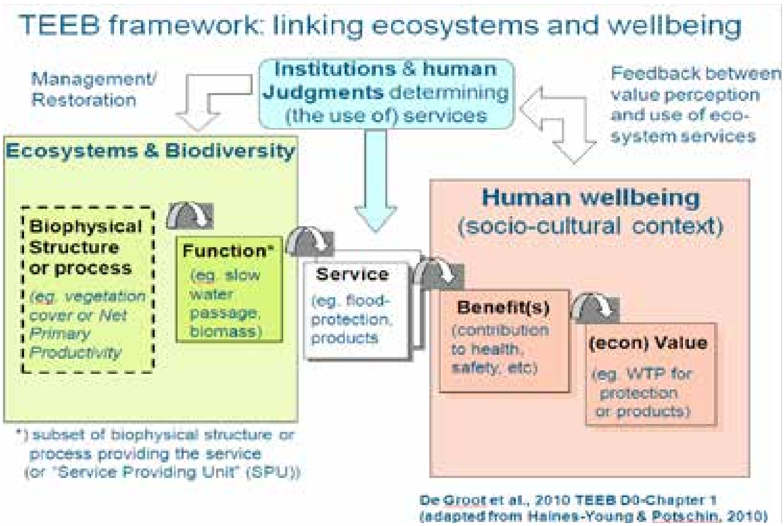
It is common for the well know taxonomies of ES like the one by MEA (Millenium Ecosystem Assessment, 2005), TEEB (The Economics of Ecosystems and Biodiversity) or CICES (Common International Classification of Ecosystem Services) to include a broad category labeled cultural ecosystem services (see Table 1) (Daniel, et al., 2012). These should not be seen as a residual category after accounting for more utilitarian ecosystem services, such as water and food provision. Cultural services have value in their own right, and they have played an important role in motivating public support for the protection of ecosystems. Although some cultural values may have little dependence on ecosystems (e.g. those associated with historic buildings, paintings, and religious relics), cultural services, like all other ecosystem services, must demonstrate a significant relationship between ecosystem structures and functions specified in the biophysical domain and the satisfaction of human needs and wants specified in the medical, psychological and/or social domain (Fig. 1).

Cultural ecosystem services are defined by:

Millennium Ecosystem Assessment (2005) as "non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences",

TEEB (de Groot, 2010) as „non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits",

CICES (Haines-Young, Potsschin, 2010) as „all non material ecosystem outputs that have symbolic, cultural or intellectual significance".



Flowchart of the procedure to obtain recreation potential

(W: water; NP: nature protection areas; DN: degree of naturalness; RPI: recreation potential index).

Figure 1. Cascade for explaining the links between exosystems and human wellbeing (Haines-Young, Potschin, 2010)

	MEA (2005)	TEEB (2009)	CICES service group (2010)	Examples of benefits
Cultural services	Spiritual and religious values	Spiritual experience	Spiritual (wilderness, naturalness, sacred species or places)	Tranquility, isolation, woodland cemeteries, sky burials
	Aesthetic values	Aesthetic information	Aesthetic, heritage (Landscape character, cultural landscapes)	Sense of place, areas of outstanding natural beauty
	Cultural diversity	Inspiration for culture, art & design		
	Recreation & ecotourism	Recreation and tourism	Recreation and community activities (charismatic or iconic wildlife or habitat, prey for hunting or collecting)	Bird or whale wathcnig, conservation activities, volunteering,
	Knowledge systems and educational values	Information for cognitive development	Information (scientific, educational)	Pollen record, tree ring record, genetic, subject mater for wildife programmes and books, etc.

Table 1. Comparison of different classification approaches to cultural services.

Most of the studies dealing with cultural ecosystem services focus on ***recreational benefits*** and information content associated with cultural services. Recreational benefits (recreation – mental and physical health) – such as enhancement of mental nad/or physicla health have been studied throughout a wide range of natural or semi-natural ecosystems (cit.). In regard to mapping and valuation of recreational services a crucial criterion is their accessibility (de Groot et al., 2009). This pressumption was adapted from Braat et al. (2008) is that the more accessible pristine systems are the higher tend to be their values (See Fig. 2), whereas the more accessible, the more intensely used and degraded systems become. Besides recreational benefits, cultural ecosystem services and their values are a function of the information content (for educaitonal, scientific purposes) which is considered to decrease with the degree of conversion.

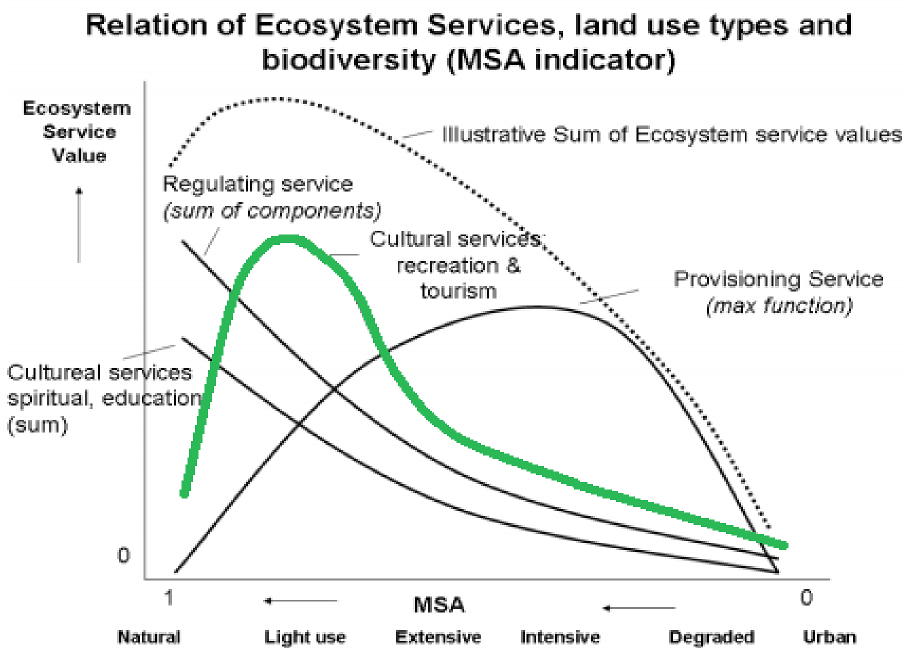


Figure 2. The generalized relationships between land use / biodiversity and ecosystem services (Source: Braat et al., 2008)

The supply of ecosystem services affects stakeholders at all institutional levels. Cultural services may be supplied by ecosystems at different ecological scales, such as a monumental tree or a natural park. Stakeholders in cultural services can vary from the individual to the global scale. For local residents, an important cultural service is commonly the enhancement of the aesthetic, cultural, natural, and recreational quality of their immediate living environment.

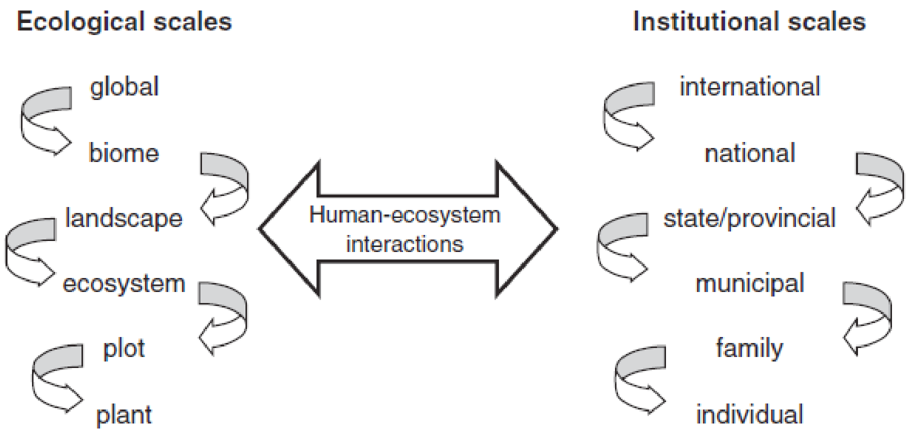


Figure 3. Ecological and institutional scales relation (source: Hein et al., 2006).

Spatial scales of ES are also determinant in their value assessment. Hein and others (Hein, et al., 2006) argue that a spatial definition is required in order to describe the ecosystem to be valued and they used the different definition of ecosystem: ***"the individuals, species and populations in a spatially defined area, the interactions among them and those between organisms and abiotic environment"***. Spatial distribution and relations are important for modelling and in turn, spatially explicit simulation models have promoted better understanding of ecosystem processes, including changes at different scales over time. However, object classes usually implemented in GIS environments may not be sufficient to describe all interactions between ecosystems and social systems that define cultural services (Daniel, et al., 2012). For example, determining the cultural heritage significance of a specific ecosystem feature requires the participation of relevant stakeholder groups. Whereas mapping the location of an identified feature can be straightforward, delineating precisely the boundary of the area within which land use changes could affect the associated heritage value can be challenging. All cultural services strongly depend on perceptions and expectations of the respective stakeholders, and considerable conceptual and technical work may be needed to represent and model the complex socioecological relationships that define and constrain a given cultural ecosystem service adequately.

3. Cultural ecosystem services mapping and assessment – national scale

ESTIMAP is one the key components in the methodology of LUISA (Land use based Integrated Sustianability Assessment Platform) and TESI8 (Total Ecosystem Service Index), (Zulian et al., 2013, Paracchini et al., 2014) where it is used as an ecosystem service module for spatial operations in GIS environment to calculate ecosystem service provision (Maes, et al. 2015). ESTIMAP consists of three main components (or methodological steps) (Paracchini et al., 2014):

1. Modelling of the ecosystem function, through a **RPI – Recreation Potential Index**. RPI is a composite indicator on the basis of findings from surveys, literature and databases.

2. Characterisation of the ecosystem service through the ROS – Recreation Opportunity Spectrum. ROS identifies three main delineation factors in order to assess the potential recreational provision of ecosystems. ROS is basically calculated by cross-tabulating the RPI with degrees of proximity/remoteness.

3. Assessment of potential demand (for one-day recreation with maximum driving distance of 80 km) – density distribution of potential visitors (residents).

More detailed explanation of steps 1.–3.:

1. RPI – can be aggregated using different components which make up the recreational potential of each cell in the layer. The recommended procedure is the one used for building composite indicators by Nardo et al. (2008), making the results dimensionless, appearing in the scale from 0–1. The components proposed in the literature represent (Paracchini et al., 2014): degree of naturalness, level of nature protection, quality of bathing water (Nevertheless these are only recommended components, which might be swapped for other components, such as for example terrain steepness, etc. it is subject to further discussion). Additionally it is possible to attribute weights to each component (Paracchini et al., 2011) to demonstrate strength and importance of each component (Figure 4). We list further variables which could be potentially included in the RPI in table 2.

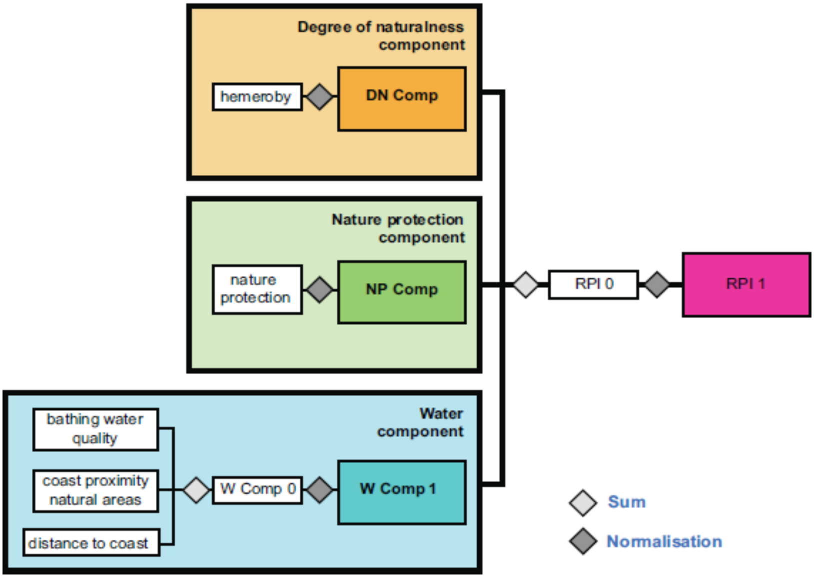
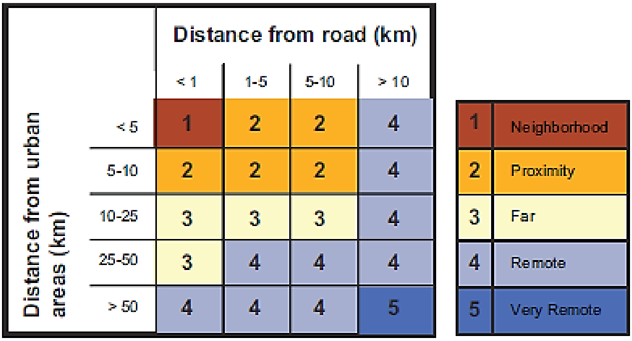


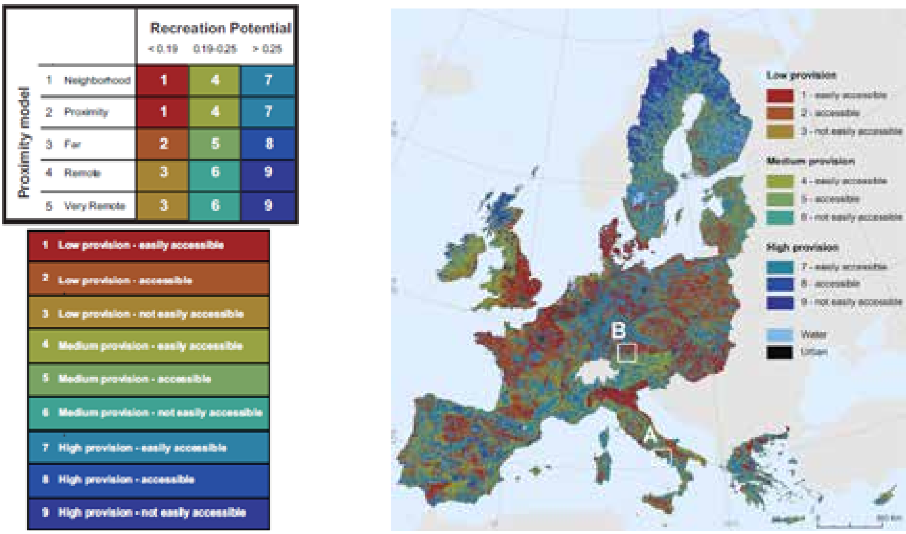
Figure 4. The flowchart of the aggregation procedure to obtain RPI (Source: Paracchini et al., 2014).

2. In order to create classes for ROS it is necessary to first address the issue of remoteness and proximity if there is the opportunity to deliver recreation to people (Figure 5). The methodology proposes using the distance from residential areas proxy, by calculating the Euclidian distance. The catego-risation of results is a result of expert panel evaluation and the degrees of proximity/remoteness are presented in the matrix in fig. 2. The ROS is basically calculated by cross-tabulating the RPI with degrees of proximity/ remoteness (Figure. 6).



Distance from urban areas (km)	Distance from road (km) < 1	1-5	5-10	> 10
< 5	1	2	2	4
5-10	2	2	2	4
10-25	3	3	3	4
25-50	3	4	4	4
> 50	4	4	4	5

Figure 5: Degrees of proximity and remoteness (Source: Paracchini et al., 2014).



Proximity model	Recreation Potential < 0.19	0.19-0.25	> 0.25
1 Neighborhood	1	4	7
2 Proximity	1	4	7
3 Far	2	5	8
4 Remote	3	6	9
5 Very Remote	3	6	9

Figure 6: ROS classes for EU wide recreation service provision (Source: Paracchini et al., 2014).

3. Modelling the potential demand – The potential flow of the service to visitors can be estimated by modelling the share of population that can theoretically access the different ROS zones. The ESTIMAP addresses daily recreation, therefore according to the analysed surveys (Maes et al., 2012a) and literature two reference distances have been used for close-to-home and daily maximum travelled distance: 8 and 80 km. The resulting data can be interpreted in terms of statistical distribution of ROS zones and percentage of potential trips per ROS zone. An alternative is also to interpret this data using a traffic-light approach in GIS environment – for example showing areas with little opportunities but high population density, areas with medium opportunities and medium density and finally many opportunities but small population density (example from Slovakia, see attached ppt file).

During the 3rd MAES Hands-On Workshop (24-26 March, Wageningen) supported by the TRAIN project, representatives of the slovak MAES-SK project[1] team completed several mapping and assessment exercises under supervision of experienced experts, of which one was solely focused on cultural ecosystem services. Adopting the methodological framework of Paracchni et al. (2014) and Zulian et al. (2013) several map outputs for cultural services were created. First of all a map representing naturalness of ecosystems was created by combing data of real and potential vegetation covers. This map was aggregated with another map of waterbodies and a morfometrical map in order to retrieve a map representing the recreational potential index (RPI). The presumption was that the higher and steeper the topography of the landscape, the more attractive it might be from a tourist perspective (Figure 7). Nevertheless this can be a point for further discussion, since also other variables might be considered for the RPI. The list of potential variables is included in Table 2. In the second step, we have aggregated the map of RPI with the existing road network proximity map to retrieve a recreational opportunity spectrum map (Figure 8).

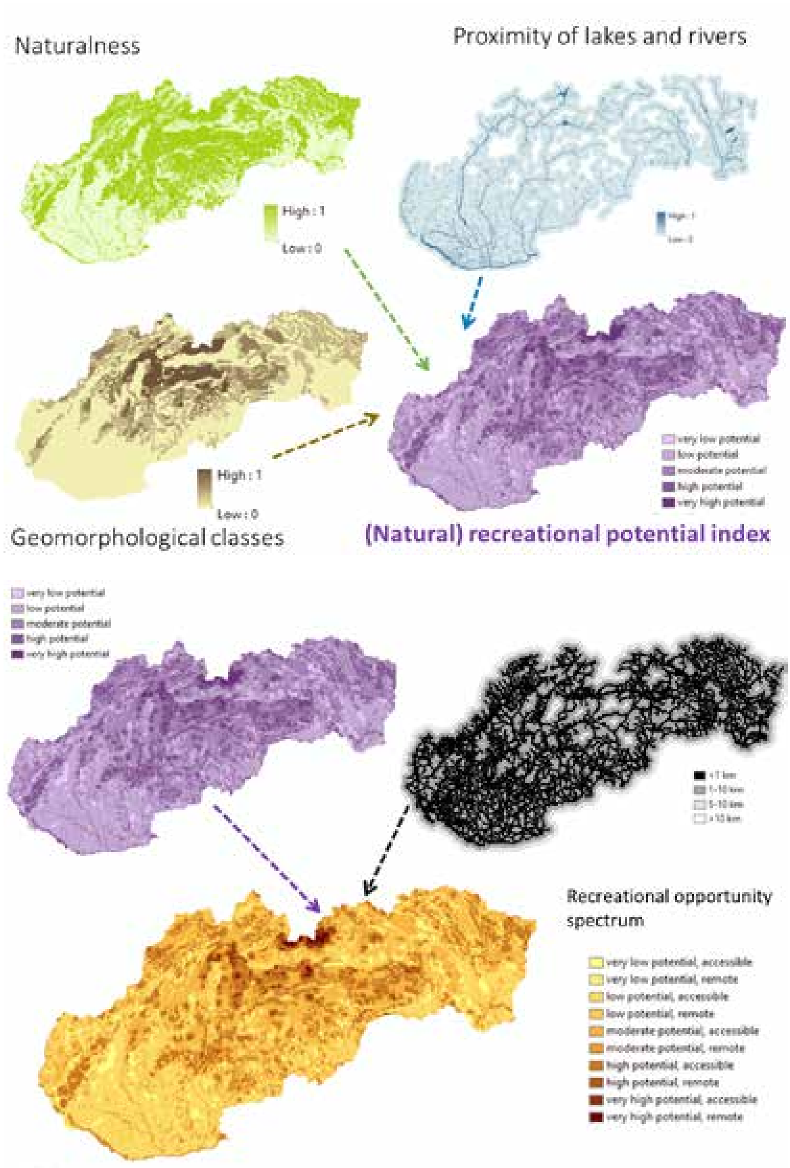


Figure 7. & 8. The recreational potential index and recreational opportunity spectrum for Slovakia (draft version only, constrained data).

1 Eva Streberová (CE SPECTRA), Peter Pastorek (Slovak Environmental Agency), Peter Mederly (Constantine the Philosopher University, Nitra)

Recreation potential index (aggregated using different components which make up the recreational potential of each cell in the layer, proposed magnitude scale: 0–1)		
Component	**Description**	**Source**
Naturalness	For example map of potential natural vegetation combined with real (current) vegetation map (Atlas krajiny)	
Level of nature protection	Natura 2000, protected areas according to national nature protection law	
Water bodies and rivers	Suitability for bathing and other recreation activities (angling, rowing, etc.)	
Other suggestions to be included in the RPI (to be discussed):		
UNESCO sites	Natural areas or sites, natural monuments with cultural, spiritual or other aesthetic relevance	
Historical landscape structures	Relicts of specific land-use in the past, secondary landscape structures, preserved as part of local heritage	
Water bodies and rivers – quality	Drinking water – mineral water for drinking, spa mineral water, non-mineral water, non-potable water,…	
Density of hiking trails	Trails for hiking, (biking?)	
Landscape diversity	Diversity of landscape structures	
Endangered species	Fauna and flora, IUCN red list classification – critically endangered, endangered, vulnerable, near threatened, least concern	
Species richness	Biodiversity	

Table 2. Other variables to be considered in RPI.

In the last step of the exercise, we have aggregated the map of Recreational opportunity spectrum (ROS) with the population density map in order to simulate potential demand for cultural ecosystem services. We have used the “traffic light” approach to simulate where there is low ROS but high demand (red) – meaning the pressure on cultural ecosystem services is threatening the provision of these services. Based on this approach, we have also identified places where there high ROS and low demand (green) and finally the blue places represent an adequate to the level of demand.

Concluding remarks: ESTIMAP framework is flexible and open to introducing new components for RPI and attributing weights to estimate importance and strength of individual components. Estimap draws on expert panels,

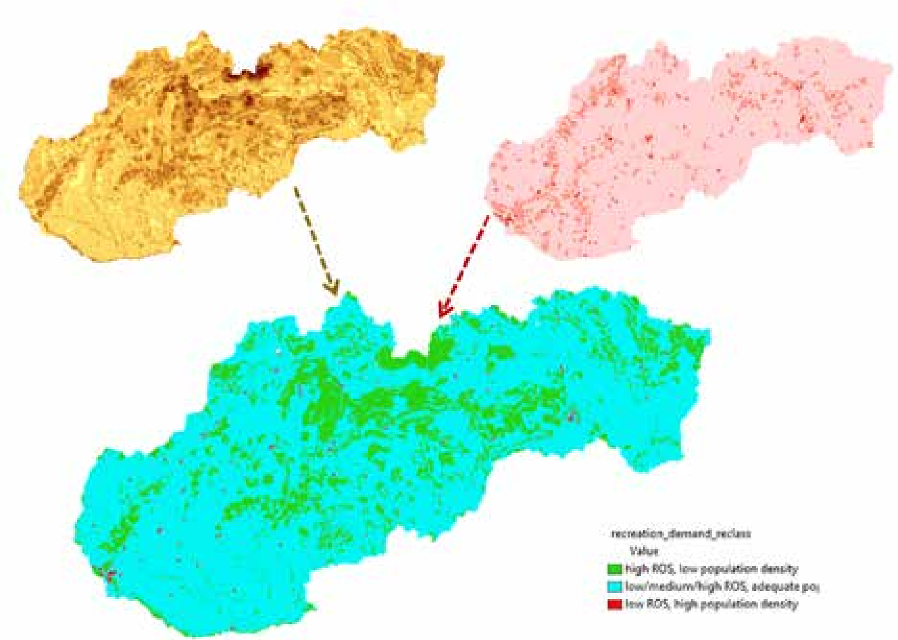


Figure 9. Demand for cultural ecosystem services based on recreation opportunity spectrum and population density in Slovakia (draft version only, constrained data).

4. Estimating economic value of cultural services: Pilot study on benefits from cultural services provided by natural city park in Bratislava

Economic value of cultural ecosystem services (CES) has been estimated in Horský park protected area (PA) by applying the method of contingent valuation, using moderated interview survey and online survey as data collection tool. The results of the survey conducted in early 2015 provided a better understanding of visitors' preferences in regard to the provision of cultural ecosystem services provided by Horský park and their willingness to pay for maintenace and support of park´s services. From the data collected via survey, we were also able to investigate possible correlations between overall willingness to pay in any form and income groups and, level of education and frequency of visits.

In regard to monetary payments, we can conclude that methods of collecting finances on voluntary basis (e.g. contribution) have much more potential in terms of real world application, although real net income would be most likely lower than mandatory forms of payment such as tax or entry fee.

Entry fee and tax implementations as methods of monetary payments have proven to be difficult to execute, for reasons of their infringement of public space status, infringement of law, philosophical incompatibility, overall unattractiveness of the concept in eyes of general public, and various legislative and technical issues. We do believe though, that that payment collection through levies is viable, but challenging and requires broad public discussion on this matter as it is more a question of societal agreement on management of common goods rather than question of management recommended by scientific findings. Our research can be therefore considered preliminary in this context and results of WTP by tax adjustment can be used to fine tune future research in this regard. Concluding this paragraph, we believe that in order to maximize potential of financial support for urban greenery (in our case, achieve total combined value of 13 677 351,84 EUR annually), it is necessary to cooperate on all levels of government and civil platforms alike.

Study area

Horský park is located in Slovakia, almost in the centre of Bratislava, the capitol of Slovak republic. The Old Town is characteristic by the presence of the oldest city structures, most premium level of real estate and is considered to be the most authentic part of Bratislava. Horský park is located in north-western part of the Old Town. Officially there are 9 entrances to the park form all directions, however the area is not gated or fenced and it is possible to enter through other unofficial entry points. Gravel and compacted soil trails cross through the forest and for the most part are not accessible to disabled visitors. Total area of PA Horský park is approximately 230, 000 m^2. Horský park emerged as spatially defined recreational area in 1868 with support of then-mayor of Bratislava Henrich Justi. In 19th century the area of park consisted largely of natural, indigenous oak and beech forest, but more tree species such as pines, ashes and chestnuts were also present. At that time, many trees in that area have had several centuries of mostly undisturbed growth behind them already. The area of the park itself was transformed essentially by modification of pre-existing forest area, modelling of surroundings and inner pathways, creation of visual connections through alleyways, building access roads, planting of decorative flora and equipping the park with 50 elements of small leisure architecture. The trail network plan was developed on behalf of mayor Justi's initiative and later on, in 1873 children's playground was built. Development through late 19th century and early 20th century consisted mostly of increasing number of decorative and leisure-oriented accessories such as benches, bird feeders and birdhouses, and small artefacts of metal accessories, but also larger structures such as observation tower. In 1907 25 panels with poems written by national poets were set up on display through the park (Enviroportal, 2007, NHP, 2008, Reháčková, 2009). Authorities did not fail to recognize the unique natural value of the park, popularity among residents, particularly local youth and students, as well as potential for short-term recreation of city dwellers an the park has since 1986 the status of a protected area.

Relevance for providing ecosystem services

In Central Europe microclimatic differences between highly developed city centres and areas of urban greenery are mostly visible in air temperature measurements, which may oscillate between 1,5–3°C during a typical summer day. On extreme hot days these differences may be even greater and climb up to 8–12°C (Supuka, 2007). According to aerial termovisual measurements done in 2007 during a typical hot summer day, the temperature in Bratislava Old Town hoverred around 38 °C. This is not surprising since it has a high density of built environment. On the same day, the temperature measured in Horský park was 30 °C. This is not a co-incidence, since a dense oak-hornbeam forest is coverring 90 % of the park´s area (Hudeková, 2011). The parks´ forest cover has proprieties which are help mitigate the local climate, nevertheless the park substantially contributes also with cultural services available to dwellers beyond the borders Old Town district.

Over decades, small elements of cultural landscape have found their way into natural domain of Horský park. Cultural features of the park include not only physical artefacts of anthropological origin but also spatial characteristics allowing and supporting certain social/cultural activities such as recreation. The trails in the park are non-paved, what allows a safe and forest-like experience for visitors. Wooden and metal footbridges allow moving through marshy areas and cross the streams. Nevertheles none of the trails within park can be considered safe for disabled visitors because of unsuitable terrain, often insufficient width and sometimes very steep gradients of elevation. Numerous resting places, most often benches of varying age, support visits of longer duration and different types of spiritual activities (contemplation, meditation) reading books, artistic activities etc. Use of this (and some other) equipment may be limited during winter months. Historical references are usually represented by surrounding architecture as well as some elements of artistic tributes to past events. Several of these art instalments (sculptures) can be found throughout the park as well as the Horský park gallery (adjacent to the park), infrastructure supporting education such as information panels dedicated to local flora and fauna, nearby cultural and historical sites and former historical buildings, information about environment protection, etc. A range of mostly individual or small group sports can be practised in the park, most popular being running and cycling, exercises of gymnastic character are encouraged by small fixtures near Gamekeeper's house. Social aspects of life in Horský park are supported by enclosures allowing social interaction throughout the year, most importantly Gamekeeper's house serving as headquarters of Horsky Pard Foundation (HPF) and coffee house "Horáreň" as well as a community house. Majority of cultural events such as movie theatre, dancing classes, thematic discussion evenings, mother's club, garage sales and local markets, sport events, etc., take place in these public enclosures, providing a platform for community interaction and promoting principles of civil society.

Considering the trail density, minimal architecture instalments, artefacts of cultural value and preserved historical heritage, we can assume that all parts of park allow for full range of cultural experiences such as visual or spiritual stimulation and aesthetic experience, education, recreational activities and social activities supported by places of gathering and social events & volunteering.

Nevertheless, the park is struggling to keep the current level of quality for ecosystem services, since it is under severe threat by erosion and vegetation trampling, vandalism, urbanisation and lack of financial resources. Currently the volunteers of the HPF spend dozens of hours working to maintain and enhance the parks environment. After discussion with the relevant stakeholders of Horský park foundation, we have designed a survey to determine the economic value of cultural services of this historical park.

A total of 113 questionnaires were submitted during period of data collection between February and March 2015. Out of total amount of questionnaires, 74 % were collected by moderated interviews with park visitors and 26 % were submitted through online survey. Several online submissions had to be formally corrected at the level or result table solely for purposes of data processing and automation of interim result production. Most of these errors were trivial in nature, e.g. entering values in words (strings) instead of numbers (integers). Field requirement settings did not let respondents submit only partially filled forms.

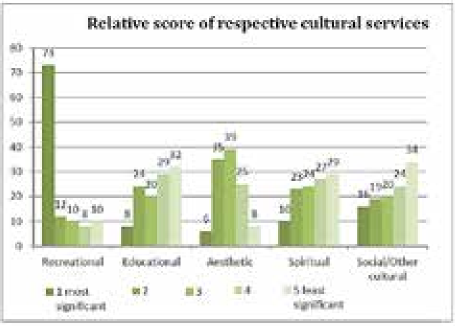
The most often performed activities within Horský park are, unsurprisingly, recreational and rehabilitative walks within natural environment: approximately 60 % of respondents use the park's infrastructure for recreational walking, often parallel to other activities such as coffee house session (almost one third of respondents), drawing or enjoying aesthetic properties of the area or spending time playing with children. Among recreational activities the majority mentioned sport related actvities, such as running, cycling and performing other sport-related activities. A significant amount of respondents (one fifth) mostly like to walk their dog.

Other activities such as attending cultural events, education (through installed panels and other means), and philanthropy were the least sought after. Several respondents opted for category of “Other”. These individuals described their activities in the park as “spiritual activities”,” usually engaging in some way with the community centre Horáreň, dog training or taking photographs.

Next, we asked the respondents to value 5 subcategories of cultural ecosystem services (CES) by using a scale from 1 to 5, where 1 meant highest significance to respondent and 5 equalled lowest level of significance. These values were weighted, calculated for their average score to determine overall received score (Table 3). Figure 8 shows absolute score numbers and relative ratios of CES available for subjective appraisal by respondents.

Group of cultural service	Value					Average weighted score (lower is better)
	1 (most important)	2	3	4	5 (least important)	
Sports and recreational	73	12	10	8	10	1,85
Educational	8	24	20	29	32	3,47
Aesthetic	6	35	39	25	8	2,95
Spiritual	10	23	24	27	29	3,36
Social/Other cultural	16	19	20	24	34	2,95

Table 3. Total score and average weighted score of cultural services (Source: Zoľák, 2015).



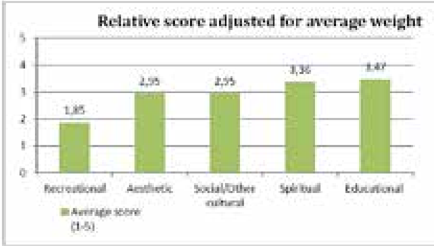


Figure 10 & 11. Relative score of respective cultural services, relative score of cultural services adjustedfor average weight (the lower the more significant to the respondent).

Results for subcategory of “Sports and recreational” cultural services are quite convincing, demonstrating that this category accumulated the largest number of votes (73) with value 1 assigned. This subcategory has also proven to have the most cohesive scoring pattern with 64,6 % of votes attributed to one value. Overall average weighted score for “Sports and recreational” cultural services subcategory is 1,85 making it the most valued subcategory of cultural services (Figure 10 & 11).

Subcategories of “Spiritual” and “Educational” take 4th and 5th place with overall score of 3,36 and 3,47 respectively. These subcategories are not too distinctive in cross-comparison but interestingly neither of them has received the highest amount of value 5 scores which were assigned to subcategory of “Social/Other cultural”.

In conclusion, recreational activities lead the preference survey in both groups of ecosystem service preference and in activities preference. Differences among other groups are more subtle, except for educational type of activities which seem to lack in popularity.

Pilot study visitors willingness to pay (WTP) for enhancing the provision of cultural ecosystem services in Horský park

Five different payment schemes were introduced to the respondents and thereafter assessed, where one of them was dismissive and remaining options were affirmative with further divergence to non-monetary and monetary options of payment (Figure 10). Approximatelly one fifth of respondents rejected the thought of any form of payment for ecosystem services in Horský park. The most prominent argument against payment was their personal conviction backed up by arguments like: a) ES should not be monetized, privatised and/or commoditised; b) Horský park is a public area within city limits with unrestricted access, analogous to plazas or squares; c) visitors already pay for management of this area through taxation.

The majority of respondents (33,33 %) would be willing to contribute in other than monetary terms – through voluntary work in the park. Minimum bid submitted was 2 hours. Maximum entered value of 2500 hours of voluntary work annually. Nevertheless this value was excluded in further evaluation. Instead, second highest value (300) was used for further calculations. 27,91 % of respondents would be willing to contribute via a voluntary one-time donation to park´s foundation. Average value of monetary tributes rounded up to 18,1 EUR, nevertheless a dononation of 10,00 EUR was the most popular choice among interviewed visitors. Thanks to no limits on both lowest and highest possible bid, collected values ranged from symbolic minimum of 1,00 EUR to more generous contributions up to 75,00 EUR. Reflecting on (Hanley, et al., 1993) we have not encountered any protest bids in this category. 10,85 % of respondents would prefer payment by entry fee every time they visit the park. The bidding bracket was limited by minimum value of 0,10 EUR and maximum of 5,00 EUR with 0,10 EUR increments. Average value of entry fee is 0,93 EUR, most often submitted value was payment of 1,00 EUR. Minimum and maximum fee were 0,50 EUR and 2,00 EUR respectively. The respondetns were offered choices related to maximum tolerable tax increase per year (5, 10, 15 and 20 EUR). 7,75 % of respondents opted for this payment method. Both modus and average yearly tax increase expected from this group of respondents is 12,50 EUR. Minimum and maximum values have been determined by limited choice at 5,00 EUR and 20,00 EUR respectively, however no respondent opted for value of 5,00 EUR (Table 4, Figure 12).

Out of 113 total respondents, 12,39 % were willing to contribute by more than one method of payment, but none of them selected more than two methods. Comparing this data to share of people willing to contribute in at least one way, we see that this percentage changes to 16,09 %. Out of those 14 parallel contributors, 12 chose a combination of voluntary work and financial aid, and 2 respondents chose 2 methods of simultaneous financial payment.

	Daily entry fee	Voluntary donation	Tax adjustment	Voluntary work
Number of respondents	14	36	10	43
Mean value	0,93	18,11	12,50	92
Modus	1,00	10,00	12,50	20
Standard deviation	0,43	19,03	5,40	378,66
Minimum value	0,50	1,00	5,00	2
Maximum value	2,00	75,00	20,00	2500

Table 4. Visitor willingness to pay by payment method (Source: Zoľák, 2015).

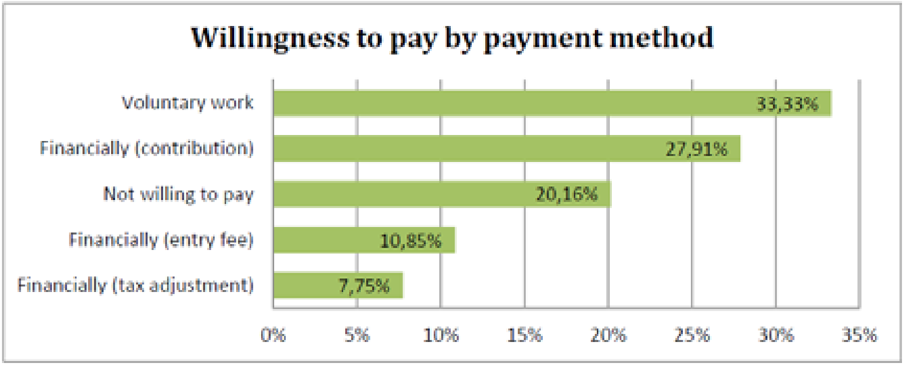


Figure 12. Preference of different payment methods (Source: Zoľák, 2015).

Total value of cultural ecosystem services (CES) in Horský park was determined by cumulative calculation of partial values. Partial values were calculated predominantly on basis of mean WTP values of respective subcategories (monetary and by voluntary work) and constants valid for every category of CES. Other variables and constants entered equations as needed depending on specific conditions and needs, e.g. minimum hourly wage for voluntary work value estimation or total number of adult visitors per year. Some estimates had to use modified constants or variables depending on logical requirements implicit for hypothetical implementation. This was particularly apparent in the case of estimating economic value based on method of entry fee; it was necessary to account for full number of visitors instead of visitors willing to pay by entry fee, because in the event of implementation, 100 % of visitors would have to pay to enter, regardless of the fact that only 10,85 % of visitors preferred this payment method according to the survey results.

Formula for calculating annual economic value (V1) consisted of total sum of partial values obtained from calculations for voluntary work, contribution and entry fees. Result for V1 total economic value of cultural services is 13,558,137.46 EUR per annum. VVWK stands for the economic value of CES based on payment method of voluntary work, VENF is the economic value based on payment method of entry fee and VCTB is the mean visitors' willingness to pay by method of contribution to park foundation.

$$V_1 = V_{VWK} + V_{ENF} + V_{CTB}$$

$$\mathbf{V_1 = 13\ 558\ 137{,}46\ EUR}$$

Formula for total value annual economic value V2 calculation is identical to formula for V1 with addition of VTAX value, including all four partial value calculations. The grand total of V2 was estimated at 13 667 351,84 EUR per annum, where VTAX is the value based on payment method of tax adjustment.

$$V_2 = V_{VWK} + V_{ENF} + V_{CTB} + V_{TAX}$$

$$\mathbf{V_2 = 13\ 677\ 351{,}84\ EUR}$$

From the perspective of correlating variables, there is aslight correlation between income groups and overall willingness to pay in any form, especially by tax adjustment, never the less there is no significant correlation between willingness to pay and level of education; frequency of visits and willingness to pay. Overall popularity of payment by contribution needs to be capitalised upon, in order to increase potential for environment improvement. Although real gains would most likely differ from our estimates of 622,006.89 EUR annually as this is an estimate of maximum value, compared to current bulk of finances available for HPF the benefits could be significant. Empirical experience from our survey shows that many people visiting the park do not think about the value of park or understand it in the context of ES provider on a regular basis. It was often our direct approach during survey that encouraged them to contemplate the value of services they consume during their stay and this has very likely had an impact on their WTP because they provided the grounds for payment justification to themselves. Proactive visitor approach combined with tools designed for visitors to internally examine the benefits and value of (C)ES might be an acceptable way for park caretaker to increase the streams of funding, educating the visitors and increasing their capital in parallel.

5. Conclusions

Global interest in environment protection is very high, but value of ES only slowly evolves beyond resource-based perception of value. In our study we demonstrated potential of integrated index of recreational opportunity spectrum and accessibility to provide potential of cultural ecosystem services on national scale in physical terms.

Application of indirect valuation method to estimate total economic value of cultural services of city park has been employed to demonstrate the role of funding in ecosystem service governance. Substantial investments are often insufficient, due to diversity perspectives of investment return. Lack of policy support in this regard allows for profits to be made easier and quicker by collecting resources or developing the land for recreation. Survey provided evidence that cultural values represent important compoment of visitors experience and are seen as a part of ecosystem value of urban park. Responent valued recreation, education as important ecosystem service that support nature related services and functions such as biodiversity and climate regulation. The framework for volunteer work in Horský park has been already laid out by Horský park Foundation (HPF) which has been in charge of park management for the past 20 years and is exercised daily within Horský park. Survey results show that one third of respondents would support this form of payment for ecosystem services, which is indeed the most popular option of payment among park visitors and economic valuation of this potential shows second largest potential in terms of financial value. The benefits of volunteer work are truly indisputable in economic terms and even more so in social terms and timulus for cooperation, aearenes rising and shared responsibility. Community life also benefits from organized events aggregating people willing to participate in volunteering for the park and works as a tool of social cohesion on local level. There are many interchangeable sources of finance available for tapping into, but human resources will usually be local, as shown by outcomes of our research.

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Managing Urban Landscape: The Use of Agent-based Models

Peter Baus,[1] **Urban Kováč,**[2] **Tatiana Kluvánková Oravská,**[2] **Jozef Komornik**[2]
1: Institute of Forest Ecology, Slovak Academy of Sciences
2: Faculty of Management Comenius University, Odbojarov 10, 820 05 Bratislava 25
4: CETIP Network

1. Introduction

Although urban areas make up a small proportion of the land surface area (EEA, 2010) they cannot be ignored as urban growth causes more dramatic changes in environmental conditions than other land-use changes (Kong et al., 2012; EEA, 2006; Lambin et al., 2001). Persistent rapid urbanization is associated with loss of biodiversity, landscape fragmentation, depletion of natural resources, increasing demands on transportation infrastructure and general enhance in system entanglement. Looking on these huge scale urban systems and their environmental problems arising from urban development we have started to think about them as a complex system (Batty, 2005) and realized their spatio-temporal dynamics. Analyzing the urban development process and then using appropriate management strategies that aid sustainable urban development is one of the most important ways to address the environment problems arising from urban growth (Fang et al., 2005; Haase and Schwarz, 2009; Jaeger et al., 2010). Monitoring urban change implies taking account of the extent and location of current and future changes. Remote sensing represents a major, though still under-used, source of current and historical urban information by providing spatially consistent coverage of large areas with both high spatial detail and temporal frequency (Cowen and Jensen, 1998; Donnay et al., 2001). With increased availability and improved quality of multi-spatial and multi-temporal remote sensing data as well as new analytical techniques, it is now possible to monitor and analyze urban expansion and land use change in a timely and cost-effective way (Yang et al., 2003). Remote sensing is relevant for identification of amount of land use changes as well as location of the changes (Weber, 2003). Precise remote sensing data could be used to quantified spatial landscape properties by using a set of metrics (McGarigal et al., 2002; Li and Wu, 2004; Martinuzzi et al., 2007) but also for modeling approach (Weber, 2003; Batty, 2005; Crooks et al., 2012). Spatial metrics characterize quantitative but also qualitative attributes of urban elements (Herold et al., 2003). In this context, spatial metrics can be a very valuable tool for planners who need to better understand and more accurately characterize urban processes and their consequences (Weber, 2003; Herold et al., 2005; Kim and Ellis, 2009). In fact, in the last ten years, it has been increasingly used to study the spatial characteristics of urban processes (Herold et al., 2003, 2005; Berling-Wolf and Wu, 2004), namely the spatial characteristics of urban patches, including their size, shape, and spatial distribution.

Association between spatial characteristics of urban landscape and urban growth was confirmed by several researches (e.g. Berry and Minser, 1997; Alberti and Waddell, 2000, Berling-Wolf and Wu, 2004; Alberti and Marzluff, 2004). Spatial metrics as a tool for quantification of the spatial characteristics of urban landscape could be used for territorial planning regarding urban growth in metropolitan areas in central Europe. These metrics allowed us to determine the spatial patterns and characteristics generated by the urban processes using remote sensing and GIS tools. Interpretations of data obtained by this quantification procedure enable description of the processes driving the change of spatial patterns. Statistical approaches can readily identify the influence of independent variables and also provide a degree of confidence regarding their contribution. Interpretation and understanding of spatial-temporal processes of urban dynamics provided by statistical analysis is essential for defining of urban growth driving forces and prediction of future urban pattern. This is a knowledge that could be used in the spatial planning process for building models providing optimal arrangement of landscape elements in the available space (Briassoulis, 2000; EPA, 2000; Weber, 2003). In the spatial planning practice in Slovakia, such models are not used except of models for transportation networks optimalization. Creation of urban management tools is a complicated process involving huge amount of data and high number of participants during whole process. The result of this process is spatially determined restriction of future land use including regulation limits. Due this fact, spatial model intended for urban management improvement must fulfill the basic requirements: (1) Model has to be built on existing data available during planning process; (2) outputs of the model has to be simple, due to involvement and participation of citizens; (3) model has to produce spatially allocated forecasts. A good model examines the whole landscape, has spatially accurate data, is broadly available for usage in regional or city planning, assesses urban growth in all areas, is based on historical data, and is consistent over time (Theobald, 2001).

Figure 1. Location of the study area within the Slovak Republic

The current shape of the city of Bratislava is obviously driven by a variety of factors, including topography, configuration of transportation networks, planning decisions, and natural resources such as Danube River. These factors interact in complex ways to form the current urban boundary. Thus, the first requirement of an urban regression model is to quantify how current spatial pattern of the city influence the future development. The second requirement is to predict these changes in urban boundaries.

The global purpose of this study is the understanding of the relationships between spatial pattern of the landscape and urban dynamics trends. The paper describes how proximate surrounding of transition areas affects their shifting process and how these formulas could be used in development of PCA model. We operated with hypothesis that proximate surrounding of particular area in the landscape affects (or indicates) probability of its change.

2. Methodology

2.1 Study area

Bratislava is the capital city of the Slovak Republic. Its area is 36 759 ha and the number of inhabitants is 428 672. The town is situated on both sides of the Danube river. The relief of the town is quite dissected. The northern part extends to slopes of the Malé Karpaty Mountains (altitude 162−559 m). The southern sector is of a lowland character; it is a part of the geographical unit of the Podunajská nížina lowland with altitude reaching 200 m above sea level. The city in its present form is a result of linking its historical centre with the surrounding villages. Studied area (Fig. 1) was selected according to the administrative division and consisted of 36 cadasters (cadastre = basic territorial unit) including city of Bratislava (19 cadasters) and surrounding villages (17 cadasters).

2.2 First mapping level

Existing aerial ortophotomaps of two periods – 2002 and 2011 – were processed. These data were used to capture the land use information and its change over time. Data processing was executed in ESRI ArcMap 9.3 environment. The process resulted in creation of two vector polygon layers on the scale of 1:10 000 capturing the land use of the landscape (Fig. 2).

The land use categories were created by manual interpretation of orthophotomaps in the ArcMap environment. In these maps, 3 thematic land-use and -cover categories were obtained:

Built-up area: housing, industry, commerce, transport including city parks, untapped spaces between buildings, etc.

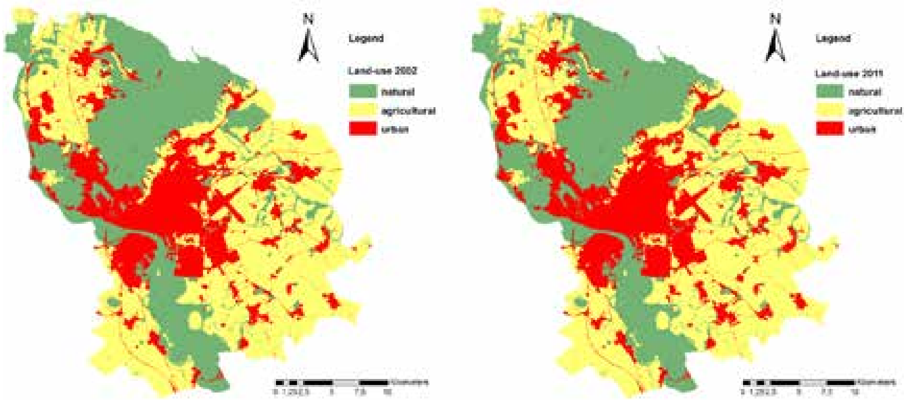

Figure 2. Land-use of study area in years 2002 and 2011

Natural area: forests, shrub areas, grasslands, water bodies, bare soil, rocks, etc.

Agricultural land: croplands, including cereal crops, vegetable crops, vineyards and fruit orchards.

The interpretation of 2011 data was made by taking the interpreted vector data of 2002 as the baseline. The identification of the changes in boundaries and/or the changes of land use included two parts. First stage was the creation of two vector layers themselves and then the layers from different years were overlaid in GIS. By means of map overlay in GIS environment we were able to determine a list of areas converted in the given time frame. In the next step we described the attributes of each area by: area position, perimeter, size, initial land-use type, target land-use type and real land-use composition of the area spatial buffer. Together, we identified 170 areas where land-use has shifted from agricultural or natural to urban use. We operated with hypothesis that areas, which have changed to similar land-use type, are going to have similar spatial patterns. These patterns create initial attributes that affect the transition process. We have divided the transition areas into two main groups. First main group consisted of areas that have changed to rural or urban housing (137 areas). Second group included areas that have changed to industrial areas, storage houses, agricultural or commerce buildings (29 areas). Average surface size of each transition area was 39 120 m^2. We established relationships between these spatial patterns and processes described above and distinct urban growth. These patterns were characterized in terms of form, size as well as type of land-use (Galster et al., 2001; Song and Knaap, 2004).

2.3 Second mapping level

Within the analysis process we considered Tobler's first law of geography which indicates that „everything is related to everything else, but near things are more related than distant things" (Tobler, 1970). Following this note we regarded the nearest land-use coverage as the most significant factor that might drive (or at least indicate) the transition process. Spatial buffer of 10 and 200 meters for each transition area was created (Fig. 3).

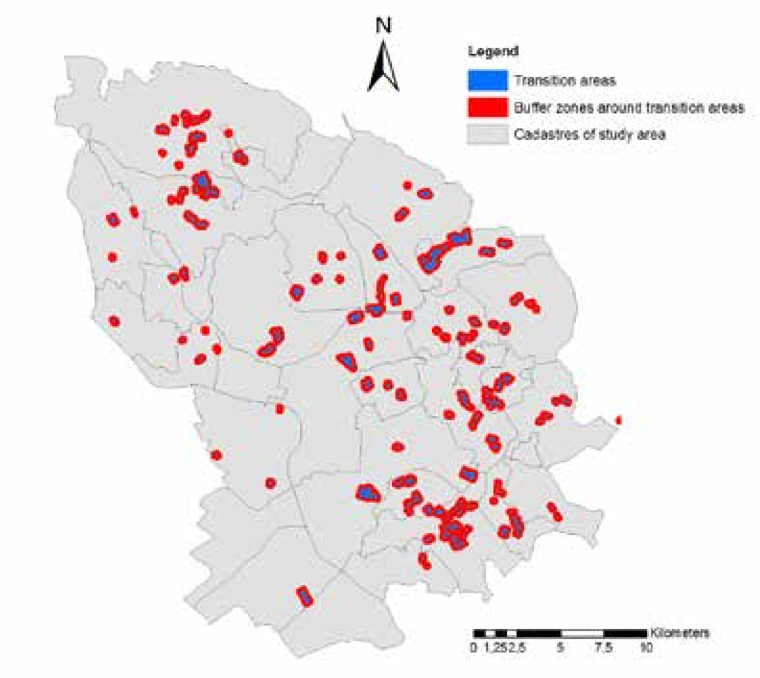

Figure 3. Areas of land-use change between years 2002 and 2011 with their 200 m buffer zones

Then we mapped land-use in these buffers and calculated area coverage (in %) of each land-use type. The mapping of the spatial buffers in GIS environment was based on data from ortophotomaps with scale of 1:2 000. We recognized 8 land-use and -cover types and their subtypes. Nomenclature is based on land-use types occurring in the study area and multiple papers mapping land-use in the same area using small-scale ortophotomaps.

Level 1	Level 2	Description
1. Native forest and bush		forests species or shrub areas with bushes between 10 and 100 %
	1.1 Broadleaved woodland	
	1.2 Small-scale woodland	
	1.3 Alleys	
	1.4 Forest narrow ride	
	1.5 Tree lines	
	1.6 Bush lines	
	1.7 Urban park	
	1.8 Small-scale bushland	
	1.9 Waterside vegetation	
2. Grasslands		herbaceous plant communities with less than 50 % of forest and bush cover, including fallow land.
	2.1 Grassland	
	2.2 Unmanaged grassland with high amount of succession vegetation	unmanaged grassland with 10–50 % of forest and bush cover
	2.3 Unmanaged grassland with small amount of succession vegetation	Unmanaged grassland with less than 10 % of forest and bush cover
3. Agricultural land		croplands, including cereal crops, vegetable crops, vineyards and fruit orchards
	3.1 Arable land	
	3.2 Horticulture	
	3.3 Small-scale arable land	
	3.4 Orchards	
	3.5 Vineyards	
4. Bare soil and rocks		
	4.1 Mineral workings and quarries	
	4.2 Sand quarries	
5. Water		rivers and lakes
	5.1 Water courses	
	5.2 Water bodies	
	5.3 Gravel field	

6. Housing and recreation		
	6.1 Individual residential buildings	
	6.2 Recreational buildings and objects	
	6.3 Educational buildings	
	6.4 Rural type residential buildings	
	6.5 Private small-scale gardens and horticulture	
	6.6 Cemetery	
	6.7 Urban type residential buildings	
	6.8 Religious buildings and objects	
	6.9 Hard areas without buildings	e.g. squares, parking areas
	6.10 Public services and facilities objects	
	6.11 Zoological and botanical gardens	
7. Industrial and technical areas		
	7.1 Industrial objects and areas, storage houses	
	7.2 Agricultural objects and areas	
	7.3 Agricultural middens	
	7.4 Constriction sites	
	7.5 Water managements objects	
	7.6 Other technical objects	Brownfields, etc.
	7.7 Wastewater treatment plant	
	7.8 Landfill waste disposals	
8. Transportation		including roads, streets, highways and railways
	8.1 Motorways, highways and primary roads	
	8.2 Non-primary roads	
	8.3 Streets in urban areas	
	8.4 Other paved roads	
	8.5 Other unpaved roads	
	8.6 Railways	
	8.7 Tram rails	
	8.8 Transportation areas and objects	

Table 1. Land-use and -cover nomenclature

2.4 Statistical methodology

The data is consisted of 170 transition areas obtained from GIS modeling. For each transition area we identified its size in square meter, its perimeter in meter, the type of landscape pattern change and the size of each adjacent area in square meter. Adjacent areas of the each transition area were divided into 8 main groups, shown in Table 1 – level 1 (Native forest and bush, Grassland, Agriculture, Bare soil and rocks, Water bodies, Housing and recreation, Industrial and technical areas, Transportation). In this study, the each adjacent area of the respective transition area unit is denoted as 8-dimensional Euclidean space vector in which each component represents the ratio of the given group of adjacent area to the total adjacent area. Finally, we identified 6 groups (1, 2, 3, 6, 7, 8 according to Table 1) to be significantly present in statistical analysis. We found out that groups 4 and 5 have neglected ratios for each transition area. The transition areas have been afterwards split up into 2 clusters. The first cluster represents landscape changes from any type of land-use to landscapes 6.4, 6.7 and 6.10 (see Table 1). The second cluster represents areas changes to 7.1, 7.2, 7.4 and 8.8 (see Table 1).

The comprehensive statistical strategy is applied to this problem. Firstly, we carried out the exploratory statistical analysis such as principal component analysis (PCA) in order to identify the reduced number of dimensions for further statistical analysis. The reason of PCA is to represent the cloud of multivariate points in a space with reduced dimensions by distorting the distances between individuals as little as possible. Components in PCA are obtained through singular value decomposition of the correlation matrix which extracts the associated eigenvectors and eigenvalues. Each eigenvector (ui) is associated with respective eigenvalue (λi). Eigenvalues are ranked in descending order (e.g. λi is rank i). The eigenvalue λi represents explained variance for the component of rank s. In other words, PCA recreates an original basis to new basis in which instead of n variables, k principal components (k should be less than n) which are linear combination of them is used to account for variance-covariance structure. In this study, PCA might change the original 6-fold dimensional space basis to the new basis in which the first principal components will play an important role in order to explain the relationship between former variables.

3. Results and discussion

Groups represented by first two principal components obtained from PCA are shown in Fig. 4. PCA results are summarized in table 2. First two components have inertia greater than 1 and summarize 53.67 % of total variance of landscape data cloud. The significance of first two dimensions has been evaluated with the following statistical test. The cumulative percentage of variance by first two principal components is compared with 0.95-quantile of the distribution of the percentages obtained by simulating data tables of equivalent size on the basis of a normal distribution. We construct the following test where H_0 is defined as the inertia explained by the first two principal components is not significantly different than inertia obtained from independent normally distributed data [1].

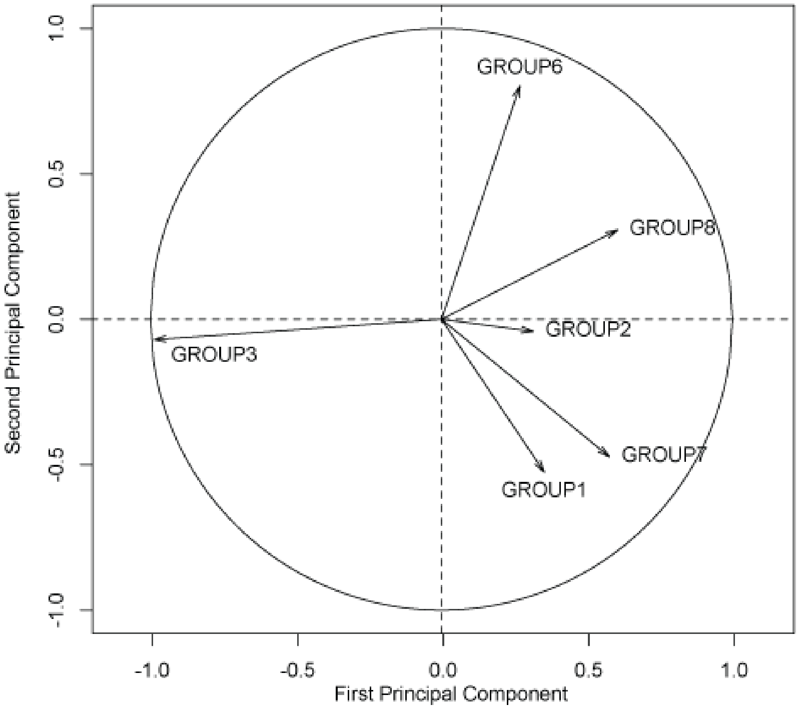

Figure 4: Groups of level 1 represented via first two principal components.

	eigenvalue	percentage of variance	cumulative percentage of variance
PCA1	1.97	32.89 %	32.89 %
PCA 2	1.25	20.78 %	53.67 %
PCA3	1.04	17.32 %	70.99 %
PCA4	0.97	16.18 %	87.17 %
PCA5	0.77	12.83 %	100.00 %
PCA 6	0.00	0.00 %	100.00 %

Table 2: The PCA results correspond to the eigenvalue (the inertia or the variance explained) associated with each of the components; the percentage of inertia associated with each component and the cumulative sum of these percentages.

According to Table A.3 in (Husson et.al, 2010) this quantile obtained for 100 individuals and 6 variables is worth 44.9 %, the percentage of given data is 53 % obtained from 170 individuals which is higher, but percentages from table A.3 in (Husson et.al, 2010) are decreasing with increasing number of individuals. It indicates that the first plane expressing a significant structure in the data. This PCA analysis should be based on first three principal components since the third component inertia is also greater than 1 and first three dimensions explains almost 71 % variance of landscape data cloud.

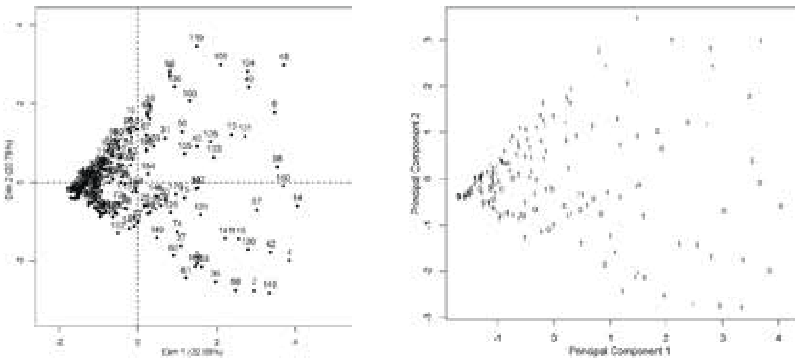

Figure 5: The left scatter plot shows dependence of first two principal components. Data points are labeled with assigned number for each transition area. The right scatter plot illustrates the same dependence but data points are labeled with the respective type of transition.

The left Fig. 5 illustrates the scatter plot between first two principal components with numbered transition areas. The transition areas for example denoted with numbers 4, 14, 150, 88, 6 and 48 have very different adjacent areas ratio vector compared with transition areas located in the dense data cloud in the left figure part. The right picture of Fig. 5 has shown the same dependence structure but data cloud points is labeled with type of transition change. It indicates that change type zero is likely to occur if transition area is located outside the dense cloud on the left part of the picture. Graphical analysis might be clarified with Fig. 6 where the same cloud of transition areas is scatter with the third and the fourth principal component. Fig. 6 has shown that moderate and significant changes in both principal components values indicate the type of change is likely to be zero than one.

4. Conclusion

The general analysis of land-use change in the past 9 years shows that the built-up area increased by more than 6.65 km2 mainly from the conversion of agriculture land. In reality this amount is even higher despite of fact that our first level analysis included only limited number of land-use categories. In this paper, we integrate PCA model with spatial metrics and provide an innovative method for predicting the urban growth pattern. In order to pragmatically incorporate the regression model as software model tool, it needs to generate effective urban simulations consistent with GIS data inputs, outputs and related functionality. This enables to utilize the software model which might be incorporated as a plugin in GIS environment. Both GIS and statistical regression modeling might be used as the predictive tools in an urban policy decision making with better understanding of discrete non-linear urban dynamics and to ensure sustainable use of the land and protection of biodiversity in the urban ecosystems. The results obtained illustrate the usefulness of spatial metrics for metropolitan land use planning. Spatial metrics can thus be applied to monitor changes in urban growth patterns. Furthermore, they can also be used to estimate potential of land-use change. We can therefore conclude that spatial metrics are highly applicable to the study of urban landscape dynamics and processes. Exploratory spatial data analysis is able to discover the influence of each continuous variable but not systematic ranking.

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Managing Climate Change: Forest Commons for Well Being of Mountain Regions

Tatiana Kluvankova, Stanislava Brnkalakova

1. Introduction

Recently, significant political attention is focus on mountains. They were granted a chapter in the Agenda 21, United Nations action plan as outcome of Rio Earth Summit in 1992. The urgent need of policy action, new agenda and strengthening of the institutional framework in sustainable mountain development was already evident. Since then, numerous efforts were initiated independently at global, international and national level to promote sustainable mountain development. There is a progress in designing and attempts for implementing mountain particular strategies (Ariza et al., 2013). The specific role of mountain regions in the carbon cycle and their importance as carbon sinks within the broader debate about climate change has already been noted. The reason was the increased atmospheric concentration of carbon dioxide since 1750 by about 32 %, primarily due to the combustion of fossil fuels and land use changes. In global arena, the important Intergovernmental Panel on Climate Change in 1988 was established and with its efforts the Unites Framework Convention on Climate Change (1992) and Kyoto Protocol (1997) were signed aiming to reduce emissions in the atmosphere. Kyoto protocol is seen as a necessary step to get nations to take the threat of global climate change seriously. Since that this protocol is not legally binding, the penalty for non-compliance emissions targets of countries, that signed it, is ineffectual. In spite of incomplete percentage of Kyoto protocol success, there was anticipated that growing trees and increasing the amount of carbon stored in terrestrial ecosystems is more effective than reducing emissions of greenhouse gases by implementation of expensive technologies to decrease the emissions of existing industries. This statement creates new opportunities for adaptive management and underlines the importance of mountain landscape, pool of ecosystems with the ability contribute to the elimination of climate crisis (EEA, 2010; van Kooten, 2004).

Nowadays, mountain landscape faces unique global challenges but also offers opportunities for sustainable development. Mountains are the most vulnerable ecosystems to climate change caused by topography. The altitude and slope orientation to sun can easily disrupt their smooth functioning and bring live hazard, such as, frequent flooding, soil erosion or food insecure to local people as well as non-residents. On the other hand, growing debates about the significant meaning of mountains is caused by their ability to provide a range of ecosystem services to people – not only to the local residents of the mountains but also to people inhabiting the lowlands and cities. Moreover, mountains as one of the richest carbon sinks provide carbon sequestration – regulating ecosystem service and thus contributing to CO_2 mitigation. In addition, by carbon sequestration, that stabilize ecosystems, other global problems, such as loss of biodiversity, natural resources exhaustibility or land degradation could be alleviate or even solved (Ariza et al., 2013; EEA, 2010; Trumper et al., 2009).

In effort to mitigate global climate change, recognition of the need for intense transboundary and upstream-downstream collaboration has been recognized in policy action. In spite of big attention to climate change research have been paid and a lot of initiative at global, international,

national level were established, the capability of local natural systems – mountains was omitted in this issue long time. As a consequence of ineffective sectoral policies as well as unsustainable use of forests is degradation of mountains. To stop and reverse this negative change, the call for new integrative approaches to sustainable development that will promote humanity to live in harmony with nature has been identified in particular we concern common pool resource regime as susianble management and governance strategy to deal with global change. This paper determine robustness of forest commons regimes in Europe and sustainability under the global change. In particular we argue that robust common pool resources regimes (CPRs) in European forest are critical for sustainable forest Management and climate change regulation.

2. Climate Regulation In European Mountain Regions

The protection of existing carbon storages is the most important strategy for preventing the mobilisation of huge amounts of carbon that are held in the ecosystems. Such strategy is urgently needed because land use change has become very dynamic and conversions of great carbon sinks such as grassland into crop land or deforestation of forested land significantly contribute to global warming (von Haaren et al., 2012; Trumper et al., 2009). In the issue to mitigate negative impact of climate change, mountains play the crucial role. These ecosystems are the biggest terrestrial ecosystem sink of carbon secured by permanent vegetative cover represented in mountains mostly by forests and grasslands. Mountain landscape is not important just as domain provider of carbon capture and maintainer of carbon cycle but also for providing another ecosystem services and goods to many people – not only to the local residents of the mountains but also to people inhabiting the lowlands. Mountain regions supply half of the world´s population with freshwater, embody pools of cultural and biological diversity and are important tourist destinations, as well as resources of key raw materials (Ariza et al., 2013; EEA, 2010; EEA, 2014). Forests have key environmental functions important for human life. They safeguard our infrastructure and settlements by preventing landslides or avalanches in mountainous regions, as well as provide catchments and filtering for water supplies. This forest ecosystem also serves a habitat for a variety of plant and animal species but of course contributing to the conservation of biodiversity varies, depending, for example, on environmental conditions and management methods (Ariza et al., 2013; EEA, 2010; Lal, 2005). Second dominant land use type in European mountain regions – grasslands are not just significant carbon sinks but their permanent plant cover reduces the heating the surface which is important for water relations. They also provide regulatory functions such as prevention of wind and water erosion. These two dominant land use types in mountains are the source of livelihood of their inhabitants. Unfortunately, global situation is causing their destruction or even abandonment resulting in poverty of local communities inhabiting these rich biodiversity pools (Amezquiza et al., 2010; Dicks et al., 2013; Doxa et al., 2012).

In Europe, mountains cover 35 % of surface. Forests covering 41 % of the total European mountain area; pasture and mosaic farmland, especially in Central and South- Eastern Europe; natural grassland, heath and sclerophyllous vegetation, especially in the Nordic, Iberian and Turkish mountains are typical kinds of European mountains land cover. Arable land is the most common in Southern Europe. Unfortunately this great European biodiversity hotspots, the best providers carbon sequestration ecosystem service and the biggest part of carbon stock in terrestrial vegetation and soil, are currently facing many negative impacts. Mountains present the most vulnerable ecosystems to climate change caused by the altitude and slope orientation to sun that can easily disrupt their smooth functioning and bring live hazard, such as, frequent flooding, soil erosion or food insecure to local people as well as non-residents. Negative land use changes and traditional management practices abandonment even more contribute to their bad state (Ariza et al., 2013; Briner et al., 2013, EEA, 2014).

Positive predictions for European mountain regions in Elkin et al. (2013) says that the impact of climate change on the biophysical processes in cold mountains could underpin ecosystem services provisioning by increase the growth of forests, grasslands and also crops mainly at higher elevations where development is currently constrained by low temperatures. To facilitate these positive predictions to come true and contribute to rural development, well-being of local communities as well as all society, policy actions in ineffective sectoral policies related to the management and protection of mountains have to be taken. Moreover forest management with primary aim of maintaining healthy forests that provide for example protection from rock fall or alavanche hazards and not the harvested timber as primary source should be governmentally more supported. Moreover, destroying a natural forest that has been evolved over centuries cannot be replaced by a plantation, as policies related with climate change promote. Its ecological value simply cannot be compared with a forest with multiple ecological benefits. Grazing livestock on grasslands as effective extensive management practice still typical for this mountain landscape with vital role in local/regional production should also be backing more. In study of Amézquiza et al. (2010) pastures and silvopastoral systems were identified as economically attractive solutions to farmers and offer environmental services including carbon sequestration and recovery of degraded areas.

Finding the best sets of ways how to effectively manage mountains is still in a question. The first important step to find solution in this issue is to understand biological processes in these ecosystems and realize what factors affecting their ability to provide carbon sequestration. After that, recognition of land use changes in European mountain regions and loopholes in European policies is necessary. All these facts are investigated in following subchapters.

3. Forest as Key Mountain Ecosystem

3.1 Forest ownership evolution

Ongoing development in forestry policy and practice in Europe shows considerable differences in the understanding of forest ownership rights in both large-scale and small-scale forestry. Forest ownership is generally understood as the legal right to freely and exclusively use, control, transfer, or otherwise benefit from a forest. Ownership can be acquired through transfers such as sale, donation, and inheritance (EU,2011).

According to Schmithüsen and Hirsch (2008) almost 50 % of forest land in the EU is privately owned. They also highlight that the area of forest in private ownership in Europe has been increasing due to a number of factors. First in some countries, such as Ireland, successful afforestation programmes have resulted in an expansion of the private forest area. In Central and Eastern Europe the re-nationalisation and privatisation of forest land have (re) established small scale-forest ownership and also generated new ownership categories such as environmental associations and foundations. Furthermore, forest land is actively traded in the UK and some publicly-owned forest land is sold in Norway (Jonsson et al, 2013). In Sweden, state owned forest land is to be transferred to private individuals, in this case through the sale of 10 % of the forest land owned by the state owned company Sveaskog (some 300.000 hectares or about 1.5 % of the total commercial forest land in Sweden) by 2019 (Regeringen 2010).

The increasing diversity of forest owners has raised challenges for policy makers. In particular it has raised concerns about what management is being undertaken in private forests. It is not only in number and proportion that private forest ownership is growing, but also in terms of diversity, boosted by societal megatrends such as economic globalisation of agricultural and forest products, labour, demography and urbanisation. The most apparent and direct impact on the transformation can be attributed to the structural changes in the European agricultural sector in general and the family farming system in particular, as much of the small-scale forest ownership historically has been associated with small-scale farming (Hogl et al 2005). This connection is gradually dissolving, and is being replaced by ownership characterized by fragmentation (by sub-division of land and/or by joint ownership) and alienation due to little or no involvement in management of the forest and residing outside the forest property. This phenomenon is known as the growing share of "new" types of forest owners, distinguished from "traditional" forest owners by distance or economic relevance, such as urban owners, agro-users etc. Another view concentrates on differences between individual and collective ownerships, imlying need for different management approaches. Among them commons as resource regimes where property is shared among users and management rules are derived and operated on self-management, collective actions and self- organization is most refered property type. Collective action represent key variable for successful management. Yet, it has to be recognized that the "traditional forest owner" is not a fixed and unambiguous concept, but has to be understood in the light of the historical context of a specific region. There is a need for a more comprehensive and diversified description of "traditional and new forest owners" in particular in respect to optimal management.

3.2 Common Pool Resources

Common pool resources (CPRs or commons) are natural and human constructed systems that generate finite quantities of resource units and therefore the use of resource by one person is subtracted from the quantity of resource units available to others (Ostrom et al., 1994). CPRs are generally acknowledged as shared or common resources or as products of the environment and society that belong to everybody and that should be protected and maintained for future generations (Walljasper, 2010). The goal to prevent overusing of CPRs often requires necessary limitation of the access to beneficiaries. The process of their exclusion through physical and institutional means is repeatedly difficult and costly. Moreover, the edge between the degree of excludability and non-excludability within CPRs is complex. Examples of such CPRs include forests, grazing ranges, fisheries, groundwater basins or irrigation systems (Ostrom et al., 1994). CPRs used jointly are facing social dilemmas in which short-term interests of individuals are in conflict with long-term interests of society and thus make governance of the commons challenging field of economic research and policy (Kluvánková-Oravská, Jílková, Kozová, 2013). Traditional approaches to address these CPR dilemmas come from the theory of property rights in resource management that is originally understood as rights to sell and alienate harvesting rights (Demsetz, 1967). Over time a number of studies have been conducted and a full set of rights, including access, withdrawal, management, exclusion and alienation was identified within the ownership (Ostrom, 2010, Schlager & Ostrom, 1992). This new approach on property-rights regimes says that ownership is not the most important anymore but rather users´ rights and management rules in relation to resource management. In other words, not right to sell and alienate is crucial, but access, withdrawal and management are seen as vital rights in relation to find sustainable ways of natural resources use.

There is a question what is standing in the way to manage resources through these regimes that have the potential to solve the issue of resource depletion. The answer is institutional monoculture. Traditional approaches to resource management claim that only the state-centralized and private management can be effective guardian of sustainable use of CPRs. But there are disputes, based on numerous theoretical and empirical studies, providing the evidence that CPR regimes, optimal and robust property regimes, could be able to ensure balanced use and protection of the natural resources, as well as the provision of public goods (e.g. ecosystem services provided by ecosystems to society). In this way human well-being would be assured not just at local level, but also at regional or even state and global scale (Kluvánková-Oravská, 2013).

Many scientists (e.g. Holmgren, 2009; Prempl et al., in review; Poteete et al., 2010; Sláviková et al., 2013) claim that local users in CPR regimes are capable of crafting own rules that allow for the sustainable and equitable management of CPRs. Moreover, due to their self-organisation and self-management, CPR regimes are able to solve the resource management problems without external authorities. These regimes typical by transfer of knowledge, resources and institutions across the scales may potentially form a set of independent self-governed systems. Due to their institutional maturity, local knowledge, communication and trust, willingness of commoners to follow own established rules and monitor others increase more than when an authority simply imposes rules. These regimes are preconditions for the continuity of social-ecological systems and have the ability to resist natural and social disturbances, as well as to avoid short-term individual interests and to provide public goods in long term (Berkes and Folke, 1998; Ostrom, 1998; Poteete et al., 2010; Anderies and Jansen, 2013; Kluvánková – Oravská, 2013).

According Ostrom et al. (1994) 'understanding the conditions under which users of CPRs successfully develop and maintain effective institutions (working rules as institutions that are continually evolved, emerged and changed in direct correlation with action) is critical to facilitating improved resource policies. One of these conditions is collective action that is closely linked to individual interest. The concept of collective action says that individuals act primarily selfish, but if they are members of a group and it is reasonably profitable for them, they should act in accordance with collective interest (Bromley, 2006; Maco, Poklembová, Ondrejička, 2013). In other words, each actor pursues a different motivation and the motivations of individuals to act on behalf of their own interests are only rarely the same than the motivations of groups of individuals, which act on behalf of common interests. But on the other hand, in spite of the scarcity of altruism in collective action and tendency of actors in group to pursue the common goal only if the achievement of this goal improves their current situation, Olson (1965) has declared that if benefits are distributed only within actors in group, who have participated in collective action, then the risk of free-riding is reduced. Moreover he highlights that lower amount of actors in a group and selective incentives are crucial for making collective action possible. The size of group has significance in social relations as well as in financial matters. With rising number of actors in group, social interactions and relations decrease and this causes insecurity of self-identification of members with the group resulting lower willingness of individuals to adjust to common group preferences. The same inconvenient situation with bigger groups appears in financial affairs. While in small groups is smaller financial demand, in bigger groups it is exactly the opposite. These facts indicate that collective action has to concentrate in smaller groups within the indication of group´s resource dependence in order to reach both, common and individual benefits. These management frameworks of smaller self-organizing groups are more capable of establishing a working system. However, the most favourable group size has not yet been set.

As Dietz (2003) states, it is hard to identify a comprehensive framework that would guide all self-governing groups to work efficiently and correctly. Moreover, management system can be successful only if users themselves regard it as legitimate and equitable. The challenge also remains in creation of mechanisms that are robust to external effects. Ostrom (1990) has demonstrated with her eight design principles for robust institutions (in Table 2), that it is still possible to define some measurable guidelines for sustainable common-pool resource governance.

4. Forest commons

Forest commons in Europe are composed of particular set of resources, their users, institutions, and mutual interactions, adaptable to natural and social disturbances often in the absence of external authority. When management is carried out in common, further opportunities to learn come from issues of participation, collective decision-making and shared responsibility. Worldwide forest commons are providing a wide range of different arrangement between and even within countries. Hence, there are also different understandings of “forest commons” and “community forests” and related concepts such as “common (or community) ownership”, “common arrangements”. Following Schlager and Ostrom (1992) and our discussion collective forest property regimes are complex, as ownership refers to bundles of rights that together constitute resource ownership arrangements as described in Table 1.

Type of right	Function	Positions
Access	The right to enter the forest while do not subtract from benefits that others can enjoy, such as hiking in the forest.	Authorised viewers: have access rights, such as those that are purchased with entry fees as national parks.
Withdrawal	The right to harvest in the forest	Authorised users: have both access and withdrawal right, such as those that are acquired firewood gathering permit from a forest.
Management	The right to regulate use and transfer system by improvements	Claimants are authorised users with management rights such as building fences, investment.
Exclusion	The right to determine who has access and who can be excluded from using the property	Proprietor holds access, withdrawal, management and exclusion rights.
Alienation	The right to sell or lease any of above rights.	Owners possess all the rights of proprietors along with the right of alienation

Table 1: Bungle of rights applied in forest governance
Source: Schlager and Ostrom (1992)

Schlager and Ostrom (1992) indicates how these bundles are combined to a set of positions that individuals hold in regard to operational settings. For many resources, one can define five types of positions that people hold who have some type of a property right and obligations that are related to that right (column 3 in table 1). They identified the patterns of rights and outcomes and found that possessing at least the three rights (access, withdrawal, and management) has significant effect to self-organize. Proprietors increased their capabilities to control harvesting and can regulate use and investment thus made a substantial difference in regard to the long-term management. In many common-property systems that have been sustained over long periods of time, none of the resource users has had the right to alienate. This provides evidence that alienation is not the key in defining right for those who have been responsible for design and adapting common-property systems (Ostrom, 2008).

Processes of globalisation affect forest management performance by accentuate economy of scale; thus actors at global scales who are not embedded in local institutional arenas may challenging local institutions' ability to effectively govern forest resources and landscapes. Survival of forest commons under a new set of vulnerabilities depends on institutional capacity to learn and adapt to on-going changes and offers promising learning experiences. This relates to European community forests, traditional commons as well as newly constituted commons.

As Dietz (2003) states, it is hard to identify a comprehensive framework that would guide all self-governing groups to work efficiently and correctly. Moreover, management system can be successful only if users themselves regard it as legitimate and equitable. The challenge also remains in creation of mechanisms that are robust to external effects. Ostrom (1990) has demonstrated with her eight design principles for robust institutions that it is still possible to define some measurable guidelines for sustainable common-pool resource governance. Driving on the experience from European forest traditional and new commons we will provide cross country meta analyses to determine key variables that makes forest commons regimes robust and adaptable to survive in long term. Key issues to be addressed are formulated in Table 2 bellow:

1.	Define clear group boundaries (There are two defined boundaries: users boundaries – group of users, resource boundaries – deals with access provided by institutions as working rules)
2.	Match rules governing use of common goods to local needs and conditions (Principle underlines the need to adjust the defined rules with the existing superior and subordinate institutional environment in line with the principle of subsidiarity. It can be presented by existing legislatures, concerning planning and property rights, or social and environmental conditions. Second outcome of this principle is fair distribution of costs, the rules-in-use allocate benefits proportional to inputs that are required)
3.	Ensure that those affected by the rules can participate in modifying the rules (Individuals affected by a resource regime are authorized to participate in making and modifying their rules. Resource regimes that use this principle should be able to craft rules to fit local circumstances and to devise rules that are considered fair by participants. As environments change over time, being able to craft local rules is particularly important as officials located far away do not know of the change. Here are several key aspects – awareness of the space, use of local knowledge, the sense of being involved and proper exchange of information.)
4.	Develop a system, carried out by community members, for monitoring members' behaviour (Just trust and reciprocity among users to keep rule-breaking levels down is not sufficient and therefore monitoring as the fourth design principle is necessary. When local users monitor each other, resource conditions are better. However, the need to involve external monitoring facilities is crucial, in order to prevent potential failures and provide for effective outputs)
5.	Use graduated sanctions for rule violators (If rules are broken, sanctions have to be applied. This method could not just eliminate emerging disorders within the community, but also educate members instead of unreasonably punishing them. Moreover, identification of „free-riders" may help to sustain the qualities of resources.)
6.	Provide accessible, low-cost means for dispute resolution (If conflicts arise within the working framework, resolution mechanisms have to be in place to keep an undisturbed local arena. Emphasis has to be set on low-cost and simple solutions, which are flexible and comprehensive enough to face emergent and unforeseen clashes. Conflicts may originate within a community, among different communities or between a community and officials for reason such as for example an overuse of the resource. Finding a compromising solution can be sometimes a challenging task and the role of communication and information exchange again occur as important element.
7.	Make sure the rule-making rights of community members are respected by outside authorities (The condition for sustaining and development of effective regimes over time is their recognition by higher authorities, national and local government. Because if higher authorities presume that only they can make authoritative rules, then sustaining a self-organized regime is very difficult.)
8.	Build responsibility for governing the common resource in nested tiers from the lowest level up to the entire interconnected system (Scaling up or down the solutions for a sustainable management of a common resource is difficult and to have the capability to cope with this issue, governing solutions have to be nested in multiple layers at multiple scales.)

Table 2: Eight commons design principles of robust governance (Ostrom, 2008; Ostrom, 1990 – adapted by Walljasper, 2011)

Ostrom (2005) explains how these particular principles fit together. She says that, "when the users of a resource design their own rules (design principle 3) that are enforced by local users or accountable to them (design principle 4) using graduated sanctions (design principle 5) that clearly define who has rights to withdraw from a well-defined resource (design principle 1) and that effectively assign costs proportionate to benefits (design principle 2), collective action and monitoring problems tend to be solved in a reinforcing manner.” Numerous studies have been done to verify these design principles of robust management and most of them confirmed high usefulness of these design principles. It has been proven that if CPR regimes meet Ostrom´s design principles, they have the capacity to be effective in resource management.

As the example of such robust CPR regimes are forest and pasture commons in Europe placed in mountains. Numerous studies (e.g. Holmgren, 2009; Kluvánková-Oravská, 2013; Prempl et al., in review) investigated their management internal rules and how eight design principles are embedded in their institutional arrangement. In Sweden, Slovakia, Slovenia, Romania, Germany, France, Poland, Portugal and Italy we find examples of traditional forest land communities while new types of community woodlands are emerging in Scotland, Austria, Wales and England. In some cases traditional commons are in transition such as in Hungary, Finland. In order to profit from the potential benefits of management in common, there is a need to systematically compare existing regimes of forest commons, and to structure research on their impacts on sustainable forest management and sustainable social development. Our interest in” traditional” and “new” common pool resources regimes (CPRs) in European forest, is based on the understanding that robust resource regimes are critical for sustainable Forest Management regardless of the property rights. Ongoing practice shows that local land users may also be CPR regime if meeting management rules typical for commons.

Analysis have confirmed the existence of crucial rights and principles in their institutional arrangement and so proved robustness of CPR regimes. In spite of forest and pasture commons were established long time ago (e.g.

Swedish commons were established in 18th century by Crown, Slovenian or Slovak commons come from the time of Slavic settlements) and have faced numerous social, political and natural disturbances, they are still present. It is a proof of their resistance against these changes as well as their effective institutional arrangement. On the other hand, as social, political and natural changes have occurred over time, CPR regimes had to adapt and still struggling with some unsolved external and internal disturbances, (investigated later). Another significant fact related to the question of effective resource management comes from conducted research is reasons for their establishment. European forest and pasture CPR regimes were developed with the aim to serve as an instrument for improved forest management with the focus on increased and sustained timber production and to provide as an instrument for sustainable economy support for farmers and the local economy. They were also shaped with the intention to provide a solid basis for taxation and to secure continues existence of an independent class of farmers and to shape their self-interest to bring it closer to serving the public goods (Carlsson et al., 1996; Holmgren, 2009; Kluvankova-Oravska, 2013; Nozicka, 1956, Sarvasova et al, 2013). This implies their considerable importance in matters of mentioned social dilemmas.

Moreover, robustness of CPR regimes is also threatened by internal changes that these regimes are facing. For example, in case of forest and pastures commons in Europe, the number of commoners is rising as the result of the inheritance process, whereby common forests and pastures are passed on through generations. Often new commoners are not known (design principle 1 – missing clear group) or do not recognize legitimacy of commons and want to put land into private ownership aiming to gain higher individual profit (design principle 3 – absenting sense of being involved). Moreover, due to the rural migration, there is an obvious decline of those members who have valuable management skills, participate in a day-to-day management or are dependent on forests and pastures (design principle 3 – unawareness of the space, design principle 4 – rising mistrust). Due to migration, commoners that are non-residents, are mostly absent on meetings and as consequences are unawareness of the resource, poor social interactions and exchange of knowledge, weak trust and the vanishing sense of being involved. In spite of their absence at meetings, benefits are still distributed among all members equally (design principle 3 and 4 are not present). This fact is demotivating for active members to continue in efficient managing of common resources. It creates interest conflicts between non-resident and resident members caused also different values and interests, but it is also contrary with social interest (design principle 6 – solution of conflicts is harder). In addition, global investors create an immediate risk for a community in maintaining the continuity of resource management and the consequent reduction of control over the resources. Another challenge is recognition of CPRs in legal framework (design principle 7 and 8 in not very well applied). In case of Slovenian commons, their recognition is poor as result of several changes of the law and imperfect government approach to reestablishment and restitution of commons. On the other hand commons in Slovakia and Sweden are quite well nested in national legislation as well as in society. There is the evidence of unsuccessful commons that are isolated far away in mountains and are not nested in social and market arena (Carlsson et al., 1996; Holmgren, 2009; Kluvankova-Oravska, 2013; Premprl et al., in review; discussions with Lidestav, Standström and Kluvankova-Oravska, 2013.).

In contrary, some positive movements are going on in the issue of effective management of CPRs with the emphasis on collective action oriented on not just providing of provisioning ecosystem services (timber production), but also cultural (recreation, education) or even regulating ecosystem services (climate regulation by forests). The case of newly established commons in Germany is initiated from private forest owners. For benefits in social, environmental and economical respect, private owners of small pieces of forest land decided for cooperative action with other neighbouring forest owners. This common management helps them to solve practical or policy forest problems and they are oriented not always conditionally on timber production but also on non-monetary targets (Schraml and Selter, 2011). Another example of new commons is community woodlands in Great Britain that might be focused more often on conservation, recreation or education than on wood production. Community group plays a role in management decisions and it may or may not own the woodland (Lawrence, 2011). Given examples of new CPR regimes show that the ownership does not always play crucial role in sustainable resource management or in providing public goods. Moreover, the meaning of collective action becomes very important and it is not necessarily oriented on timber production as used to be in past. Even in some traditional forest and pastures commons in Europe, there is the evidence that some new commoners tend to more recreational values of common forest. Important role of CPR regimes in sustainable resource management has also been proven by behavioural experiments between forest commoners and private owners (Kluvankova – Oravska and Gezik, in review) where greater resource-sustainable oriented logic, self-organisation under the communication and following formal rules were present. It shows an experience from the real world situation where commoners sharing common resource have to co-ordinate and adjust their behaviour accordingly, and it is practically impossible to cut a forest without communicating with others.

In spite of mentioned potential of CPR regimes to solve social dilemmas, the complexity of the contemporary world, in particular in terms of the diversity of interests, multiple decision actors and dynamics of natural and social processes, makes these commons more vulnerable to external disturbances. Complexity of actors, migration of shareholders, climate change intensity and pressure of global market constitute four major global change drivers. CPR regimes, that represent complex social-natural systems, are currently challenged by global market that is not embedded in local institutional arenas. There is the evident need for institutional change at all scale such as implement adaptive measures to cope with four drivers and adapt measures for survival. Common pool resource regime where resource users become a service providers via adapting carbon sequestration regime to mitigate CO_2 (carbon forestry) would contribute to the scaling down strategic global environmental policy objectives as well as increase well being of mountain communities by providing incentive for collective and sustainable forest management.

5. Conclusion

The significance of design principles and management rules to achieve stable common-pool resource management is apparent. They appear to synthesize core factors that affect the probability of long-term survival of an institution, developed by the users of a resource (Ostrom 2009). There is the evidence of numerous successful as well as failed cases of CPR management that were influenced by several internal and external impulses. However, CPR regimes have potential to achieve more sustainable use of natural resources, great provision of public goods but also deal with the question on how to boost economy of local communities. In addition, collective action and shared benefits between individuals in group are promising foundation in future movements in effective governance of common pool resources. To achieve more sustainable and less demandable management of CPRs in favour to providing public good may be at the expense of users and their benefits.

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