Conference Volume | 5th Symposium for Research in Protected Areas, 10 to 12 June 2013, Mittersill | pages 587 - 590

Linking the wilderness continuum concept to protected areas

Christoph Plutzar[1], Flora Hejjas[2], Michael Zika[2], Bernhard Kohler[2]

[1]Institute of Social Ecology (SEC), IFF – Faculty of Interdisciplinary Studies, Alpen Adria University, Austria
[2]WWF Austria

Abstract

In this study we present a spatially explicit wilderness model for the Austrian territory using Geographic Information System techniques combining data and information from different sources. This model uses the wilderness continuum concept, implemented by an approach developed by the Australian Heritage Commission that makes wilderness quantifiable by assigning each locality a quantitative wilderness quality index. Considering that, due to the long anthropogenic colonization, only few true pristine wilderness areas are left in Central European landscapes we identify regions that still show wilderness qualities. The result is used for a gap analysis considering established protected areas and exploring potentials to locate wild areas suited for the establishment for secondary wilderness.

Keywords

Wilderness, wild areas, protected areas, Natura 2000, Austria, wilderness continuum concept, GIS, spatial model

Introduction

The establishment of protected areas is closely connected to the idea of wilderness, areas with low impact of human society providing natural dynamics and processes as well as opportunitiesfor recreation and solitude. Beginning in the later 19th century the conservation movement in the USA, inspired by ideas of concepts of thinkers and activists like Henry David Thoreau, John Muir or Aldo Leopold, gradually imposed the implementation of National Parks. This development began with the Yellowstone National Park, which was established 1872, and led to the declaration of the Wilderness Act in 1964, which designated land as “wilderness” for the first time.

The shift in nature conservation over the last decades from an organismic-oriented point of view to a more ecosystem-oriented approach drew the attention to the importance and value of such pristine areas. This awareness led to a resolution of the European Parliament in 2009 to improve protection and funding for wilderness in Europe.In the same year a first conference on Wilderness and Large Natural Habitat Areas was organized through the Wild Europe initiative, an initiative on wilderness incorporating European environmental NGOs and European Commission. After the conference the Austrian Ministry of Environment has placed the idea of wilderness at the heart of the new strategy (endorsed in 2010), declaring that all Austrian national parks shall henceforth focus on ecological process management in their core zones (explicitly referred to as ”wilderness”).

But Central European landscapes have faced anthropogenic alteration for thousands of years, soonly few true pristine wilderness areas are left. On a first look this might reduce the importance of wilderness in human dominated regions. But MACKEY et al. (1998) emphasize that in the context of nature conservation, and as a consequence of protected areas, the concept of wilderness quality plays an important role besides the concept of wilderness areas. Wilderness quality is “the extent to which any specified unit area is remote from and undisturbed by the impacts and influence of modern technological society” (MACKEY et al. 1998). Many indicators reflecting the wilderness quality of an area are related to indicators reflecting the state of health of an ecosystem. So whenever conservation interests go beyond a species-based focus and integrate a perspective on ecosystems and their processes, an approach considering wilderness quality adds valuable possibilities and insights. An established concept to handle wilderness quality is the wilderness continuum, initially developed by R. Nash in the 1980s (NASH 2001). Based on this idea various methods were used to assign each locality of a study area a quantitative wilderness quality index, indicating and distinguishing wild and not wild places on a continuous scale. European cases for this approach were applied to several regions for example The United Kingdom (CARVER et al. 2002), Scotland (CARVER et al. 2012), the Alps (KAISSL 2002) and even the whole European territory (FISHER et al. 2010). These examples have proven the feasibility and utility of wilderness continuum mapping.

Despite of the lack of true wilderness areas with large extend in Austria there are still remote areas with extensive land use, so called wild areas, still keeping many aspects of wilderness. These areas have a high potential to become - by changing current land use - secondary wilderness regions (KOHLER et al. 2012). The goal of this study is to identify such areas with a high potential for wilderness for the Austrian territory by mapping the wilderness continuum described above. Further we want to estimate the wilderness quality of existing protected areas like the

core zones of National Parks (and additionally of the Natura 2000 sites) and to identify areas with high wilderness quality without protection status.

Methods

To estimate the wilderness continuum we use the approach of LESSLIE et al. (1993), which distinguishes four different aspects of wilderness: (1) remoteness from settlement (remoteness from places of permanent habitation); (2) remoteness from access (remoteness from constructed vehicular access routes like roads and railways; (3) apparent naturalness (the degree to which the landscape is free from the presence of the permanent structures of modern technological society); and (4) biophysical naturalness (the degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society).

Similar to FRITZ et al. (2000) we estimate and combine these four indicators using a multi-criteria evaluation (MCE) framework implemented in a Geographic Information System (GIS).We calculate weighted distance decay models on raster level with a spatial resolution of 100 meters using following input data sets:

1. Remoteness from settlement: based on a map of soil sealing (KOPECKY & KAHABKA 2009) as proxy for settlements we calculated a weighted pathdistance to locations with sealed soil. The pathdistance was favoured over the Euclidian distance because it considers topographical surface conditions, which were implemented by using a digital elevation model (JARVIS et al. 2008).For weighting we applied a kernel density to estimate the density of settlements.
2. Remoteness from access: we used the Open Street Map data (Geofabrik 2012) to calculate traffic-weighted pathdistance models. We distinguished between line features like roads and points representing public transport stops like railway stations. In the first case tunnelled sections were excluded.
3. Apparent naturalness: similar to the remoteness from access weighted distance-decay functions were calculated using several civilization facilities as input: skiing areas (Umweltbundesamt 2012), hydroelectric power stations (WALDER & LITSCHAUER 2010), other power stations (Geofabrik 2012), power lines (Geofabrik 2012), alpine huts and shelters (Geofabrik 2012), railway network (Geofabrik 2012) and buildings (Geofabrik 2012).
4. Biophysical naturalness: due to a lack of adequate land use data we usedthe CORINE land cover data set (EEA-ETC/LUSI 2007) as a proxy for human impact on the environment, applying weights according to the degree of naturalness of land cover. Additionally we applied the degree of hemeroby (GRABHERR et al. 1998) for wooded areas.

For the integration of all intermediate results described above we followed two different approaches. To get an overall estimation of wilderness quality we used a weighted overlay which considers all features within a certain radius at a given location. This method is suited for highly populated areaslike most European landscapes and contradicts to the Australian approach, which only takes the most important factor into account (FRITZ et al. 2000). In the Austrian case this method tends to underestimate the influence of single facilities in remote areas (like alpine huts), because they accumulate much lesser weight compared to crowded localities. To be able to consider such facilities in these sensitive areas we adapted the Australian approach and applied a so called minimum operator (which corresponds to a logical “and”). As a consequence for each locality the smallest and hence most influential distance value was taken into account.

To obtain a final spatially explicit estimation of the wilderness quality index for all of Austria we calculated the average of these two layers. In a last step we intersected the core zones of the Austrian National Parks as well as the Natura 2000 sites with the wilderness continuum map to estimate the wilderness quality for these areas.

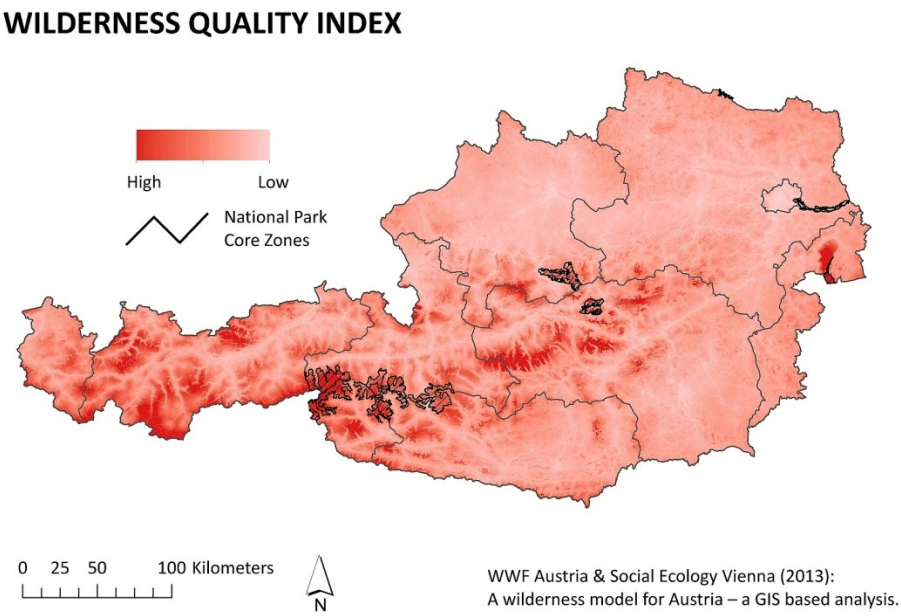

Figure 1: Map shows the wilderness quality index for all of Austria and on top the boundaries of the Austrian National Park core zones.

Results

The wilderness continuum is shown in Figure 1, together with the core zones of Austrian National Parks(but for reasons of clarity not the Natura 2000 sites). Most areas with high wilderness quality are located in mountainous regions with higher elevations,located in the western parts of Austria, for example Hohe Tauern, Niedere Tauern, Ötztaler Alpen, Lechtaler Alpen, Karwendel and Totes Gebirge. One exception is the large sheet of water of Lake Neusiedl situated in the east at the border to Hungary. As was expected the populated regions of Vienna, Lower Austria, Upper Austria, the south-western parts of Styria and the large alpine valleys show consistently low wilderness quality values.

Figure 2 shows a comparison of the wilderness quality of the core zones of Austrian National Parks (separated for each federal state[1]) as well as the Natura 2000 sites in relation to the Austrian territory.
The median of Austria's wilderness quality index is 0.14 and one of the National Parks, Donau-Auen, has a similar range of values. The part in Lower Austria has a median of 0.16 whereas the part in Vienna shows a slightly smaller median of 0.11. All other national parks as well as the Natura 2000 sites show clear higher wilderness quality values. The highest median can be found in Neusiedlersee (0.69), followed by Hohe Tauern Tyrol (0.46), Hohe Tauern Salzburg (0.39), Hohe Tauern Carinthia (0.37), Gesäuse (0.28), Kalkalpen (0.23), Thayatal (0.23) and the Natura 2000 sites (0.19).

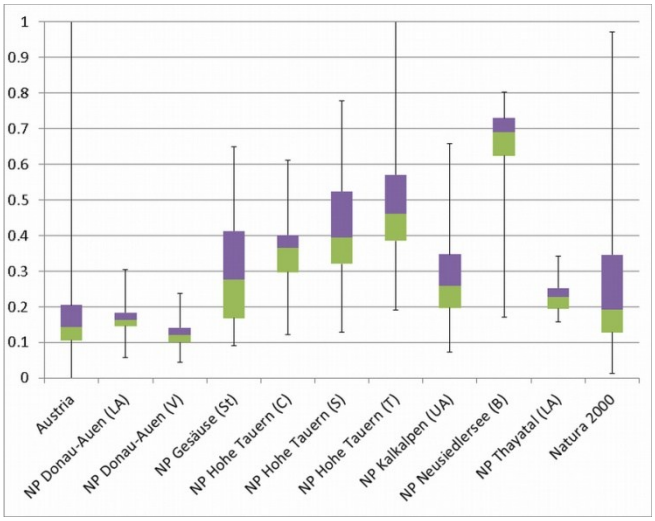

Figure 2: Box plot presents the wilderness quality index in Austrian National Parks and Natura 2000 sites, indicating minimum, 25thpercentil, median, 75thpercentil and maximum for each area. B: Burgenland, C: Carinthia, LA: Lower Austria, S: Salzburg, St: Styria, UA: Upper Austria, T: Tyrol, V: Vienna.

Discussion

The spatial pattern of the Austria's wilderness continuum shows that mountain ranges are favoured over lowlands. This is an expectable result since intensity of land use as well as most human activities decline with increasing altitudes. Nevertheless we are able to present this effect on a quantitative basis, underpinning the importance of alpine habitats for preserving natural processes and services on a large scale. Moreover this approach is able to provide a starting point to compare the level of naturalness for different regions and localities, considering various aspects of anthropogenic disturbances.An overlay with Austria's National Park core zones and Natura 2000 sites reveals that the vast majority of Austria's network of high level protected areas providesa wilderness index above the average, indicating high wild land quality. Given a certain minimum size, some of the core zones have the capability to establish wilderness, fulfilling the requirements of the Wild Europe initiative for wilderness and wild areas (Wild Europe 2012).Detailed local studies could offer scenarios how to protect existing aspects of wilderness as well as how to change recent management and land use to develop wilderness in a sustainable way. Candidates for such a process are the National Parks Hohe Tauern and Kalkalpen.
Although some of the areas with high wilderness quality enjoy a high status of protection, like the core zones of National Parks, and others are covered by Natura 2000 (e.g. Ötztaler Alpen, Karwendel), some have no adequate protection at all (e.g. Lechtaler Alpen, Stubaier Alpen). These areas deserve special considerations when it comes to conservation issues like connectivity of (alpine) habitats.
The high wilderness quality value for Lake Neusiedl is a consequence of the input data used. We were facing a lack of data focusing on human activities on lakes – like ferries, sailing or fishery – resultingin an underestimation of human impact in freshwater habitats. This bias has to be considered when reviewing the result and emphasizes the importance of data quality and completeness. It is clear that this assessment misses several factors, important for a full and extensive evaluation of Austria's wilderness continuum (like hunting or grazing activities). But we hope that in the long run this study will help to improve the relationship and interaction between nature conservation, protected areas and the wilderness idea in a beneficial and fruitful way.

[1]kindly provided by Amt der Burgenländischen Landesregierung; Amt der Kärntner Landesregierung; Amt der Salzburger Landesregierung, (c) SAGIS; Amt der Tiroler Landesregierung, TIRIS 2012; Amt der Steiermärkischen Landesregierung; Amt der Oberösterreichischen Landesregierung; Stadt Wien - data.wien.gv.at; Amt der Niederösterreichischen Landesregierung

Conclusion

The study presented is a first spatially explicit assessment of the wilderness quality for Austria. It shows that, despite of the long human colonization of Austria's landscapes, there are still large, unfragmentedareas left, equipped with high wilderness quality values. These regions can be considered mainly as wild land with high potential to become secondary wilderness, providing natural processes and dynamics. Looking at the whole of Austria this potential is covered partly by the Austrian network of protected areas, especially the core zones of National Parks, but also the Natura 2000 sites. The core zones show, with one exception,clear higher wilderness quality than the Austrian average and hence can be seen as important basis for the protection of large-scale natural processes. Nevertheless national studies tend to miss local or regional characteristics, last but not least because of insufficient data quality and availability. So further in detail studies, focusing on a specific region and considering its individuality, will help to improve the mapping of the wilderness continuum in Austria as well as our understanding of the meaning of wild land for nature conservation.

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Contact

Christoph Plutzar
Christoph.Plutzar@aau.at

Institute of Social Ecology (SEC)
IFF - Faculty of Interdisciplinary Studies
AlpenAdria University
Schottenfeldgasse 29
A-1070 Vienna
Austria

Flora Hejjas
Flora.Hejjas@wwf.at

Michael Zika
Michael.Zika@wwf.at

Bernhard Kohler
Bernhard.Kohler@wwf.at

WWF Austria
Ottakringer Straße 114 – 116
1160 Wien
Austria