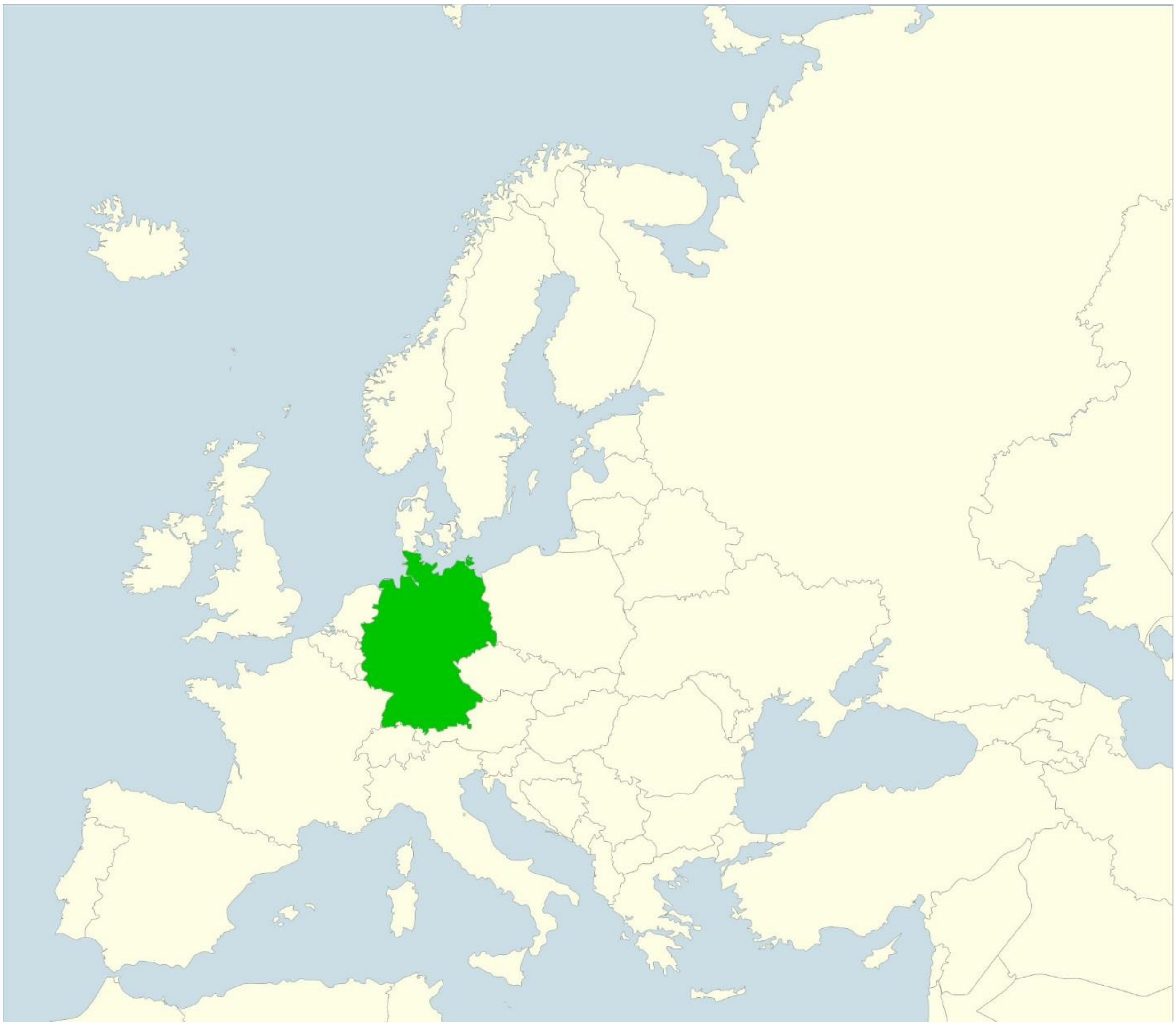
Europ Europ. Countrys. · Vol. 10 · 2018 · No. 4 · p. 652-672
DOI: 10.2478/euco-2018-0036

sciendo

European Countryside MENDELU

CULTURAL HERITAGE AND WIND TURBINES – A METHOD TO REDUCE CONFLICTS IN LANDSCAPE PLANNING AND MANAGEMENT: STUDIES IN THE GERMAN ORE MOUNTAINS

Patrick Wieduwilt[1], Peter Wirth[2]



[1] Patrick Wieduwilt, researcher. Institute of Industrial Archaeology and History of Science and Technology, Technische Universität Bergakademie Freiberg, Silbermannstraße 2, 09599 Freiberg, Germany. e-mail: patrick.wieduvilt@web.de

[2] Dr. rer. nat. Peter Wirth, Leibnitz Institute of Ecological Urban and Regional Development, Weberplatz 1, 01217 Dresden, Germany; e-mail: P.Wirth@ioer.de

Received 5 January 2018; Accepted 26 July 2018

Abstract: Landscape policy, management and planning can be interpreted as involving a dualism of conservation and transformation goals. Serious conflicts can emerge when conservation and development goals are contradictory. This paper reflects on the goal conflict between the establishment of a world heritage destination with 39 individual elements and the development of wind power facilities in the German Ore Mountains. In order to meet these challenges, the authors created a GIS-based so-called “Multiple-Visual-Link Method”. By calculating viewsheds with a tailor-made GIS application and defining distance zones (short, middle, long), the user is able to estimate the visual relations between the two types of subjects in a bigger area with a favorable cost-benefit relation. The compact algorithmic approach leads to solid results which can be translated into planning recommendations. There is also potential for it to be applied to similar goal conflicts.

Keywords: landscape policy, goal conflict, UNESCO World Heritage, GIS, regional planning, Germany

1. Introduction

Landscape policy, management and planning can be interpreted as involving a dualism of conservation and transformation goals. On the one hand, there is societal concern to retain characteristic natural and artificial elements of the landscape and in specific cases even complete landform ensembles. In the last decades, this has been closely connected with approaches of natural and cultural heritage protection (Fairclough and Möller, 2008). On the other hand, there are numerous socio-economic needs like food production, generation of energy, water supply, and building land improvement that drive land use and landscape changes and transitions. Landscape planning and management have to handle both sides simultaneously (Printsmann et al., 2012). Nevertheless, serious conflicts can emerge when conservation and development goals are contradictory (Bohnet and Konold, 2015).

A typical recent case of this nature can be found in an old German cultural landscape, the Erzgebirge (Ore Mountains) in Saxony[3]. This mountain range is characterized by 800 years of mining history. In recognition of this, in the 1990s, an initiative was started to protect the manifold remains of human impact on the landscape under the world heritage status. The goal was implemented step by step. Following registration in the German tentative list for UNESCO heritage sites in 1998 (Welterbekonvent Erzgebirge, 2015), a facility study was compiled. In the end, 39 elements with a relationship to mining history, spread all over the mountain range, were identified as potential world heritage and were called Mining Cultural Landscape Ore Mountains. As customary, buffer zones and view axes were defined for each element to avoid visual disturbances.

In parallel to this conservation process, the Ore Mountains became a target area for wind power development. As the natural conditions on the high plains of the mountain range are very suitable, first wind turbines were erected in the middle of the 1990s. At the end of 2012 in the Chemnitz planning region, where the German part of the Ore Mountains is situated, 335 wind power plants could be found, also spread over the whole area (PV Chemnitz, 2013). Additionally, in the framework of the revision of the regional plan, even more priority areas for wind power are foreseen (PV Chemnitz, 2015).

This paper reflects on the goal conflict between the establishment of a world heritage destination and the development of wind power facilities in the German Ore Mountains and a compact method to reduce this conflict. Normally, the visual impact of individual wind turbines is simulated with the help of three-dimensional visualization techniques. This involves a wind turbine being

[3] Though the Ore Maintains also range to the Czech Republic, this article only considers the German part. This is appropriate, as the institutional framework conditions regarding spatial planning and monument protection are different in Germany and the Czech Republic.

projected on a landscape photograph in a realistic position and scale to enable study of its spatial effect (e.g., Grontmij GmbH, 2013, p. 48ff; Kloos et al., 2014, p. 67 ff). Bearing in mind that in our case, the visual links between multiple subjects of protection and multiple locations of wind turbines require investigation, a three-dimensional visualization of each visual link seems hardly possible, as it is time-consuming and cost-intensive. Against this background, the aim of this paper is to develop a systematic method which can contribute to solving the conflict between conservation and development goals in a transparent and efficient way. In order to meet these challenges, we developed a GIS-based so-called “Multiple-Visual-Link Method” as an instrument to support planning decisions. With the help of this method, critical visual links between heritage elements and wind turbines shall be identified. The approach is tailor-made for planning at a regional level, where the localization of wind turbines in most of the German federal states, including Saxony, is realized. The research questions are: What are the work steps of the described method? What are the potentials and limits of the Multiple-Visual-Link Method? And what are the opportunities for a wider implementation of the method beyond the example described here?

In the next section (2), discussion about the dualism of conservation and transformation goals will be embedded in theoretical discussions about the interpretation of landscapes. Furthermore, the influence of wind power on landscapes and its different perceptions are identified. In Section 3, we looked at existing conflicts between world heritage sites and wind turbines using two prominent German examples. The following Section 4 presents the Multiple-Visual-Link Method, describing the individual steps using the example of the Mining Cultural Landscape Ore Mountains in Saxony including the concrete results. The scientific and practical outputs are discussed in Section 5. Last but not least, in the concluding section, the main findings are summarized, and some research perspectives are drafted.

2. Perceptions of cultural landscapes and the influence of wind turbines

The cultural landscapes in Europe are a result of thousands of years of human influence on nature. There are rarely areas in Europe that have not experienced human impact and it is hardly possible to divide landscapes into “natural” and “cultural” ones. Of much more importance today is the degree of human influence on landscape (Naveh, 1995). According to this human-environment interaction, landscapes can be interpreted as dynamic entities, and landscape change is understood as a permanent process, sometimes proceeding faster, sometimes slower (Bürgi et al., 2005). Though we can find a lot of interpretations of the term landscape today, there are certain prevailing notions. According to Jones and Stenseke (2011, pp. 6–8), the most important ones are: *landscape as morphology*, which stresses the physical character of landscapes, the natural and cultural forms; *landscape as scenery*, which relates to the aesthetic experience of the landscape including feelings and emotions and is often connected with the experiences of local people, leading to subjective social constructions of landscape closely related to terms of identity; and *landscape as polity*, which refers to the characteristics and conditions of land use systems with customs, institutions and law-making.

Consequently, landscapes can be seen in different ways at the same time, perhaps as a physical unit, as a land use pattern, as part of a homeland, as a historical place with specific meanings, as societal heritage, etc., and different perceptions can be combined (compare Alumäe et al., 2003). Landscapes can be interpreted as an “interactive phenomenon”, including cultural construct, spatial phenomenon, political phenomenon and ideologies/values (Taylor, 2009, p. 13). All the described aspects also find expression in the political context. According to the European Landscape Convention, “’Landscape’ means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000, p. 3).

This societal perception of landscape is quite a new issue in the scientific and political discussion. And it has a range of further implications. Whereas landscape was seen as a subject of production over centuries, today it is also interpreted as a subject of conservation and heritage (Jones, 2003; see also Section 3), and new questions are emerging in research and practice like “what should be preserved and what should be left to change” (Pinto-Correia and Kristensen, 2013, p. 249).

In this notion of multifunctional cultural landscapes, the relationship between different development goals and between development and conservation goals in one and the same area is a challenge for landscape management (Bohnet and Konold, 2015). The implementation of conservation goals is often connected with restrictions for other land use forms. It is oriented towards safeguarding measures to maintain the state of the art or which modify this state in a predefined way according to the conservation goals. This often means the persistence of natural and/or human-made structures that are no longer supported by recent land use practices. In contrast, policy changes like the EU Common Agricultural Policy (CAP), energy transition or infrastructure projects trigger manifold land use changes. This leads to new forms of land use, changes in the landscape scenery or of land use patterns. This may conflict with conservation goals. Consequently, there is a need to balance conservation goals with several development claims (Short, 2008). The European Landscape Convention therefore pursues the aim to "promote landscape protection, management *and* planning" (Council of Europe, 2000, p. 3).

Wind power has been an attractive option for zero-carbon policymaking in many parts of the world since the end of the 1990s (McDowall et al., 2013) and it has also become the most dynamic renewable energy form in Germany in recent years. Installed wind power capacity in Germany was 17 MW in 2000. According to the Global Wind Energy Council, it had increased to 318 MW by 2013 (GWEC, 2016). The reasons for this are mainly the natural wind potential offshore as well as onshore and the proactive renewable energy policy that guarantees a predefined price for feeding into the general power grid. This makes Germany the biggest producer of wind power in Europe and the third in the world (behind China and US). The political goal of the country is to enhance the share of renewable energies in the total consumption of electricity to a minimum of 35% by 2020 (2011: 20%). In the same time period, the proportion of renewables in total energy consumption shall rise to 18% in Germany (2011: 11.5%, BMWi, 2015). This implies a radical change in energy policy and is only possible with strong investment in new facilities, ultimately in wind turbines.

At the end of 2012, one-third of electricity production from renewable sources in Germany came from wind power, representing about 8% of total electricity consumption. About 23,600 wind turbines with an installed capacity of 34,200 MW produced 47.4 terawatt-hours of electric power at the end of 2013 (IWES, 2013, p. 7). The distribution of individual facilities varies greatly. The strongest focus is on offshore and coastal locations. Onshore, the high plains of the mountain ranges have become very attractive areas for the energy industry (BfN/BBSR, 2014, p. 9). But not only is the overall capacity of wind energy growing in Germany. The size and capacity of individual wind turbines is also increasing. In 2011, a new facility was on average 150 meters tall with a capacity of 2.5 megawatt. Thus, height has doubled in one decade, and capacity is now ten-fold (ibidem). All in all, we can speak of a spatial enlargement of wind fields in combination with an increase in the size and power of individual units.

These developments have spurred a scientific and public debate on the impacts of renewable energies on the landscape. Perceptions of wind power are indeed very varied. Rather, traditional notions of landscape, based on a pattern of agricultural and silvicultural land use, stress the disturbing impacts of new energy facilities. Such perceptions are often articulated in contrast to concepts of "energy landscapes" in which technical elements are seen as an expression of innovation and progress. Moreover, wind power can be seen as an opportunity to generate income in rural areas (Järvelä et al., 2009).

Against this background, wind power use has become the most frequent trigger of landscape-related local debates in Germany (Leibenath and Otto, 2013) and problems of local acceptance have won importance (Bertsch et al., 2016). Debates are highly emotional and have a strong relationship to landscape perceptions. This effect is particularly pronounced when world heritage sites have visual links to planned or existing wind turbines. A report of the UNESCO World Heritage Center has attempted to analyze the causes and impacts of wind turbines on world heritage sites (Veillon, 2014). The next section will explain the position of the World Heritage Committee and provide some examples of conflicts to date.

3. World Heritage Sites and Conflicts with Wind Turbines

In modern societies, world heritage sites are highly appreciated and acknowledged. Many people identify with the sites and have a great emotional link to them (World Heritage Centre, 2014, p. 3). It is thus not surprising that wide-ranging conflicts emerge when world heritage sites are influenced negatively, e.g., by the erection of large wind turbines. In 2014, the world heritage convention published a study which analyzed all factors threatening the outstanding universal value of world heritage sites in the period from 1979 to 2013. The starting point for the report was an online survey to document all threats in Africa, the Arabian region, Asia, Europe, and North and South America in 2012. Overall, 2642 conservation reports on 469 world heritage sites were evaluated. The aim was to generate a database to describe the threats according to various criteria, among other renewable energies (Veillon, 2014, p.3). The study concludes that in the period from 1979 to 2013, overall, 28 cases affecting eight world heritages sites were recorded. Obviously, only a small proportion of heritage sites have been impaired by renewable energy facilities to this day. Nevertheless, the authors of this paper see it as important to reflect on this conflict as we are still at the beginning of a global process. Wind is not only the most frequent renewable energy source worldwide (Veillon, 2014, p. 3), increasing demand must be expected in the future. Consequently, finding proper locations for wind turbines is a challenging task when conflicts with heritage subjects are to be avoided or reduced.

When we speak about this conflict, it has to be mentioned that there is already a zoning concept available to protect world heritage sites. According to the UNESCO Operational Guidelines, every world heritage site must be defined by “core zones” and “buffer zones”. The core zone is the area where the nominated property is situated, and the buffer zone is the area to protect the surrounding area of the heritage subject (UNESCO World Heritage Centre, 2015, pp. 103–107). In fact, the buffer zone is designed to reduce possible external influences which can induce a conflict with the world heritage status (ibidem). This can be – for instance – visual links with wind turbines. But, as we will show now, the zoning concept can hardly consider all relations between heritage sites and potentially disturbing factors, and older zoning concepts hardly considered the size of modern wind turbines as described in Section 2.

With a total height of 200 meters, such turbines are visible up to 80 kilometers in lowlands and up to 30 kilometers in low mountain ranges (according to Nohl, 2001, p. 81). It becomes clear that the protection of world heritage sites in relation to their surrounding environment is being pushed to the limit and cannot be realized with the sole use of the Operational Guidelines of UNESCO World Heritage. A buffer zone – as a rule – often ends a few 100 meters away from the heritage subject. Only in rare cases does the buffer zone extend over a few kilometers. Therefore, conflicts between world heritage sites and wind turbines seem to be unavoidable. In the following, we will show two such examples.

Of course, conflicts between wind power development and heritage sites are a problem in many countries. Prominent cases include the island of Mont-Saint-Michel, one of the most important landmarks in France (Simons, 2011), and the Jurassic Coast in southern England (Quilter, 2015); but there are several more. As wind power development has a strong institutional background: national energy policy, the relevant legislation on energy and planning, practice of law, and – not to forget – the planning system, we use German cases to introduce the investigation in the Ore Mountains.

3.1 Wartburg Castle

Wartburg Castle is a medieval castle in the Thuringian Forest Mountains built in the year 1067. Its present appearance dates to several historical events. Among others, it is the place where the church reformer Martin Luther translated the New Testament of the Bible into the German language. Wartburg Castle has been a listed world heritage site since 1999 (UNESCO-Welterbestätten Deutschland, 2012). In 2005, the respective planning authority approved the construction of two wind turbines with a total height of 141 meters on Milmesberg mountain (Sternberg, 2011). Although the location is 7 kilometers away from the medieval castle (Maslaton, 2013, p. 1–2), the turbines would be clearly visible from the Wartburg (Maslaton, 2011).

Shortly after the approval of the wind turbines, an intensive public debate about the visual relationship between the planned wind facilities and Wartburg Castle started. Many people and also heritage organizations interpreted the erection of the wind turbines as an impairment of the outstanding universal value of the medieval castle. In consequence, it was also seen as threatening the world heritage status with negative impacts on the region's image and – possibly – leading to a declining number of visitors (Leißling, 2006). The conflict escalated into long-term litigation when the municipality of Marksuhl, situated in the neighborhood of Wartburg Castle, went to court to prevent the construction of the wind turbines. The legal action took a period of over eight years and involved a number of convolutions. In the first instance, the Meiningen Administrative Court considered the building permission as unlawful. It justified this decision by arguing that the visibility of the Castle is not limited. Rather, an unbiased view from Wartburg Castle towards Thuringian Forest was important for the outstanding universal value (Leißling, 2006).

In the second instance, the same court decided in appeal proceedings in 2010 that the building permit for the wind turbines on Milmesberg mountain was lawful. The court now argued that the impairment of landscape and the view from Wartburg castle to Thuringian Forest is limited and no threat of the world heritage status of Wartburg Castle could be expected (Verwaltungsgericht Meiningen, 2010).

At this point, the Thuringian Regional Office for Archaeology and Preservation of Historical Monuments took an active role in the dispute about the wind turbines on Milmesberg mountain. In December 2011, the medieval castle and surrounding woodlands of the Thuringian Forest Mountains including Milmesberg mountain were listed as a landscape park (Völker, 2011, p. 3).

This change in the framework conditions led to another turn in the case. Before the court could make a final decision, the investor abandoned the plan to construct the wind turbines and proposed a photovoltaic system project on Milmesberg mountain as an alternative. Both parties agreed on this compromise in August 2013 (WER, 2013, p. 4).

3.2 Upper Middle Rhine Valley

In 2002, a 65-kilometer section of the River Rhine valley between the cities of Koblenz and Bingen was listed as world heritage. The outstanding universal value of this cultural landscape is defined by a unique combination of geological, historical, cultural and industrial features. Furthermore, the Upper Middle Rhine Valley (UMVR) is declared to be a symbol of German romanticism (Grontmij GmbH, 2013, p. 1). The views out of the valley to mountain ranges with wine terraces are described as unique. In addition to this, there are multiple visual links between several viewpoints and castles. But the Rhine Valley has also been and remains an area with manifold economic activities creating pressure for change. Therefore, it is not surprising that some rivalries between economic development and the protection/conservation of the cultural landscape have emerged (Grontmij GmbH, 2013, pp. 1–2). One of these is the planning of wind turbines in the mountain ranges of the UMRV. There have been attempts to construct wind turbines in the buffer zone of the UMRV as well as at locations outside the buffer zone but with a visual link to significant viewpoints of the valley (Stoll, 2013a).

In December 2012, a conflict emerged between the German Commission for UNESCO as the advocate of the world heritage site and an association of municipalities who favored the wind turbines. The municipalities argued that the expansion of wind energy could bring additional revenue into the region and support economic growth. The supporters of the wind turbines considered that nature conservation should not prevent the economic development of a region (Michel, 2013, p. 1). In contrast, the German Commission for UNESCO stated that the planned wind turbines would affect the outstanding and universal value of the UMRV in a negative way.

To manage the situation, the communal association (Zweckverband) World Heritage Upper Middle Rhine Valley and the Ministry of Education, Science and Culture of Rheinland-Pfalz as agents for the world heritage site commissioned a visibility study for the planned wind turbines (Grontmij GmbH, 2013, pp. 2–3). The study clearly showed the significance of an unbiased view from the most important points and castles for the historical cultural landscape. In fact, wind turbines should be completely excluded from the buffer zones of the UMRV, and also prohibited from certain other locations outside the buffer zones (Grontmij GmbH, 2013, pp. 104–108). Also in this case, litigation took place. Based on the results of the study, the administrative court Koblenz decided to exclude all wind turbines from the buffer zone of the UMRV. One question that remained unanswered was how to handle the view axes outside the buffer zones where wind turbines are acceptable from a legal point of view (OVG Rheinland-Pfalz, 2016).

3.3 Interim conclusion

The examples underline that the planning of wind turbines and landscape protection in the context of world heritage sites in Germany is a complex area of tension. Although world heritage sites with landscape-shaping significance are protected with buffer zones, conflicts with wind turbines could not be avoided. Conflicting parties are not only the investors in renewable energies and the curators of heritage and regional planning authorities, but also local governments and citizens' groups. The conflicts often have a high media impact and become an emotional issue among the local population.

Obviously, the visual linkages between wind turbines and heritage subjects are hardly avoidable if reliance is placed solely on the instrument of buffer zones and view axes. Buffer zones are often too small and view axes respect only short distances. Moreover, the conflicts regarding Wartburg Castle and the Rhine Valley demonstrate that it is of great importance for planners to use resilient criteria to define wind fields in relation to heritage subjects. Additionally, it seems possible that a set of clear criteria could help the courts of law to make decisions on a solid thematic basis.

In consequence, it is highly recommendable to investigate long-distance relations as an additional tool to be linked to the buffer zones and view axes already in use. This extension of established instruments would have a double advantage. On the one hand, it would guarantee the more effective protection of heritage subjects, and on the other hand it would increase planning reliability for competing land use forms like renewable energies.

4. Case Study Ore Mountains – Description of the Multiple-Visual-Link Method

4.1 Geographical description

The Chemnitz Planning Region, containing all elements of the Mining Cultural Landscape Ore Mountains on the German side, is located in the southeast of the Federal Republic of Germany and borders on the Czech Republic (Figure 1). With an area of about 6,500 km^2, the region encompasses the cities of Chemnitz, Zwickau, Plauen and Freiberg including their surroundings and has a population of about 1.5 million (2017). This results in a population density of about 220 per km^2, which is remarkably high in relation to other low mountain ranges in Central Europe. In geographical terms, the region spans from altitudes of around 200 m above sea level in the north to more than 1,000 m in the south where the higher elevations of the Ore Mountains are found. Average wind speed in the region ranges from medium to high, making it an attractive area for wind power development. Turning to land use in the planning district, agriculture dominates with 51% of the total area, forestry accounts for 32% and settlements/traffic areas cover 15% (2017). Thus, we find a fully utilized cultural landscape with many challenges for the users.

According to the political energy goals of Saxony (PV Chemnitz, 2015, pp. 8), the region is challenged to improve the annual production of wind energy from 1,700 to 2,200 gigawatt hours by 2022. These energy production goals shall be achieved by a combination of repowering (substitution of old turbines by taller ones with a higher capacity) and defining new wind fields. Both developments (repowering and extension) could provoke new conflicts with heritage sites, as the visual relations to heritage subjects would change with implementation (IWTG, 2013).

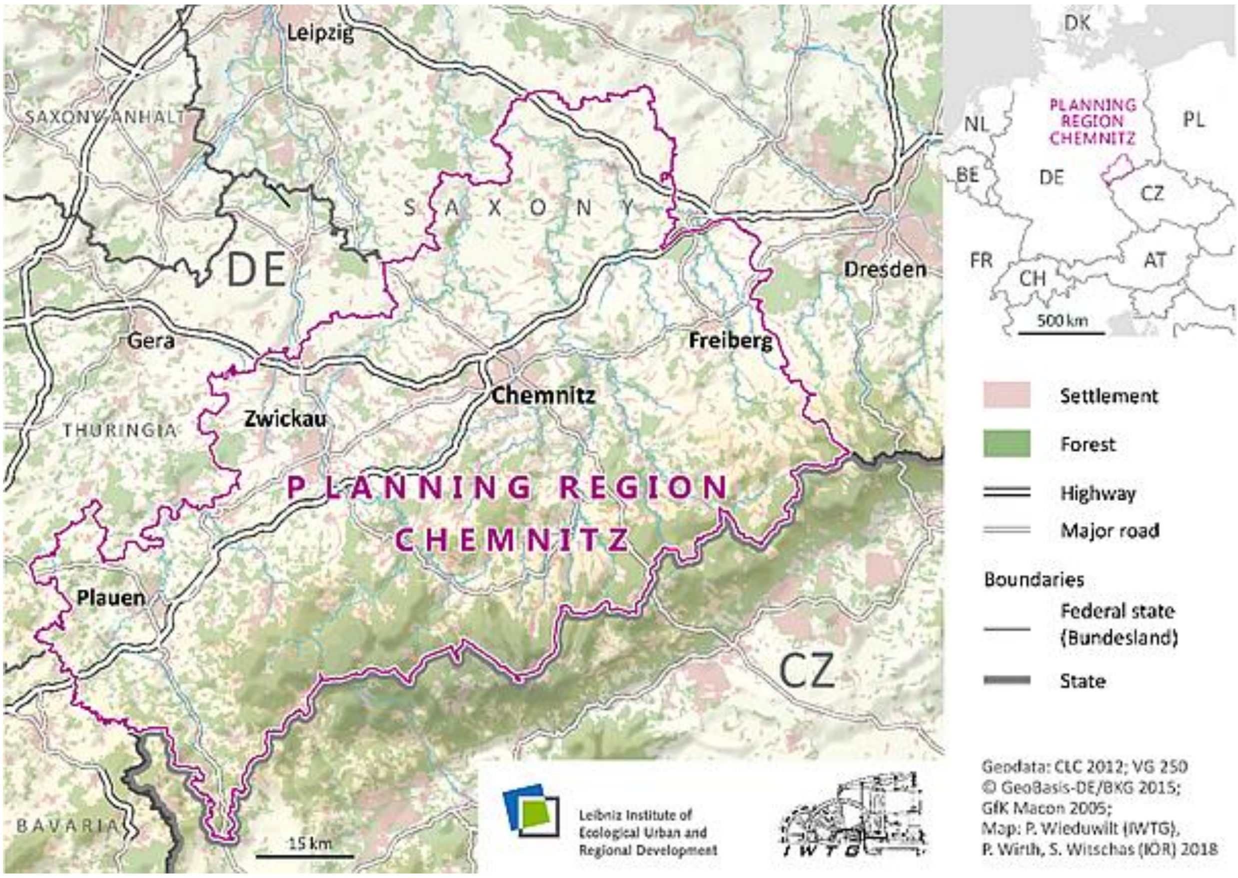


Fig 1. Planning Region Chemnitz – location and overview.

4.2 Inventory and Classification

Wind Power Facilities

As threats for the world heritage nomination can emanate from existing and planned wind turbines, both categories must be considered in this investigation. At the starting point of the Regional Wind Energy Concept in 2013, there were already 335 wind turbines in existence (see the purple symbols in Figure 2). From the map, it is obvious that in most cases a higher number of wind turbines are concentrated in several relatively small areas.

To define areas for new wind facilities, the Planning Association of the Chemnitz Region is using – like most planning authorities in Germany – a two-step procedure which is based on several fundamental decisions by the German courts (Bovet, 2015). At first, all areas, which are not available for wind energy production, so-called taboo zones, are defined and excluded from the total planning area. These are mainly settlement areas including a minimum distance zone, infrastructure facilities (e.g., roads, airports) including distance zones, different subjects of landscape and nature protection, as well as the habitats of birds and other protected species. The result is a number of so-called “potential areas for wind turbines”, free of any excluding factors. The remaining areas are judged in a second step in terms of compatibility with other public interests and defined as concentration areas, termed “suitable areas for wind energy”. In detail, this procedure is described in the “Regional Wind Energy Concept” (PV Chemnitz, 2013, p. 12 ff).

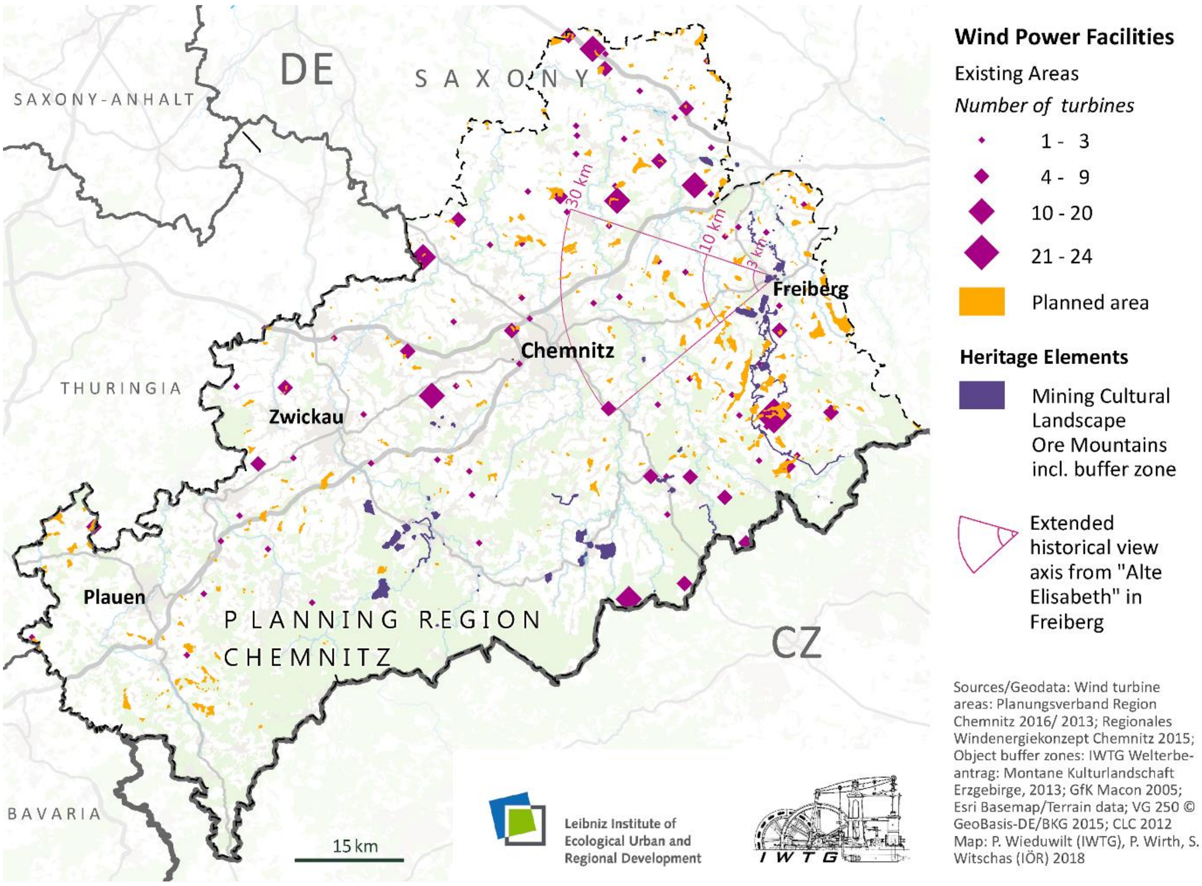


Fig 2. Planning Region Chemnitz – Wind power facilities and elements of the Mining Cultural Landscape Ore Mountains.

As a result of the first step, the Regional Planning Association detected 360 “potential areas for wind turbines” in the region (see the orange shapes in Figure 2). For the latter, we subsequently use the more manageable term “planned wind turbines”. In fact, in the 2013 Wind Energy Concept of the region (PV Chemnitz, 2013), the world heritage elements of the Mining Cultural Landscape Ore Mountains were not yet considered as taboo criteria. To avoid subsequent problems, the Regional Planning Association decided to initiate further investigations. This was the motivation for the study presented here. The data pertaining to the existing and planned wind turbines, especially the geographical coordinates and the total height of the existing wind power plants, were provided by the Planning Association.

Elements of the World Heritage

As already mentioned, the proclamation of the Mining Cultural Landscape Ore Mountains as a heritage subject represents an appreciation of about 800 years of mining in the area. Several minerals were extracted from the mountain range in the past, mainly silver, but also iron, lead, copper, nickel and tin. At other places, coal, lime and other raw materials were mined. And in the last phase from 1945 to 1990, uranium was the most important resource extracted from the Ore Mountains (Wagenbreth and Wächtler, 2012). Therefore, it is no wonder that to this very day, a lot of significant remains of mining history are found in many parts of the Ore Mountains. These are mainly the underground and surface facilities of the old mines, ore processing plants, a range of cities and settlements founded as mining towns, cultural traditions and customs and – finally – a cultural landscape which is characterized by mining dumps, surface breaks caused by mining, artificial watercourses, and several landmarks like shaft towers and smokestacks. Beginning in 2008, implementation studies were elaborated for each individual subject including spatial boundaries and buffer zones. Supported by the Saxon state government, the application was submitted to the UNESCO authorities in April 2014 (Welterbekonvent Erzgebirge, 2015). After a revision phase in 2016-17, the final decision is expected for 2019. This nomination for the world heritage status focuses on 500 German and Czech mining objects.

To enhance understanding of the regional embedding, the German objects of the mining landscape have been grouped into 39 substantive elements (Table 1). Each element can consist of several individual monuments, called “component parts”. To explain the relationship between heritage objects and elements, we look more closely at one of these elements – the “Historic Center of Freiberg” (Element No 5 in Table 1) in Section 4.3. In general, the single objects are heterogeneous: individual monuments (e.g., shaft buildings), groups of buildings (e.g., smelting complexes), townscapes (Freiberg, Annaberg, Marienberg and Schneeberg), linear elements (e.g., man-made ditches) and mining legacies in the landscape like mining heaps (Welterbekonvent Erzgebirge, 2015, p. 27). All elements of the Mining Cultural Landscape Ore Mountains are also pictured in Figure 2 as blue shapes, including the buffer zones.

Tab 1. Elements of the Mining Cultural Landscape Ore Mountains. Source: IWTG, 2013)

Nr.	Element of the Mining Cultural Landscape
E 1	*Element 1: Altenberg-Zinnwald Mining Landscape*
E 2	*Element 2: Glashütte Watch-making Industry Monuments*
E 3	*Element 3: Dippoldiswalde Medieval Silver Mines*
E 4	*Element 4: Brand-Erbisdorf Mining Landscape*
E 5	*Element 5: Historic Center of Freiberg*
E 6	*Element 6: Himmelfahrt Fundgrube Mining Landscape Freiberg*
E 7	*Element 7: Zug Mining Landscape*
E 8	*Element 8: Muldenhütten Metallurgical Complex*
E 9	*Element 9: Freiberg Northern Mining District with Ore Canal*
E 10	*Element 10: Gersdorf Mining Landscape and Altzella Monastery*
E 11	*Element 11: Freiberg Mining Water Management System*
E 12	*Element 12: Augustusburg Hunting Lodge*
E 13	*Element 13: Lengefeld Lime Works*
E 14	*Element 14: Historic Center of Marienberg*
E 15	*Element 15: Mining Landscape Lauta*
E 16	*Element 16: Grüner Graben Pobershau (water ditch)*
E 17	*Element 17: Grünthal Liquation Hut Complex*
E 18	*Element 18: Monuments of the Wooden Craftart in Seiffen*
E 19	*Element 19: Ehrenfriedersdorf Mining Landscape*
E 20	*Element 20: Niederzwönitz Paper Mill*
E 21	*Element 21: Historic Center of Annaberg*
E 22	*Element 22: Frohnau Mining Landscape*
E 23	*Element 23: Buchholz Mining Landscape*
E 24	*Element 24: Pöhlberg Mining Landscape*
E 25	*Element 25: Scheibenberg Geotope*
E 26	*Element 26: Schmalzgrube Ironworks Jöhstadt*
E 27	*Element 27: Historic Mining Monuments in Aue*
E 28	*Element 28: Schneeberger Floßgraben (timber transport ditch)*
E 29	*Element 29: Bad Schlema Mining Landscape*
E 30	*Element 30: Historic Center of Schneeberg*
E 31	*Element 31: Weißer Hirsch Fundgrube Schneeberg (mine)*
E 32	*Element 32: Schneeberg Mining Landscape*
E 33	*Element 33: Schindlers Werk Blue Dye Factory Zschorlau*
E 34	*Element 34: Hoher Forst Mining Landscape near Schneeberg*
E 35	*Element 35: Mining Landscape Eibenstock*
E 36	*Element 36: Erlahammer Ironworks Schwarzenberg*
E 37	*Element 37: Schwarzenberg Castle*
E 38	*Element 38: Monuments of Uranium Mining*
E 39	*Element 39: Monuments of Coal Mining*

Naturally, combining the protection of a historical mining landscape nominated for world heritage status and the development of wind energy is a challenging task for the relevant actors in spatial planning. In terms of the implementation of the competing goals, it is obviously important to enquire into the planning authority's scope for maneuvering. As location, shape and meaning of the listed elements of the world heritage application were accurately defined, politically agreed and already submitted to the World Heritage Committee, this subject was not negotiable. From this point of view, wind energy development was the flexible factor in the planning process.

4.3 Calculation of viewsheds with GIS

The basic concept for the method to be developed follows the calculation of viewsheds. For this task, we use selected tools of geo-information systems (GIS) which are already state of the art and can be found in several visibility studies, for example, in the Kanton Basel-Landschaft in Switzerland (Nateco, 2013) and in the Upper Middle Rhine Valley (Grontmij GmbH, 2013). GIS has become a widely-used tool in different fields of spatial planning. A typical application is the calculation of visual view relations between different objects based on digital elevation models. This function offers the possibility to generate viewsheds, showing the visible geographical area from a defined location. The generation of such viewsheds is typically used in terrain analyses which are important for several disciplines like urban, regional and landscape planning, archaeology and also for military purposes (see Weitkamp, 2011, p. 209). Basically, the operation viewshed calculates a possible visible space from a viewpoint in the terrain, including information of the surface rendering and the observer position above the ground (ibidem, p. 209). Using these options, the visual range of wind turbines can also be calculated. This issue was comprehensively investigated in the Ore Mountains by Wieduwilt (2014) in a master thesis. The methodological approach of the study is summarized in this paper, including a wider interpretation in the context of spatial planning and conclusions for the further development of the method.

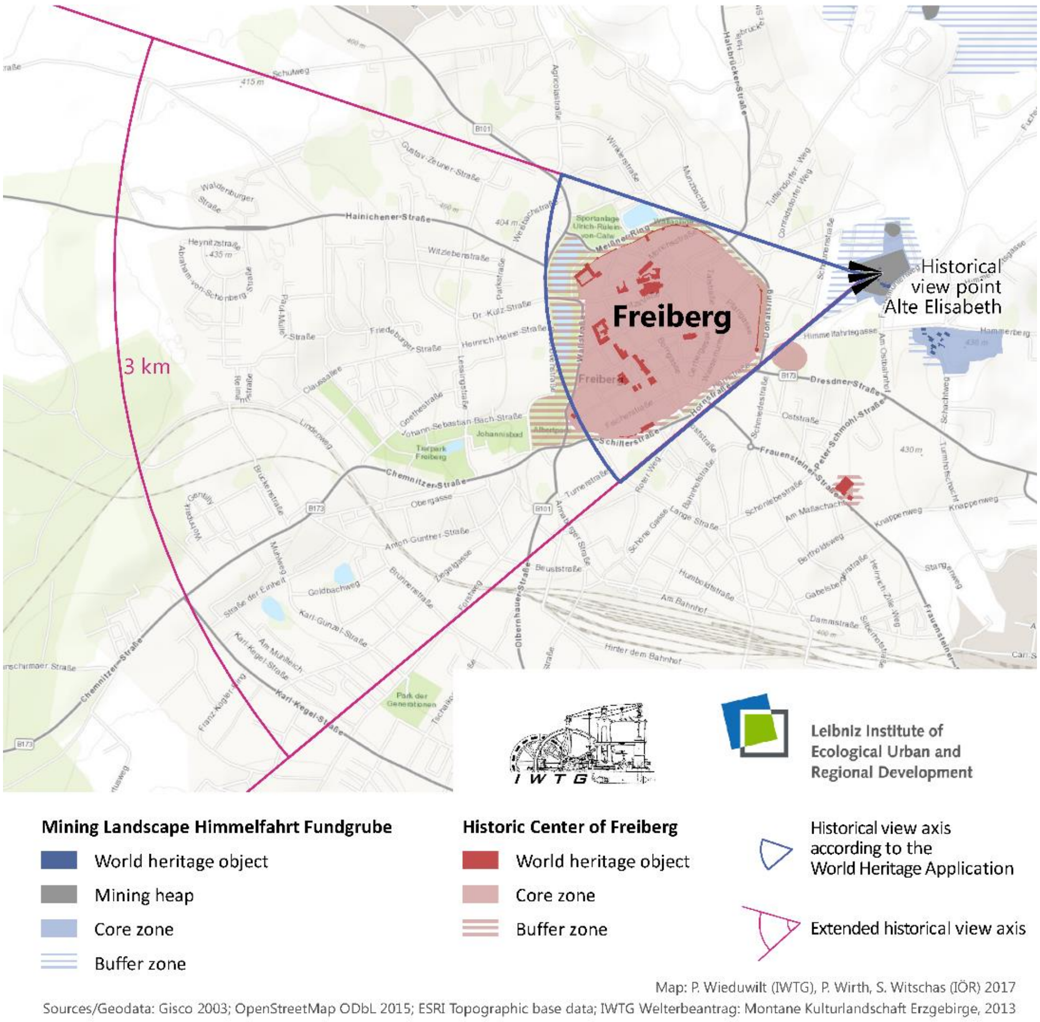


Fig 3. World heritage elements and view axis in the Freiberg area.

Before we focus on the methodology, it is necessary to review the input data. We use the example of the “Historic Center of Freiberg” (Element 5 in Table 1; see Figure 3) to demonstrate the starting position of our investigation. This element of the Mining Cultural Heritage includes five component parts: the historic center, the cathedral, the city hall, Donats Grave, and the historic town fortification. In the figure, we can see the world heritage objects of the “Historic Center of Freiberg” (dark red color), the core zone (light red) and the buffer zone (light red stripes). Every heritage element is characterized in this way. In addition to this, for 16 out of the 39 elements, historical view axes have been defined in the world heritage application, each of them with a historical viewpoint and a historical scenic overview. These historical view axes describe a short distance relation between the view point and the heritage element. The extension of these historical view axes is a maximum of 1 kilometer (IWTG, 2013). In our detailed view of Figure 3, we can see such an axis. This one is located on the top of the heap of the Alte Elisabeth Fundgrube Mine, a site of the Mining Landscape Himmelfahrt Fundgrube (see Element 6 in Table 1). This element of the mining cultural landscape is pictured as a blue shape in the figure. Characteristically, the view is directed on the historic city center of Freiberg (Element 5).

4.4 Distance Analyses

The impact of a wind turbine depends not only on pure (theoretical) visibility but also on the distance in relation to a historical landmark or viewpoint. In fact, the dominant visual impact of wind turbines decreases with increasing distance to them. This distance aspect between a viewer and objects in the landscape was already captured in older concepts of landscape planning (e.g., Grosjean, 1986; Litton, 1972). Most of these concepts distinguish three zones: short, middle and long distance. Here, we combine the typical characteristics of human perception as described by Nohl (2001, pp. 81–82) with a distance concept proposed by Grosjean (1986) (Table 2).

Tab 2. Distance zones in landscape perception.

Zone	**Human perception (Acc. to Nohl, 2001)**	**Kilometers (acc. to Grosjean, 1986)**
Short-distance	*Maximum detail; differentiation like colors and shapes; intensive perception of individual landscape elements*	*0–3*
Middle-distance	*A distance view to objects; the landscape and individual elements merge; view perspectives between landmarks and the environment still exist*	*3–10*
Long-distance	*Observing a schematic scenery; view perspectives between individual objects and the landscape lose importance*	*10–30*

Using this system, all historical view axes were extended to a maximum distance of 30 km, divided into the three distance zones 0–3, 3–10 and 10–30 kilometers (see Table 2) and depicted in Figures 1, 2 and 3. In addition to this, elements with no defined historical view axis were given a circular buffering zone with a maximum distance of 30 km. All operations were performed using GIS.

In a subsequent step, all existing (purple symbols in Figure 1 and 2) and planned wind turbines (orange symbols in Figure 2 around the potential areas for wind turbines), which are in the extended historical view axes or in the circular buffering of each element were recorded and categorized in relation to the distance zones.

4.5 Visibility Analyses

In this investigation, we calculated visibility based on the total height from all existing and planned wind turbines. As explained in Section 4.3, the visible range of objects in the GIS-based terrain analyses is termed viewsheds. They describe the theoretical visibility of the wind turbines in the landscape. In our example in Figure 3, where the viewshed of the wind turbine overlaps the historical view point, the wind turbine is theoretically visible at the historical view point. For elements with no historical view axis, the viewshed of the wind turbines was calculated in the same way. We expect wind turbines to have a visual impact when they are visible in the core or buffer zone of the element with no historical view axis. Therefore, if part of the core ore buffer zone is overlapped by the viewshed of a wind turbine, the latter is theoretically visible in this part of the core ore buffer zone.

The data used for the calculation were provided by the planning association of the Chemnitz Region (see 4.3.2). This included the height and the location of each individual existing wind turbine in connection with the digital elevation model. Moreover, the planning association provided the data for the planned wind turbines based on the draft version of the Regional Wind Energy Concept (PV Chemnitz, 2013). The calculation of the visual range of planned wind turbines was performed in the same way as for the existing ones, except in one point. As the definite height of planned wind turbines is unknown, it had to be calculated as a theoretical assumption in accordance with state-of-the-art wind power technology. On this basis, the visual range of all planned wind turbines was calculated using a height of 200 meters above ground.

Unfortunately, information about the height of vegetation and the surrounding buildings were not available for the calculation. Consequently, we have to accept that there are some differences between the results of the mathematic modeling and reality.

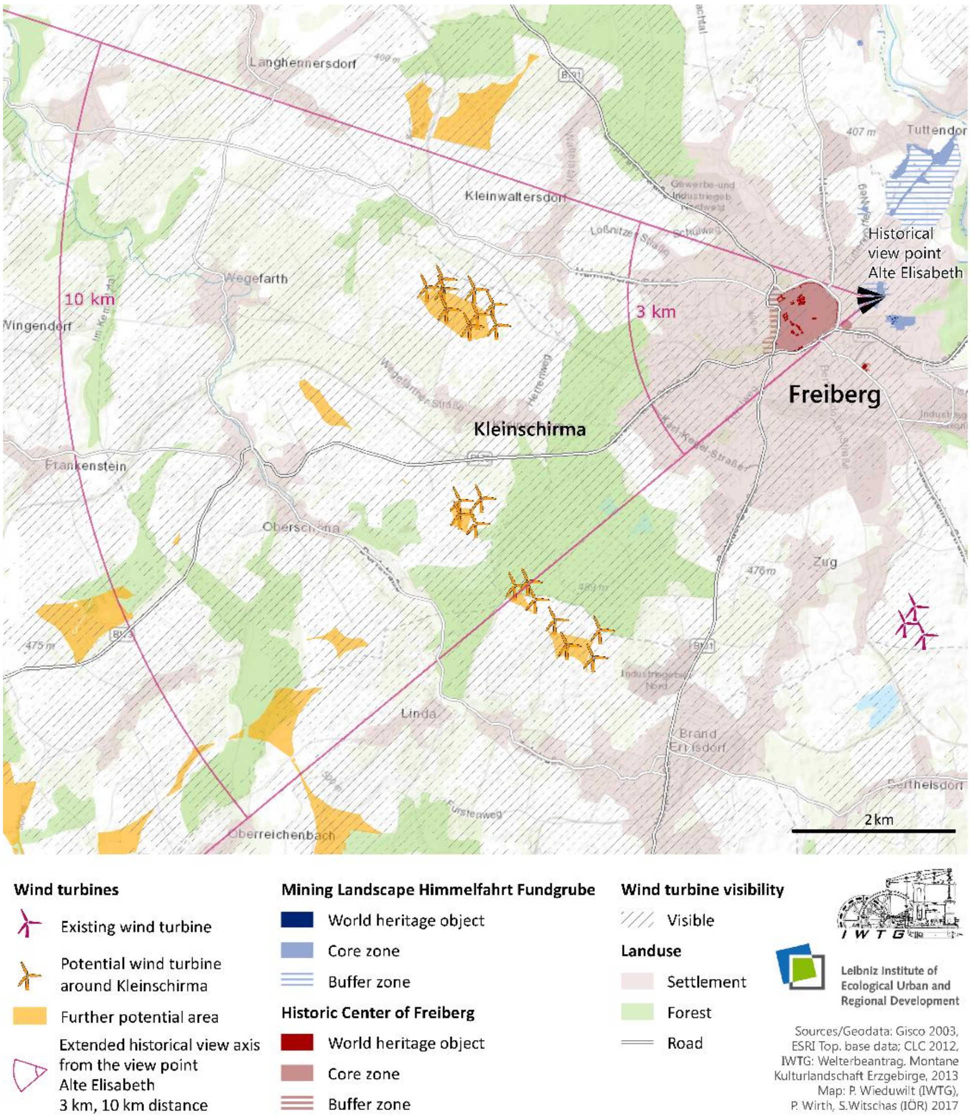


Fig 4. The Historic Mining City Freiberg with surrounding wind power facilities (existing and planned).

To fulfill the task, the complete planning region was investigated. As it would be confusing to display here all visual links between the elements of the Mining Cultural Landscape Ore Mountains and the wind turbines (existing and planned), we reduced the complexity and focus exclusively on our example Element 5 (see Figure 4). When we overlap the extended view axis with the potential area for wind turbines "Kleinschirma", we can see that the visible range (shaped area = viewshed seen in Figures 3 and 4) of all planned wind turbines overlaps the viewpoint from the heap of the Alte Elisabeth Fundgrube Mine. This indicates that all planned wind turbines in the potential area "Kleinschirma" would be visible in the middle-distance zone (10 km).

4.6 Appraisal of Visual Relations

Having explained the methodology used to detect visual links between the elements of the Mining Cultural Landscape Ore Mountains on the one hand and existing as well as planned wind turbines on the other hand, under consideration of distances, we can now delineate the results of the case study. All in all, we found that the 39 heritage elements have a total number of 533 visual links to existing wind turbines. The high number of visual links results from the possibility that a heritage element can have several visual links to wind turbines. In relation to the planned wind turbines (360 locations of "suitable areas for wind energy") there are even 1544 visual links. Accordingly, the total number of visual links would nearly triple if the planned wind turbines were constructed.

However, not all elements are affected in the same way (Figure 5). The vertical axis of the charts shows the number of visual links of all wind turbines (existing and planned) related to the elements. The horizontal axis shows each element and the respective possible visual links to wind turbines. Both visual links of existing (green) and planned (pink) wind turbines are pictured in the figure. Therefore, we could also see what would happen if all planned wind fields were realized.

Obviously, the heritage elements in the Mining Region Freiberg, are characterized by the highest number of visual links to existing and planned wind turbines (E 5, E 6, E 7, E 9, E 11). This is because this location contains the highest number of potential areas for wind power plants, and also because the density of heritage elements is notably high in this part of the Chemnitz planning region. On the other hand, the elements E 1, E 2, E 3, E 17, E 22, E 24, E 25 have no visual links to wind turbines.

Furthermore, there are eight heritage elements (E 14, E 17, E 18, E 19, E 26, E 29, E 31, E 33) with visual links to planned wind turbines, which have no visual links to existing wind turbines. If the plans were realized, the visual impact on these elements would increase significantly. But not all of them would be affected in the same way (Figure 5).

In the subsequent step, we focus on the statistical distribution of visual links in relation to the predefined distance zones. Firstly, we looked at the current situation with the visual links of the elements in relation to the existing wind turbines (Figure 6, left graph). Only 3 percent of all visual links of existing wind turbines are located up to the 3 km distance zone. Moreover, we can see that 44 percent of visual links of existing wind turbines are located in the 3-10 km distance zone. The highest amount of 53 percent visual links are located in the 10-30 km distance zone.

Looking at the statistical distribution of visual links of planned wind turbines in relation to the distance zones, the situation is more problematic (Figure 6, right graph). If the plans were realized, the total amount of visual links would triple in the short-distance and middle-distance zones, and nearly quadruple in the long-distance zone. Although the number of visual links would increase significantly with the new planning concept, the share between the distance zones (short, middle, long) would hardly change.

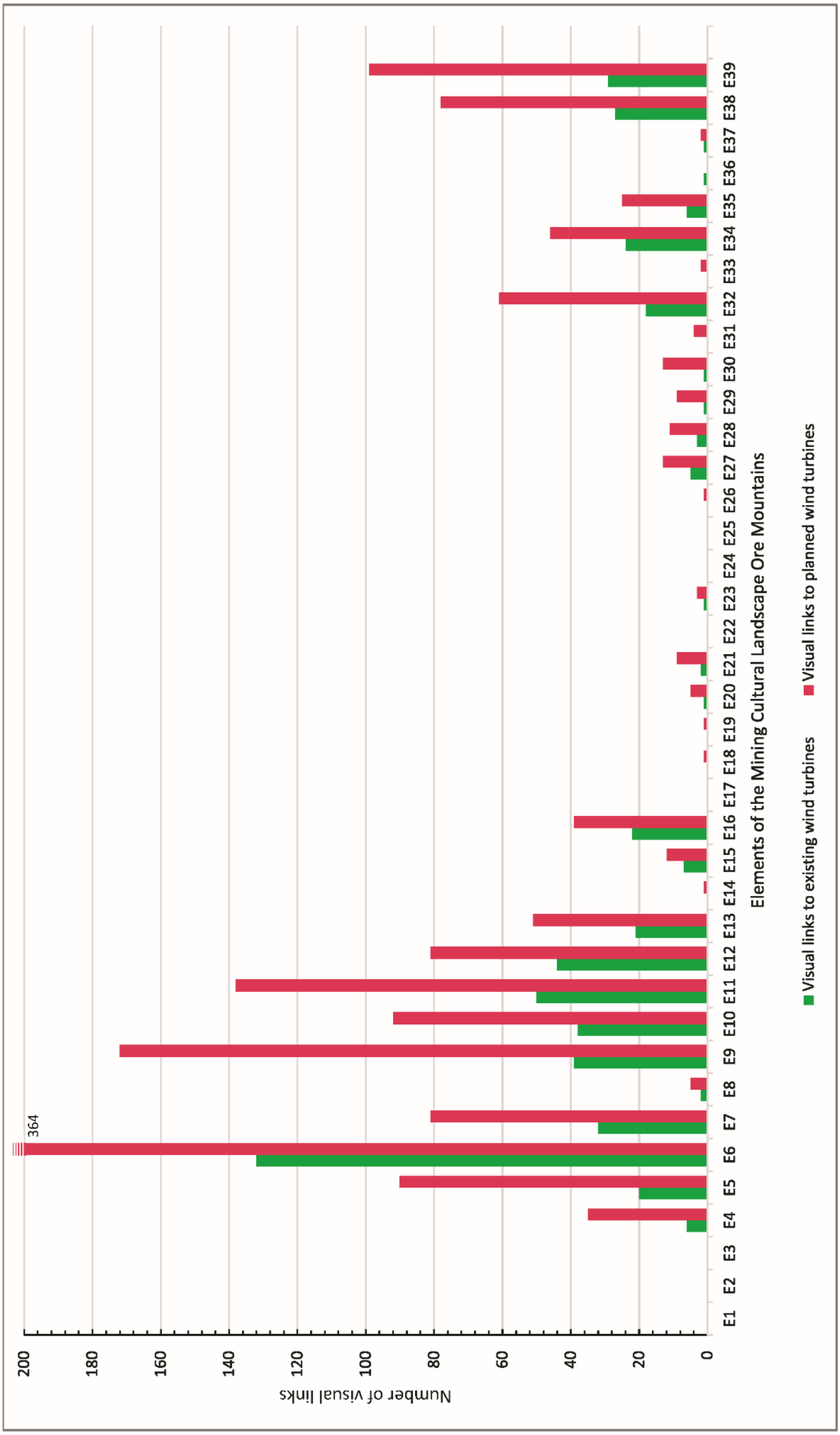


Fig 5. The 39 elements of the Mining Cultural Landscape Ore Mountains and their visual links to existing and planned wind turbines (evaluation result).

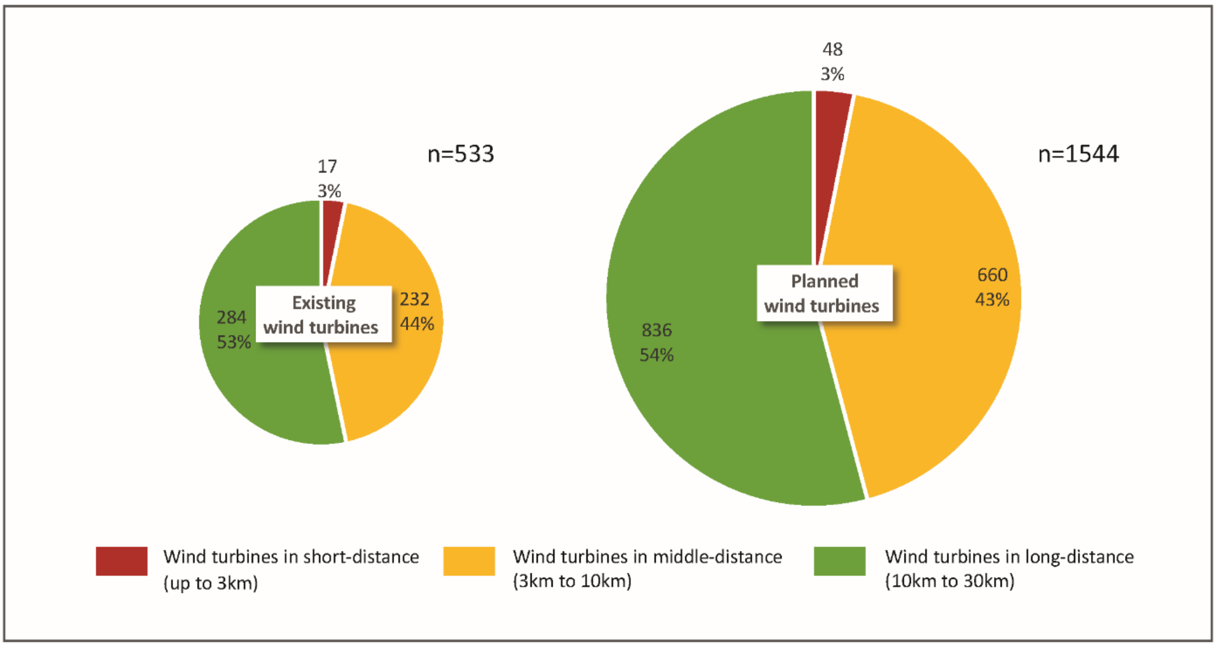


Fig 6. Statistical distribution of visual links to existing and planned wind turbines related to distance zones.

5. Discussion

First and foremost, the method described in the previous section – called the Multiple-Visual-Link Method – is highly suitable to characterize the visual relations between multiple subjects of protection (in our case 39 elements of a planned world heritage site in the German Ore Mountains) and a large number of wind turbines (here more than 600), some already in existence, some still under consideration in a planning procedure. By calculating viewsheds with a tailor-made GIS application, the user is able to estimate the visual relation between the two types of subjects in a larger area with a favorable cost-benefit relation. In combination with a distance module, one can adjust whether there is a visual relation between two subjects or not, and also how intensive the relation is (short, middle, long distance). With the help of distance zone models which are already state of the art in landscape planning, it is possible to get a general overview of a multitude of visual relations in a large area as a basis for a rough evaluation of the negative impacts of wind turbines on heritage subjects.

The algorithmic approach developed here leads to solid results which can be translated into planning recommendations. In the above described region, it is possible to identify clearly determined categories of visual relations. For the planning authority responsible, these are important hints on critical locations of existing or planned wind turbines. The recommendations can vary:

Of course, wind turbines located in the *short-distance zone* have the highest potential to impair the integrity of elements of the Mining Cultural Landscape Ore Mountains. We suggest excluding these locations from the current and future planning of wind turbines. Regarding existing wind turbines in the short-distance zone, we recommend prohibiting renewals after the end of the operation time of the wind power plants.

The visual links of wind turbines in the *middle-distance zone* have a lower potential to impair the integrity of the heritage elements. But it is possible that wind turbines in this zone may have a disturbing influence on heritage elements, mainly those with a strong vertical component such as the silhouettes of mining towns, churches, shaft-frames, smokestacks etc. Planning instances should thus have a closer look at such cases to estimate the conflict potential, maybe by using traditional visualization methods.

At least we can generalize that all visual links of wind turbines in the *long-distance* zone have little potential to impair the visual integrity of the heritage elements. In general, these locations seem to be suitable for future wind energy planning. Only in specific cases where a wind turbine is located in the long-distance sector of an extended historical view axis does a case-by-case study seem meaningful.

As we can see, the developed method cannot replace case-by-case studies completely. As the method does not consider specific topographic situations like vegetation and building structures, reality can differ to a certain degree. Consequently, it can be necessary to complement the Multiple-Visual-Link Method by individual case studies. The strength of the general method described here is that it can significantly reduce the number of visual links that must be investigated by in-depth studies.

The development of such a method can be seen as an important improvement to manage the conflict between conservation and development goals in cultural landscapes. As the results presented here are based on a general concept for an entire planning district, the method also fulfills the requirements of German legislation: it provides a coherent concept for the whole planning region. This makes the discussed method an interesting tool for regional planning, particularly in the process of determining "suitable areas for wind energy".

Taking the Ore Mountains as a case study, the method was developed for a low mountain range (altitude up to 1,000 meters) with a comparatively high population density, and strong cultural influence (settlements, forestry, agriculture, tourism, natural protection, former mining) under humid climate conditions. In general, the authors do not see restrictions to the use of the approach under different natural and institutional conditions. Of course, it may be necessary to modify the approach for specific geographical conditions. For instance, "visible space" and "perceived landscape openness" (Weitkamp et al., 2014, p. 140) depend significantly on landscape character. Consequently, in lowlands, the distance-zone concept will probably require modification, as visual distances of 30 kilometers are hardly relevant in such areas.

6. Conclusion

It is safe to say that goal conflicts between conservation and development goals will continue to be a challenge for landscape, urban and regional planning in the future. Consequently, there is a need for instruments to be used to reduce or to avoid conflicts, as described in this paper.

The Multiple-Visible-Link Method was primarily developed to describe the relations between wind power facilities and monument objects. Of course, the opportunities for implementation seem to be much broader. On the one hand, it seems to be possible to adapt the method for similar problems and conflicts of visual relations, for instance, the visibility of high voltage power lines. On the other hand, functional relations also have a distance aspect like the spatial relation between the habitats of bats and disturbing utilities like motorways.

Bearing this in mind, there is a need to specify and to sensitize the method. When we come back to our example of visible links between heritage subjects and wind turbines, it is obvious that the component parts of the planned world heritage site vary in nature. The character of an old water ditch resulting from mining times differs from that of the medieval miners' church in one of the mountain towns. At the moment, the described method is hardly able to consider such individual features of the subjects of protection. For this reason, further research is necessary to include the different vulnerability of the subjects of protection in relation to disturbing factors.

Finally, it should be mentioned that the introduced method is clearly a supportive technological tool to optimize and to objectify planning decisions. Mainly, it is intended for public authorities and experts in the field of wind power planning and management. The method has the potential to make decisions about the location of wind fields more transparent. It may also contribute to objectifying public discussions about wind power projects and to more acceptance for wind turbines. Recent research has shown that this can be a challenging and exhausting task for investors and planners (Wirth and Leibenath, 2017).

Acknowledgements

The authors would like to thank Dr. Jens Uhlig from the Planning Association of the Chemnitz Region for the close cooperation and for the helpful comments.

[1] Alumäe, H., Printsmann, A. & Palang, H. (2003). Cultural and historical values in landscape planning: locals‘ perception. In: Palang, H. & Fry, G., eds., *Landscape Interfaces. Cultural Heritage in Changing Landscapes* (pp. 125–145). Dordrecht/Boston/London: Kluwer.

[2] Bertsch, V., Hall, M., Weinhardt, C. & Fichtner, W. (2016). Public acceptance and preferences related to renewable energy and grid expansion policy: Empirical insights for Germany. *Energy* 114, 465–477. DOI: 10.1016/j.energy.2016.08.022.

[3] Bohnet, I. C. & Konold, W. (2015). New approaches to support implementation of nature conservation, landscape management and cultural landscape development: experiences from Germany's southwest. *Sustainable Sciences* 10(2), 245–255. DOI: 10.1007/s11625-015-0290-z.

[4] Bovet, J. (2015). Steuerung der Windenergie durch Raumordnung. Aktuelle Rechtsprechung als Herausforderung für die Planung. In *Ausbaukontroverse Windenergie* (pp. 591–602). Stuttgart: Franz-Steiner-Verlag.

[5] Bürgi, M., Hersperger, A. M. & Schneeberger, N. (2005). Driving forces of landscape change – current and new directions. *Landscape Ecology* 19(8), 857–868. DOI: 10.1007/s10980-005-0245-3.

[6] Fairclough, G. & Möller, P. G., eds. (2008). *Landscape as Heritage. The Management and Protection of Landscape in Europe, a summary by the COST A27 project "Landmarks,"* Bern: Geographica Bernensia.

[7] Grosjean, G. (1986). *Ästhetische Bewertung ländlicher Räume: am Beispiel von Grindelwald im Vergleich mit anderen schweizerischen Räumen und in zeitlicher Veränderung*. Bern: Universität Bern.

[8] Järvelä, M., Jokinen, P., Huttunen, S. & Puupponen, A. (2009). Local food and renewable energy as emerging new alternatives of rural sustainability in Finland. *European Countryside* 1(2), 113–124. DOI: 10.2478/v10091-009-0010-8.

[9] Jones, M. (2003). The concept of cultural landscape: discourse and narratives. In Palang, H. & Fry, G., eds., *Landscape Interfaces. Cultural Heritage in Changing Landscapes* (pp. 21–51), Dordrecht/Boston/London: Kluwer.

[10] Jones, M. & Stenseke, M., eds. (2011). *The European Landscape Convention*. Dordrecht: Springer Netherlands.

[11] Kloos, M., Tebart, P. & Wachten, K. (2014). *Unabhängiges Gutachten zur Welterbeverträglichkeit geplanter Windkraftanlagen in Wiesbaden* [research report]. Wiesbaden: Landeshauptstadt.

[12] Leibenath, M. & Otto, A. (2013). Local debates about 'landscape' as viewed by German regional planners: Results of a representative survey in a discourse-analytical framework. *Land Use Policy* 32, 366–374. DOI: 10.1016/j.landusepol.2012.11.011.

[13] Litton, R. B. (1972). Aesthetic dimensions of the landscape. In Krutilla, J. V., ed., *Natural Environments: Studies in Theoretical and Applied Analysis* (pp. 262–291). Baltimore: Johns Hopkins University Press.

[14] McDowall, W., Ekins, P., Radošević, S. & Zhang, L. (2013). The development of wind power in China, Europe and the USA: how have policies and innovation system activities co-evolved? *Technologic Analysis and Strategic Management* 25(2), 163–185. DOI: 10.1080/09537325.2012.759204.

[15] Naveh, Z. (1995). Interactions of landscapes and cultures. *Landscape Urban Planning* 32(1), 43–54. DOI: 10.1016/0169-2046(94)00183-4.

[16] Nohl, W. (2001). *Landschaftsplanung: ästhetische und rekreative Aspekte. Konzepte, Begründungen und Verfahrensweisen auf der Ebene des Landschaftsplans*. Berlin: Patzer.

[17] Pinto-Correia, T. & Kristensen, L. (2013). Linking research to practice: The landscape as the basis for integrating social and ecological perspectives of the rural. *Landscape and Urban Planning* 120, 248–256. DOI: 10.1016/j.landurbplan.2013.07.005.

[18] Printsmann, A., Kruse, A. & Roth, M. (2012). Introduction for living in agricultural landscapes: practice, heritage and identity. *European Countryside* 4(2), 89–100. DOI: 10.2478/v10091-012-0016-5.

[19] Quilter, J. (2015). Navitus Bay rejected. *Wind Power Offshore*. URL https://www.windpoweroffshore.com/article/1363660 (accessed 6.26.18).

[20] Short, C. (2008). Balancing nature conservation "needs" and those of other land uses in a multi-functional context: High-value nature conservation sites in lowland England. In Robinson, G., ed., *Sustainable Rural Systems. Sustainable Agriculture and Rural Communities* (pp. 125–144). Farnham: Ashgate.

[21] Simons, S. (2011). UNESCO's Wind Turbine Problem: Mont-Saint-Michel's World Heritage Status Under Threat. *Spiegel Online*. URL: http://www.spiegel.de/international/europe/unesco-s-wind-turbine-problem-mont-saint-michel-s-world-heritage-status-under-threat-a-744555.html (accessed 6.26.18).

[22] Taylor, K. (2009). Cultural Landscapes and Asia: Reconciling International and Southeast Asian Regional Values. *Landscape Research* 34(1), 7–31. DOI: 10.1080/01426390802387513.

[23] Veillon, R. (2014). *State of conservation of World Heritage properties. A statistical analysis (1979–2013)*. Paris: UNESCO World Heritage Center.

[24] Wagenbreth, O. & Wächtler, E., eds. (2012). *Bergbau im Erzgebirge*. Heidelberg: Springer.

[25] Weitkamp, G. (2011). Mapping landscape openness with isovists. *Research in Urbanism Series* 2, 205–223. DOI: 10.7480/rius.2.213.

[26] Weitkamp, G., Lammeren, R. van & Bregt, A. (2014). Validation of isovist variables as predictors of perceived landscape openness. *Landscape and Urban Planning* 125, 140–145. DOI: 10.1016/j.landurbplan.2014.02.021.

[27] Wieduwilt, P. (2014). *Potenzielle Auswirkungen von Windenergieanlagen auf Sichtbeziehungen von Welterbestätten: Eine GIS-gestützte Analyse am Beispiel der Montanen Kulturlandschaft Erzgebirge/Krušnohoří* [Master Thesis]. Freiberg: TU Bergakademie.

[28] Wirth, P. & Leibenath, M. (2017). Die Rolle der Regionalplanung im Umgang mit Windenergiekonflikten in Deutschland und Perspektiven für die raumbezogene Forschung. *Raumforschung und Raumordnung – Spatial Research and Planning* 75(4), 389–398. DOI: 10.1007/s13147-016-0436-1.

Other sources

[29] BfN/BBSR (Ed.) 2014. Den Landschaftswandel gestalten! Bundesamt für Naturschutz (BfN, Federal Agency for Nature Conservation), Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR, Federal Office for Building and Regional Planning), Bonn. http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_architektur/ila/lp/Forschung/laufende%20 Forschung/FuE_Landschaftswandel_Band03_2.Auflage.pdf.

[30] BMWi, 2015. Erneuerbare Energien auf einen Blick [WWW Document]. URL http://www.bmwi.de/DE/Themen/Energie/Erneuerbare-Energien/erneuerbare-energien-auf-einen-blick.html (accessed 8.21.15).

[31] Council of Europe, 2000. European Landscape Convention. http://conventions.coe.int/Treaty/Commun/QueVoulezVous.asp?NT=176&CM=8&CL=ENG.

[32] Grontmij GmbH, 2013. Sichtachsenstudie – Windkraft und UNESCO Welterbe Oberes Mittelrheintal. Gutachterliche Bewertung des Konfliktpotenzials hinsichtlich der Verträglichkeit von Windenergieanlagen mit dem Welterbe – Status und Empfehlungen zum Umgang mit visuell sensiblen Bereichen [WWW Document]. URL http://www.welterbe-oberes-mittelrheintal.de/fileadmin/dokumente/PDF/Sichtachsenstudie/Sichtachsenstudie_Welterbe-OM_Dez-2013.pdf (accessed 6.16.17).

[33] GWEC, 2016. Global Wind Report. Global Wind Energy Council [WWW Document]. Statistics. URL http://www.gwec.net/global-figures/graphs/ (accessed 6.27.17).

[34] IWES (Ed.) 2013. Wind Energy Report Germany 2013. Fraunhofer Institute for Wind Energy and System Technology. http://www.windmonitor.de/report.

[35] IWTG, 2013. Mining Cultural Landscape Erzgebirge/Krušnohoří. Management Plan. Institut für Industriearchäologie, Wissenschafts- und Technikgeschichte. TU Bergakademie Freiberg.

[36] Leißling, W. (2006). Wie weit reicht der Umgebungsschutz eines Einzeldenkmals? Windpark gegen Wartburg. Bauwelt 37–39.

[37] Maslaton, M., 2011. Rechtsstreit um Windenergieanlagen in Thüringen ruht. Maslaton Rechtsanwaltsgesellschaft mbH [WWW Document]. URL https://www.maslaton.de/news/Rechtsstreit-um-Windenergieanlagen-in-Thueringen-ruht--n20 (accessed 7.3.17).

[38] Michel, M. (2013). Oberes Mittelrheintal soll komplett ohne Windräder bleiben. Rhein-Ztg.

[39] Nateco, 2013. Windenergiestudie. Analyse der Landschaftsverträglichkeit. Untersuchung im Kanton Basel-Landschaft (Schweiz).

[40] OVG Rheinland-Pfalz, 2016. Der Antrag der Klägerin auf Zulassung der Berufung gegen das Urteil des Verwaltungsgerichts Koblenz vom 20. Oktober 2015 wird abgelehnt. Oberverwaltungsgericht Rheinland-Pfalz, AZ 1 A 11091/15 OVG.

[41] PV Chemnitz, 2015. Regionales Windenergiekonzept. Entwurf für das Beteiligungsverfahren gemäß §§ 9 und 10 ROG in Verbindung mit § 6 Abs. 2 SächsLPlG. Planungsverband Region Chemnitz [WWW Document]. URL http://www.pv-rc.de/downloads/6_II_windenergiekonzept/I_Windenergiekonzept_Text_und_Anlagenteil.pdf

[42] PV Chemnitz, 2013. Regionalplan. Regionales Windenergiekonzept. Beteiligung an der Ausarbeitung des Planentwurfs gemäß § 9 ROG in Verbindung mit § 6 Abs. 1 SächsLPlG. Planungsverband Region Chemnitz.

[43] Sternberg, J. P. (2011). Was würde Luther dazu sagen? Christ und Welt. Zeit.

[44] UNESCO World Heritage Centre, 2015. The Operational Guidelines for the Implementation of the World Heritage Convention [WWW Document]. UNESCO World Herit. Cent. URL http://whc.unesco.org/en/guidelines/ (accessed 6.15.17).

[45] UNESCO-Welterbestätten Deutschland, 2012. UNESCO-Welterbe in Deutschland. Geschichte voller Leben [WWW Document]. URL http://www.unesco-welterbe.de/service/brochure (accessed 6.15.17).

[46] Verwaltungsgericht Meiningen, 2010. Urteil vom 28.07.2010, AZ 5 K 670/06 Me.

[47] Völker, S.-U. (2011). Untersuchung warnt vor Windrädern auf Milmesberg bei Marksuhl. *Thüringer Allgemeine 27072011*. URL http://www.thueringer-allgemeine.de/web/zgt/suche/detail/-/specific/Untersuchung-warnt-vor-Windraedern-auf-Milmesberg-bei-Marksuhl-924726121 (accessed 6.15.17).

[48] Welterbekonvent Erzgebirge (Ed.) 2015. The mining cultural landscape Erzgebirge/Krušnohoří on its journey to world heritage status. Welterbekonvent Erzgebirge, Wirtschaftsförderung Erzgebirge. http://www.montanregion-

erzgebirge.de/fileadmin/Welterbe_Aktuell/downloads/brochures/Broschuere_Montanregion_Erz_en.pdf.

[49] WER, 2013. Milmesberg: Keine Windräder in Sichtweite der Wartburg [WWW Document]. Koord. Wind. URL http://k-wer.net/wp-content/uploads/2014/10/WER-aktuell-6-2013-download.pdf (accessed 11.9.17).