WIND FARMS AND LANDSCAPE VISUAL OVERLOAD

VJETROELEKTRANE I VIZUALNA OPTEREĆENOST KRAJOLIKA

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UDK 712.3:621.311.245>(497.5)=111
Primljeno / *Received*: 2014-11-08
Prethodno priopćenje
Preliminary communication

The process of wind turbine allocation which has already started in Croatia is currently based on the legislative regulatory system that lacks a basic national strategy plan for the integration of wind turbines into landscape. The result of this kind of 'case to case' approach to development is the uncertainty regarding the potential consequences of these actions on landscape. One of the possible consequences of interpolating a greater number of wind turbines in a rural landscape is its complete visual transformation into a landscape of technical character and, as a result, the loss of its former natural and cultural values. Rural coastal areas are potentially the most affected due to their great potential for the development of wind turbines.

The main dilemma in this paper is the issue of a potential visual overload of sensitive rural areas in Croatia. Thus, a projection of visual exposure of all the existing and planned wind farms was made for this purpose. Such projection could be useful for any future cumulative visual impact assessment of wind turbines on the existing landscape, as well as for the development of an appropriate strategy plan for wind power exploitation.

Keywords: Wind farm; rural landscape; visual overload

Introduction

The process of wind farm planning that has become more popular in Croatia lately (especially in the last 5 to 10 years) has already resulted in a large visual impact on certain Croatian landscapes. Some Croatian landscapes are more affected, especially rural landscapes of Dalmatia and Kvarner. Although there are many different aspects of the issue of impact on the landscape to argue about, the main focus of this research is the problem of landscape visual overload. This mainly refers to the excessive number of wind turbines (of one or more wind farms) in a particular landscape unit or in an observer's visual field. Also, the result of their construction is often a complete transformation of a certain landscape type into a landscape of emphasized technological characteristics. For example, the result could be a complete visual transformation of some rural landscapes into landscapes with technical characteristics. The potential consequence of this visual overload trend is the negative perception of wind farm landscape by dwellers, visitors and /or tourists.

When talking about a visual overload, one can differentiate between two main terms: carrying capacity and absorption capacity. *Carrying capacity* refers to the question of wind turbine number that can be interpolated into the landscape without causing a visual overload. Generally, when this capacity is exceeded, the landscape is perceived as supersaturated (e.g. the entire horizon of the observer is filled with wind turbines). An example of such a transformation is shown in Figure 1 where we can see a visually pleasant landscape (wind farm Vrataruša near Senj, Croatia) and a complete transformation of that same landscape shown in Figure 2 (photo simulation of the previous picture). We can see a visually cumbersome landscape due to the number of wind turbines (the perceptual field is overwhelmed).

Absorption capacity refers to the degree of change which a certain landscape is able to withstand. The degree of change is considered

Figure 1 Visually pleasant landscape (wind farm Vrataruša, Senj, Croatia)

Figure 2 Visually cumbersome landscape due to the number of wind turbines (wind farm Vrataruša-photo simulation)

Figure 3 Rural landscape with wind turbines

Figure 4 Landscape of wind turbines (photo simulation)

positive if it does not substantially alter the existing landscape characteristics. A negative degree of change is the one which substantially degrades the existing landscape features. For example, a wind farm becomes visually dominant landscape element, while other landscape elements lose their importance in landscape perception. This transition is presented in Figure 3 and Figure 4 where we can see a "rural landscape with wind turbines" transformed into a "landscape of wind turbines". In Figure 3 wind turbines are in a proportional relationship to other landscape elements and in Figure 4 wind turbines are visually dominant over other landscape elements and the rural features of the landscape are lost.

The problem of landscape visual overload is something that should be primarily regulated by strategic planning documents (at the strategic planning level) and later on, when a specific case of wind farm planning or an existing wind farm expansion is considered, it should be comprehensively covered in the environmental impact study (in the process of environmental impact assessment). Despite this logic, the strategy documents concerning this subject do not exist in Croatian legislative plans.

On the other hand, in most cases, environmental impact studies are dealing with an isolated case of one wind farm or sometimes even with only one particular part of a wind farm. These studies do not consider other potential locations for wind farm building nor the visual impact of other potential wind farms in the area. In this way, in the process of the visual impact assessment of the wind farm planning, there is a lack of cumulative impact and the question of landscape visual overload is only partially covered. This results in an uncertainty regarding the ultimate visual impact that can occur when a larger number of wind farms or wind turbines are present within a particular landscape unit or a region. Rural and cultural landscapes are the ones most affected with this kind of planning (or the lack of one).

Therefore, the main dilemma of this study is the possibility of a wind farm visual overload of some landscapes in Croatia. After analyzing Croatian wind farm database, it has become apparent that there are not many wind farms in existence at the moment. On the other hand, there seem to be many possible locations that have been designated for wind farm development and are now in different phases of exploration or realization, notably in Dalmatia and Kvarner regions. Accordingly, the pressure on landscape in these areas of Croatia is the greatest, as these are the areas with the highest wind potential (URL 4). For this reason, we have also chosen Dalmatia, the part from Gračac city to Zagvozd,

as the research area for this study. Visual exposure analysis of the existing and planned wind farms has been made and the aim of this analysis is to determine potentially vulnerable parts of the landscape in relation to the future introduction of wind farms. Hence, the aim is to expose the landscape parts which are at risk of becoming visually overloaded or, in other words, of losing their existing visual characteristics and becoming completely transformed into a landscape of predominant technological features.

Review of the previous researches

Across Europe, wind power usage has been growing and there are signs that such growth will be sustained or increased (Warren et al., 2005). Members of the European Union have committed to increase consumption of renewable energy for 20% by 2020 and the aims of Croatian development strategy are focused on similar efforts (Aničić et al., 2013). In Croatia, wind farms are the most common renewable energy source, which means that in the upcoming years we will probably be faced with even more pressure on the Croatian landscape.

The development of wind power is controversial due to the conflicts between the aims of development and protection. The development of wind farms is driven by a desire to increase renewable energy sources and protection actions derive from concerns about the loss of natural, cultural or visual values of landscapes (transformation of "too many" landscapes into landscapes of predominant technical characteristics). Furthermore, there are concerns that the impacts of wind farms on landscape would damage tourism (Warren et al., 2005), especially in countries where landscape has an important role for the tourism industry. The resolution of this controversy between development and protection will have great implications on the way the land is used and will change rural landscapes for decades to come (Warren et al., 2005). Although there are many different aspects of the impact on landscape to debate about, the main focus of this research is the problem of landscape visual overload. The visual overload refers to the excessive number of wind turbines (of one or more wind farms) in a particular landscape unit or the observer's visual field. In terms of perception it could be related to terms of carrying capacity and absorption capacity (Aničić et al., 2012).

In this regard, some studies on wind farm landscape perception have been done. The results of the majority of these researches of which some of them have been done in Croatia (Cifrić, Trako, 2008a; Cifrić, Trako 2008b, Miščetić et al., 2008), have shown that public opinion about the wind farm landscape varies from neutral to mostly positive. Surveys of public opinion frequently show that large majorities of residents in areas with wind farms are in favor of wind power, both in principle and in practice, and that positive attitudes increase through time and with proximity to wind farms (Warren et al., 2005: 858). But, on the other hand, studies have also shown that in situations when the wind turbine numbers exceed certain quantity (number of wind turbines in some particular landscape) the perception of that wind farm landscape is less positive. DeWine-Wright (2005) cites a study in which a better acceptance of wind farms was determined when there were no more than nine wind turbines, as well as a study that mentions a better acceptance of wind farms with smaller number of wind turbines than those with a large number. A study conducted in Ireland (URL 5) also showed greater preference for wind farms with 5-10 than for those with larger number of turbines. The document of the European Council (URL 2) also notes that positive perception does not depend on a single wind turbine placement in a landscape, but instead on the perception of the whole wind farm (or wind turbines). These studies have shown that the perception of a wind farm landscape is more positive in cases of landscapes with a smaller number of wind turbines. Subsequently, the issue of visual overload of a landscape caused by an excessive number of wind turbines is certainly very important, especially in situations where an increasing number of wind farms (wind turbines) within a particular landscape unit is to be expected.

In order to avoid abovementioned problems it is common to develop visual assessments as a part of environmental impact studies. But in many cases visual assessments deal with an isolated case of one wind farm without considering other potential locations for wind farm building. Moreover, guidance documents for wind energy visual assessment vary in terms of regulatory approach (Corry, 2012). Many authors have suggested that it is not the best practice and that the planning process should start with higher level document (strategy plan) which prevents case to case planning system (Warren et al., 2005; Yay, 2010; Aničić et al., 2013; URL 1).

Photographic simulations are the most common way of illustrating likely landscape change - more common than models and three dimensional virtual depictions (Corry, 2012: 303, 304). The quality of visual assessments should be strictly maintained so that the pre-development predictions can reliably, accurately, reasonably and completely depict the nature and the extent of a landscape change resulting from renewable energy development (Corry, 2012). Extremely valuable document was adopted by the Council of Europe at the 6th Conference on the European Landscape Convention: "Landscape and Wind Turbines" (URL 2). One part of the document says: "*The criteria for landscape evaluation of wind turbine construction vary from one region to another and it is impossible to have uniform criteria for the whole of Europe. There are, however, some basic principles which apply to all cases. These mainly concern factors related to the morphology of the area and the proportions of the landscape. It is also important to consider aspects relating to the co-visibility of wind turbines. Lastly, it is important to define strategies for special and/or legally protected landscapes and to establish exclusion zones. In conclusion, it is recommended that the harnessing of wind energy be planned on a wide scale and that siting strategies be drawn up as far as possible in advance of any specific projects that may be submitted to local or regional authorities.*" (URL 2: 3). Apart from the pre-planned approach, there is a concept of plan-led approach which involves identifying areas considered more or less suitable (or unsuitable) for wind energy development. Such areas should be designated in development plans in order to provide clarity for the developers, the planning authorities, and the public (URL 3). Hence the need for introduction of new planning methods and the need for upgrading the Croatian planning system which guides the integration of wind farms into the landscape.

Method

A visual exposure analysis of the existing and planned wind farms has been made for the purpose of this study. The research area is Dalmatia, the part from Gračac city to Zagvozd, as it is the area with most pressure in terms of existing and planned wind farms in Croatia. The factor of distance in visual exposure analysis consists of visibility zones within a 25 km radius from each wind farm. Data on wind farm plans are taken from the Croatian register of Renewable Energy Sources (URL 6), and the analysis of visual exposure is formed by using geographic information system (GIS). Three main models have been constructed for the purpose of this study: a) visual exposure of the existing wind farms, b) visual exposure of the planned wind farms and c) cumulative visual exposure of the existing and planned wind farms.

Moreover, the term wind farm is defined as the area determined by the spatial planning documentation for the construction of wind turbines. On the other hand, wind turbine is individual (wind) turbine regardless of the formal wind farm which it belongs to. This is because the perception of wind farms does not recognize border fields (areas) intended for contraction but implies taking into account all wind turbines in the observers visual field.

The aim of this analysis is to determine potentially vulnerable parts of landscape in relation to its future usage. Hence, the aim is to expose the parts of landscape which are at risk of becoming visually overloaded, in case of planned development and are, in other words, in danger of losing their existing visual characteristics by being completely transformed into a landscape of predominant technological features.

Results

Visual exposure of existing wind farms. Figure 5 shows a visual exposure of the existing wind farms. Green areas indicate all areas from which the existing wind farms are visible and where the existing wind farms have an impact on the landscape, which is especially evident in the area between Šibenik, Sinj and Split. As a result, some landscapes have changed and have become predominantly technological. At this moment, it is mostly visible in the area between Šibenik and Split.

Visual exposure of planned wind farms. Figure 6 shows the construction of additional 30 wind farms in which case the visual impact on the landscape will be even bigger as the visible area would increase considerably. The area of the strongest impact, aside from the territory between Šibenik, Sinj and Split, is the area between the towns Knin and Sinj. For example, the area from Gračac to Split, which is 100 kilometers of air distance in total, will be mainly occupied by wind turbines.

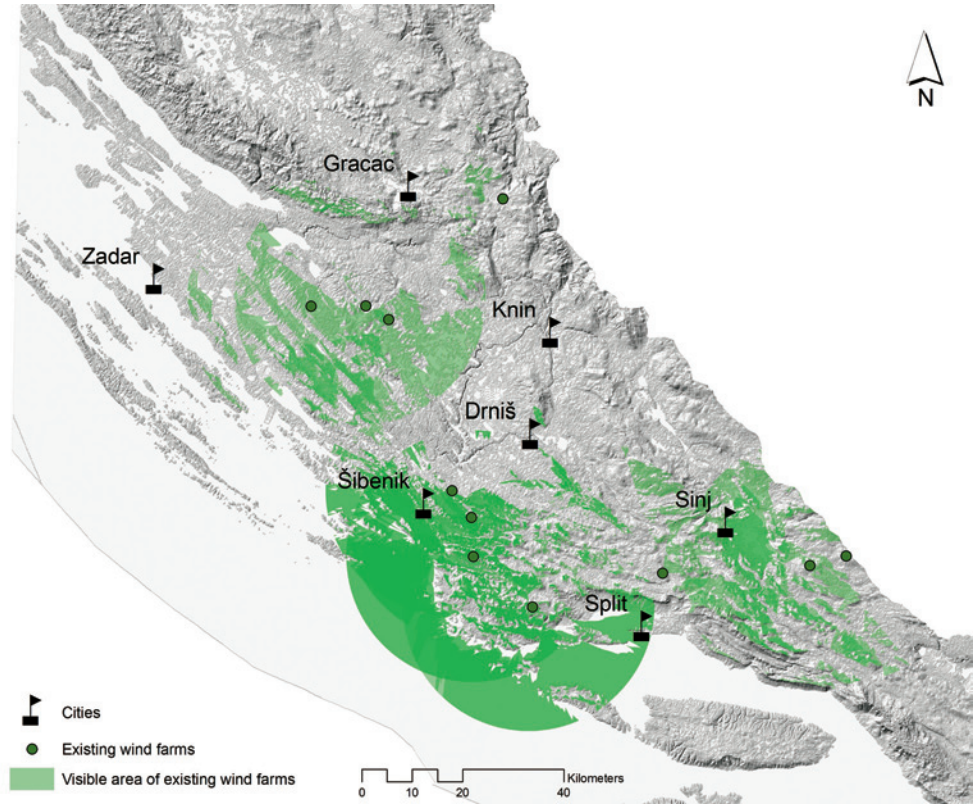

Figure 5 Visual exposure of existing wind farms

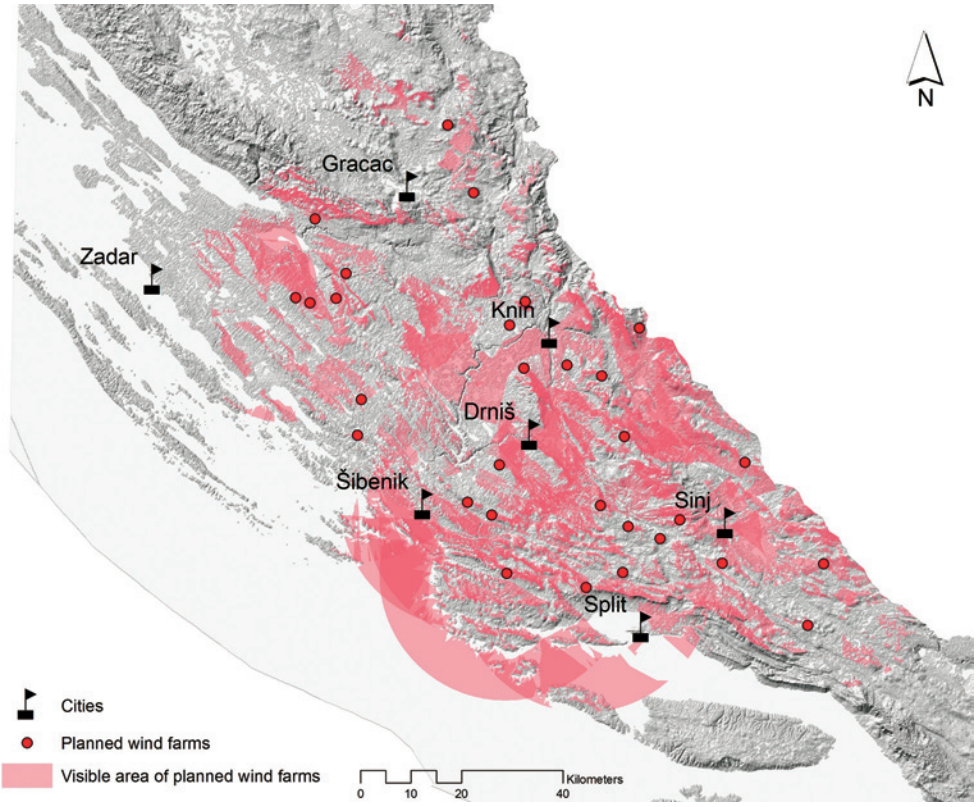

Figure 6 Visual exposure of planned wind farms

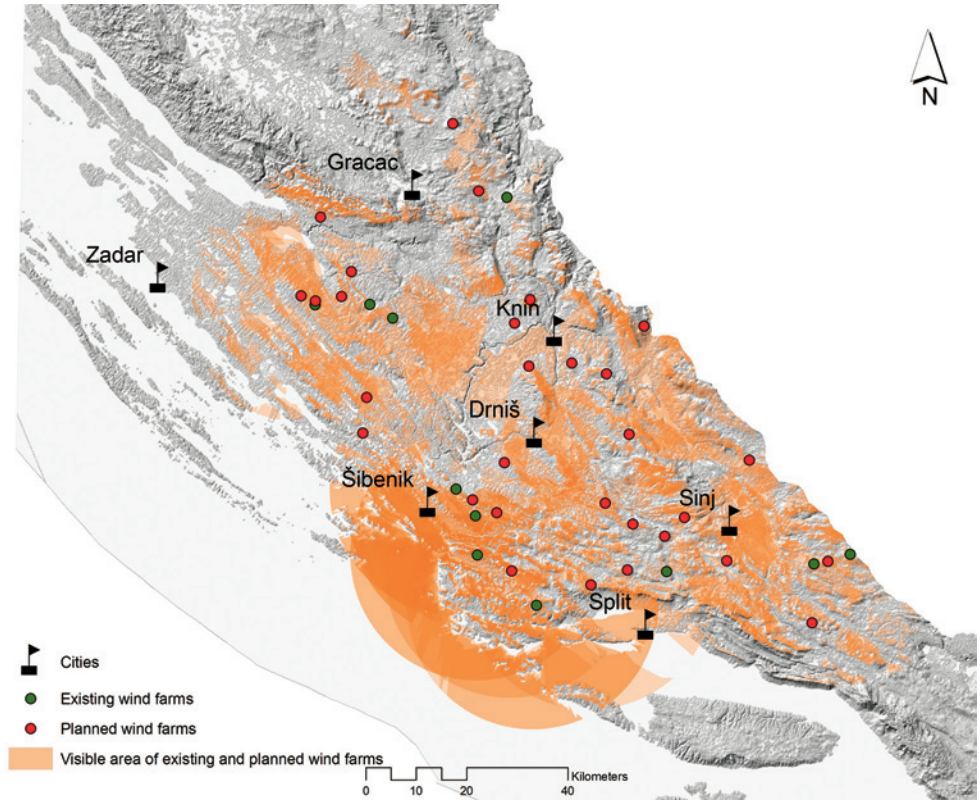

Figure 7 Cumulative visual exposure of the existing and planned wind farms

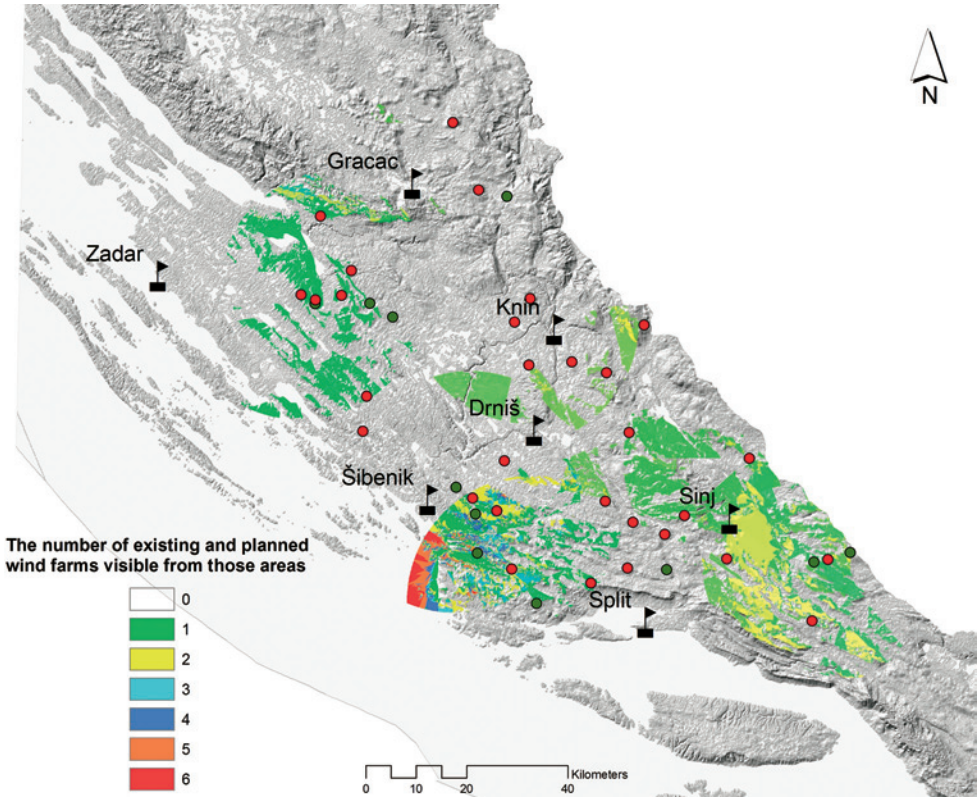

Figure 8 Detailed analysis of cumulative visual exposure of the existing and planned wind farms - area from Split to Šibenik

Cumulative visual exposure of existing and planned wind farms (Fig. 7) shows a cumulative visual exposure of the existing as well as planned wind farms. In total, there are already 11 existing wind farms in this area and another 30 planned for construction. As we can see from the map, wind farms are visible from almost every part of the analyzed area. The biggest impact is marked in darker shade, which means that from these areas even several wind farms are visible simultaneously. These areas are also possibly the most vulnerable in terms of exceeding the landscape carrying capacity and the landscape absorption capacity. In other words, these areas are at risk of becoming visually overloaded with wind turbines in case of planned development. It is possible that wind farms become predominant elements of the landscape, occupying almost the whole horizon. Besides, the areas are in danger of becoming completely transformed into a landscape of predominant technological features. Apart from the cities mentioned earlier in this presentation, this region is also characterized by numerous smaller settlements nicely embedded in the rural landscape. As it can be seen from the visual analysis, there is a possibility of a visual impact on the National Park Krka that can result in the degradation of the existing views from and around the national park. Also, a significant number of wind turbines are visible from the coast, which is a very important area for tourism.

The extent of these impacts has become more noticeable in an additional, more detailed analysis (Fig. 8). For example, further analysis of the area southeast from the city of Šibenik, shows that from certain points, maybe even areas, there are several different wind farms that are simultaneously visible in the same visual field at the same time. In other words, it is very likely that, according to the existing wind farms database, the planned development will result in the exceeding of carrying and absorption capacity of landscape in these areas.

Discussion

Analysis of this study indicates the uncertainty of the existing planning process regarding the potential impact of the planned wind farms on landscape. Although the integration of these areas into the existing landscape is based on a certain legislative regulatory system, the lack of a basic strategy plan is more than obvious. One of the consequences of this 'case to case' development is the uncertainty in the degree of impact that this planning process can leave on landscapes features and visual identity of the analyzed area. As we can see, the wind farms have already affected many landscapes in the analyzed area. For example, vistas that we have from the highway between Šibenik and Split mainly include the view of the wind farms spread all over the countryside owing to the continuous construction of wind turbines in the landscape. Additionally, there are even more wind farms planned in that same area. Besides, some of the wind farms are visible from the coast and coastal towns, the areas which are important for Croatian tourism. For example, from the city of Šibenik several different wind farms have already become visible. In addition, according to the Croatian register of Renewable Energy Sources (URL 6), Dalmatia is very attractive for other renewable energy sources such as solar power which puts even more pressure on the landscape of the study area. These examples, combined with other similar ones along the Croatian coast, create an impression that in the years to come it could be difficult to apply a well-known tourist advertisement "The Mediterranean as it once was" to some coastal cities and cultural and rural landscapes of Dalmatia. It does not mean that it is impossible to place a number of wind energy projects in the same landscape area or within the same visual field. However, such placement has more weight in sensitive landscapes, highly sensitive view points, along scenic routes or landscapes with great natural, cultural or other values desirable for various activities or sectors like tourism.

It is important to mention that the scale of the analysis from this study may indicate a potential risk, but a more detailed analysis is required for the real impact risk evaluation. The final impact may vary significantly depending on the distance of the observer, for example, the impact differs if the position of the observer is 5 or 20 kilometers from the wind turbine. The intensity of the impact also depends on the wind farm appearance, number, arrangement, the wind turbine's height and other parameters. Potential viewpoints and influences also depend on a number of factors relating to the number of potential viewers, cultural or historical significance of landscape, natural features in the area, presence of visual barriers in the distance and so on. Besides, there is no reason to believe that all planned wind farms will actually be interpolated into the landscape (they all must have an investor and have to pass the procedure of environmental impact assessment), but uncertainty does exist in

terms of influence level. Also, there is a risk that analysis and guidelines for the interpolation of wind farms in some regions will be provided only after most of the impact has already occurred and when it is too late to take an appropriate action.

In relation to this, the only remaining tool for wind farm development in Croatia is an environmental impact assessment. Therefore, it is of great importance to integrate a cumulative effect analysis of the existing and planned wind farms into the environmental impact study. We can define the cumulative effect as the perceived effect on the landscape of two or more wind energy developments visible from any place (URL 3). As the industry of wind power develops and more wind farms are allowed, the potential cumulative impacts are increasing in significance (IWEA, 2012). Cumulative visual impact analysis can contribute to the protection of landscape values and is a common and a highly recommended tool in visual impact assessment (IWEA, 2012; Aničić et al., 2013).

As already mentioned, still there is no national strategy for integration of wind farms into landscape in Croatia. National strategy plan is a crucial document for proper sustainable development which enables a maximum usage of resources and at the same time protection of the existing landscape and spatial values. Warren et al. (2005) argues that a strategy plan could reduce the uncertainty concerning cumulative development effects of wind farms. Aničić et al. (2013) states that one of the basic tasks of planning is to create a system of pre-planned development which would precede individual projects, as well as the development of national landscape criteria based on the European Landscape Convention. The aim of those efforts is not to protect "valuable" landscapes from the construction of wind turbines. On the contrary, the aim is to define a method for placing wind turbines in the landscape while preserving its coherence (URL 2). To this end, it is recommended that the authorities develop their own landscape criteria and that they draw up overall spatial plans for wind power in the areas where it is not present. The drawing up of comprehensive plans will make it possible to forestall a good many conflicts that would be more difficult to resolve once specific projects have been submitted to the bodies responsible for authorizing them (URL 2).

Conclusion

When it comes to wind farms planning, there is a bit of a contradictory situation in Croatia. On one hand, wind farm development is being encouraged while on the other there is a need to preserve landscape values like present features, identity, authenticity and others. The process of wind turbine allocation in Croatia is currently based on the legislative regulatory system but, generally speaking, there is a lack of specific measures which could be practically implemented in order to protect landscape values. Without them we cannot be sure about the consequences appearing in the landscape due to such development. The results of this study indicate that certain landscapes of Croatia are under great pressure and in danger to be completely transformed into landscapes with technical features. These areas are also potentially most vulnerable in terms of exceeding the landscape carrying capacity and the landscape absorption capacity.

Unfortunately, it seems that the present 'case to case planning', with all its possible consequences, is likely to be our only planning option in the near future as well. The possibility of increasing wind farm development areas in Croatia has already been announced this year and will be analyzed with new possibility studies. It means that, in the years to come, we will face even more pressure on the landscape in Croatia which is why the need for new planning methods is logical. It can be concluded that a national strategic plan for the integration of wind turbines into the landscape is a necessity.

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