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Transportation planning and quiet natural areas preservation: Aircraft overflights noise assessment in a National Park

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ABSTRACT

Global transportation growth causes several disproportionate impacts on the environment as, for instance, noise pollution which is related to negative effects on human health but also to quiet natural areas decline and biodiversity loss. Besides, sound is a component of ecosystems severely threatened by transportation noise disturbance which is related to negative effects on ecosystem functions. This study deals with aircraft noise impact on natural environments from a multiple innovative perspective. It complementarily combines: noise modeling, field measurements, soundscape audibility, human perception and spatial pattern tools for assessing the chronic growing outdoor noise pollution of ecosystems at landscape scale. Firstly, noticeable soundscape degradation from aircraft overflights has been found causing severe acoustic fragmentation and disruptions in the quietness of a national park in Spain (European Union). Air traffic caused sound pressure levels to increase by approximately 8 decibels from natural ambient levels. Secondly, spatial pattern tools together with noise mapping have been found to be useful in providing decision support for decisions-making through anthropogenic noise impact assessment on the natural environment. Finally, public opinion did not perceive aircraft noise-disruption as being as relevant as that quantified by technical procedures. Although 82% of visitors agree that anthropogenic noise pollution may negatively impact on conservation.

Introduction

Sound is a component of terrestrial, freshwater and marine ecosystems, and the world is full of sounds emanating from biological (biophony), geophysical (geophony) and anthropogenic (anthropophony) sources, which define the soundscapes

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or the entire sonic energy of landscapes (Pijanowski et al., 2011; Farina, 2014). But soundscape is also a cultural domain (Scarre and Lawson, 2006) and it is recognized as a natural resource, (by for instance the US National Parks Service), that may require protection, maintenance, restoration and noise management in accordance with the best science available (NPS, 2004). Besides, soundscapes are essential for animal communication, and acoustical resources or opportunities for quietness or solitude may be compelling reasons for visiting national parks (Lynch et al., 2011; Carver et al., 2013; Mace et al., 2013a, 2013b). However, anthropogenic noise pollution is becoming a global pollutant of natural environments, and human-caused habitat degradation and fragmentation threatens biological conservation (Johansson et al., 2005; Laiolo, 2010). Indeed, opportunities to experience noise-free intervals in nature are disappearing, particularly due to aircraft noise pollution over protected areas (Lynch et al., 2011). In fact, anthropogenic disturbances in ecosystems may be more important and widespread than previously imagined (Blickley and Patricelli, 2010; Newton et al., 2011) because there are many hidden costs of noise exposure (Francis and Barber, 2013) that may not be properly assessed at present (Brown et al., 2011).

Noise pollution affects innumerable aspects of ecosystem functions and it may cause long-distance negative effects on biodiversity and the provision of services (Balvanera et al., 2006; Blickley and Patricelli, 2010; Barber et al., 2011; Chan et al., 2010; Lynch et al., 2011; Farina, 2014). In addition, it has been suggested that human activities and induced land use changes may have a greater impact on terrestrial biodiversity than climate change (Sala et al., 2000). Moreover, highly fragmented or heavily visited locations may be priority candidates for noise management (Barber et al., 2010) and managers must strive to target resources for minimizing the impacts in which the adverse effects of human disturbance are the greatest (Yasué, 2006). In this sense, the European Union (EU) is committed to large scale and long term biodiversity conservation strategies (Directive EEC/92/43; Directive 2009/147/EC), and environmental noise management (Directive 2002/49/EC). Additionally, the environmental noise directive (END) should not only be applied to noise to which humans are exposed in built-up areas but also to preserve quiet areas of good sound quality in open country. However, biodiversity is a central issue of policies promoting sustainable development, and establishing protected areas is a centerpiece in global conservation strategies (Geneletti, 2003; Pietrzyk-Kaszyńska et al., 2012). Transport development is also one of the EU's foremost common policies and it generates several disproportionate types of non-negligible environmental impacts (EEA, 2009; Ponti et al., 2013). Furthermore, protected areas cannot stop the loss of biodiversity (Mora and Sale, 2011) nor can they prevent opportunities to experience noise-free intervals from disappearing (Lynch et al., 2011).

Currently, there is agreement on the fact that biodiversity conservation and management of protected areas should minimize habitat loss and fragmentation (Crouzeilles et al., 2013). However, certain environmental metrics at particular stages of land planning are needed by stakeholders for rigorously quantifying environmental perturbation (Chester and Ryerson, 2014). In this sense, environmental impact assessment tools could set priorities to conduct strategies in land planning and biodiversity conservation (Safont et al., 2012). Therefore, a set of noise features must be properly characterized to ensure their relevancy in sustainable initiatives (Francis and Barber, 2013) but interdisciplinarity is a continuing weakness in the integration of the environment into decision-making (Nicolson et al., 2002; Nunan et al., 2012). As the ecological effects of transportation networks often occur far away from the source (Forman, 2001), decision-making also requires spatial modeling tools focused on patterns of change for understanding and monitoring environmental impacts (Veldkamp and Verburg, 2004; Komers and Stanojevic, 2013). Furthermore, many social-ecological problems are a consequence of mismatches in management scales (Delsink et al., 2013) and landscape scale investigations of noise pollution have been proposed as being urgently needed in this context (Barber et al., 2011). Nevertheless, interdisciplinarity and conservation-oriented discussion and interaction between ecological and engineering perspectives have often not been found despite being demanded for more than 30 years (Noss, 1983; Holm et al., 2013; Tagliafierro et al., 2013).

Simulation models help to assess complex environmental problems involving numerous parties (Nicolson et al., 2002), and systematic approaches to conservation planning and management require the evaluation of the spatial and temporal dynamics of human disturbances (Yasué, 2006; Newton et al., 2011). On the other hand, visitors are also central stakeholders in the management of national parks and other protected areas (Müller and Job, 2009). Nevertheless, public opinion has generally been ignored although a better understanding of public perceptions and attitudes could provide an important insight into social acceptability in land planning processes (Sharp et al., 2011). Therefore, a multi-perspective approach also considering public participation by exploring people's perceptions and expectations could also provide a valuable variety of information to managers and decision-makers when looking for long-term success at achieving social and conservational objectives (D'Antonio et al., 2013; Pilcher et al., 2009).

This study aims to introduce ecological perspectives in environmental noise management and assessment at a requested scale for promoting interdisciplinarity in order to contribute to sustainability implementation among sectorial stakeholders (e.g. conservation managers, land planning, transport infrastructures developing, etc.). The potential noise pollution impact on the natural environment of a remote mountain valley at a national park located 35 km away from a major international airport has been assessed in four ways; noise measuring, noise modeling, soundscape audibility and also exploring public opinion by a field survey. Initially, three hypotheses have been defined in this study: (i) aircraft traffic noise remotely pollutes the natural soundscapes, (ii) ecological spatial pattern metrics may assist aircraft noise impact assessment at the landscape scale, and (iii) audible anthropogenic noise pollution has negative impacts on visitors' experience.