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Increased isolation of two Biosphere Reserves and surrounding protected areas (WAP ecological complex, West Africa)

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Summary

Protected areas such as nature reserves have been found to be effective in preventing habitat destruction and protecting ecosystems within their borders. Recent studies however found extensive loss of tropical forest habitat around protected areas, vastly contributing to increase the levels of ecological isolation. Using high-resolution satellite data we investigated the isolation trend occurring in the W-Arly-Pendjari (WAP) ecological complex in West Africa. A land-cover change analysis was performed for the period 1984–2002: savanna vegetation extension and loss were derived within the complex and in a 30 km peripheral buffer. Sample regions in the buffer were also analysed using selected spatial indicators to quantify temporal trends in habitat fragmentation. Implications for change in relative capacity to conserve biodiversity were discussed through the calculation of the species richness capacity (SRC). More than 14.5% of savanna habitat was lost in the WAP peripheral areas, while 0.3% was converted inside the complex. The degree of fragmentation of remnant savanna habitat has also drastically increased. Despite the effectiveness of the park conservation programme, we found through the SRC approach that the WAP complex is decreasing its potential capacity to conserve species richness. This process is mainly due to the rapid and extended agricultural expansion taking place around the complex. A better understanding of the ecological

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dynamics occurring in the peripheral regions of reserves and the consideration of development needs are key variables to achieve conservation goals in protected areas.

Introduction

Protected areas are the cornerstones of conservation strategies worldwide. They preserve key ecosystems against biodiversity loss (Myers, Mittermeier, Mittermeier, da Fonseca, & Kents, 2000), promote sustainable management and offer unique 'laboratories' to investigate ecosystem functioning and complexity. In tropical areas especially, nature reserves have been found to be effective in preventing habitat destruction and protecting ecosystems within their borders (Bruner, Gullison, Price, & da Fonseca, 2001). Although their extension represents 11.5% of the Earth's land surface (Rodrigues et al., 2004), some studies suggested that at least 50% of total land would be needed to protect the actual global biodiversity (Soulé & Sanjayan, 1998).

Protected areas are important targets of research on *insularity*, i.e. the isolation and fragmentation by anthropogenic conversion of natural habitats (Ramade, 2003). Recent research highlighted extensive loss of tropical forest habitat around protected areas with consequent increasing ecological isolation (DeFries, Hansen, Newton, & Hansen, 2005; Struhsaker, Struhsaker, & Siex, 2005). Reserves where surrounding original biotopes have been degraded or converted to non-natural cover can be subject to a series of changes in microclimate, soil, and vegetation composition that affect population structure and dynamics of species living inside the core protected areas (Gascon, Williamson, & Da Fonseca, 2000; Margules & Pressey, 2000). Such a process of isolation can reduce the likelihood of persistence of certain species, decrease population sizes and increase their extinction risk (Brooks, Pimm, & Oyugi, 1999; Davies, Margules, & Lawrence, 2000; Pimm, Jones, & Diamond, 1988). Species extinction in protected areas is in fact often linked with reserve isolation and limited size (Wilcove & May, 1986; Woodroffe & Ginsberg, 1998). The overall *functional* size of protected areas can comprise their surrounding regions of preserved habitats or a mosaic of natural biotopes and human-managed land; as a consequence, peripheral lands are strongly linked to the ecological processes occurring in the core reserve. Outside the reserve, animals can find nutrients, water and accomplish processes such as feeding, reproduction and migration. Population dynamics may take advantage of higher reproduction rates occurring outside the reserve, contributing to maintain inner *sink* populations or, the contrary, be subjected to human-induced mortality (Hansen & Rotella, 2002). In many protected areas, population sinks are located beyond the reserve's peripheral areas, where conflicts with humans are more evident and higher number of individuals are killed. Hence, for some species such as large carnivores, conservation priority should be given to counteract human persecution within peripheral areas, and to maximise the reserves' size (Woodroffe & Ginsberg, 1998). Reserves' edge areas, due to changes in land-use and to the action of exogenous factors acting from the surrounding lands (e.g. cattle grazing, fires, hunting, etc.), are more prone to impoverishment of vegetation and changes in biotic composition (Laurance et al., 2002). As they act as exchange interfaces, their structure plays a key role for the future of the internal protected habitats (Gascon et al., 2000). To counteract the effects of isolation and external disturbances, buffer zones around the protected core areas are often adopted in the architectural strategy of natural reserves planning (Laurance & Gascon, 1997): here restrictions are applied on resources use, and development policies and actions are taken to enhance conservation of valuable habitats (Sayer, 1991).

Habitat conversion into human exploited lands produces harmful effects on biodiversity conservation not only by decreasing portions of valuable natural habitats but also by fragmenting the *continuum* of eco-mosaics constituting the landscape (*sensu* Forman, 1997). Habitat fragmentation is in fact recognised as one of the major threats to species survival in human-disturbed environments by contributing to the isolation of inhabiting populations and by decreasing their size (Lienert, 2004; Saunders, Hobbs, & Margules, 1991). Biotopes isolation depending on species characteristics and the intensity of the phenomenon, can lead to local population extirpation (Vos & Stumpel, 1995; Young, Boyle, & Brown, 1996), can decrease available resources and modify the abiotic conditions of the landscape,