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A CONTRIBUTION TO ADAPTATION AND IMPLEMENTATION MECHANISMS FOR ECOLOGICAL STRUCTURE IN SPATIAL PLANS

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Mount Pico on Pico Island, the Azores, Portugal

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ABSTRACT

Small islands, as the Azores, a Portuguese archipelago located in the middle of the North Atlantic Ocean, are highly susceptible to natural hazards and low adaptive capacity to maintain ecological functions. The cumulative effect of environmental and socio-economic pressures increases their vulnerability and reduces resilience. The balance between efficient environmental management approaches and natural resources exploitation is particularly challenging on small islands. Space is limited and human activities can hardly be relocated, requiring new tools and solutions for spatial planning.

Currently, both Portuguese and Azorean spatial planning systems commits the creation and mapping of an ecological structure (ES), which must include systems for protection of natural, cultural, agricultural and forestry values and resources. However, no detailed guidelines are provided and a consensual and standardized methodology to implement is missing. Using Pico Island as case study, the main goal of this PhD project is the creation of a process of designing the ES adapted to the Azores, based on scientific criteria, ecosystem functions (EFs) and accomplishing remaining legislation in force.

In order to understand the status of the application of the ES, a critical analysis of the available literature was performed to propose a conceptual framework to define ES for small islands. A methodology to determine the efficiency of current protected areas (PAs) in meeting species conservation targets and to identify alternative or complementary areas relevant for conservation, to include in the ES, was developed. Carbon storage, as an example of EFs, was estimated and mapped to be considered in the design of the ES. And an exploratory analysis of the EFs on Pico Island to integrate them in the spatial planning process and to design the ES was developed.

The proposed framework to define ES for small islands is based on: (i) the identification and mapping of island's territorial units (step 1); (ii) the definition of the priority ES, applying current legislation (step 2a); (iii) the definition of the secondary ES, identifying and mapping EFs based on previous territorial units (step 2b); and (iv) the association of the information from steps 2a and 2b, applying a multi-criteria decision making methodology, producing a map of ES for the entire island (step 3). The methodology aggregating and mapping EFs was relatively simple to implement with available expert knowledge. The analysis suggested that the use of EFs, along with multi-criteria decision-making techniques, could successfully contribute to define ES and integrate spatial planning.

The proposed framework to design the ES meets the requirements of local legislation and uses an EF approach that is increasingly advocated in European recommendations. This framework is presented as a strategic and flexible way to support decision-making by allowing the identification of integrated and participated solutions, decreasing trade-offs and reconciling the needs of nature conservation and socioeconomic development. This approach could be readily extended to other islands and regions with features similar to the Azores.

Key words

Spatial planning; environmental planning; ecological structure; green infrastructure; ecosystem functions; small islands; Azores

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RESUMO (IN PORTUGUESE)

As pequenas ilhas, como os Açores, um arquipélago autónomo da República Portuguesa, localizado no norte do Oceano Atlântico, apresentam uma elevada susceptibilidade a desastres naturais e baixa capacidade adaptativa para manter funções ecológicas. O efeito cumulativo de pressões ambientais e socioeconómicas aumenta a vulnerabilidade e a reduz a resiliência destes territórios. Encontrar um equilíbrio entre o desenvolvimento de uma gestão ambiental eficiente e a exploração dos recursos naturais é particularmente desafiador. Nestas regiões o espaço é limitado e as actividades humanas dificilmente poderão ser relocalizadas, exigindo novas ferramentas e novas soluções para o ordenamento do território.

Actualmente, tanto a legislação nacional portuguesa, como a legislação regional dos Açores, determinam que deve ser criada e cartografada uma estrutura ecológica (EE), que deverá incluir os sistemas de protecção dos valores e recursos naturais, culturais, agrícolas e florestais. No entanto, não têm sido disponibilizadas directrizes nem têm sido adoptadas metodologias consensuais e padronizadas para implementar a EE. Utilizando a ilha do Pico como caso de estudo, o objectivo global do presente projecto de doutoramento é a criação de um processo de delimitação da EE adaptando-o aos Açores, tendo por base critérios científicos, as funções dos ecossistemas (FEs) e cumprindo com a legislação em vigor.

A fim de conhecer a situação sobre a aplicação da EE, foi realizada uma análise crítica de literatura disponível para a proposta de um modelo conceptual para definir a EE em pequenas ilhas. Foi definida uma metodologia para determinar a eficiência das actuais áreas protegidas (APs) no cumprimento de objectivos de conservação das espécies e para identificar áreas alternativas ou complementares com relevância para a conservação, que pudessem ser incluídas na EE. Como sendo um exemplo de FE, o stock de carbono foi estimado e cartografado para ser considerado na delimitação da EE. E foi realizada uma análise preliminar às funções dos ecossistemas na ilha do Pico, para integrarem o processo de ordenamento do território e a cartografia da EE.

O modelo conceptual proposto para delimitar a EE em pequenas ilhas é baseado: (i) na identificação e cartografia de unidades territoriais da ilha (passo 1); (ii) na definição da EE prioritária, identificando a legislação em vigor (passo 2a); (iii) na definição da EE secundária, identificando e cartografando as FEs baseados nas unidades territoriais anteriores (passo 2b); e (iv) na associação da informação dos passos 2a e 2b, aplicando uma metodologia de tomada de decisão por multi-critério, resultando uma carta de EE para toda ilha (passo 3). A metodologia de agregação e cartografia das FEs demonstrou-se relativamente simples de implementar, com a devida disponibilidade de conhecimento especializado. A análise sugere que o recurso às FEs, juntamente com técnicas de tomada de decisão por multi-critério, pode contribuir com sucesso para a delimitação da EE e para a integração no ordenamento do território.

O modelo proposto para delimitar a EE satisfaz os requisitos da legislação local e utiliza uma abordagem com as FEs que tem sido cada vez mais defendida em recomendações europeias. O modelo é apresentado como um suporte estratégico e flexível à tomada de decisão, ao permitir a

identificação de soluções integradas e participadas, reduzindo os *trade-offs* e conciliando as necessidades de conservação da natureza com o desenvolvimento socioeconómico. Esta abordagem poderá ser estendida a outras ilhas e regiões com características semelhantes às dos Açores.

Palavras-chave

Ordenamento do território; planeamento ambiental; estrutura ecológica; infra-estrutura verde; funções dos ecossistemas; pequenas ilhas; Açores

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LIST OF ABBREVIATIONS

3CBIO	Third cycle in Biology
AH	Architectural heritage
ARSP	Azores Regional Spatial Plan
AUC	Area under the curve
Cfb	Climate warm temperate with humid and warm summers
CO_2	Carbon dioxide
E	Endangered
EC	European Commission
EF	Ecosystem function
ERU	Ecological reference unit
ES	Ecological structure
EU	European Union
FP	Forestry perimeters
GI	Green infrastructure
HPD	Hydric public domain
HR	Hydric reserves
INP	Island Natural Park
IUCN	International Union for Conservation of Nature
LULC	Land use/land cover
LULUCF	Land use, land-use change, and forestry
Maximal coverage	Optimal solution that maximized species coverage with similar costs
MCDM	Multi-criteria decision-making
Minimum set	Quasi-optimal solution that minimized the protected number of cells while protecting the same average proportion of each species' range
MMP	Municipal Master Plan
NAR	National Agricultural Reserve
NER	National Ecological Reserve
PA	Protected areas
ppmin	Minimum annual precipitation
pprange	Annual range of precipitation
R	Rare
RAR	Regional Agricultural Reserve
REDD	Reduce emissions from deforestation and forest degradation

ROC	Receiver operating characteristic
RT	Regionally threatened
SDM	Species distribution model
SPCA	Spatial Plans for Coastal Areas
SPLW	Spatial Plans for Lagoon's Watershed
SPVC	Spatial Plan for Protected Landscape for Vineyard Culture
T	Threatened
tmax	Maximum annual temperature
TU	Territorial unit
V	Vulnerable

PUBLICATIONS IN DISSERTATION

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