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Analysis of the implementation of the "Man and the Biosphere" programme in the biosphere reserves of Andalusia

Análisis de la implantación del programa "Hombre y la Biosfera" en las reservas de biosfera de Andalucía

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Abstract

The Spanish Committee for the Man and the Biosphere (MaB) Programme runs a programme that monitors the Spanish Network of Biosphere Reserves. The monitoring programme features a system of indicators enabling the degree of implementation and the territorial integration of the Biosphere Reserves (BRs) located on Spanish territory. This paper sets out a statistical analysis based on the results of the degree of implementation for the BRs of Andalusia (Spain) obtained for the period 2008-2014. The analysis allows the identification of the indicators that have had the most influence on the degree of implementation in the Andalusian BRs, as well as the factors that may be strengthened in order to enhance the degree of implementation. The effectiveness of the indicator system will be improved if additional work is done to redefine those conceptual aspects that tend to generate discrepancies in the interpretation of compliance with the requirements of the variables. To improve the management of the Andalusian BRs, complementary studies to allow the evaluation of the impact of the initiatives related to the implementation of the MaB Program, should be carried out.

Keywords
Andalusia • degree of implementation • monitoring • participation in management • UNESCO MaB Programme

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Resumen

El Comité Español del Programa MaB cuenta con el Programa de Seguimiento de la Red Española de Reservas de Biosfera. El programa dispone de un sistema de indicadores que permiten estudiar el grado de implantación y la integración territorial de las Reservas de Biosfera (RBs) del territorio español. En este trabajo se presenta el análisis estadístico efectuado a los resultados obtenidos del grado de implantación de las RBs de Andalucía (España) durante el período 2008-2014. El análisis ha permitido identificar los indicadores que mayor influencia han tenido en el grado de implantación de las RBs, así como los factores que podrían ser fortalecidos para incrementar este grado de implantación. La efectividad del sistema de indicadores se verá reforzada si se realiza un trabajo adicional para redefinir aquellos aspectos conceptuales que tienden a generar discrepancias en la interpretación del cumplimiento de los requisitos de las variables. Para mejorar la gestión de las RBs de Andalucía, se deberían llevar a cabo estudios complementarios que permitan la evaluación del impacto de las iniciativas relacionadas con la implantación del Programa MaB.

Palabras clave
Andalucía • grado de implementación • monitoreo • participación en la gestión • Programa MaB UNESCO

Introduction

The Biosphere Reserves (BRs) of the UNESCO MaB Programme are areas in which *"methods for managing natural resources are put to the test while simultaneously fostering economic development"* (41). However, the mere designation of an area as a Biosphere Reserve (BR) does not guarantee the real or full implementation of the concept (1, 8, 16, 43). At the 1995 International Conference of Seville, it was established that the competent authority would review the situation of each BR every ten years and submit a report based on the fulfilment of the criteria upon which they were designated (40). By means of such evaluation, it would be possible to assess the effectiveness of their management, thereby helping to determine the potential that such areas possess in terms of achieving their goals, identifying opportunities and threats, and encouraging stakeholders to adapt to changing conditions (31). This evaluation must contemplate an integral and multidimensional view of sustainability and be complemented with a systemic approach both in the conceptualization and in its operational component (37).

Various authors (29, 31) suggest that the 10-year interval between the periodic reviews is excessively long, posing challenges for the monitoring of BRs. Such challenges affect the efficiency of the periodic review process as an effective mechanism for ensuring their quality and degree of implementation (3, 30). The alternatives suggested in order to overcome the challenges include: establishing provisional mechanisms for submitting reports; reducing the time between periodic reviews, and the establishment of an information system

with mechanisms and indicators enabling the state and effectiveness of the implementation of the BRs to be reviewed, being much more closely linked to the periodic review process (29, 30, 31).

The Spanish Network of Biosphere Reserves (Spanish acronym: RERB) comprises 48 areas, covers 10.9% of the total surface area of Spain (more than 5.5 million hectares) and encompasses a population of nearly two million inhabitants (4.12% of the total). The Spanish Committee for the MaB Programme is coordinated by the Autonomous Organisation of National Parks (Spanish acronym: OAPN) and runs a RERB Monitoring Programme. The RERB Monitoring Programme is one of various results obtained from the Montseny Plan of Action (Spanish acronym: PAMO) for the RERB (38). The PAMO was the adaptation carried out in the Spanish context of the Madrid Action Plan (Spanish acronym: PAM) for the RERB (26, 41). This Programme was designed to gather information about the state and evolution of the Spanish BRs and assess the attainments achieved in terms of the challenges set by the MaB Programme. Within the framework of the Monitoring Programme, the Reserves have been assessed over three periods: 2008-2010, 2010-2013 and 2013-2014.

In its initial stages, the RERB Monitoring Programme relied on a total of 17 indicators, each of them being a synthesis of a range of variables. Seven of these indicators were designed to provide information about the degree of consolidation of the RERB. The ten remaining indicators were designed to provide information about two fundamental aspects of Spanish BRs: their degree of implementation (fulfilment of the basic requirements stemming from the BR concept) and their territorial integration. Those who developed the indicator system (OAPN and TRAGSA) decided that the Spanish BRs' degree of implementation would be assessed by six indicators, and their territorial integration would be assessed by means of four indicators (38). In 2013 OAPN and TRAGSA presented a new system to assess the implementation of Spanish BRs by means of eight indicators (39). One of the reasons for carrying out these adjustments could have been probably, not wanting to lose sight of the ecological and social elements on which the BR's are based. These elements that go beyond the promotion of a practice or set of practices, must be understood by the researchers and local actors, who form the main basis for the construction and even more, the evaluation and transformation of the BR's and their agro-ecological systems (25). Since 2013, the methodology used, the results obtained and the appropriateness of the indicators themselves, have been analysed on an ongoing basis by the Management Council and by the Scientific Council, both advisory bodies to the Spanish Committee for the MaB Programme.

At the time of writing, the degree of implementation of the BRs that make up the RERB is assessed by eight indicators. Some of these indicators contain "lock" variables, a concept that had not been considered at the initial stages of the Monitoring Programme. Lock variables are those that, when they accrue a score of 0 for total non-compliance, render the indicator to which they correspond non-assessable due to non-fulfilment of a basic requirement of the MaB Programme (28). In order to obtain the final assessment of the BR, the non-assessable indicator is assigned a value of 0. A non-assessable indicator reduces the

score obtained by the BR and is taken as evidence that, at its next periodic review, the BR may be subjected to a recommendation from the MaB Programme's International Coordination Council. In the event of this not being addressed, it may result in the triggering of the withdrawal mechanism of the World Network of Biosphere Reserves (WNBR).

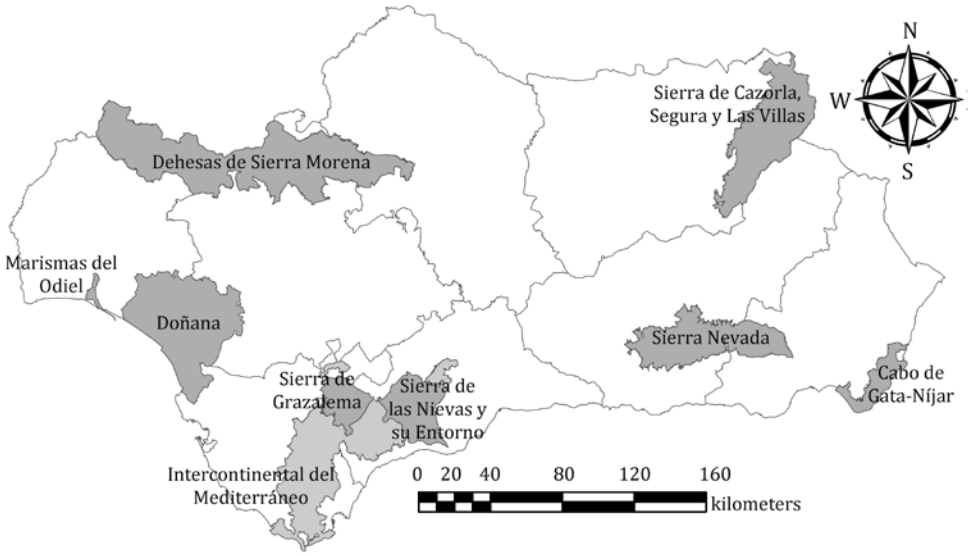
Based on the results obtained through the Monitoring Program of the Spanish Network of Biosphere Reserves, the objectives of this article are: i) to identify the behavior of the implementation of the Andalusian BRs over the 2008-2014 period and ii) to identify the incidence of the indicator "Participation in management" in the levels of implementation achieved by these BRs.

The hypotheses of this work are: i) In the three follow-up evaluations of the Spanish Network of Biosphere Reserves carried out during the period 2008 - 2014, the Biosphere Reserves of Andalusia obtained the same degree of implementation and ii) the indicator "Participation in management" is the indicator that has the greatest impact on the degree of implementation achieved by the BRs of Andalusia.

Materials and methods

Area of study

Nine of the 48 Spanish BRs are located in the Autonomous Community of Andalusia (southern Spain), and are known as the Andalusian Biosphere Reserve Network (Spanish acronym: RRBA). The RRBA (figure 1) comprises a significant part of the overall RERB in Spain, both in terms of number and in terms of designated surface area (table 1, page 132).



Source: Authors' own compilation, with information from the Environmental Information Network of Andalusia.
Fuente: Elaboración propia con información de la Red de Información Ambiental de Andalucía.

Figure 1. Geographical distribution of Andalusian Biosphere Reserves.
Figura 1. Distribución geográfica de las Reservas de Biosfera de Andalucía.

Table 1. Andalusian Biosphere Reserves.
Tabla 1. Reservas de Biosfera de Andalucía.

Andalusian Biosphere Reserves	Year of creation	Area (ha)	Provinces	N° municipalities (partial and/or total territorial integration)
Sierra de Grazalema (henceforth RBSG)	1977	51,695	Cádiz and Málaga	14
Doñana (RBDÑ)	1980	268,293	Huelva, Seville and Cádiz	14
Sierras de Cazorla, Segura y las Villas (RBCSV)	1983	217,000[a]	Jaén	26
Marismas del Odiel (RBMO)	1983	7,185	Huelva	4
Sierra Nevada (RBSNV)	1986	172,238	Almería and Granada Granada	60
Sierrra de las Nieves y su Entorno (SNyE)	1995	93,930	Málaga	11
Cabo de Gata-Níjar (RBCGN)	1997	49,624	Almería	3
Dehesas de Sierra Morena (RBDSM)	2002	427,400	Huelva, Seville and Córdoba	43
Intercontinental del Mediterráneo (IM)	2006	907,185.02 (423,535 in Andalusia)	Cádiz and Málaga (Andalusia) and Tétouan, Chefchaouen, Larache and Tangier (Morocco)	109[b]

Source: Authors' own compilation of data from the Environmental and Territorial Planning Council of the Andalusian Regional Government (Junta de Andalucía).

[a] Extended in 2014 as a response to the recommendations made by the ICC for the MaB Programme after its periodic review in 2003.

[b] 66 municipalities in Andalusia are included, 22 in the province of Cádiz and 39 in Málaga, while 48 municipalities are involved in Morocco, of which 23 belong to Tétouan, 17 to Chefchaouen, seven to the province of Larache and one to the province of Tangier.

Fuente: Elaboración propia con datos de la Consejería de Medio Ambiente y Ordenación del Territorio de la Junta de Andalucía (Junta de Andalucía).

[a] Ampliada en el año 2014 para dar respuesta a las recomendaciones que el CIC del Programa MaB emitió tras su revisión periódica del año 2003.

[b] En Andalucía participan 66 municipios, 22 de la provincia de Cádiz y 39 de Málaga, mientras que en Marruecos participan 48 municipios, de los que 23 pertenecen a la provincia de Tetuán, 17 a Chefchaouen, siete a la provincia de Larache, y uno a la provincia de Tánger.

Table 2. Implementation indicators of the RRBA BRs, expressed as percentages (2008-2014).

Tabla 2. Indicadores de implantación de las RBs de la RRBA, expresada en porcentajes (2008-2014).

INDICATOR	BR									RRBA
	SG*	DÑ*	CSV*	SNV*	MO*	SNyE*	CGN*	DSM*	IM*	
2008-2010 PERIOD										
Zoning	23.33	43.33	23.33	55.00	43.33	56.67	66.67	56.67	66.67	48.33
Management body	53.33	48.33	53.33	48.33	53.33	46.67	53.33	38.33	86.67	53.52
Participation in management	76.67	76.67	76.67	76.67	76.67	65.00	76.67	0.00	45.00	63.64
Planning and management tools	33.33	33.33	33.33	33.33	33.33	66.67	33.33	16.67	50.00	50.00
Available resources	50.00	50.00	50.00	50.00	50.00	100.00	50.00	50.00	33.33	53.70
Initiatives for the fulfilmentof functions	48.00	48.00	48.00	48.00	48.00	40.67	48.00	48.00	48.00	47.19
SYNTHESIS OF THE PERIOD	47.44	49.94	47.44	51.89	50.78	51.50	54.67	34.95	54.94	49.28
2010-2013 PERIOD										
Zoning	100.00	100.00	100.00	100.00	56.67	90.00	100.00	100.00	100.00	94.07
Management body	100.00	100.00	100.00	100.00	93.33	41.67	100.00	93.33	83.33	90.18
Participation in management	76.67	86.67	90.00	100.00	66.67	66.67	66.67	86.67	66.67	78.52
Management plan (and action programme)	76.67	76.67	76.67	100.00	76.67	53.33	76.67	76.67	86.67	77.78
Initiatives for fulfilment of the conservation function	93.33	100.00	93.33	100.00	76.67	83.33	83.33	90.00	93.33	90.37
Initiatives for the fulfilment of the development function	93.33	100.00	93.00	100.00	60.00	76.67	86.67	86.67	93.33	87.78
Initiatives for the fulfilment of the logistics support function	71.67	68.33	80.00	75	66.67	65.00	71.67	58.33	45.00	66.85
Participation in networks	90.00	90.00	90.00	100.00	90.00	100.00	90.00	90.00	90.00	92.22
SYNTHESIS OF THE PERIOD	87.71	90.21	90.42	96.88	73.33	72.08	84.38	85.21	82.29	84.72
2013-2014 PERIOD										
Zoning	100.00	100.00	33.33	100.00	0.00	33.33	33.33	33.33	100.00	59.26
Management body	100.00	100.00	73.33	100.00	65.00	75.00	73.33	73.33	73.33	81.48
Participation in management	100.00	100.00	100.00	100.00	80.00	76.67	66.67	86.67	56.67	85.19
Management plan (and action programme)	86.67	100.00	100.00	100.00	53.33	56.67	76.67	80.00	76.67	81.11
Initiatives for fulfilment of the conservation function	93.33	100.00	100.00	100.00	66.67	93.33	76.67	100.00	93.33	91.48
Initiatives for the fulfilment of the development function	93.33	100.00	93.00	100.00	60.00	86.67	86.67	86.67	86.67	88.15
Initiatives for the fulfilment of the logistics support function	65.00	75.00	80.00	66.67	55.00	65.00	71.67	71.67	58.33	67.59
Participation in networks	93.33	93.33	93.33	100	93.33	100	93.33	100	93.33	95.55
SYNTHESIS OF THE PERIOD	91.46	96.04	84.17	95.83	59.17	73.33	72.29	78.96	79.79	81.23

Source: Authors' own compilation from RERB Monitoring Programme reports (2011-2015).

Fuente: Elaboración propia a partir de los informes del Programa de Seguimiento de la RERB (2011-2015).

*.- Key to abbreviations: BR (Biosphere Reserves), SG (Sierra de Grazalema), DÑ (Doñana), CSV (Cazorla, Segura y las Villas), SNV (Sierra Nevada), MO (Marismas del Odiel), SNyE (Sierra de las Nieves and its surroundings), CGN (Cabo de Gata Níjar), DSM (Dehesas de Sierra Morena), IM (Mediterranean Intercontinental), RRBA (Andalusian Network of Biosphere Reserves).

*.- Clave de abreviaciones: BR (Reserva de Biosfera), SG (Sierra de Grazalema), DÑ (Doñana), CSV (Cazorla, Segura y las Villas), SNV (Sierra Nevada), MO (Marismas del Odiel), SNyE (Sierra de las Nieves y su entorno), CGN (Cabo de Gata Níjar), DSM (Dehesas de Sierra Morena), IM (Intercontinental del Mediterráneo), RRBA (Red de Reservas de Biosfera de Andalucía).

Sources for data used

The data used in this article are derived from the results of evaluating the implementation indicators of the RRBA BRs over the period 2008-2014. These data were obtained by the Spanish Committee for the MaB Programme, via application of the RERB Monitoring Programme (28, 38, 39). The main data used are set out in table 2 (page 133).

Calculation of new indicators

Owing to the fact that the indicators for the 2008-2010 period differ from those of the other two periods (2010-2013, 2013-2014), a series of statistical inferences (atypical values, jumps or discontinuities, concentrations of values, variable of those that make up the indicator, possible response options to the variable, percentage contribution of the variable in the final value of the indicator) were made to obtain the data that would enable a statistical analysis of the whole period (2008-2014).

When checking the methodology used to calculate the indicator of "Initiatives for the fulfilment of functions" for the period 2008-2010 (38), it was noted that it comprised variables that were the equivalent to some of the new indicators included in the reports for the 2010-2014 period (29, 39). Thus, bearing in mind the contribution of each indicator, its corresponding value for the 2008-2010 period was calculated. The variable-indicator equivalences were the following:

- "Number of initiatives that fundamentally contribute to fulfilment of the conservation function" was considered to be equivalent to the indicator "Initiatives for fulfilment of the conservation function".
- "Number of initiatives that fundamentally contribute to fulfilment of the development function" was considered to be equivalent to the indicator "Initiatives for fulfilment of the developments function".
- "Number of initiatives that fundamentally contribute to fulfilment of the logistics support function" was considered to be equivalent to the indicator "Initiatives for fulfilment of the function for logistics support".

This was done because the variables used to calculate the indicators are basically descriptive. For each, there were four possible options, so, the possible responses of these variables were like the ones that make up the indicator for which equivalence was proposed.

In addition, indicator 8, "Participation in networks", included in 2010-2013 and 2013-2014, was not considered in the report for the 2008-2012 period. For its calculation, quantitative and qualitative analyzes of each of the variables that make up each of the indicators of the three periods analyzed, were carried out, according to the methodology proposed by the OAPN (28), combining this with multiple regression techniques applied to all the BRs in Spain. Finally, indicator 3, "Instruments for planning and management", for the 2008-2010 period was deemed to be the exact equivalent of indicator 4, "Management plan (and action programme)", in the other two periods.

The indicators for the whole period (2008-2014) as well as the abbreviations used in the statistical analysis are shown in table 3 (page 135).

Table 3. Indicators analysed for the RRBA (2008-2014).
Tabla 3. Indicadores analizados para la RRBA (2008-2014).

Indicator	Abbreviations for the statistical analysis
Zoning	IND 1
Management body	IND 2
Participation in management	IND 3
Management plan (and action programme)	IND 4
Initiatives for fulfilment of the conservation function	IND 5
Initiatives for fulfilment of the development function	IND 6
Initiatives for fulfilment of the logistics support function	IND 7
Participation in networks	IND 8

Methodology for the statistical analysis of the data

An exploratory analysis of the data was carried out using the ANOVA (21) procedure. This enabled the normality and the homogeneity of the indicator variances to be assessed to a 95% level of confidence.

The variance analysis and the test of means were carried out using the GLM procedure (36) with a level of significance of 0.05. For the analysis of variance, the three periods being studied (2008-2010, 2010-2013 and 2013-14) were assumen as treatments. And for the means test, Tukey's studentized range was used (36).

As well as providing the mean for each period, the test of means enabled identification of the minimum significant differences. These two analyses (the analysis of variances and test of means) were used in conjunction to compare the means of the indicators over the different periods of study. The comparison made it possible to determine the differences between the three periods in terms of two basic aspects: i) the performance of each indicator and ii) the degrees of implementation achieved. All these enabled to establish the importance of one or more periods of time.

In addition, canonical discriminant analysis (CDA) (12) was used to identify the influence that each of the indicators had on the degrees of implementation achieved in the RRBA. The CDA groups correspond to the periods under study. The statistical analysis was based on the following multivariate lineal model:

$$y_{ijkh} = \mu_h + BRi_h + Pj_h + \varepsilon_{ijkh}$$

where:

y_{ijkh} = multivariate vector of the k observation relating to the h variable for the BRi and period j.

μ_h = multivariate vector of general means relating to the h variable.

BRi_h = multivariate vector of the effects of the RBi on the h variable.

Pj_h = multivariate vector of the period j on the h variable.

ε_{ijkh} = multivariate vector for random errors associated with the observations vector y_{ijkh}.

(In the present study, the multivariate vector of the effects of interaction between BRi and the period j on the h variable was not included in the model, because no repetitions were present).

With the standard variables obtained from the analysis, a canonical discriminant graph was drawn up (20).

The Minitab (Minitab Inc., State College, Pennsylvania) and SAS version 9.4 (SAS Inst., Inc., Cary, North Carolina) programs were used to manage the data and perform the calculations.

Results

Table 4 shows the values of the indicators for the period 2008-2010 that were used for the analysis of the entire 2008-2014 period. The values of indicators 1, 2 and 3 correspond to those obtained with the RERB Monitoring Program. The values of indicators 4, 5, 6, 7 and 8 correspond to those calculated in this article.

Exploratory analysis of the indicator data for the period 2008-2014 showed that none of the indicators presented any significant deviation regarding the assumptions of normality and homogeneity of the variances to a degree of 95% of confidence. This fact revealed an absence of limitations for conducting the ANOVA.

Table 4. New implementation indicators for RRBA 2008-2010 in percentages.
Tabla 4. Nuevos indicadores de implantación para la RRBA 2008-2010 en porcentajes.

INDICATOR	BR									RRBA
	SG	DÑ	CSV	SNV	MO	SNyE	CGN	DSM	IM	
1. Zoning	23.33	43.33	23.33	55.00	43.33	56.67	66.67	56.67	66.67	48.33
2. Management body	53.33	48.33	53.33	48.33	53.33	46.67	53.33	38.33	86.67	53.52
3. Participation in management	76.67	76.67	76.67	76.67	76.67	65.00	76.67	0.00	45.00	63.64
4. Management plan (and action programme)	33.33	33.33	33.33	33.33	33.33	66.67	33.33	16.67	50.00	37.04
5. Initiatives for fulfilment of the conservation function	66.66	66.66	66.66	33.33	66.66	0.00	66.66	66.66	33.33	51.85
6. Initiatives for fulfilment of the development function	33.33	33.33	33.33	66.66	33.33	66.66	33.33	33.33	66.66	44.44
7. Initiatives for fulfilment of the logistics support function	66.66	66.66	66.66	66.66	66.66	66.66	66.66	66.66	66.66	66.66
8. Participation in networks	64.64	64.64	64.64	76.49	64.64	76.49	64.64	64.64	76.49	68.59
SYNTHESIS OF THE PERIOD	52.24	54.12	52.24	57.06	54.74	55.6	57.66	42.87	61.44	54.22

The ANOVA of the indicators, to a 0.05 degree of significance, highlighted significant differences in indicators 1, 2, 4, 5, 6 and 8, but not in indicators 3 or 7 (table 5).

The results of Tukey's test of means are shown in table 6 (page 138). It is noticeable that seven of the eight indicators show no significant differences for the periods 2010-2013 and 2013-2014. The 2008-2010 period is significantly different from the other two periods for five of the eight indicators. The three periods analysed do not show significant differences for indicators 3 and 7. The 2010-2013 period exhibits significant differences with respect to the other two for indicator 1.

The multivariate analysis of the data using CDA revealed a significant effect ($\alpha = 0.05$) for the result of Wilks's multivariate Lambda test (table 7, page 138). The value obtained by running the CDA test with this statistic (0.008 with $P < 0.0001$), indicates that the multivariate contrast that explains the relationship between the values of the nine reserves' eight indicators in the three periods analyzed, is significant ($\alpha = 0.05$). This statistic also revealed that there is separation between groups and a supposition of multivariate error normality.

The CDA results for the relationship between the effects of BR indicators and P, demonstrate that this relationship needs only two dimensions in order to be represented (table 8, page 138). However, out of these two dimensions, only the first is significant ($\alpha = 0.05$), entailing that the relation is one-dimensional. The eigenvalue proportion (or the proportion of explained variability) of the first canonical variable (Can 1) is 0.991, which indicates that the first canonical function represents 99.1% of the total variation of the relationship between the effects of the RBs and P (table 8, page 138). The second canonical variable (Can 2) only accounts for 0.9% of the said variation.

Figure 2 (page 139), shows the canonical discriminant structure of the three periods analyzed.

Table 5. ANOVA for the degree-of-implementation indicators of the RRBA BRs, 2008-2014.

Tabla 5. Análisis de varianza para los indicadores del nivel de implantación de las RB de la RRBA (período 2008-2014).

Indicator	Sum of squared error	Mean squared error	Value of F	Pr
IND1	16,708.88	696.20	7.40	0.0031
IND2	5,940.99	247.54	13.34	0.0001
IND3	8,843.78	368.49	3.06	0.0653 *
IND4	5,232.49	218.02	24.86	<0.0001
IND5	6,324.63	263.53	17.40	<0.0001
IND6	4,646.16	193.59	29.36	<0.0001
IND7	1,342.20	55.92	0.04	0.9617 *
IND8	448.02	18.67	322.43	<0.0001

*Pr >α= 0.05.

Table 6. Means test for the degree of implementation indicators of the RRBA BRs, 2008-2014.

Tabla 6. Prueba de medias para los indicadores del nivel de implantación de las RB de la RRBA 2008-2014.

Tukey's studentised range test (HSD) (α = 0.05)				
VARIABLE	**2008-2010**	**2010-2013**	**2013-2014**	**df**
IND1	48.220 b	94.070 a	59.260 b	31.062
IND2	53.517 b	90.184 a	81.480 a	18.522
IND3	63.336 a	78.521 a	85.187 a	22.598
IND4	37.036 b	77.780 a	81.112 a	17.382
IND5	51.847 b	90.369 a	91.481 a	19.111
IND6	44.440 b	87.778 a	88.149 a	16.380
IND7	66.660 a	66.852 a	67.593 a	8.804
IND8	49.189 b	92.222 a	95.553 a	5.086

Values with different letters in the same row differ significantly between periods.
Valores con letras diferentes en la misma fila difieren significativamente entre periodos.

Table 7. Statistics of multiple variables and F approximations.

Tabla 7. Estadísticos de múltiples variables y aproximaciones F.

Statistic	Value	F-Value	Num DF	Den DF	Pr > F
Wilks's Lambda	0.008	21.30	16	34.0	<.0001
Pillai trace	1.382	5.03	16	36.0	<.0001
Hotelling-Lawley trace	73.107	74.64	16	24.5	<.0001
Roy's largest root	72.453	163.02	8	18.0	<.0001

The F statistic for Roy's largest root is an upper limit. The F statistic for Wilks's Lambda is exact.
El estadístico F para la raíz mayor de Roy es un límite superior. El estadístico F para Lambda de Wilks es exacto.

Table 8. Summary of CDA for the relationship between the effects of the BR indicators and P.

Tabla 8. Resumen del ADC para la relación entre los efectos de los indicadores de las RBs y P.

Canonical variable	Canonical correlation	Eigenvalue	Proportion eigenvalue	Accumulated proportion	Value of probability
Can 1	0.99	72.453	0.991	0.991	<.0001
Can 2	0.63	0.654	0.009	1.000	0.1764

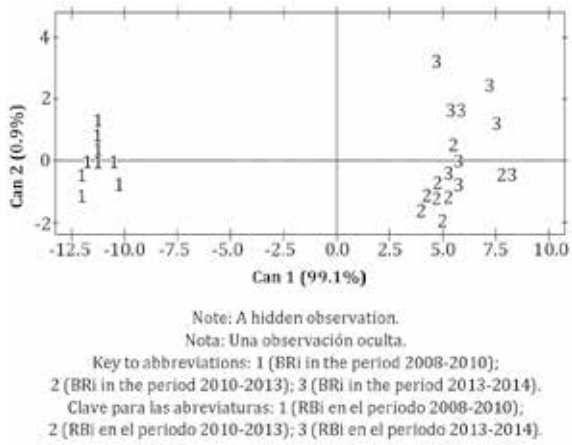


Figure 2. Canonical discriminant structure plot of the three periods analysed.

Figura 2. Estructura discriminante canónica de los tres periodos analizados.

The impact of both canonical axes is observable in 100% of the total variability. In the case of the first factorial plane (Can 1 *vs.* Can 2), 99.1% of the variation between the periods being analyzed is accounted by the first canonical dimension (Can 1), whereas the second canonical dimension (Can 2) only accounts for 0.9% of variability. Can 1 is mainly aligned with the second and third periods (2012-2013 and 2013-2014). Can 2 is determined mainly by the first period (2008-2010).

Table 9, shows the coefficients of total canonical structure (also known as the correlation structure or canonical discriminant weights), which indicate the correlations between the indicators and the canonical functions. From this table it may be observed that Can 1 is strongly dominated indicator 8, followed by indicators 6 and 4 and to a lesser extent by indicators 5 and 2, all of them positive.

Table 9. Coefficients of total canonical structure.

Tabla 9. Coeficientes de estructura canónica total.

Variable	Total canonical structure	
	Can1	**Can2**
IND1	0.403	**-0.748**
IND2	**0.702**	**-0.319**
IND3	0.440	0.178
IND4	**0.827**	0.022
IND5	**0.774**	-0.033
IND6	**0.847**	-0.059
IND7	0.040	0.065
IND8	**0.989**	0.020

Can 2 is dominated by indicators 1 and 2, both with negative values and not as large as those of the first canonical axis. Thus, it is evident that the total variation in the relationship between the effects of the BR indicators and P is due, principally, to indicators 8, 6 and 4, and therefore, these three indicators are responsible for a major portion of the discrimination between the combinations of the BR indicators and P.

Discussion

Implementation performance

Two clearly differentiated phases, 2008-2010 and 2010-2014, become apparent after the analysis of the implementation period of the RRBA BRs (2008-2014). In the first phase there was a lesser degree of implementation than in the second, as shown by the values obtained in the test of the indicators' means (table 6, page 138). The differences between these two phases may be explained by i) the fact that the periodic application of the indicators has served as a learning tool for the Andalusian BRs (31), something that also emerges from the approval of all these reserves' periodic review reports over the last ten years, some of them without receiving any type of recommendation from the MaB Programme ICC; ii) the effort expended by the Spanish Committee for the MaB Programme to improve the understanding, the differences in criteria and the application of the indicators; iii) the managerial improvements in these areas instituted by the competent body of the Andalusian Regional Government.

The indicators that recorded improved results in the second phase were: Indicator 2, "Management body", Indicator 4, "Management plan and action programme", Indicator 5, "Initiatives for fulfilment of the conservation function", Indicator 6, "Initiatives for fulfilment of the development function" and Indicator 8, "Participation in networks".

The management body for Andalusian BRs is the Environment Department of the Andalusian Regional Government, which it delegates responsibility for action on the ground to the manager of each BR (2). The improvements in indicator 2, "Management body", may be related to the increase and/or advances in: i) the consultation-participation and decision-taking mechanisms; ii) the representation of various public administrations with territorial faculties; iii) the ability to promote and implement an integrated, participatory and sustainable management plan; iv) the fulfilment of the Andalusian Biosphere Reserves Committee's functions. (The Andalusian Biosphere Reserves Committee is an advisory and coordination body reporting to the Andalusian Regional Government on the subject of Biosphere Reserves, which has, among other functions, the task of supporting managing coordination Andalusian BRs).

The management plans of the Andalusian BRs have been the main instruments for the management and planning of the protected areas that constitute them (6). In this context, the progress shown by indicator 4, "Management plan (and action programme)", may be due to: i) improvements and adaptations of the contents of the management tools of the protected areas that constitute the RRBA. It is expected that within the management and planning instruments of Andalusia's protected areas, the goals and functions of the BRs to which they belong are explicitly set out. ii) the design of specific

management schemes for one or more of Andalusia's BRs; iii) drafting and/or improvements in the action programmes. The action programmes should i) incorporate the goals and the three functions of the BRs, ii) have the resources needed for their application and iii) make provisos for a research and monitoring programme.

It is no surprise that Indicator 5, "Initiatives for fulfilment of the development function", exhibited improved results in the second phase. The Autonomous Community of Andalusia has been characterised by its interest, commitment and dynamism in environmental matters, particularly the protection of natural resources (22, 33). This is demonstrated by the numerous regional programmes and schemes geared towards the conservation, protection and recuperation of various aspects of natural heritage that complement those derived from national and international origins.

Meanwhile the improved results for indicator 6, "Initiatives for fulfilment of the development function", may reflect the effort made by the Andalusian Regional Government to offer local inhabitants opportunities to improve their quality of life and welfare by making sustainable use of natural resources. It is acknowledged that the protected areas currently comprising the Andalusian BRs, have become places where the environment is appreciated as a basic productive resource for sustained economic growth, thus turning the business sector into a key part of sustainable development (11). In keeping with this, it may be supposed that the Andalusian BRs have made headway in learning to master the rational exploitation and conservation of natural heritage and encouraging integrated human development, which are basic goals of all BRs (9).

Indicator 3, "Participation in management", and Indicator 7, "Initiatives for fulfilment of the logistics support function", present a very consistent trajectory over the three periods analysed, probably due to the fact that they are components in which Andalusian BRs have exhibited particular strengths, and hence no major effort has been made to improve them, and/or they have been assigned secondary priority in the management of these reserves.

Indicator 1, "Zoning", is the indicator that presents the most inconsistent pattern. The mean value of this indicator during the second period of study, is significantly greater than the first and third periods. In other words, there was considerable improvement in the second period with regards to the first, but the mean decreased considerably in the third period compared to the second, regressing to the values obtained in the initial period. This performance may be explained by: i) more thorough reviews of zoning, which led to falls in this parameter in some of the BRs; ii) differences of criteria in the way the indicators were applied over the course of the three periods; iii) the influence of "lock" variables on the annulment of this indicator in some BRs; iv) the alteration of the indicators, revealing cases of basic non-fulfilment of the MaB Programme.

Influence of the indicators on the degree of implementation

The indicators that have the greatest influence on the degree of implementation achieved by the BRs of Andalusia, are Indicator 8, "Participation in networks", Indicator 6, "Initiatives for fulfilment of the development function", and Indicator 4, "Management plan (and action programme)". These results differ from the findings reported by the Vietnam BRs (4).

Stakeholders in the latter reserves, perceive that the key factors most impinging on their management, and thus , that explain the successful implementation of the MaB Programme, are: Participation and collaboration; Governance; Finance and resources; Awareness and communication; and Management and implementation (4).

It appears that the degrees of implementation achieved by the BRs of Andalusia may be explained by: i) the exchange of knowledge and experiences using national and international environmental networks; ii) the relatively large population residing within them, and the actions carried out by the Managing Body to encourage and investigate sustainable development, and to integrate it into conservation; iii) the contents of the management plans, the degree to which policies are integrated into these and their corresponding action programmes. Bearing all these results in mind, there is a case to be made for the RRBA bringing forward improvement and strengthening initiatives for the management plan and the development function, since it may be possible to increase the degree of implementation of the MaB Programme at such Reserves.

The indicator with the least influence on the degrees of implementation achieved by Andalusian Biosphere Reserves appears to be Indicator 7, "Initiatives for fulfilment of the logistics support function", followed by Indicator 1, "Zoning" and Indicator 3, "Participation in management". According to the results obtained, initiatives related to the investigation and management of knowledge, to communication and to territorial visibility have not been determining factors in the implementation of these reserves. As far as Schliep and Stoll-Kleemann (2010) are concerned, the weaknesses existing in the implementation of the BR concept may be corrected by improving communication between the interested parties and encouraging the development of capabilities. Meanwhile, as far as the MaB Programme is concerned, people and organisations should be equipped with the ability to address the functions and designation criteria of BRs (42). To this end, it would be worth carrying out studies and action plans in order to strengthen the logistics support function in Andalusian BRs, in spite of the fact that to date, it may not have been a key factor in their implementation.

Indicator 3, "Participation in management", appears to have had little influence on the degrees of implementation of Andalusian BRs over the 2008-2014 period. Thus, it may be said that the current levels of participation achieved by these reserves, have not been determining factors in the outcomes of the MaB Programme, which may be an indication of the participatory processes not having been completely developed (35). This indicator provides information on the organ of participation, on the representativeness of social stakeholders, the level of participation and the social stakeholders capacity to influence. However, this indicator is difficult to rate because there are still conceptual and methodological gaps with regard to participation in the management of a BR and its assessment (28). Moreover, the indicator does not allow for assessment of the effectiveness of the dynamics of the participatory processes, the level of organic and functional representation, nor applications that would involve new stakeholders in the management of the BR (5).

It is important to emphasize that the participatory process of a BR can help to correct those aspects that hinder its implementation (34) possibly due to social learning, the building of relationships and the improvement in the understanding of other participants perspectives that this process generates (27). In this context, the results support the recommendation made by Schultz *et al*. (2011) on the desirability of carrying out further in-depth studies that would allow other factors, related to participation, to be analysed, such as governance structures and management practices. And those made by Hernandez-Hernandez *et al.* (2018), related to the essential strengthening of the links between the actors. Otherwise, the territory will continue to suffer the effects of the disarticulation in space and time, where local actors can take effective measures to build a territory socially fair, economically viable and harmoneous (14). Studies of this sort might contribute to the management and implementation of BRs in general, and particularly in Andalusia.

Monitoring indicators and the impact of BRs

The system of indicators used for the RERB has been useful in reviewing the state and the effectiveness of the implementation of BRs in Andalusia, enabling the basic MaB Programme requirements to be measured. Nevertheless, the system does not allow for assessment of the quality and characteristics of the initiatives carried out to comply with the functions and designation criteria of the BRs, nor their impact on sustainable development. In other words, the system does not allow for the attainment of the goals set out in their management assessed instruments.

In general terms, when a protected area, and particularly a BR, is effectively managed and administered, it becomes a secure site for the conservation of biodiversity and for the provision of ecosystems services that in turn contribute to humanity welfare (7, 10, 13, 15, 17, 44). There is thus a need, as other authors have acknowledged, to identify performance indicators for BRs enabling the effectiveness of attainment of its goals to be evaluated, and hence its contribution to global targets for conservation and sustainability (19).

The evaluation of learning and the progress made towards a BR's sustainable development is a major challenge that needs to be addressed by those in charge of its periodic review (31). The creation of a methodological process enabling the headway made by these Andalusian BRs to be evaluated in terms of the attainment of sustainable development, would improve their periodic review processes. Such an evaluation would provide information about the management impacts of Andalusian BRs, confirming whether such territories are fulfilling the goal of becoming exemplary places for the testing and demonstration of sustainable development methods at a regional level (29, 40). The information obtained could foster a process of ongoing learning accompanied by reflection and innovation, and allowing the creation of appropiate policies and strategies for the territory, giving effective responses to the current context of global socio-ecological change (18). These policies and strategies must be carefully planned, considering all the actors involved in benefit of the environment, natural resources and inhabitants of the BRs. In addition, the aforementioned policies and strat-

egies should prioritize the rational use of resources and the regional economic benefit, whose primary objective should be to maintain the integral sustainability of the territory by contextualizing social, economic and environmental benefits (23, 24, 32).

Conclusions

The study of the performance of values obtained from the Monitoring Programme indicators of the RERB has enabled different phases in the implementation of Andalusian BRs to be established. The statistical methods used have enabled identification of those aspects of the management of Andalusian BRs that need to be strengthened in order to increase their levels of implementation. Nevertheless, there are still many aspects that need to be estudied in terms of each of the factors that shape the way the BRs of Andalusia are implemented.

The system of indicators used by the RERB has enabled the degree of fulfilment of the basic requirements of the MaB Programme in the Andalusian BRs, to be evaluated. Although the system has helped to address the periodic review process of these Reserves in a positive manner, its effectiveness in evaluating implementation will be enhanced if further work is done on redefining those conceptual aspects that tend to lead to discrepancies of interpretation among the interested that participate in assessing the indicators. These interpretation discrepancies could also be reduced if: i) the evaluation was carried out jointly between the manager of the BR and a member of the Scientific Council; ii) a checklist of compliance with the requirements and conditions of the assessment assigned to each variable was completed; and iii) the respective evidence supporting the valuation assigned to each variable was provided. Complementary studies enabling in-depth investigation of the characteristics, the quality and impact of the initiatives taken in the BRS of Andalusia in terms of the fulfilment of designation criteria, and the functions befitting BRs, should also be carried out. Some of these complementary studies could be the evaluation of the level of compliance with the Sustainable Development Goals and the assessment of the management of the BR by the local communities.

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