

# Analysis of the National Ecological Reserve among contiguous municipalities: methodologies, elaboration criteria and harmonization

Summary internship report for obtaining the master's degree in Spatial Planning and Urbanism

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May 2023

## Extended Abstract

### Abstract

The National Ecological Reserve (NER) was created in 1983 and its legal regime has undergone several changes to date. These changes were aimed at resolving limitations and difficulties encountered by the various stakeholders in the NER delimitation and management process, supported by technical studies, however, they led to the use of different NER delimitation criteria over time, which in turn led to discontinuities between NER delimitation maps, making unification complex and compromising the idea of the NER as a cohesive structure at national level.

The present internship report falls within a proposal requested by the Direção Geral do Território (DGT) to deepen investigations into NER, namely, studying the existence of discontinuities in the REN, accounting for their extent and understanding the limitations and failures of the NER delimitation process.

To do so, we began by understanding legislative framework of NER and the changes that this figure has undergone over 40 years. Then, criteria were defined for the selection of a set of contiguous municipalities, resulting in three different study areas. As there were no similar studies to compare with, it was necessary to develop our own methodology to obtain the results. Finally, the results were presented using tables, charts, and maps.

Contrary to expectations, it was concluded that the NER present in the common administrative boundaries of the contiguous municipalities studied is mostly continuous. Even so, as this is not completely continuous, it was possible to analyze the extensions in the common administrative boundaries of the studied municipalities where this was detected to be discontinuous. It is found that there is a clear relationship between the discontinuities detected and the fact that there are NER maps delimited under different legal regimes.

*Keywords: National Ecological Reserve, Discontinuities, Continuities and Legal Regimes.*

## Introduction

This internship report arises from the interest of the Direção-Geral do Território (DGT) in collaborating and establishing partnerships with higher education institutions in order to deepen research and studies on the National Ecological Reserve (NER). The previous stage of this report was developed in the Direção de Serviços de Ordenamento do Território/Divisão de Informação e Gestão Territorial (DSOT/DIGT) of the DGT.

The NER is “(...) a biophysical structure that integrates the set of areas that, due to their ecological value and sensitivity or exposure and susceptibility to natural risks, are subject to special protection (...)”, also being “(...) a restriction of public utility, to which a special territorial regime applies, establishing a set of conditions for the occupation, use and transformation of the land, identifying uses and actions compatible with the objectives of this regime in the various types of areas (...)” aiming to “(...) contribute to the sustainable occupation and use of the territory (...)” (Article 2 of Decreto-Lei n.º 166/2008, of August 22).

This figure has undergone several changes over the years, aimed at resolving limitations and difficulties in the delimitation and management process, but this has led to the use of different criteria and disharmony between the NER maps. Currently, there is a widespread idea that the NER is a discontinuous structure, but there are no precise studies on its actual discontinuity, which makes this investigation relevant in order to understand if there are real discontinuities in the reserve, identify their extent and understand the limitations and failures of the current process of delimitation of the reserve.

The internship report aims to study the maps of the NER in contiguous municipalities and identify discontinuities, as well as find resolution methodologies for these situations. understanding the patterns that these differences follow, identifying to what extent the physical and human characteristics of the territory influence the degree of discontinuity of NER between contiguous municipalities, and creating methodologies for cartographic harmonization of NER.

## National Ecological Reserve (NER)

The NER was created in 1983 as “(...) a fundamental instrument for land use planning on a national scale (...)” (Preamble to Decree-Law No. 321/83, of 5 July) , with the aim of integrating “(...) all areas essential to the ecological stability of the environment and the rational use of natural resources, aiming at the correct territorial planning(...)” (Article 1 of Decree-Law No. 321 /83, of July 5th).

The need to create this figure arises from the expansion of urban areas, the construction of infrastructure and manufacturing units and inert exploration that significantly affect the stability of ecological systems, the perennality of agricultural systems and other activities on which our society depends.

Despite the importance of this diploma, it did not achieve the relevance that was conjectured, as it lacked regulation in several subjects. Only with the publication of the “Lei de Bases do Ambiente” was a legal framework created for the government to legislate on this matter (Andresen et al., 2005; Albergaria, 2006; Mendes, 2012; Nero, 2014).

The Legal Regime of the National Ecological Reserve (LRNER) was consolidated in 1990 with the publication of Decree-Law No. 93/90, of March 19, which underwent several changes over the years, until its revocation in 2008 by Decree- law n.º 166/2008 of 22 August.

This decree introduced significant changes in relation to the objectivity of concepts and the simplification of administrative procedures, as well as sharing competencies between the entities involved (Mendes, 2012; Nero, 2014). However, this also underwent several changes until it was amended and republished in its current wording by Decree-Law No. 124/2019, of August 28, which arises from an obvious need to prioritize the current scenario of climate change and extreme weather events, with the purpose of protecting resources and minimizing natural risks (Ramos, 2009).

NER is “(...) a biophysical structure that integrates the set of areas that, due to their sensitivity, function and ecological value or due to their exposure and susceptibility to natural risks, are subject to special protection(...)”, as

well as "(...) a restriction of public utility, to which a special territorial regime applies that establishes a set of constraints to occupation, use and transformation of the soil, identifying the uses and actions compatible with the objectives of this regime in different types of areas (...)". This figure aims to "(...) contribute to the sustainable occupation and use of the territory (...)" (Decree-Law No. 166/2008 of August 22nd in its current version, Decree-Law No. 124/2019 of August 28th).

According to LRNER, the delimitation of the NER is developed in two levels: strategic and operational. The strategic level was established through the National and Regional Strategic Guidelines (NRSG), which translate into guidelines and guiding criteria for delimiting the areas integrated in NER, and the operational level was achieved through the mapping of the areas integrated in NER at the municipal level.

The areas to be included in the NER are organized into three categories - coastal protection areas, areas relevant to the sustainability of the terrestrial hydrological cycle and natural risk prevention areas – which are divided into several types.

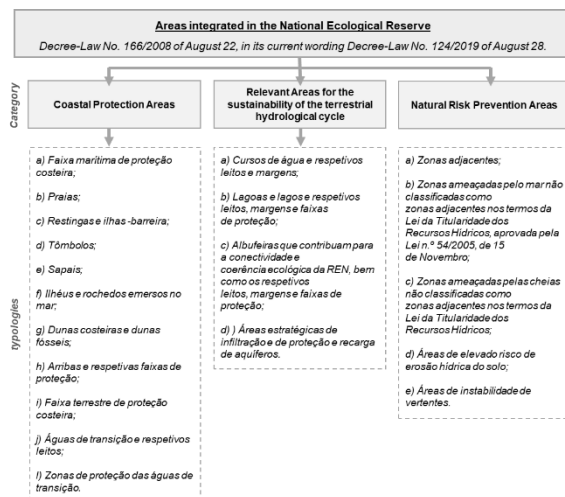


Figure 1 - Explanatory scheme of the areas that integrate the NER. Production: Own. Source: Article 4 of Decree-Law no. 124/2019, of 28 August.

The changes in the areas integrated into NER follow the ideological transformation that occurs from one regime to another. In most of typologies, there have been changes, whether they are changes in their definition or in the delimitation criteria.

## Characterization of the study areas

With the aim of making the study as inclusive as possible, to identify patterns of discontinuity in the NER, municipalities with different geographical locations and morphological characteristics were selected.

These municipalities were selected according to three criteria: they had to be contiguous; located on the administrative boundary between Regional Coordination and Development Commissions (RCDC); and their delimitation maps for the NER were prepared under different legal frameworks, namely: Decree-Law n.º 93/90, of March 19 or Decree-Law n.º 166/2008, of the 22 of August. A municipality without a published NER map was also selected, in order to compare it with the NER delimitation of its neighbors.

These municipalities were grouped into three study areas. The first area encompasses contiguous municipalities from RCDC Norte (São João da Pesqueira, Sernancelhe and Penedono) and RCDC Centro (Sátão, Aguiar da Beira, Trancoso and Mêda), the second area encompasses contiguous municipalities from RCDC Centro (Batalha, Leiria and Pombal) and RCDC Lisboa e Vale do Tejo (Alcanena, Ourém, Torres Novas and Entroncamento), and the third area encompasses contiguous municipalities from RCDC Alentejo (Santiago do Cacém and Odemira) and RCDC Algarve (Aljezur, Monchique, Silves and Lagoa).

Seven municipalities were selected whose NER delimitations were elaborate in accordance with Decree-Law no. 93/90, of March 19 (São João da Pesqueira, Penedono, Alcanena, Torres Novas, Odemira, Aljezur, and Monchique). Six municipalities were chosen whose NER delimitations were elaborate in accordance with Transitional Regime, period of time in which, despite the publication of Decree-Law no. 166/2008, of August 22, Decree-Law no. 93/90, of March 19 continued to be used in the elaboration of the delimitation of the NER maps until the approval of the NRSG (Mêda, Trancoso, Ourém, Santiago do Cacém, Silves, and Lagoa). Six municipalities were included whose NER delimitations were elaborate in accordance with Decree-Law no. 166/2008, of 22 August (Mêda, Trancoso, Ourém, Santiago

do Cacém, Silves, and Lagoa). Additionally, a municipality that has no published NER letter (Entroncamento) was selected for comparison with its neighboring municipalities' NER delimitations.

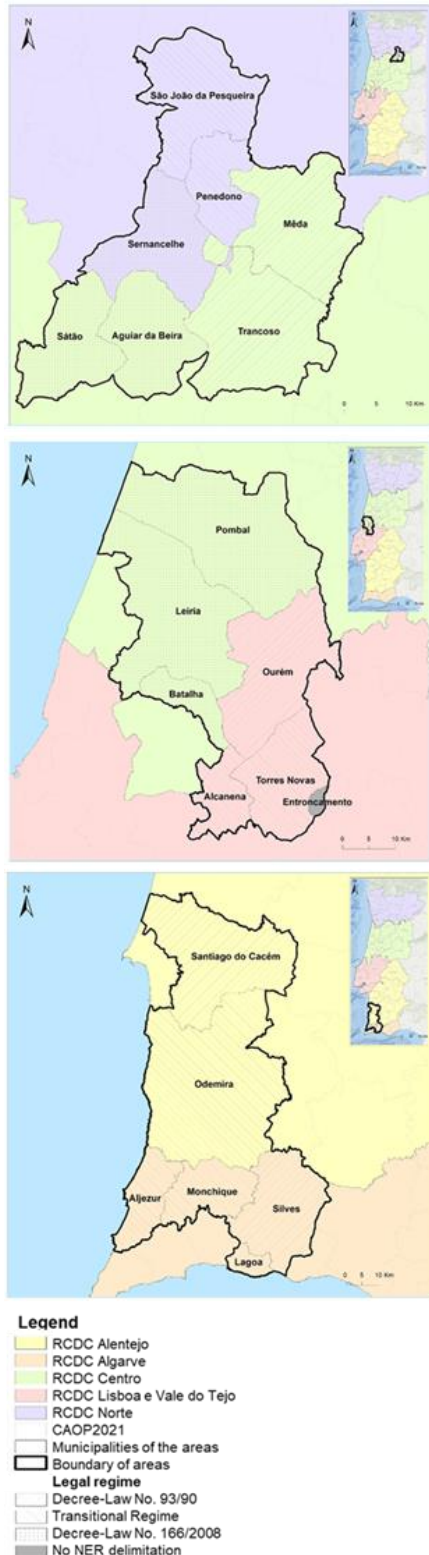


Figure 2 - Geographic framing of the study areas. Production: Own. Source: DGT, 2022.

## Methodology

Throughout the investigation, six methodological steps were developed, as outlined in the following figure, which will be explained in detail below.

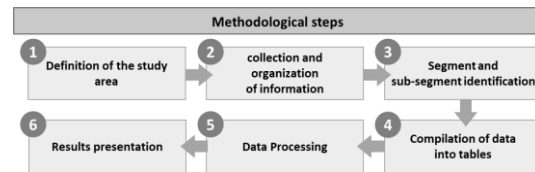


Figure 3 - Methodological outline of the work steps. Production: Own.

In the first stage, municipalities were selected, and study areas were defined as explained in the "Characterization of study areas".

In the second stage of this work, the collection and organization of information was carried out, and this information was registered in Excel tables and structured to allow a comparative and objective analysis. For each municipality, information was collected regarding: the dynamics (delimitation, alteration, rectification, or material correction) of the NER maps, along with their respective dates, diplomas, LRNER used, scope and justification; the structure of the information contained in the current NER maps (matrix, vector or both); and the base cartography used.

In the third stage of this work, the identification of each common administrative boundary between pairs of contiguous municipalities, referred to as "segment," and their segregation into "sub-segments" were carried out. ArcGIS was the software used for the visualization and analysis of the geographical data in question. 28 line-type shapefiles were created for each segment, based on the official administrative map of Portugal 2021 (CAOP 2021). The segment shapefiles were divided into several "sub-segments" by observing the NER maps of each municipality. The division was made whenever there was an absence of NER, presence of NER, and when the NER was present, the overlap between typologies was considered.

The fourth stage of this work is achieved with the compilation of data into tables for each of the identified segment. All the information necessary for the analysis of NER

discontinuities was recorded in the tables, including identification of the area, of the segment (with its respective length in kilometers), the two contiguous municipalities under analysis for each segment, the sub-segments (with their respective length in meters), the presence or absence of NER in each sub-segments ("With NER" = 1 and "Without NER" = 0), the typologies of NER present in each municipality and their respective continuity or discontinuity ("Without NER" = 0, "Continuous" = 1 and "Discontinuous" = -1), and finally, the percentage of discontinuity of each sub-segments was calculated (based on the number of identified types identified as discontinuous in relation to the total types identified in the sub-segments), these values were georeferenced and maps were produced.

In the fifth stage of this work, data processing was carried out, where the use of "double-entry matrices" was chosen as the treatment method. This method allows for the relating of multiple variables of the same theme, in this case, the various typologies of the NER with each other, to discover the relationships between variables in a matrix. The double-entry matrix of each section was filled using the "sub-segments length (m)" from the alphanumeric table, with the typologies of municipality A identified in the columns and the typologies of municipality B identified in the rows. This method allows for the relating of typologies from municipality A to municipality B to account for the length of the sub-segments where the typologies are continuous and where they are discontinuous.

Identification		Municipality B					S/REN
		Tip. 1	Tip. 2	Tip. 3	Tip. 4	Tip. 5	
Municipality A	Tip. 1	200					
	Tip. 2			300			200
	Tip. 3			800		700	50
	Tip. 4			200		100	50
	Tip. 5						
	S/REN			200			700

Figure 4 - Explanatory scheme of the methodological process: Double entry matrix. Production: Own.

Through "double-entry matrices" a "Tables for analysis of discontinuities in NER" were produced, where information was gathered on: total length of the segments; length and percentage of the segments without the NER ("Without NER"); length and percentage of the

segments where the NER was identified ("With NER"); length and percentage of the segments where continuous NER was identified ("Continuous NER"); and also the length and percentage of the segments where discontinuous NER was identified ("Discontinuous NPG").

	Length (m)	Length (%)
<b>Total (Border)</b>	2450	100
<b>Without NER</b>	700	28,6
<b>NER (Continuous and Discontinuous)</b>	1750	71,4
<b>Continuous NER</b>	1000	40,8
<b>Discontinuous NER</b>	1550	63,3

Figure 5 - Explanatory scheme of the methodological process: NER discontinuity analysis table. Production: Own.

It was also decided to create discontinuity analysis tables by typology to diagnose which of the NER typologies had the highest percentage of discontinuity.

Typologies	Total	Continuous NER		Discontinuous NER	
	meters	meters	%	meters	%
Tip. 1	200	200	100	0	0
Tip. 2	500	0	0	500	100
Tip. 3	1350	800	59,3	550	40,7
Tip. 4	250	0	0	250	100
Tip. 5	700	0	0	700	100

Figure 6 - Explanatory scheme of the methodological process: Analysis table of NER discontinuities by typology. Production: Own.

Finally, the sixth and final stage of work was the presentation of results, where graphs and maps were developed with the data obtained so far. This stage will be presented next.

## Result analysis

By applying the methodology presented previously, it was possible to obtain results for each segment regarding the extent (in meters and percentage) of the segment where it was detected the absence of NER ("Without NER"), presence of NER ("With NER"), presence of Continuous NER ("Continuous NER"), and the presence of Discontinuous NER ("Discontinuous NER") were verified.

It is important to note that the absence of NER ("Without NER") and the presence of NER ("With NER") cannot occur simultaneously, therefore they are considered mutually exclusive events.

However, the presence of Continuous NER ("Continuous NER") and the presence of Discontinuous NER ("Discontinuous NER") are mutually non-exclusive, as they can occur simultaneously because there is overlapping of NER typologies, being that in the same extension of a sub-segment it is possible to have continuous typologies and discontinuous typologies at the same time.

With the sum of the results obtained in the different segment, the values for each of the areas were obtained, and through these the total results were arrived at (total extension studied).

It was found that in the total extent analyzed, the presence of NER ("With NER") is higher than the absence of NER ("Without NER"), meaning that the percentage of "With NER" extent is 67,4% while the percentage of "Without NER" extent is 32,6% in relation to the total extent analyzed. It is important to note that this pattern was observed in the vast majority of segment in area 2 and 3, however, in most segment in area 1, the opposite was verified.

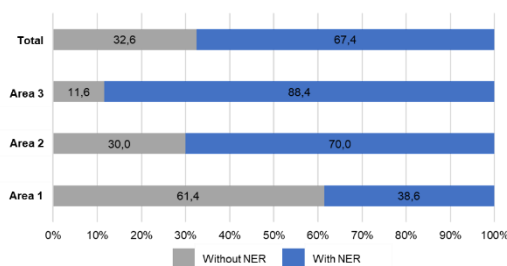


Figure 7 - Graph of the total NER extension in the areas under analysis. Source: DGT, 2022. Production: Own.

Due to the theme studied, focus was given to the extension where the presence of NER ("With NER") was verified to analyze the presence of Continuous NER ("Continuous NER") and the presence of Discontinuous NER ("Discontinuous NER"). In the total extent analyzed, the presence of Continuous NER ("Continuous NER") is higher than the presence of Discontinuous NER ("Discontinuous NER"), that is, the percentage of extension "Continuous NER" is 47,1%, while the extension percentage of "Discontinuous NER" is 29,9%. It is important to note that although this pattern is observed in all areas studied, the difference between the percentage of extension with "Continuous NER"

and the percentage with "Discontinuous NER" extension is low in areas 1 and 2. In area 3, this difference is quite high.

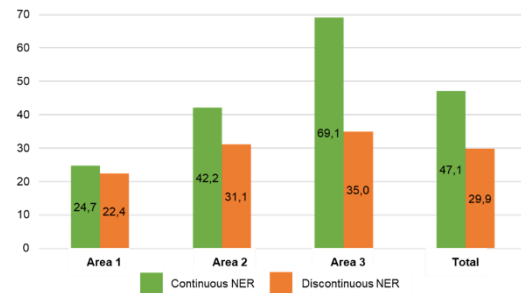


Figure 8 - Graph of the total continuous and discontinuous NER extension in the areas under analysis. Source: DGT, 2022. Production: Own.

It should be noted that not all NER typologies were present in the total analyzed extension. Among the identified typologies, those with the highest representativeness in the total analysis are also the typologies with the highest frequency of discontinuity. These are "Áreas de máxima infiltração" and/or "Cabeceiras das linhas de água" or "Áreas estratégicas de infiltração e de proteção e recarga de aquíferos", "Áreas com risco de erosão" or "Áreas de elevado risco de erosão hídrica do solo", "Cursos de água e respetivos leitos e margens" and "Zonas ameaçadas pelas cheias".

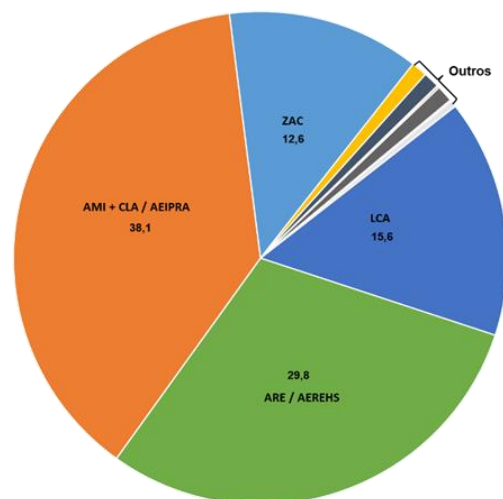


Figure 9 - Graph with the weight of identified NER typologies in the total under analysis (%). Source: DGT, 2022. Production: Own.



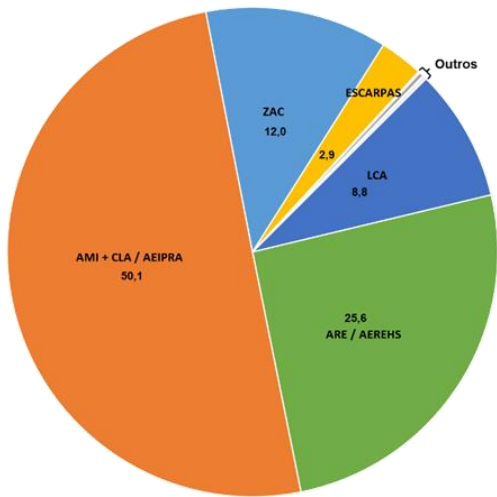


Figure 10 - Chart of the frequency of discontinuities of the NER typologies identified in the total under analysis (%). Source: DGT, 2022. Production: Own.

A sample of segments was chosen to analyze the factors that impact the continuity and discontinuity of these typologies. A sample of segments was chosen to analyze the factors that impact the continuity and discontinuity of these typologies. It was found that in segments where these typologies have a high percentage of continuity, the legal regime used for the delimitation of NER was the same, as well as the method used to delimitate these typologies being similar. The opposite was observed in segments where these typologies have a high percentage of discontinuity.

To better understand the detected discontinuities, the obtained results were related to a set of parameters selected for their high potential to generate discontinuities in the NER, associated with the characteristics of the boundaries of the studied NER maps, namely: the use of different LRNER in the elaboration of the NER maps, the use of cartographic scales in the NER maps, the difference in publication years of the NER maps between contiguous municipalities, and also the issue of the RCDC to which the municipalities belong. Through the calculation of these parameters, a "discontinuity parameter indicator" was developed.

From this analysis, it is expected that there is a correlation between the value of the "Discontinuity parameter indicator" and the percentage of continuous and discontinuous NER in each segment, that is, the lower the value of the "Discontinuity parameter indicator",

the higher the percentage of continuous NER, as well as the higher the value of the "Discontinuity parameter indicator", the higher the percentage of discontinuous NER.

Identification	Area	Segment	Possible discontinuity parameters				Differences in scale	Discontinuity parameter indicator
			Differences in RCDC	Differences in LRNER	Variation in years of publication of the NER maps	Differences in scale		
1		1	#	#		25	#	3
		2	=	=		1	#	3
		3	#	#		24	#	3
		4	=	=		3	#	1
		5	#	#		3	#	2
		6	#	#		19	#	2
		7	=	#		19	#	3
		8	#	#		0	#	1
		9	#	#		6	#	2
		10	=	#		9	#	1
		11	=	#		1	#	1
2		12	=	#		24	#	2
		13	#	#		0	#	2
		14	#	#		20	#	3
		15	#	#		4	#	2
		16	=	#		0	#	2
		17	#	#		4	#	2
		18	=	#		1	#	1
		19	#	#		5	#	2
		20	#	#			#	2
		21	=	#	N/C	N/C	#	N/C
		22	=	#		1	#	1
3		23	#	#		0	#	2
		24	#	#		1	#	2
		25	#	#		25	#	2
		26	=	#		1	#	1
		27	=	#		26	#	1
		28	=	#		1	#	0

Figure 11 - Calculation of Discontinuity Parameters Indicator. Source: DGT, 2022. Production: Own.

Identification	Area	Segment	Discontinuity parameter indicator	Results obtained (%)	
				Continuous NER	Discontinuous NER
1		1	3	25.6	17.1
		2	1	54.6	48.6
		3	3	5.0	10.3
		4	0	13.6	10.5
		5	1	39.2	26.8
		6	2	6.6	5.9
		7	3	7.2	15.2
		8	1	26.3	16.5
		9	2	8.7	29.3
		10	1	6.3	22.3
		11	0	35.7	15.8
2		12	2	100	2.4
		13	0	49.1	18.6
		14	3	100	4.7
		15	2	64.1	39.7
		16	0	50.8	22.1
		17	2	46.6	46.2
		18	0	26.5	8.1
		19	2	21.4	47.5
		20	N/C	0	80.4
		21	2	62.1	37.9
		3		22	1
23	2			90.7	94.3
24	1			100	0.0
25	4			99.6	21.3
26	1			93.1	6.9
27	3			86.8	13.2
28	0			23.3	42.2

Figure 12 - Comparison of the Discontinuity Parameters Indicator results with the diagnosed results. Source: DGT, 2022. Production: Own.

It has been found that the parameters that have the greatest potential to generate discontinuity are the use of different legal frameworks when delimiting the NER maps, as well as the significant difference in years between the publication of the NER maps. It was also concluded that the selected parameters are not sufficient to fully justify the detected NER discontinuities, as it was not always possible to establish a relationship between the high value of discontinuity and the analyzed parameters.

## Conclusion

With this investigation it was concluded that in the common administrative limit of the contiguous municipalities studied, the NER is mostly continuous. However, as it is not completely continuous, it is possible to study the extensions where it is discontinuous, in these cases it was found that:

- The percentage of discontinuous NER is similar in the three areas under analysis.
- The typologies with higher expression in analysis also have a greater frequency of discontinuity.
- There is a clear relationship between the discontinuities detected in NER and the fact that there are still NER maps delimited under different legal regimes.

Based on this study, it is evident that the assumption that gave rise to this internship and the subsequent report, that NER is currently discontinued, is not confirmed. However, it should be noted that this conclusion is a generalization based on the results obtained, lacking comparison with other similar studies. As such, the development of similar studies for the remaining municipalities is of utmost importance, allowing for an assessment of whether the results are similar or divergent in the national context.

A fundamental part of this report involved identifying suggestions that contribute to the harmonization of the NER, on a national scale. In this regard, five proposals were established, aiming to avoid discontinuities. It is proposed, in the first instance, the rapid updating of the NER maps to the current legal regime in all municipalities. The second suggestion involves increasing the incentive for communication and cooperation between municipalities. The third proposal is to monitor inter-municipal continuity in the different NER maps. This function should preferably be attributed to one of the entities involved in the monitoring process of the delimitation of the NER by the municipalities, or the responsibility of a new body with this function. The fourth suggestion is to promote the NER as a figure that protects not only ecosystems, but also the population, aiming to improve the perception of what NER is all about.

Finally, the last proposal is a reflection on NER's delimitation responsibility, suggesting that this task should be at the national or regional level to avoid disarticulations between municipalities.

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