



# Ecosystem Accounts in Spain: Update of the SEEA-EA implementation at national level

*Fernando Santos Martín, Adrián García Bruzón*

*This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 817527*



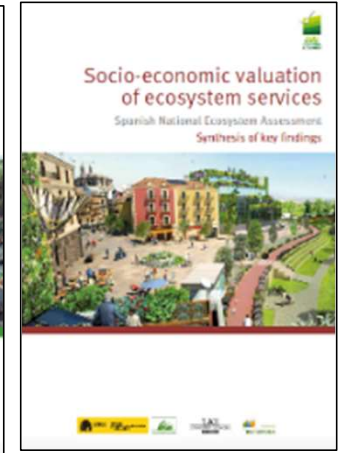
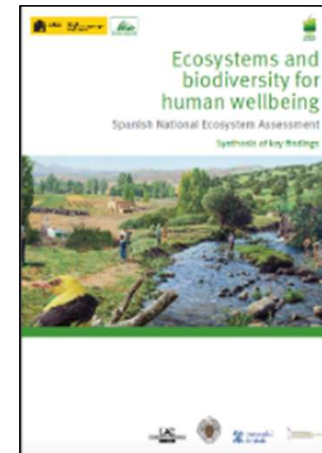
# Ecosystem Accounts in Spain



**MAIA**  
Mapping and Assessment for  
Integrated ecosystem Accounting

In Spain we have been working on Mapping and Assessment Ecosystem and their Services at national scale since 2010

Ecosystem accounting is an approach consistent with the assessment, valuation and mapping of ecosystems and their services.



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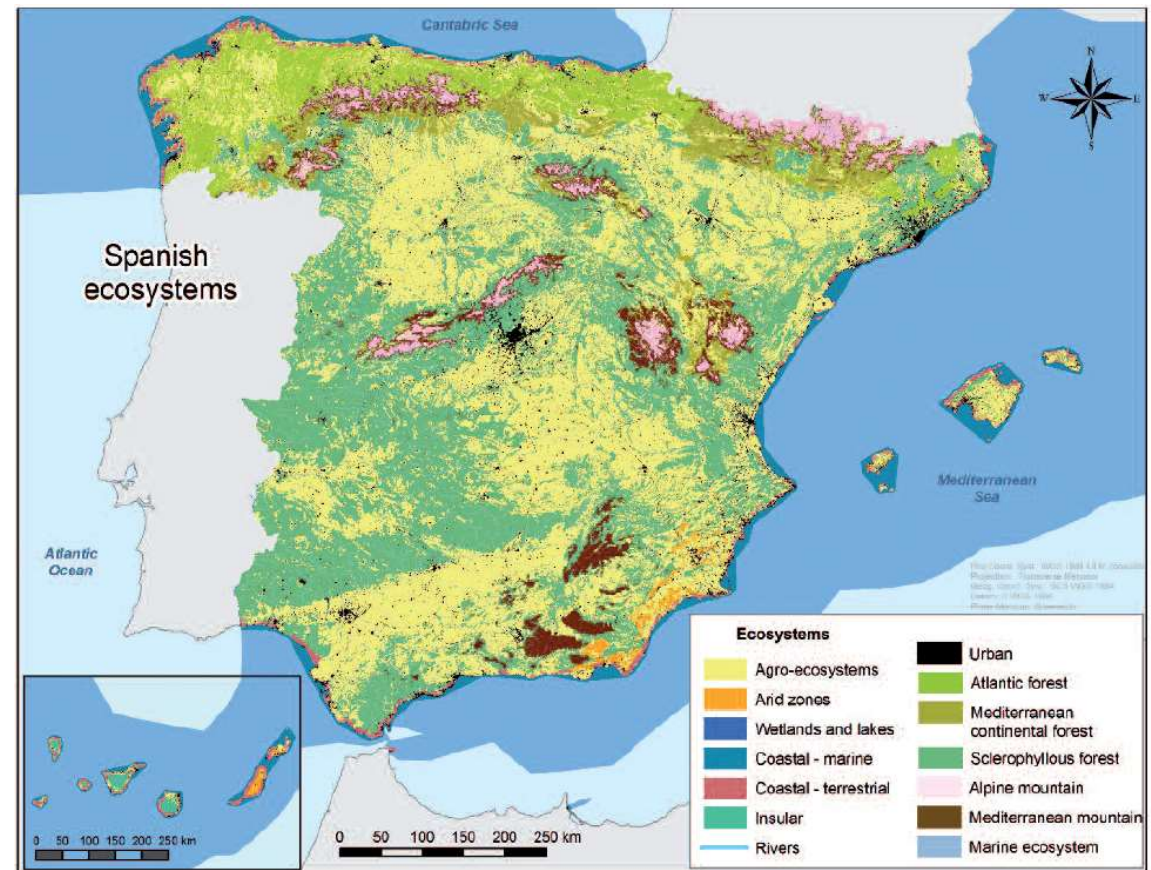
Government	Research
Ministry of Ecological Transition (MITECO)	Universidad Rey Juan Carlos de Madrid (URJC)
National Institute of Statistics of Spain (INE)	Spanish National Research Council (CSIC)

### Involved partners and stakeholders

Based on D5.1 (Annex 10 section 2);  
European NCA stakeholder day

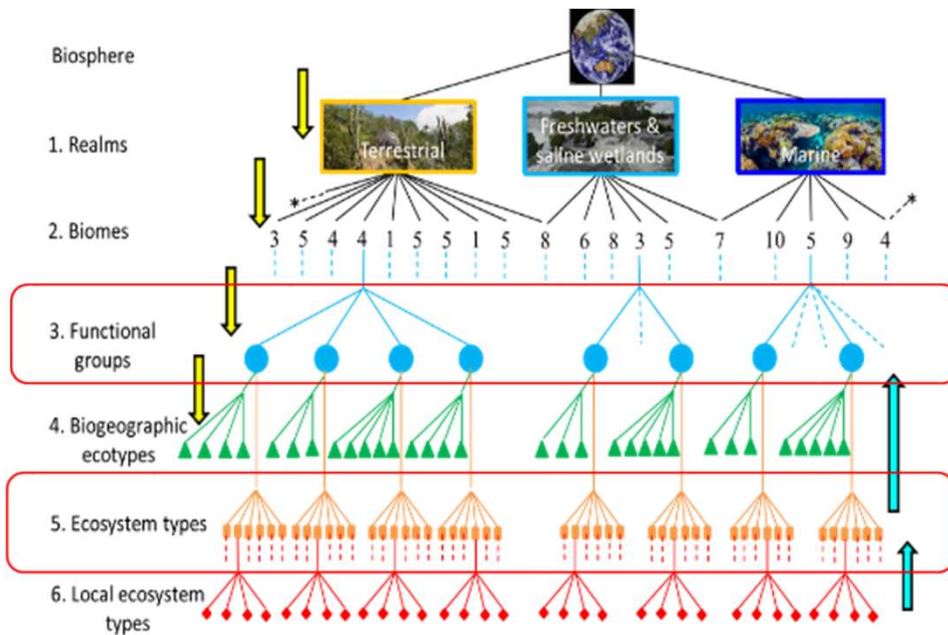
## Spanish ecosystem classification (EME, 2012)

Ecosystem types	
Forest	Sclerophyllous Mediterranean
	Continental Mediterranean
	Mountain Mediterranean
	Atlantic
	Alpine
	Insular
Grassland	Sclerophyllous Mediterranean
	Continental Mediterranean
	Mountain Mediterranean
	Atlantic
	Alpine
	Insular
Shrubland	Sclerophyllous Mediterranean
	Continental Mediterranean
	Mountain Mediterranean
	Atlantic
	Alpine
	Insular
Other lands	Arid zones
	Coastal areas
	Other land
Aquatic	Wetlands
	Rivers and lakes
Cropland	Perennial woody crops
	Annual crops
Settlements	Urban



We have developed crosswalks between Spanish Ecosystems, IUCN, MAES and LULUCF ecosystem types

## IUCN Global Ecosystem Typology



LULUCF_level_1	id_1	MAES_level_1	LULUCF_level_2	id_2
Forest land	100	Forest and woodland	Broadleaved	110
			Coniferous	120
			Mixed	130
			Other Forests	100
Grassland	200	Grassland	Woodland	210
		Heathland and shrub	Shrubland	220
		Grassland	Perennial	230
Other Land	400	Sparsely vegetated land	Other Grassland	200
			Other Land	400
Wetlands	500	Inlands wetlands	Wetlands and Peatlands	500
		Rivers and lakes	Inland	510
		Marine inlets	Seaside	520
Cropland	700	Cropland	Perennial woody crops	710
			Annual crops	720
			Other Crops	700
Settlements	800	Urban	Settlements	800

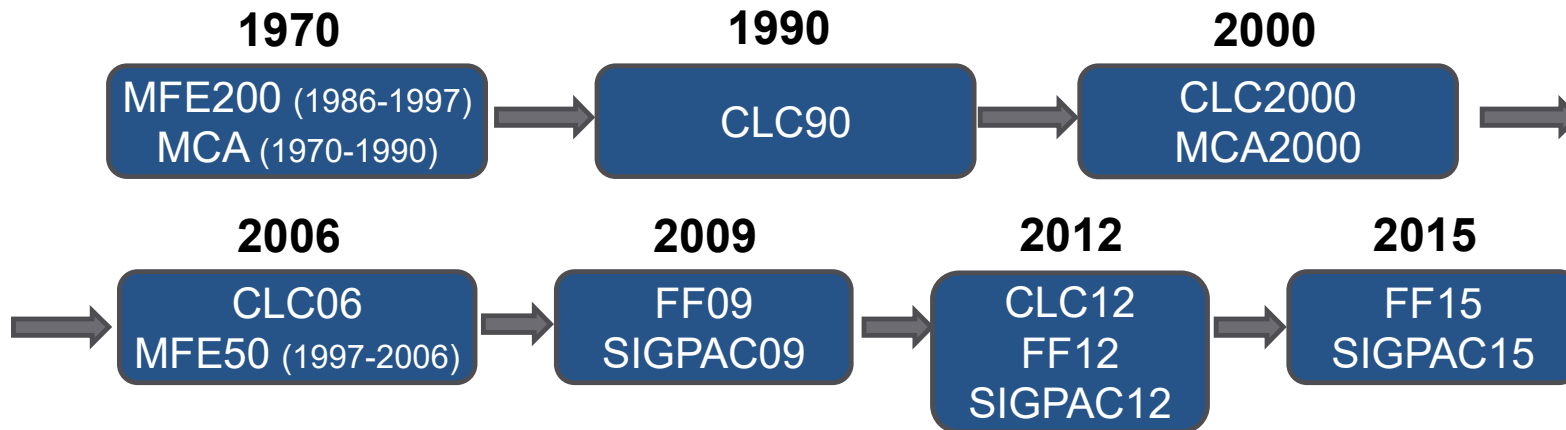


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In Spain we are using LULUCF (Land Use, Land Use Change and Forestry) a multisource dataset for ecosystem accounting. LULUCF provide a high spatial resolution (25 meters per pixel) information for a significant time period (1970-2015).



**Source:** Spanish Ministry for the Ecological Transition and the Demographic challenge

MFE200: Spanish Forest Map. 1:200.000

MFE50. Spanish Forest Map. 1:50.000

MCA: Crop and Harvest Map

FF: Update of changes in MFE50

CLC: Corine Land Cover

SIGPAC: Geographic Information System of Agricultural Plots

Country	Scale			Accounts				
	National	Regional	Local	Extent	Condition	ES Supply and Use	Asset	Biodiversity
Belgium		X (Flanders)		X	X	X	X	X
Bulgaria		X (Plovdiv)	X (Karlovo)	X		X		
Czech	X			X		X	X	
France			X (to be decided)	X	X		X	
Finland	X			X	X	X		X
Germany	X			X		X		
Greece		X (Peloponnesus)		X		X		X
Netherlands	X			X				
Norway		X (Greater Oslo)	X (Oslo)	X	X	X		X
Spain	X	X (Andalusia)		X	X	X		X
<b>Total</b>	<b>5</b>	<b>5</b>	<b>3</b>	<b>10</b>	<b>4</b>	<b>8</b>	<b>3</b>	<b>4</b>



# Ecosystem Accounts in Spain



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## STATUS OF THE BIOPHYSICAL ECOSYSTEM ACCOUNTS IN SPAIN

FINISHED

IN PROCESS



7

### Biophysical Accounts

Extent

Condition

### Ecosystem services

Supply

Use

### Valuation techniques

Supply

Use

### Monetary Accounts

Ecosystem assets

Thematic accounts:  
Water,  
Marine  
Biodiversity

Source: SEEA- Ecosystem Accounting (UN 2021)



# Ecosystem Accounts in Spain



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**1. EXTENT ACCOUNTS:** A methodology has been developed and tested at national level following the principles outlined in SEEA-EA (chapter 4), compiling an ecosystem extent account for terrestrial ecosystems.

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journal homepage: [www.elsevier.com/locate/scitotenv](http://www.elsevier.com/locate/scitotenv)



How the ecosystem extent is changing: A national-level accounting approach and application

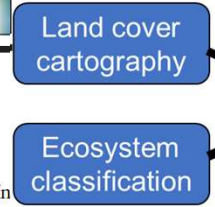
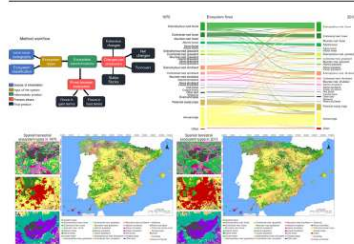
Adrián G. Bruzón\*, Patricia Arrogante-Funes, Pablo Martínez de Anguita, Carlos J. Novillo, Fernando Santos-Martín

Department of Chemical and Environmental Technology, ESCET, Rey Juan Carlos University, C/Talipán s/n, Móstoles, 28933 Madrid, Spain

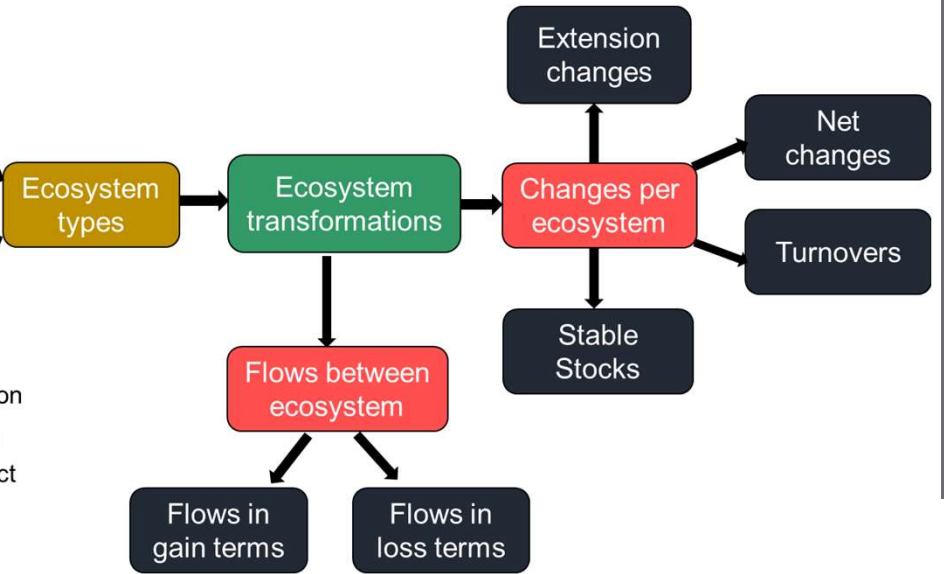
### HIGHLIGHTS

- A proposal to assess a national ecosystem extent account meets of SEEA-EA.
- The ecosystem types based on of the National Ecosystem Assessment of Spain.
- Ecosystem types were combined with the LULUCF database of Spain
- The proposed classification went through a validation process based on LUCAS.
- Main ecosystem flows found are urbanisation, afforestation, and cropland loss.

### GRAPHICAL ABSTRACT



- Source of information
- Input of the system
- Intermediate product
- Process phase
- Final product



G. Bruzón et al. 2021





# Ecosystem Accounts in Spain

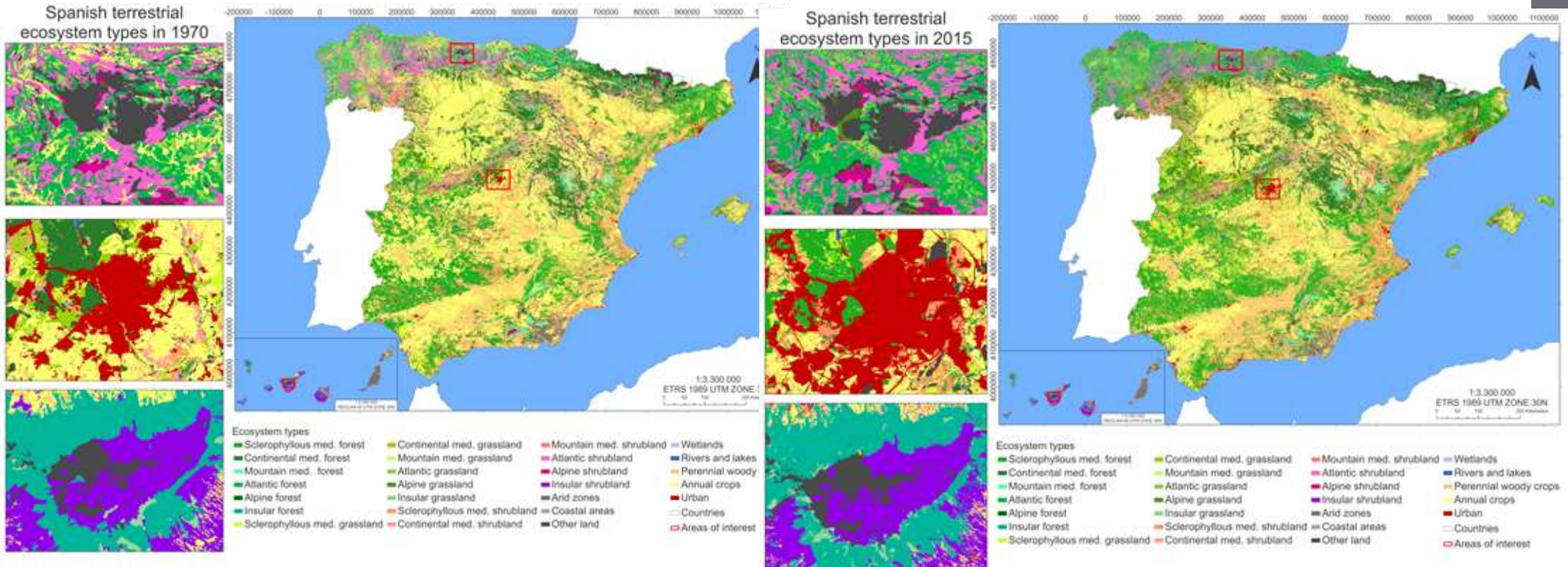


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**1. EXTENT ACCOUNTS:** ecosystem extent account results are presented for terrestrial ecosystems for different time periods between 1970-2015 (1970, 1990, 2000, 2006, 2009, 2012, 2015).

**1970**

**2015**





# Ecosystem Accounts in Spain



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**1. EXTENT ACCOUNTS:** ecosystem extent accounts tables are presented for terrestrial ecosystems for different time periods between 1970-2015 (1970, 1990, 2000, 2006, 2009, 2012, 2015).

Extent accounts of forest ecosystems in Spain (1970-2015)

Ecosystems	Sclerophyllous med. forest	Continental med. forest	Mountain med. forest	Atlantic forest	Alpine forest	Insular forest
Initial Extent	73324.90	41020.50	4209.00	23493.30	1484.70	1228.50
Reductions	23157.10	12124.80	936.30	5417.90	432.00	247.90
Additions	34231.60	18155.30	1044.10	11416.00	586.80	375.00
Net Additions	11074.50	6030.60	107.70	5998.10	154.80	127.10
Net_%	2.19	1.19	0.02	1.18	0.03	0.03
Total turnover	57388.80	30280.10	1980.40	16833.80	1018.90	623.00
Turnover_%	11.33	5.98	0.39	3.32	0.20	0.12
Stable Stock	50167.70	28895.80	3272.70	18075.40	1052.60	980.60
Stable_%	9.91	5.71	0.65	3.57	0.21	0.19
Final Extent	84399.60	47051.10	4316.70	29491.50	1639.50	1355.60

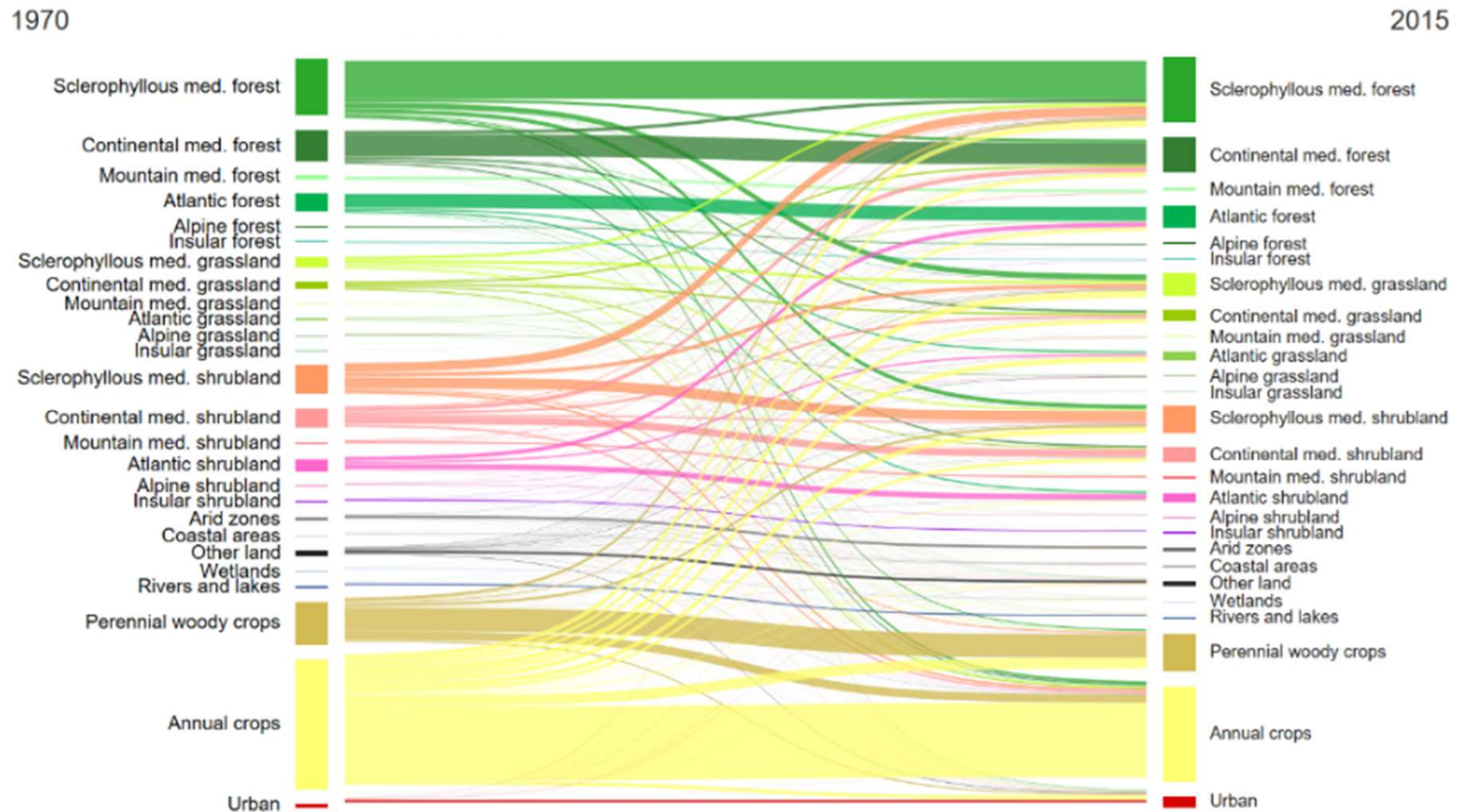


# Ecosystem Accounts in Spain

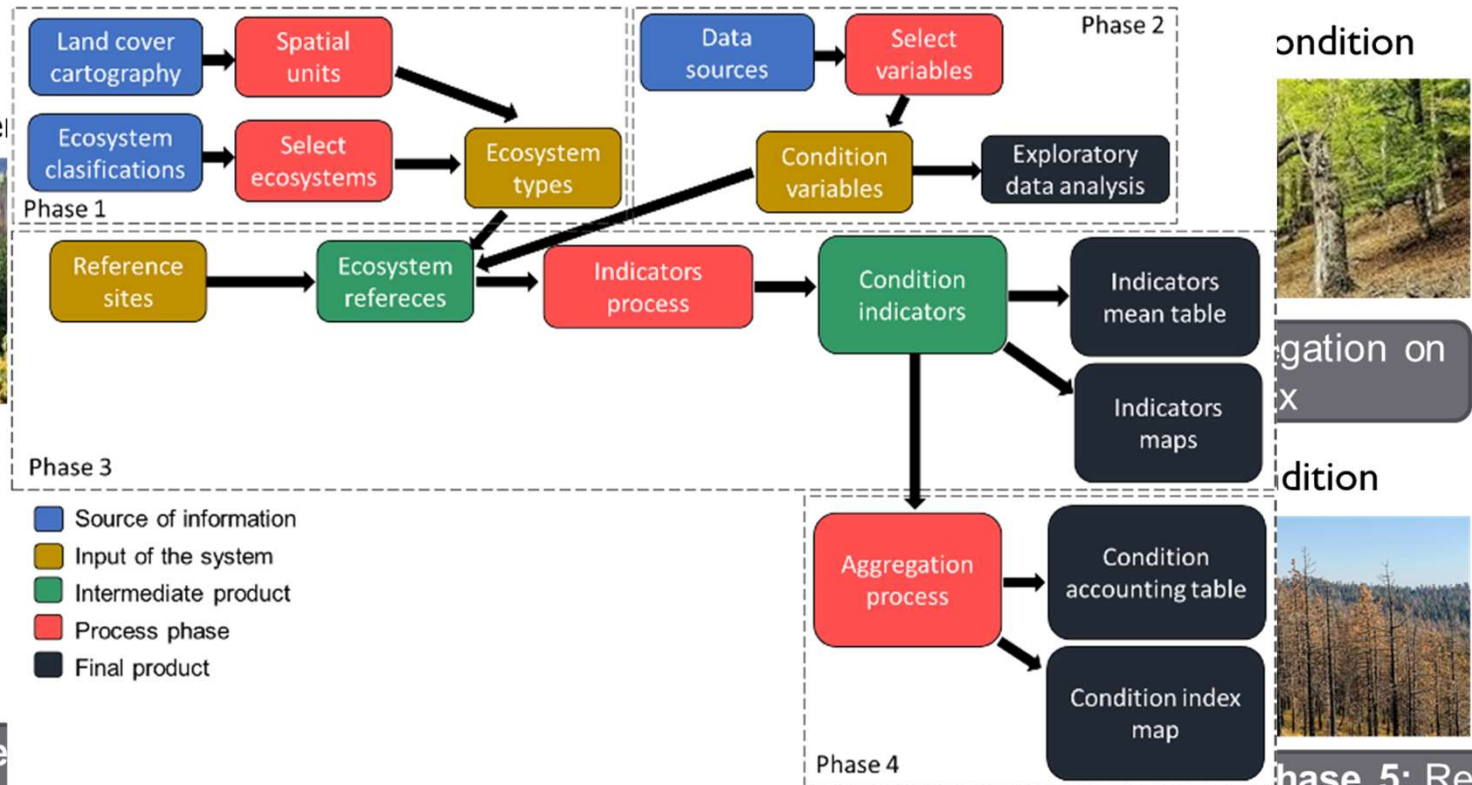
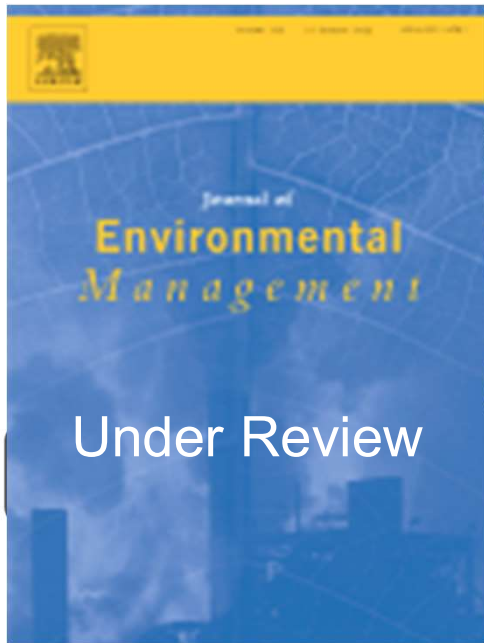


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## 1. EXTENT ACCOUNTS: ecosystem **change** results are presented for terrestrial ecosystems for the same time periods between 1970-2015.



**2. CONDITIONS ACCOUNTS:** A methodology has been developed at national level following the principles outlined in SEEA-EA (chapter 5) for **forest ecosystem** for the time period 2000-2015.



Phase reference areas

Reference areas

Phase 5: Report in accounting tables

12



# Ecosystem Accounts in Spain



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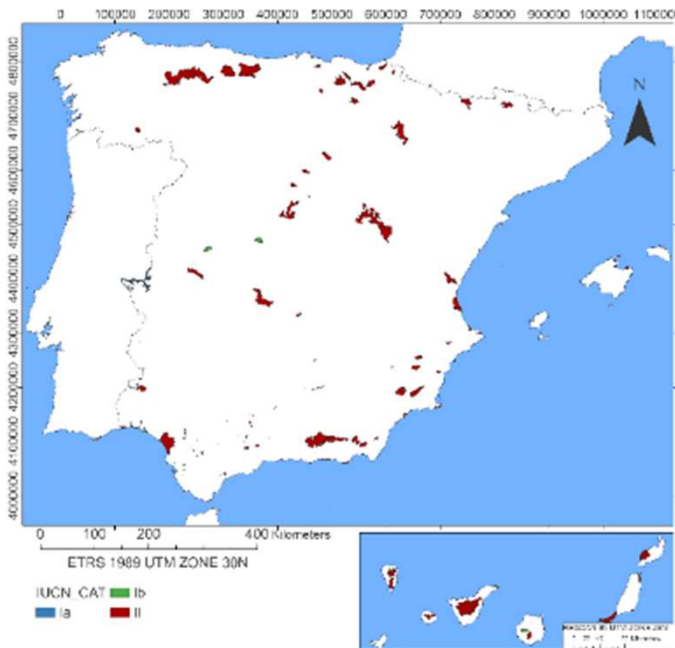
**2. CONDITIONS ACCOUNTS:** The SEEA-EA condition is a metric that captures, through a set of key indicators, the state and functioning of the ecosystem in relation to both its ecological condition and its capacity to provide ecosystem services.

Indicators used in the forest condition in Spain

Group	Class	Weigth	Indicator	Source	Resolution (m)
Abiotic characteristics	Physical state	0,07	NDWI	Landsat	30
		0,07	Soil organic carbon	Lucas	1000
	Chemical state	0,07	Ozone (AOT40f)	EEA	2000
		0,07	Nitrogen Deposition (Critical Loads)	EEA	5000
Biotic characteristics	Composition state	0,1	Forest bird richness	MITERD	1000
		0,1	Richness of forest flora	MITERD	1000
	Structural state	0,12	Tree cover	Modis	250
	Functional state	0,1	NDVI	Landsat	30
		0,08	Gross primary production	Modis	500
Landscape characteristics	Landscape characteristics	0,12	Forest area density	Guidos	50
		0,1	Naturalness index	Guidos	50

Based on **areas of least disturbance**, in forests that meet these two criteria:

- We use the forest areas included in the protected areas classified in the IUCN categories of level I, II.
- We include forests that have not undergone changes in cover since 1970.



Reference table

Ecosystem type	Ecosystem Forest type	Alpine			
		Broadleaved		Coniferous	
	ECT class	Indicator	Ref Max	Ref Min	Ref Max
Physical state	NDWI	0,22	0,1	0,29	0,11
	SOC	0,12	0,05	0,10	0,03
Structural state	FCC	0,98	0,64	0,94	0,58
	NDVI	0,48	0,27	0,51	0,22
Landscape characteristics	FAD	0,80	0,4	0,79	0,45

A different reference is generated for each indicator and forest type.



# Ecosystem Accounts in Spain

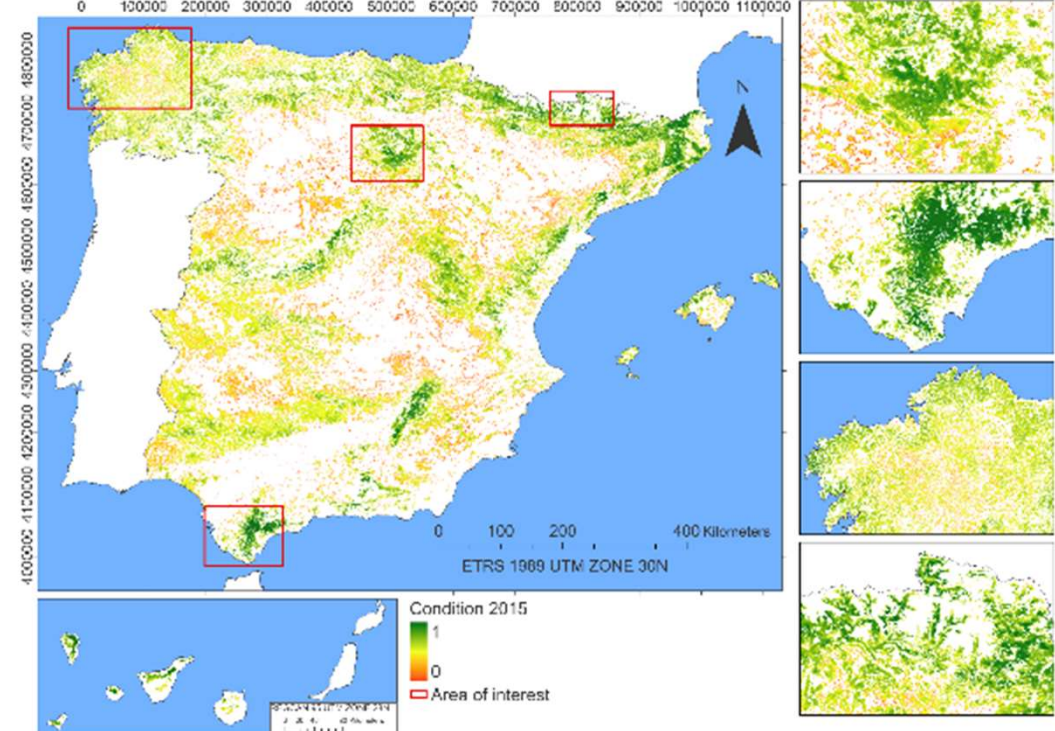
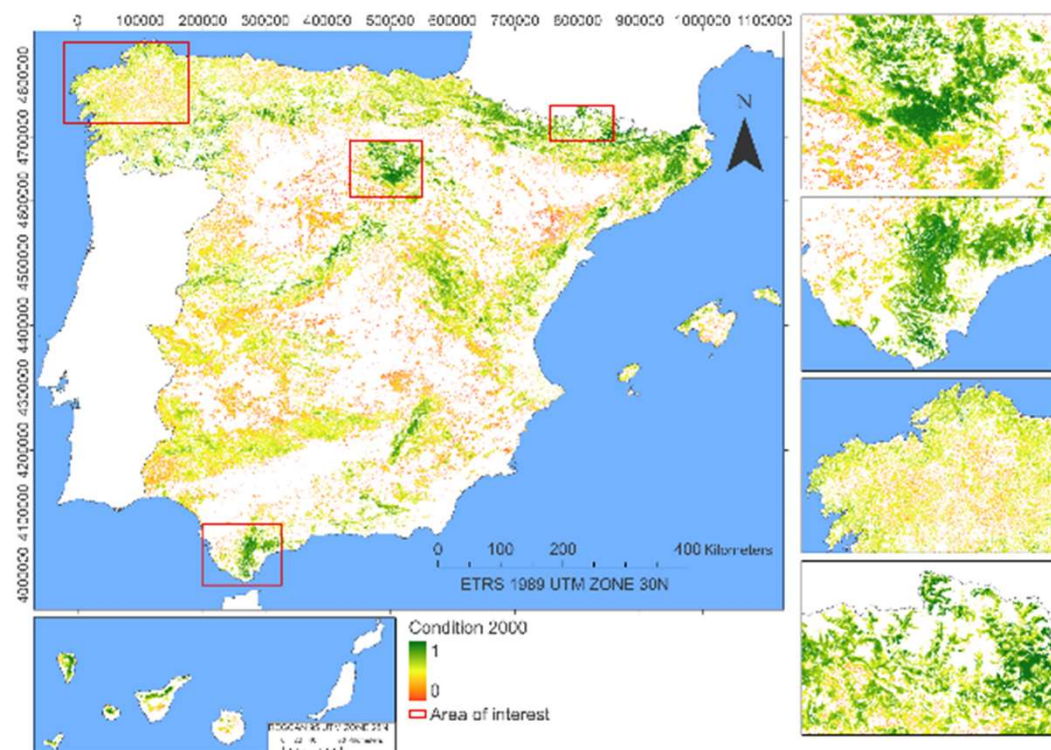


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**2. CONDITIONS ACCOUNTS:** results are presented in maps for forest ecosystems for different time periods between 2000-2015.

**2000**

**2015**





# Ecosystem Accounts in Spain



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**2. CONDITIONS ACCOUNTS:** results are presented in **accounting tables** for forest ecosystems for different time periods between 2000-2015.

Condition index by forest type

Forest Type	2000	2015	Change	Forest Type	2000	2015	Change
Mixed Alpine	0.764	0.794	3.10%	Con. Insular	0.585	0.618	3.30%
Con. Alpine	0.737	0.749	1.30%	Con. Mountain Med.	0.609	0.614	0.50%
Broad. Alpine	0.666	0.709	4.30%	Con. Continental Med.	0.595	0.607	1.10%
Mixed Insular	0.654	0.68	2.60%	Mixed Mountain Med.	0.589	0.607	1.70%
Broad. Insular	0.661	0.677	1.60%	Broad. Mountain Med.	0.604	0.602	-0.23%
Con. Atlantic	0.618	0.653	3.50%	Mixed Sclerophyllous Med.	0.57	0.601	3.10%
Mixed Atlantic	0.588	0.632	4.50%	Broad. Continental Med.	0.553	0.572	1.90%
Broad. Atlantic	0.582	0.62	3.80%	Con. Sclerophyllous Med.	0.542	0.57	2.80%
Mixed Continental Med.	0.605	0.618	1.30%	Broad. Sclerophyllous Med.	0.536	0.562	2.60%



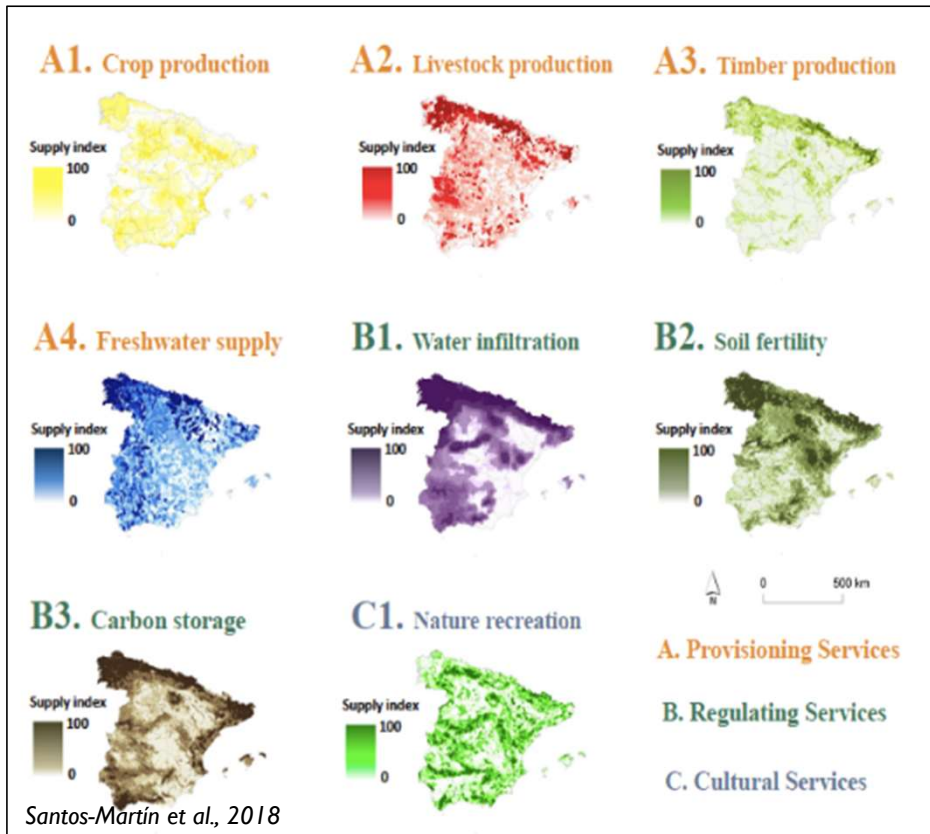


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## 3. ECOSYSTEM SERVICES ACCOUNTS (biophysical): In previous projects we have mapped, valued and assessed multiple ES. Here we only present the work done within MAIA.



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Full Length Article

National blue carbon assets and future perspectives

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ARTICLE INFO

ABSTRACT

1. Introduction

The Millennium Ecosystem Assessment has provided evidence of both the past and ongoing degradation of biodiversity and ecosystem services (MA, 2005). A variety of international initiatives has been developed to assess and monitor ecosystem services, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which provides the scientific basis for decision-making on biodiversity and ecosystem services. The IPBES Global Assessment Report (GAR) (Díaz et al., 2019) provides the most comprehensive assessment to date of the state of biodiversity and ecosystem services worldwide. The GAR identifies the main drivers of biodiversity loss and ecosystem services degradation, and the need for integrated and coherent action across all sectors of society to address these challenges. The GAR also identifies the need for a new generation of ecosystem services indicators that can provide a comprehensive assessment of the state of ecosystem services and the impact of human activities on these services. This paper presents the results of a study that aims to assess the state of ecosystem services in Spain, and to identify the main drivers of ecosystem services degradation in this country. The study is based on a comprehensive assessment of the state of ecosystem services in Spain, and on the identification of the main drivers of ecosystem services degradation in this country. The results of the study show that ecosystem services in Spain are generally in good health, but that there are some areas of concern. The main drivers of ecosystem services degradation in Spain are land-use change, climate change, and pollution. The study also identifies the need for a new generation of ecosystem services indicators that can provide a comprehensive assessment of the state of ecosystem services and the impact of human activities on these services. This paper presents the results of a study that aims to assess the state of ecosystem services in Spain, and to identify the main drivers of ecosystem services degradation in this country. The study is based on a comprehensive assessment of the state of ecosystem services in Spain, and on the identification of the main drivers of ecosystem services degradation in this country. The results of the study show that ecosystem services in Spain are generally in good health, but that there are some areas of concern. The main drivers of ecosystem services degradation in Spain are land-use change, climate change, and pollution. The study also identifies the need for a new generation of ecosystem services indicators that can provide a comprehensive assessment of the state of ecosystem services and the impact of human activities on these services.

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**1. Introduction**

Land-use change is occurring worldwide and affects human well-being by impacting the delivery of multiple ecosystem services (ES) (Lambin et al., 2014; Allan et al., 2015; Robinson et al., 2017). Two main processes have been recognized as the most important drivers of land-use change: (a) land-use intensification to enhance food productivity, which occurs by decreasing the majority of ES and leads to the abandonment of marginal land (Burgin et al., 2014; Foley, 2008); and (b) land-use protection, which occurs via the establishment of protected areas to preserve biodiversity, thus preserving certain areas from land-use transformation (Barbour et al., 2010; Ouyang et al., 2016). Presently, these two processes lead to an abandonment of extensive traditional landscape practices, which are essential for the production of many ES (Engberg et al., 2012; Palomo et al., 2010). The underlying reason for this co-production is that ES are products of coupled socio-ecological systems and therefore depend on ecological processes as well as on social and biophysical variables (Eigenbrood, 2016; Kemp, 2016).

The Mediterranean region is characterized by the historical co-evolution of social and ecological systems that have promoted coupled social-ecological systems (Pascarella et al., 2015; Sánchez et al., 2013). The drivers of land-use change mentioned above alter social-ecological processes and structures and have a direct effect on the conversion of multifunctional landscapes into more simple, mono-functional landscapes (Hijnen, 2010). Multifunctional landscapes represent an example of social-ecological systems with an intermediate level of disturbance, and ecosystems with a certain degree of extensive human management can maximize the diversity of ES that are delivered (Dunbar et al., 2010b; Martín-López et al., 2014). In the last few decades in industrialized countries, this type of social-ecological system has been replaced by intensified land uses that have a short-term monetary value and a low capacity to supply a diverse flow of ES (Poljčak, 2005; Pita et al., 2016). Moreover, although some of these areas

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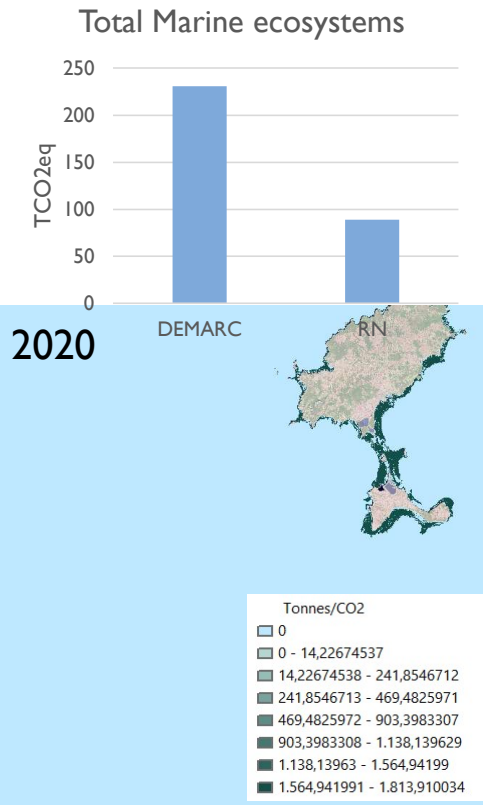


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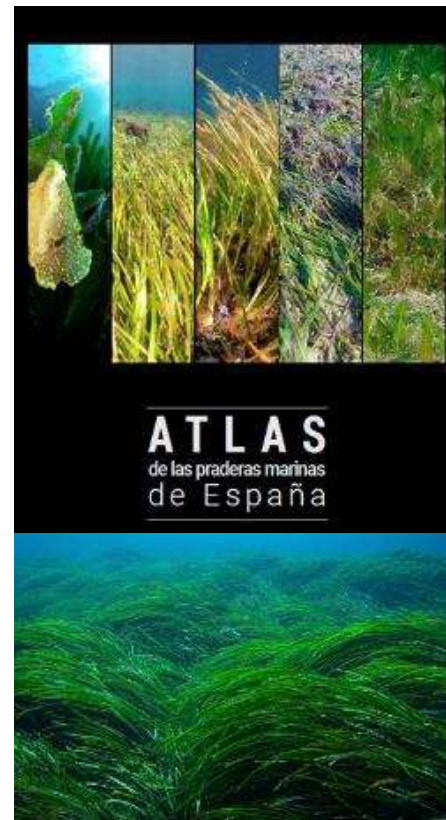
## 3. ECOSYSTEM SERVICES ACCOUNTS (biophysical)

### 3.1. GLOBAL CLIMATE REGULATION: Marine ecosystem carbon sequestration accounts.

**InVEST**  
integrated valuation of  
ecosystem services  
and tradeoffs



Scale: 1:750.000



Ecosystem Services 53 (2022) 101397

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Full Length Article

**National blue carbon assessment in Spain using InVEST: Current state and future perspectives**

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**ABSTRACT**  
Coastal and marine ecosystems supply multiple services in which human well-being is highly dependent. However, high-resolution spatial distribution studies of marine ecosystem services are scarce, even if it is known that this information is needed to better manage and conserve these ecosystems. With the aim of filling this gap, in this study we have: (1) mapped and assessed the current capacity of marine phanerogams (*Posidonia oceanica*, *Cymodocea nodosa*, *Zostera noltii*, *Spartina maritima*, and *Halodule wrightii*) to store and sequester blue carbon in Spain; (2) mapped and assessed the future capacity of marine phanerogams to store and sequester blue carbon under three plausible futures; and (3) assess the economic implications of these scenarios. Our results are based on the InVEST Blue Carbon model and exhibit high spatial resolution (100 m/pixel) of carbon stored in marine phanerogams. We found that 82% of carbon storage and sequestration by marine phanerogams is currently managed within Natura 2000 areas. However, results from the modelled future scenarios indicate a consistent decrease in the amount of carbon stored in these ecosystems by 2050 (24% less in the business-as-usual scenario). The economic impact of these losses is equivalent to 17,074 million € (around 1.6% of the Spanish GDP). Finally, we consider that a transformative management change is needed to conserve marine phanerogams in Spain, and we discuss the importance of the Natura 2000 Network in managing marine ecosystems and their services in the near future.

**1. Introduction**

Marine biodiversity loss is increasingly impairing the ocean's capacity to provide fundamental ecosystem services (ES) for human well-being (Werns et al., 2006). The loss of coastal and marine ecosystems will be further increased by climate change (Ehrt and Nedler, 1999; Harley et al., 2006; Koch et al., 2013) and, ironically, marine ecosystems play a fundamental role in the carbon storage and sequestration processes that contribute to climate change mitigation (Quatrini et al., 2013; Macho et al., 2014). Several studies have indicated that seagrass habitats, the main contributor to this carbon storage, are declining worldwide due to human impacts, which implies an alarming increase in their extinction risk (Ehrt et al., 2013). Nevertheless, studies on marine ecosystems, especially studies that quantify and spatially assess marine ES, remain scarce (Townsend et al., 2014).

Coastal and marine ecosystems are, and have always been, a source of multiple ES, not only for providing food (fisheries and aquaculture) and the extraction of raw materials (biotic and non-biotic) but also regulating (climate regulation, coastal protection) and cultural services such as tourism and cultural heritage, among others (Perrone and Lubchenco, 1997; Börlke-Hoeflich et al., 2015; Hartam et al., 2015). One of the most important marine ecosystems in terms of ES is seagrass meadows formed by marine phanerogams, such as *Posidonia oceanica*, *Cymodocea nodosa*, or *Zostera noltii*. Marine phanerogams are flowering plants that live totally submerged in shallow marine waters on all continents except Antarctica (Ehrt et al., 2013). They form extensive underwater meadows that provide a wide range of ES, such as providing food and shelter for a wide variety of organisms, acting as fish nursery, protecting the coastline against disturbances, enhancing water purification, and even providing trophic resources and shelter to terrestrial

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2212-0416/© 2021 Elsevier B.V. All rights reserved.

## 3. ECOSYSTEM SERVICES ACCOUNTS (biophysical)

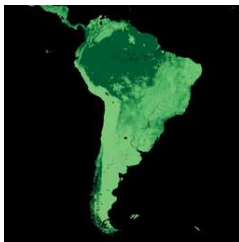
### 3.1. GLOBAL CLIMATE REGULATION: Terrestrial ecosystems carbon sequestration accounts.

**InVEST**

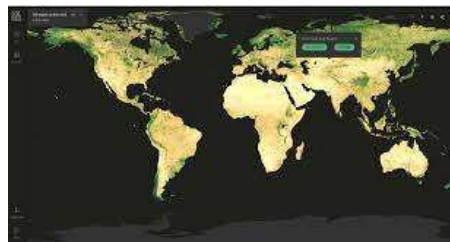
integrated valuation of  
ecosystem services  
and tradeoffs

#### Source of data

Global Aboveground and  
Belowground Biomass Carbon  
Density Maps (NASA)



Soil Organic Carbon  
Stock Maps (ISRIC)

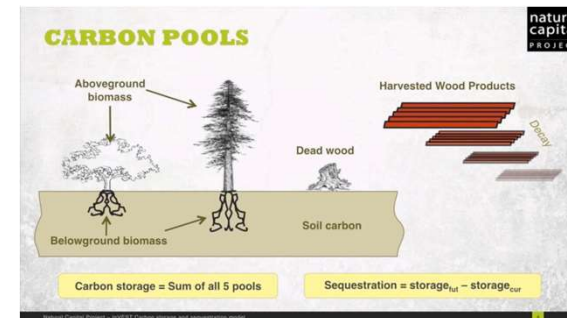


Information on dead wood  
from the Spanish forest  
monitoring network (MITERD)



Accumulated carbon in 5 “deposits/pool”:

1. aerial biomass
2. underground biomass
3. dead biomass
4. Soil
5. Biomass of cut wood (not included)

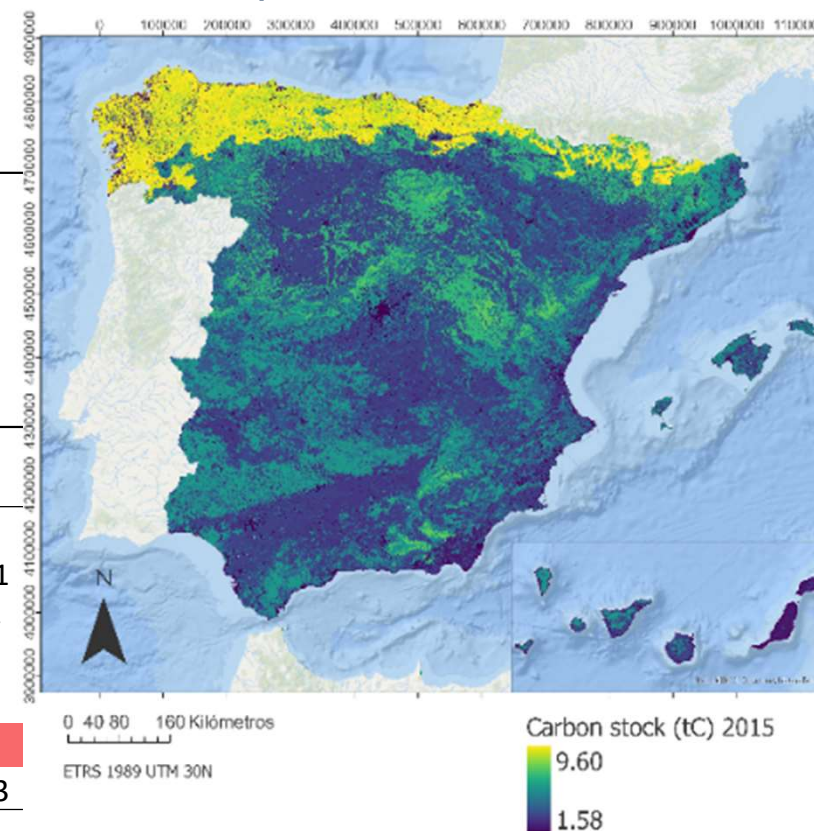


## 3. ECOSYSTEM SERVICES ACCOUNTS (biophysical)

### 3.1. GLOBAL CLIMATE REGULATION: Terrestrial ecosystems carbon sequestration accounts.

Carbon sequestration of forest ecosystems in Spain (2000-2015)

	Sclerophyllous med. forest	Continental med. forest	Mountain med. forest	Atlantic forest	Alpine forest	Insular forest
Carbon sequestration(tC/ha/year)	4.74	5.54	6.08	8.62	9.61	4.73
C_above	1.31	1.8	1.93	2.47	3.8	0.5
C_below	0.6	0.7	0.77	0.85	1.2	0.4
C_soil	2.79	3	3.34	5.17	4.35	3.65
C_dead	0.04	0.03	0.04	0.13	0.25	0.18
Carbon sequestration(tC/year)						
Opening (2000)	38522250	25027164	2617813	23956412	1558167	592321
Additions	6381466	3542196	100841	3284237	146404	97394
Reductions	4858163	155665	5811	113596	8077	2996
Net Change	1523303	3386531	95030	3170641	138327	94398
Net Change %	1.6%	3.5%	0.1%	3.3%	0.1%	0.1%
Closing (2015)	40045607	26078713	2625679	25423170	1575344	641783





# Ecosystem Accounts in Spain



**MAIA**  
Mapping and Assessment for  
Integrated ecosystem Accounting

## 3. ECOSYSTEM SERVICES ACCOUNTS (biophysical)

### 3.2. AESTHETIC QUALITY OF THE LANDSCAPE

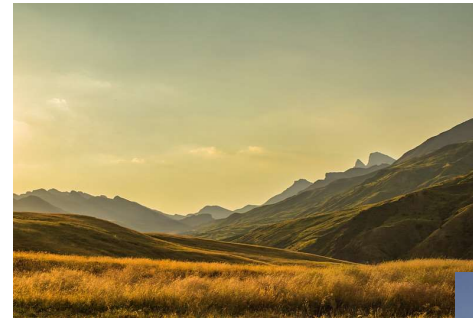
:A methodology has been developed at national level using artificial intelligence and social networks (*Havinga, I. et al (2021)*).

National questionnaire in Spain to verify AI model predictions.

Aesthetic quality prediction based on Flickr and deep learning at 5 km resolution for a single cell



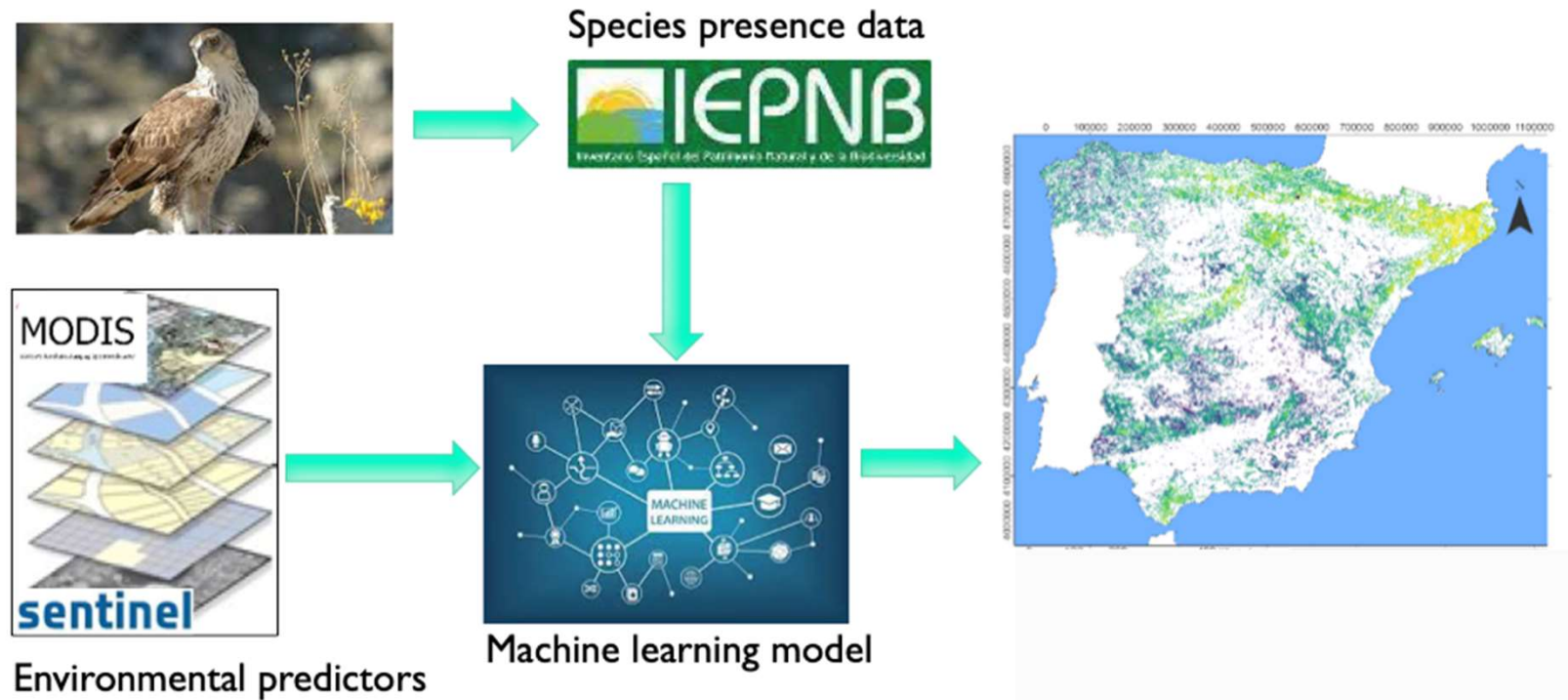
<b>Northeast</b> (Barcelona, Gerona, Tarragona, Lérida, Huesca, Zaragoza, Baleares)
<b>East</b> (Castellón, Valencia, Alicante, Murcia, Albacete)
<b>South</b> (Badajoz, Huelva, Sevilla, Córdoba, Jaén, Cádiz, Málaga, Granada, Almería)
<b>Centre</b> (Madrid, Ciudad Real, Cuenca, Teruel, Guadalajara, Soria, Toledo, Ávila, Segovia, Valladolid, Zamora, Salamanca, Cáceres)
<b>North / Northwest</b> (La Coruña, Lugo, Pontevedra, Orense, Asturias, León, Cantabria, Palencia, Burgos, La Rioja, Navarra, Álava, Vizcaya, Guipúzcoa )



## 4. THEMATIC ACCOUNTS:

### 4.1. BIODIVERSITY: Valuation of species in Spain included in Habitats Directive and the Birds Directive.

This account developed using machine learning techniques between the years 2000 and 2015.



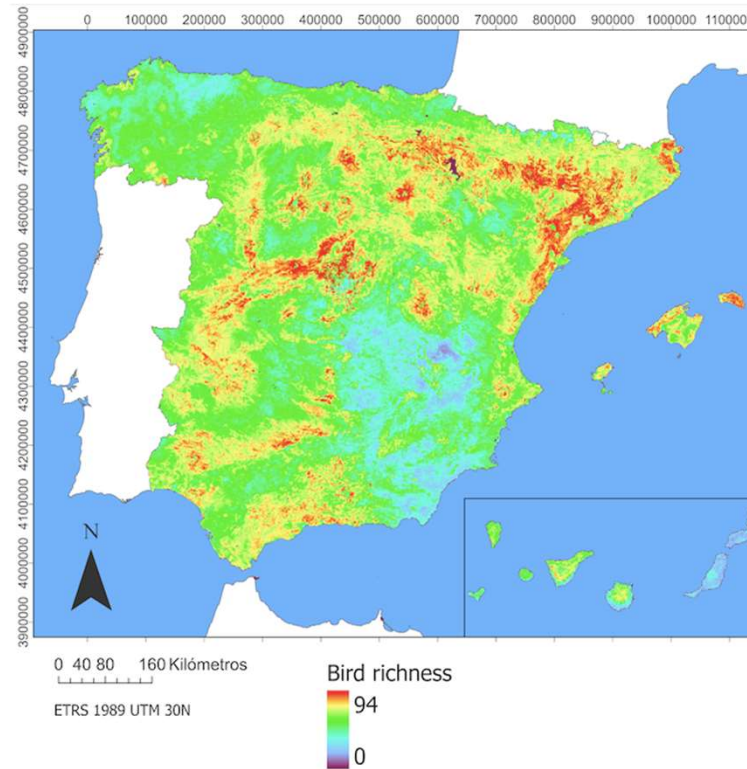
## 4. THEMATIC ACCOUNTS:

### 4.1. BIODIVERSITY:

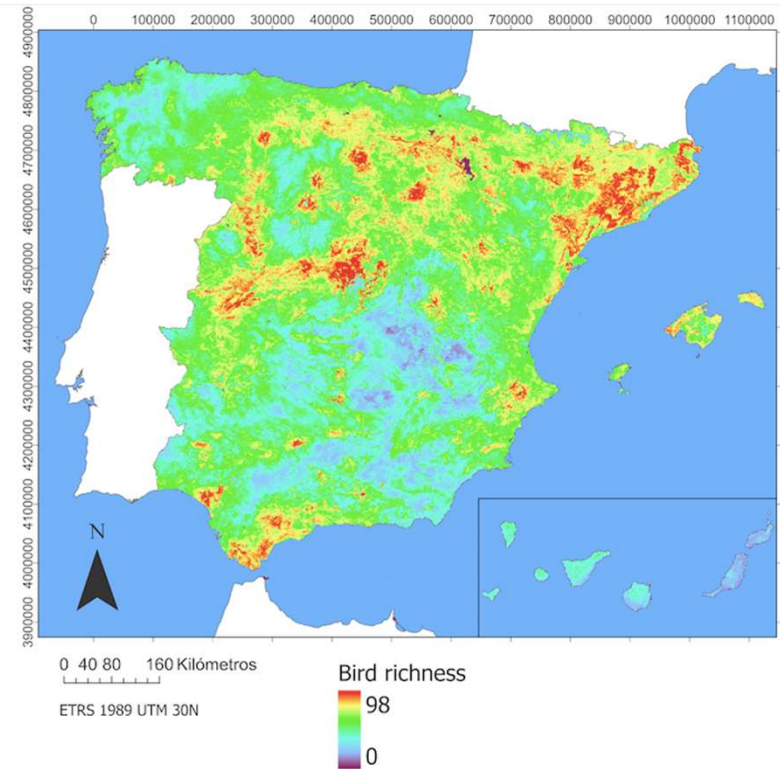
Species include in the account

Taxon	Species
Amphibians	14
Arthropods	26
Birds	230
Mammals	46
Reptiles	27
Vascular plants	178
<b>Total</b>	<b>521</b>

### Birds richness 2015



### Birds richness 2020





# Ecosystem Accounts in Spain



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Promote ecosystem accounting through various communication and outreach activities

## MAIA ACCOUNT EXPLORER







# Ecosystem Accounts in Spain



**MAIA**  
Mapping and Assessment for  
Integrated ecosystem Accounting

**Promote ecosystem accounting through various communication and outreach activities**

<https://cuentas-eco-esp-urjc.l.hub.arcgis.com/>

## SPANISH ECOSYSTEM ACCOUNT EXPLORER



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Accounting <http://maiaportal.eu/>