



**Testing forest ecosystem condition accounts:
Two pilots at national (Spain) and European level**

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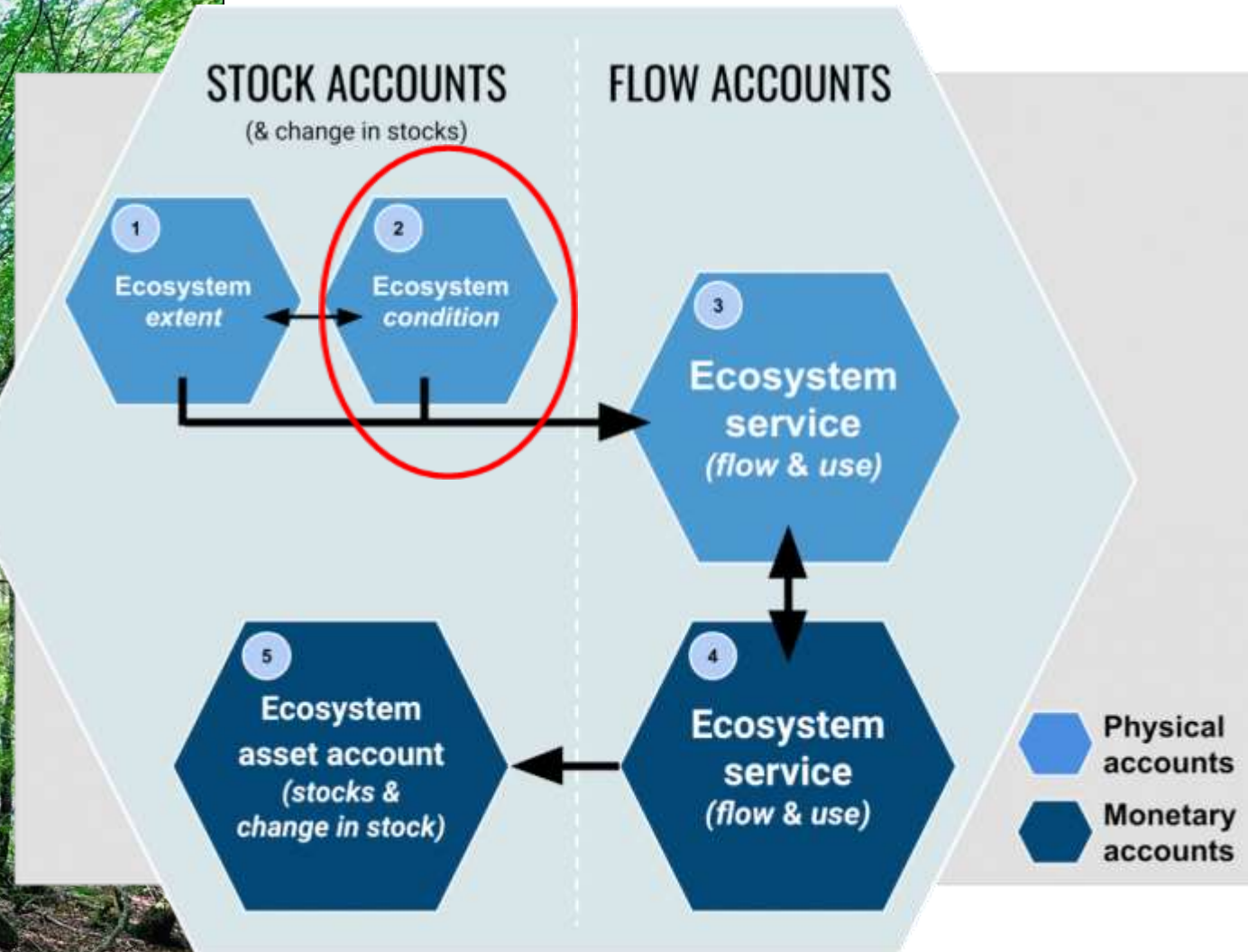
Introduction

For the Spanish Pilot we are working in ecosystem accounting as part of MAIA H2020 EU project:

- We collaborate with the Ministry of Ecological Transition and Demographic Challenge and National Statistics Office to elaborate national ecosystem accounts .
- We finished ecosystem extent accounts for the period 1970 and 2015.
- We tested SEEA-EA methodology for forest condition accounts for period 2000-2015
- Currently, working on biophysical and economic ES accounts.

For the European forest Pilot, we are working together with the European Joint Research Center (JRC) in the project “**Mapping the condition of forests in the EU relative to a reference condition**”.

- The project follow the SEEA EA guidelines on ecosystem condition accounts.
- This project **describes an approach to upscale the Spanish approach to EU level.**



Based on the SEEA-EA guidelines: ecosystem condition is the quality of an ecosystem measured in terms of its abiotic, biotic and landscape characteristics. Condition is assessed with respect to an ecosystem's composition, structure and function which, in turn, underpin the ecosystem integrity of the ecosystem, and support its capacity to supply ecosystem services.

Table 5.1: The SEEA Ecosystem Condition Typology (ECT)

ECT groups and classes
<p>Group A: Abiotic ecosystem characteristics</p> <p>Class A1. Physical state characteristics: physical descriptors of the abiotic components of the ecosystem (e.g., soil structure, water availability)</p> <p>Class A2. Chemical state characteristics: chemical composition of abiotic ecosystem compartments (e.g., soil nutrient levels, water quality, air pollutant concentrations)</p>
<p>Group B: Biotic ecosystem characteristics</p> <p>Class B1. Compositional state characteristics: composition / diversity of ecological communities at a given location and time (e.g., presence / abundance of key species, diversity of relevant species groups)</p> <p>Class B2. Structural state characteristics: aggregate properties (e.g., mass, density) of the whole ecosystem or its main biotic components (e.g., total biomass, canopy coverage, annual maximum normalized difference vegetation index (NDVI))</p> <p>Class B3. Functional state characteristics: summary statistics (e.g., frequency, intensity) of the biological, chemical, and physical interactions between the main ecosystem compartments (e.g., primary productivity, community age, disturbance frequency)</p>
<p>Group C: Landscape level characteristics</p> <p>Class C1. Landscape and seascape characteristics: metrics describing mosaics of ecosystem types at coarse (landscape, seascape) spatial scales (e.g., landscape diversity, connectivity, fragmentation)</p>



Forest condition accounts methodology: Adaptation of the SEE-EA guidelines

Stage 1: Ecosystem types

Classification of forest ecosystems based on land cover cartography, ecosystem classification and biogeographical regions.

Stage 2: Indicators selection

Selection criteria of indicators:

- 1. Directionality or normativity** (the indicator has to be related in a straightforward manner to ecosystem condition; it has to be sensitive to human influence or pressures that decrease condition);
- 2. Spatially and temporal explicit data** in order to track changes
3. For every ECT class have at least **1 indicator**.

Stage 3: Reference sites

Reference values based on areas of an **undisturbed or minimally disturbed condition**:

- Primary forest
- Forest areas included in protected areas classified in IUCN level I or II categories.
- Forests that have not undergone cover changes since 1970.

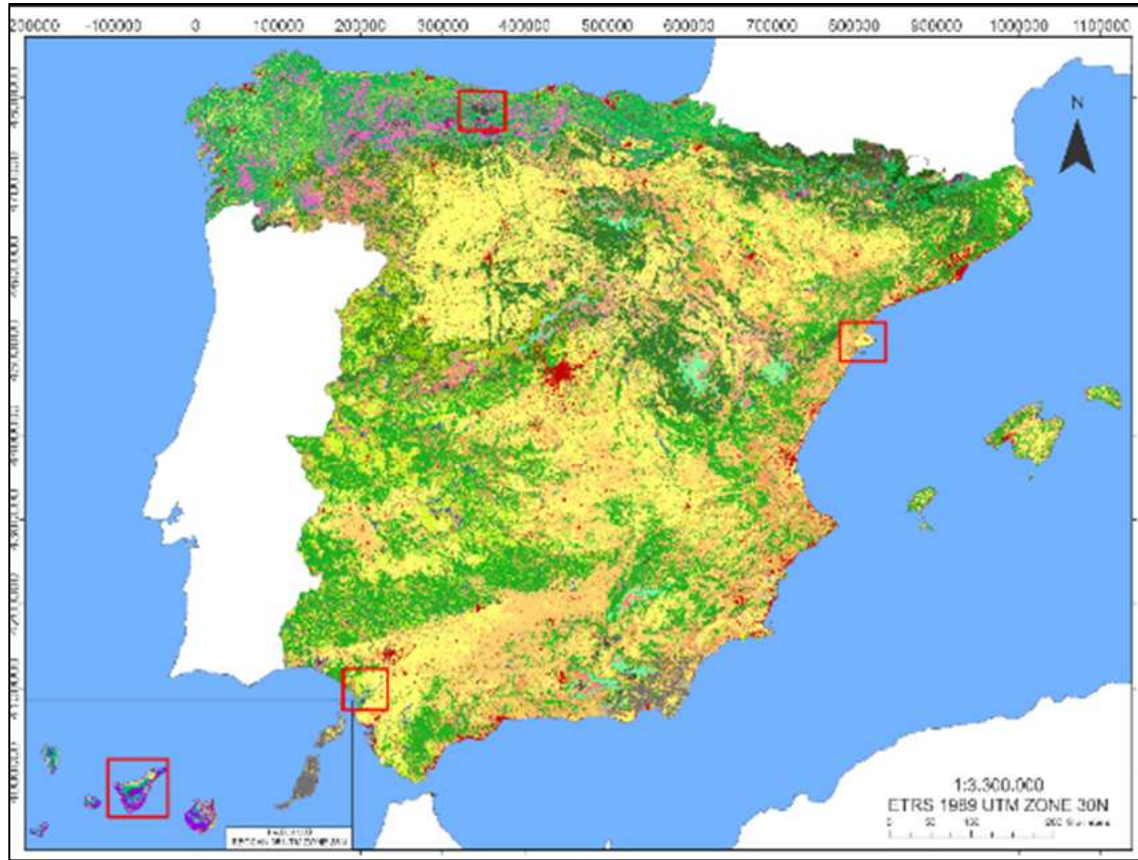
A reference value has been generated by indicator, and ecosystem type.

Stage 4: Aggregation

We have evaluated the **distance between the weighted indicators in the reference areas** with the rest of the forest areas.

Finally, we divide the **condition index into five categories**, from unfavorable to favorable.

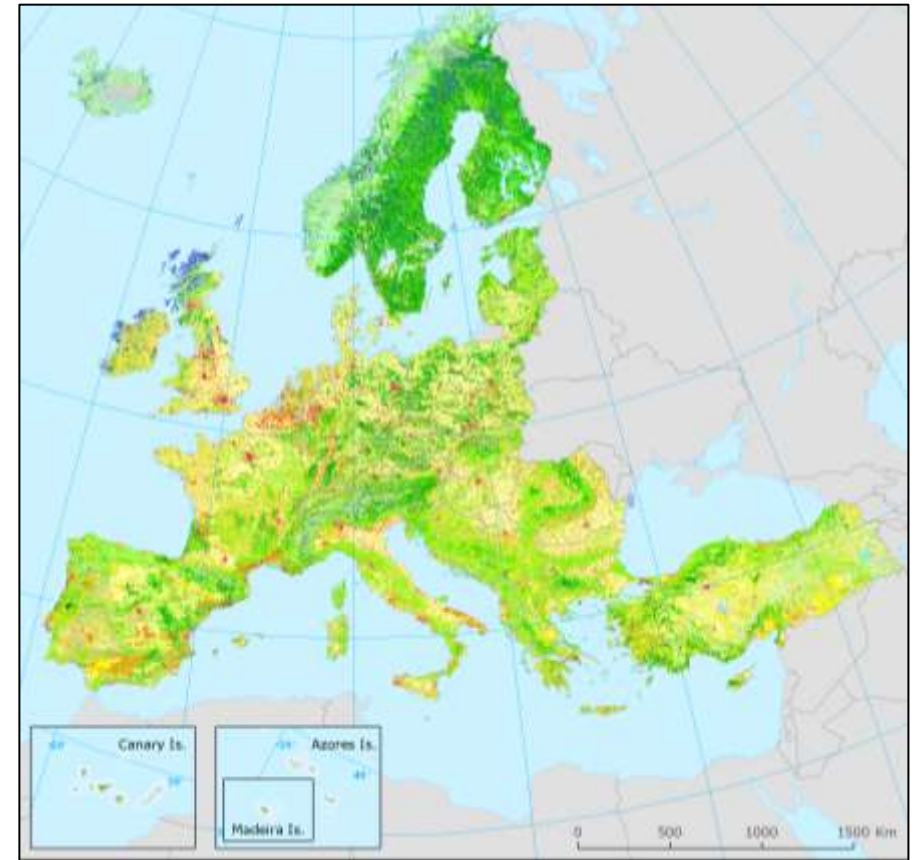
Stage I: Forest ecosystems classifications



For the Spanish pilot we used a combination of LULUCF database and the ecosystem classification developed for National Ecosystem Assessment (SNEA, 2014)

6 types of forest ecosystem x 3 types of tree cover.

A total of 18 types of forest.



For Europe pilot we used the forest categories of Corine Land Cover database and the Biogeographical regions found in Europe

11 Biogeographical regions x 4 types of tree cover.

A total of 44 types of forest.

Stage 2: Indicators Selections

Spanish pilot

Class	Indicator	Source
Physical state	NDWI	Landsat
	SOC	JRC /Eurostat
Chemical state	AOT40f	EEA
	Critical loads for eutrophication	EEA
	Critical loads for acidification	EEA
Compositional state	Species richness forest birds	Art. 12 D.Aves
	Species richness forest mammals	Art. 17 D.Habitat
	Species richness forest vascular plants	Art. 17 D.Habitat
Structural state	Tree cover	Modis
Functional state	NDVI	Landsat
	GPP	Modis
	NPP	Modis
Landscape characteristics	Morphological analysis of spatial patterns	Guidos
	Forest area density	Guidos
	Naturalness index	Guidos

In Spanish pilot we used **15 indicators** to measure the condition index

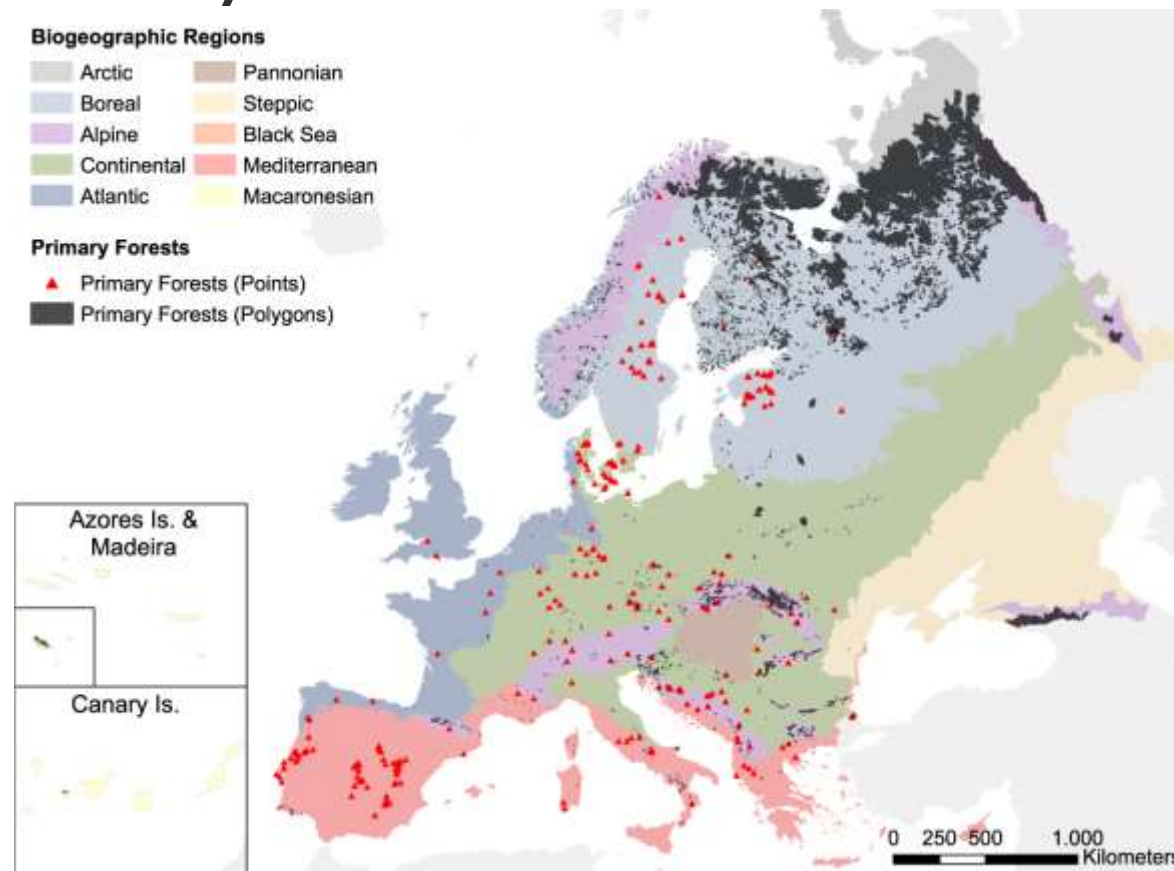
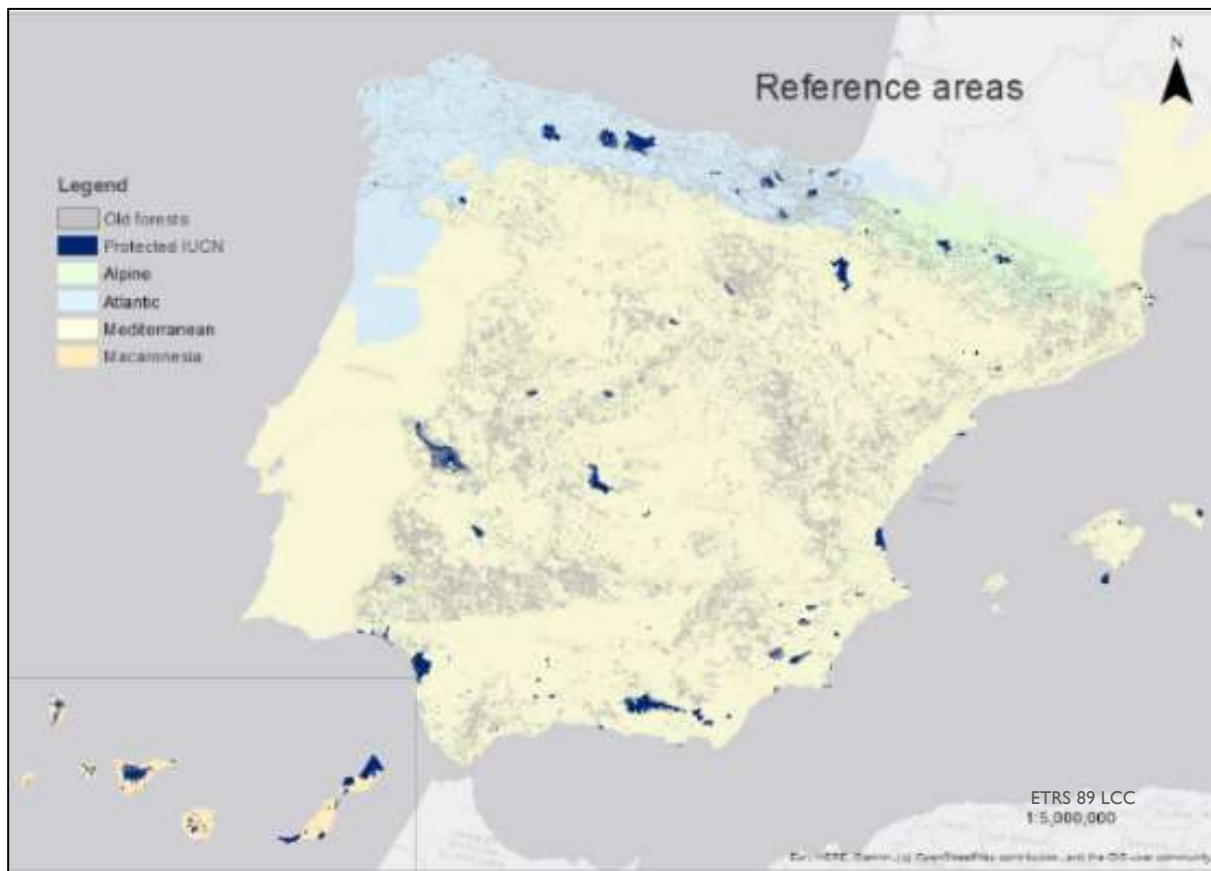
Europe pilot

Class	Indicator	Source
Physical state	NDWI	Modis
	SOC	JRC /Eurostat
Chemical state	Critical loads for eutrophication	EEA
	Critical loads for acidification	EEA
Compositional state	Species richness forest birds	Art. 12 D.Aves
Structural state	Tree cover	Copernicus
Functional state	NDVI	Modis
Landscape characteristics	Forest area density	Guidos
	Landscape mosaic	Guidos

In Europe pilot we used **9 indicators** to measure the condition index

Stage 3: Reference Sites

We used the reference based on **undisturbed sites or minimally disturbed condition.**



Selection criteria for reference sites:

1. Protected areas classify under UICN level I, II. AND
2. Forests which not have cover change since 1970.

Selection criteria for reference sites:

1. Primary forests OR
2. Protected areas UICN level I, II OR
3. Reference sites of other similar biogeographical regions.

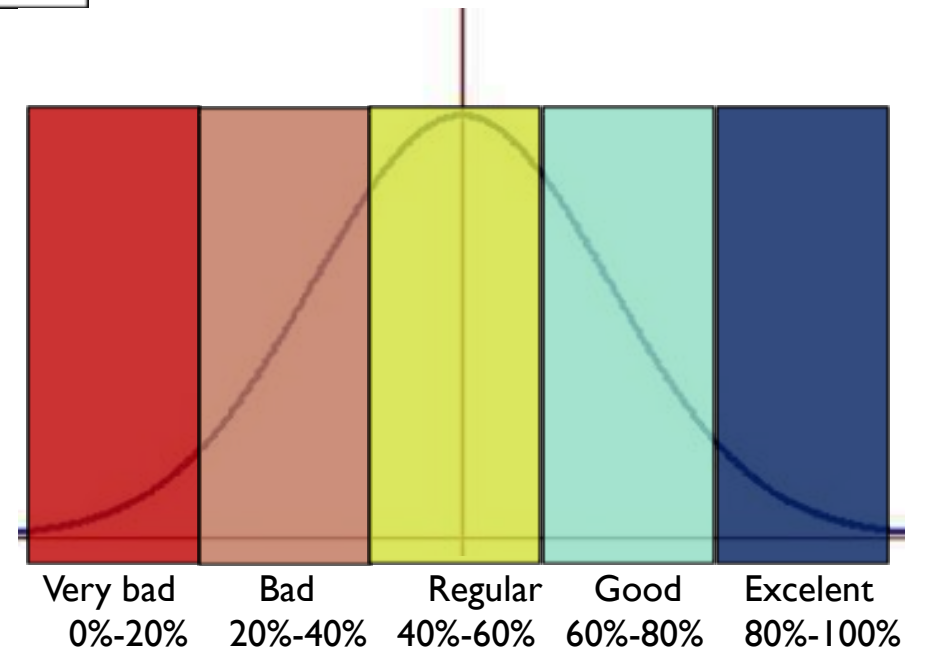
Stage 4: Aggregation

The aggregation is based on the evaluation of the distance from the reference areas with all forests types. The formula used is a variant of min-max feature:

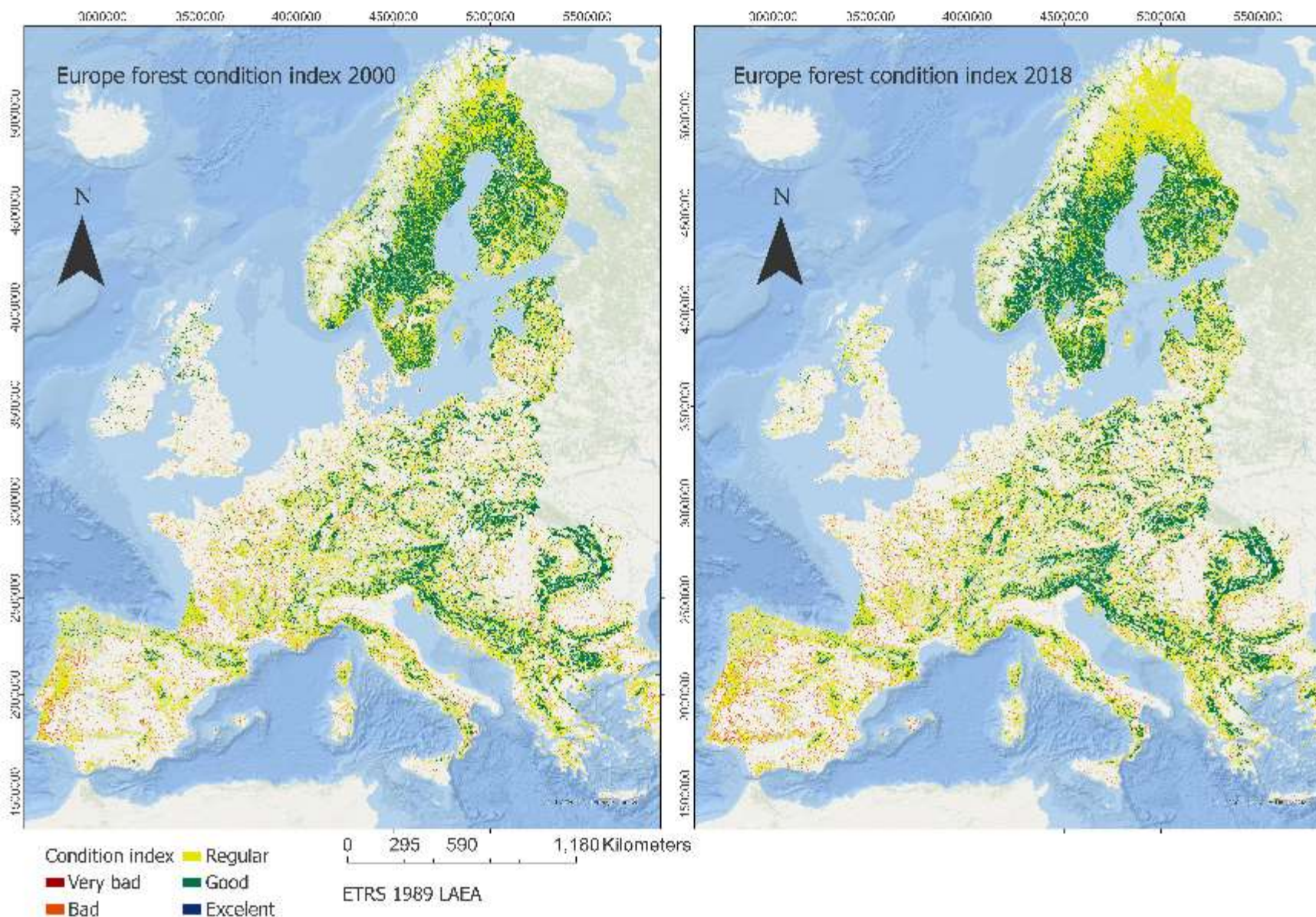
$$indice = \sum_1^i (w_i \frac{x - min.ref_i}{max.ref_i - min.ref_i})$$

Equation I

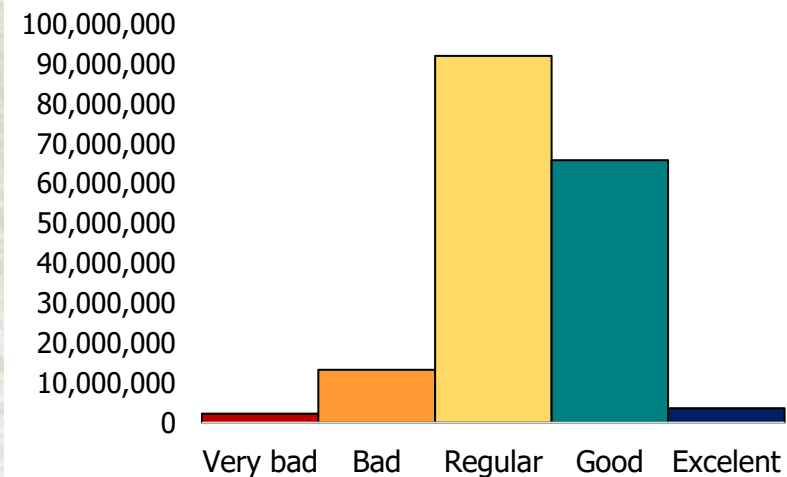
Then, we divided the index in five categories (less to 20%, 20-40%, 40-60%, 60-80% and high to 80%) to create a **categorical ecosystem condition index**.



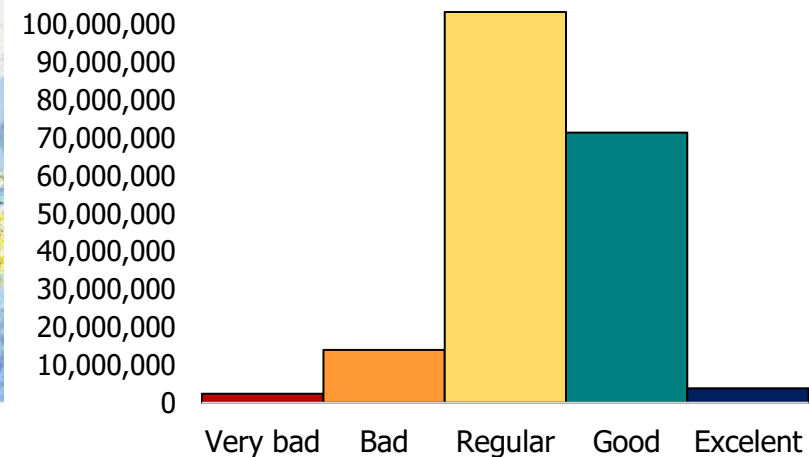
Stage 4: Aggregation



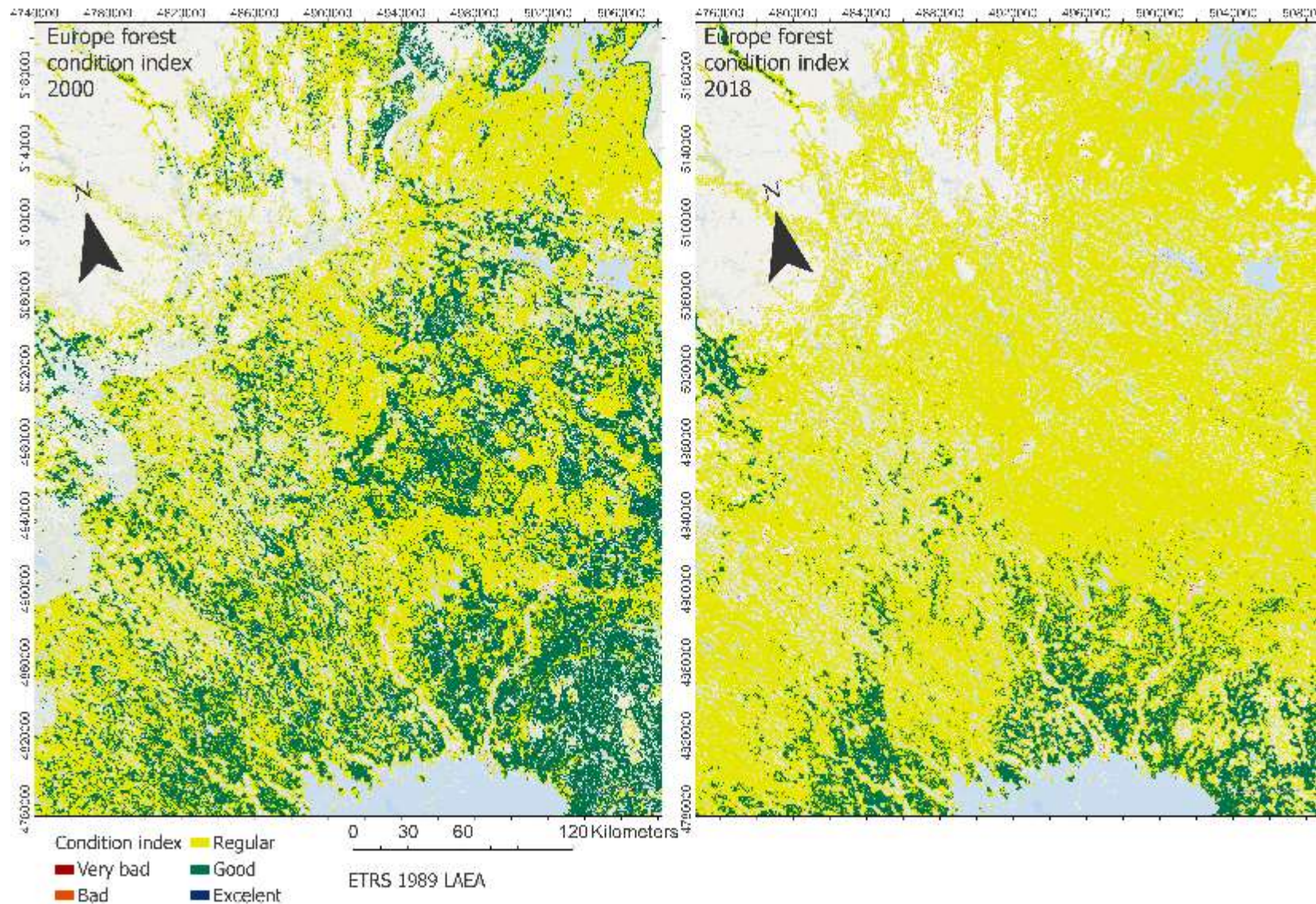
Europe forest condition index 2000



Europe forest condition index 2018



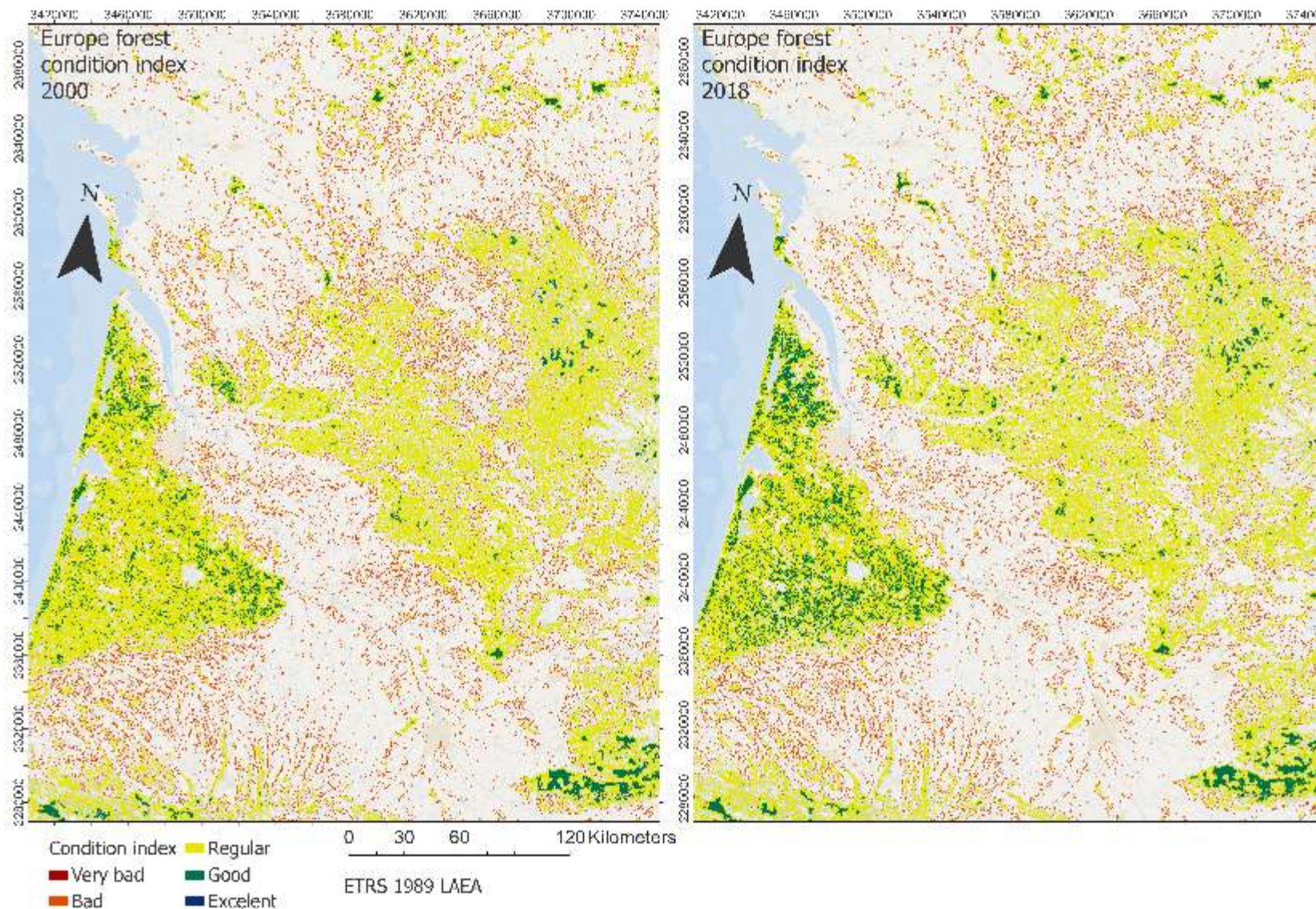
Stage 4: Aggregation



Example of negative trend in the condition index. Boreal forest.

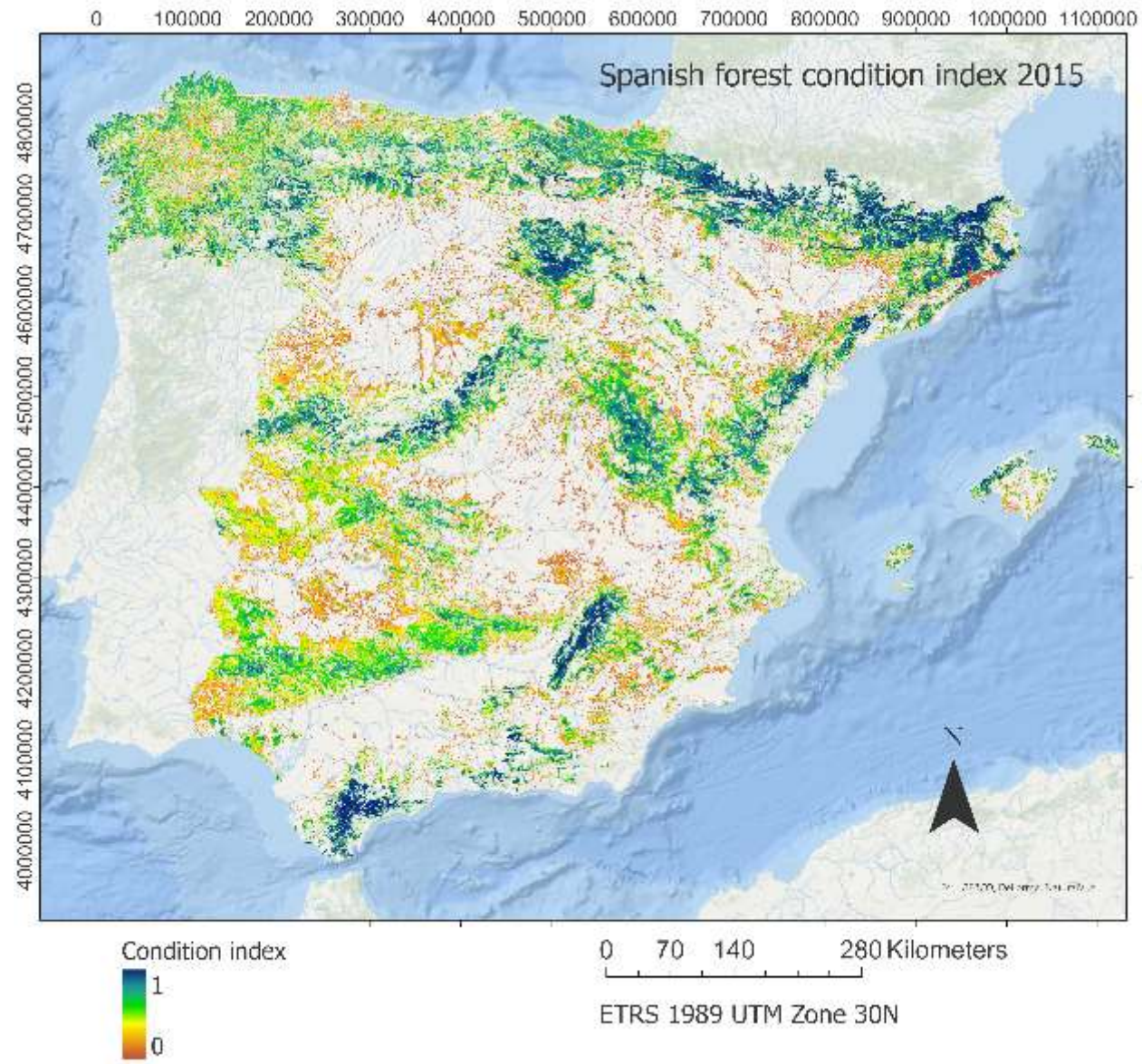
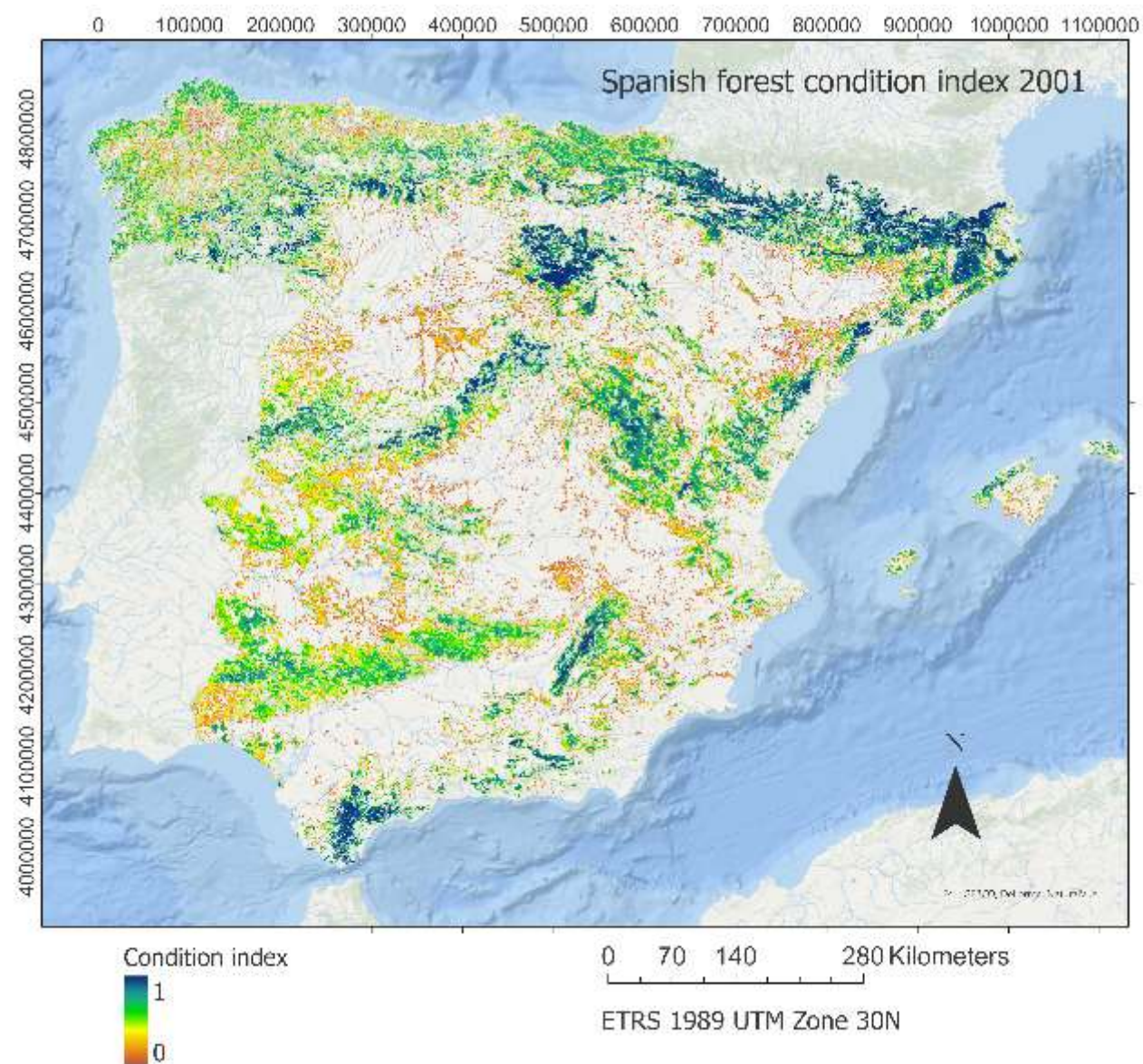


Stage 4: Aggregation

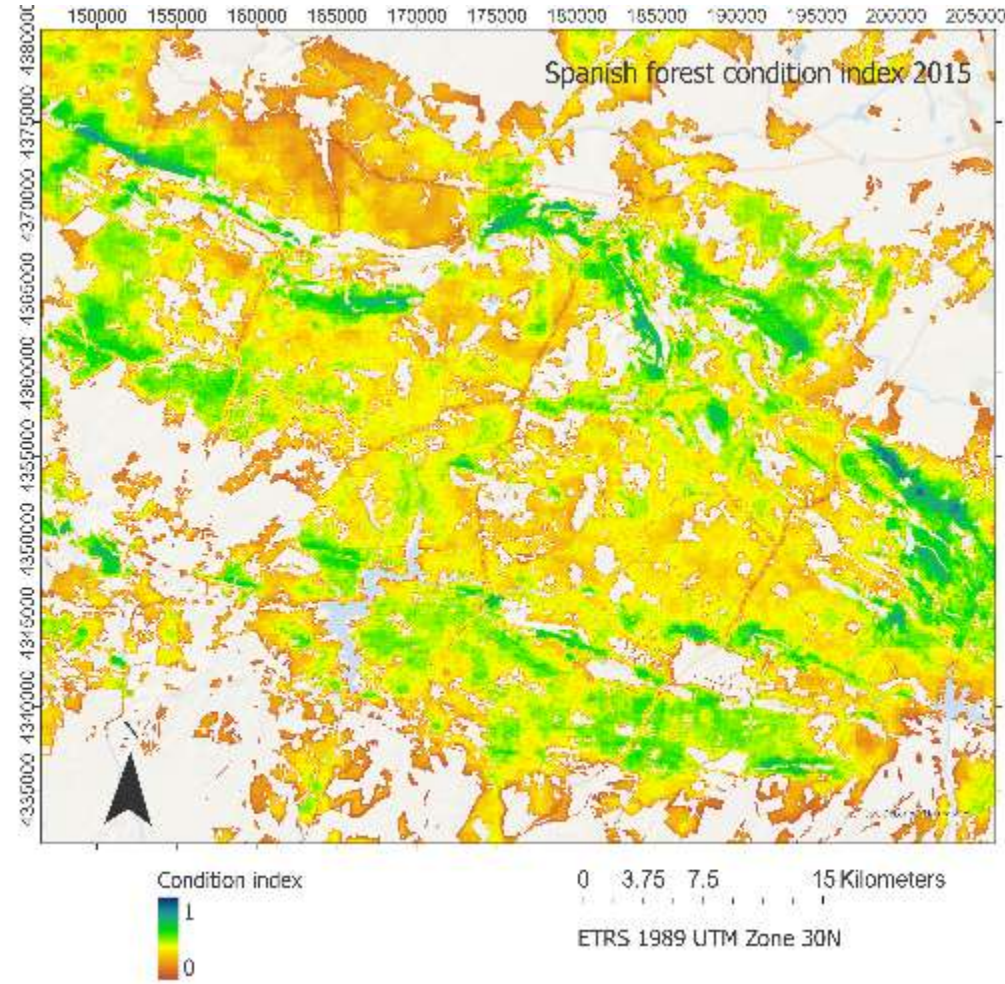
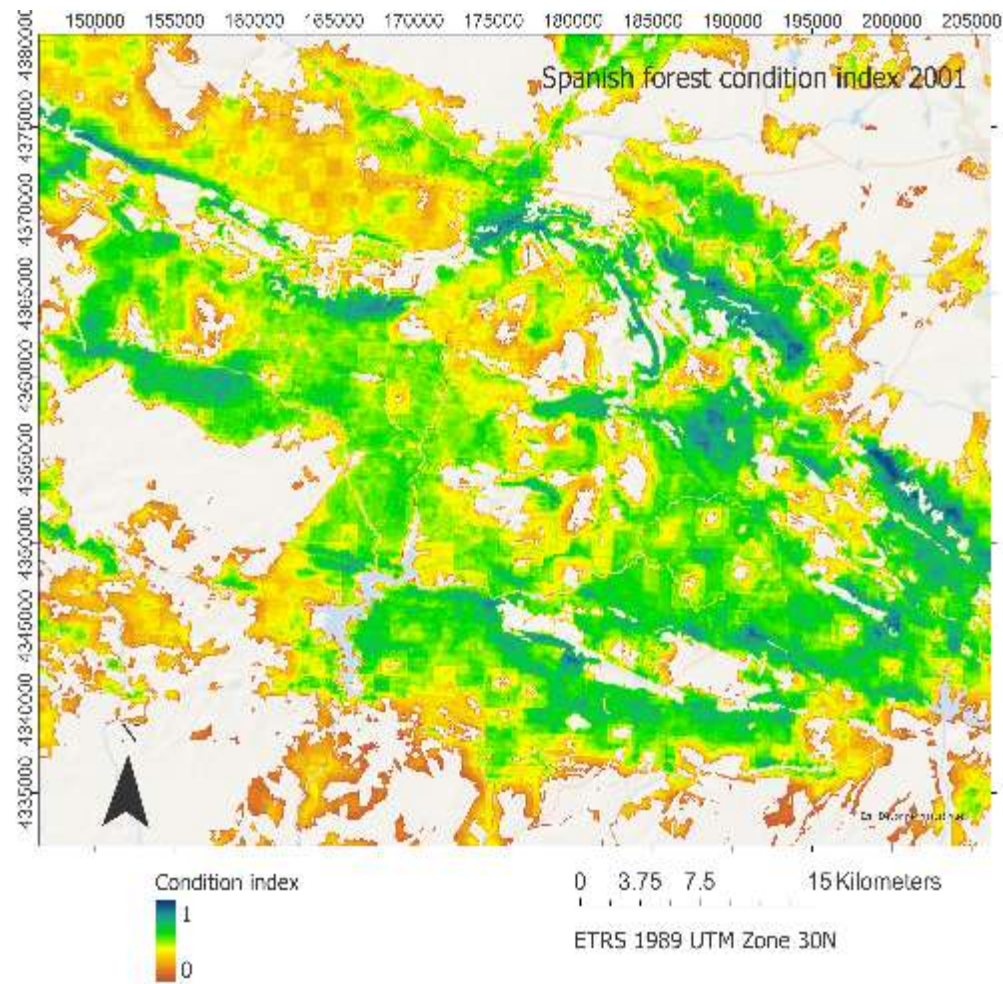


Example of positive trend in the condition index. Atlantic forest.

Stage 4: Aggregation

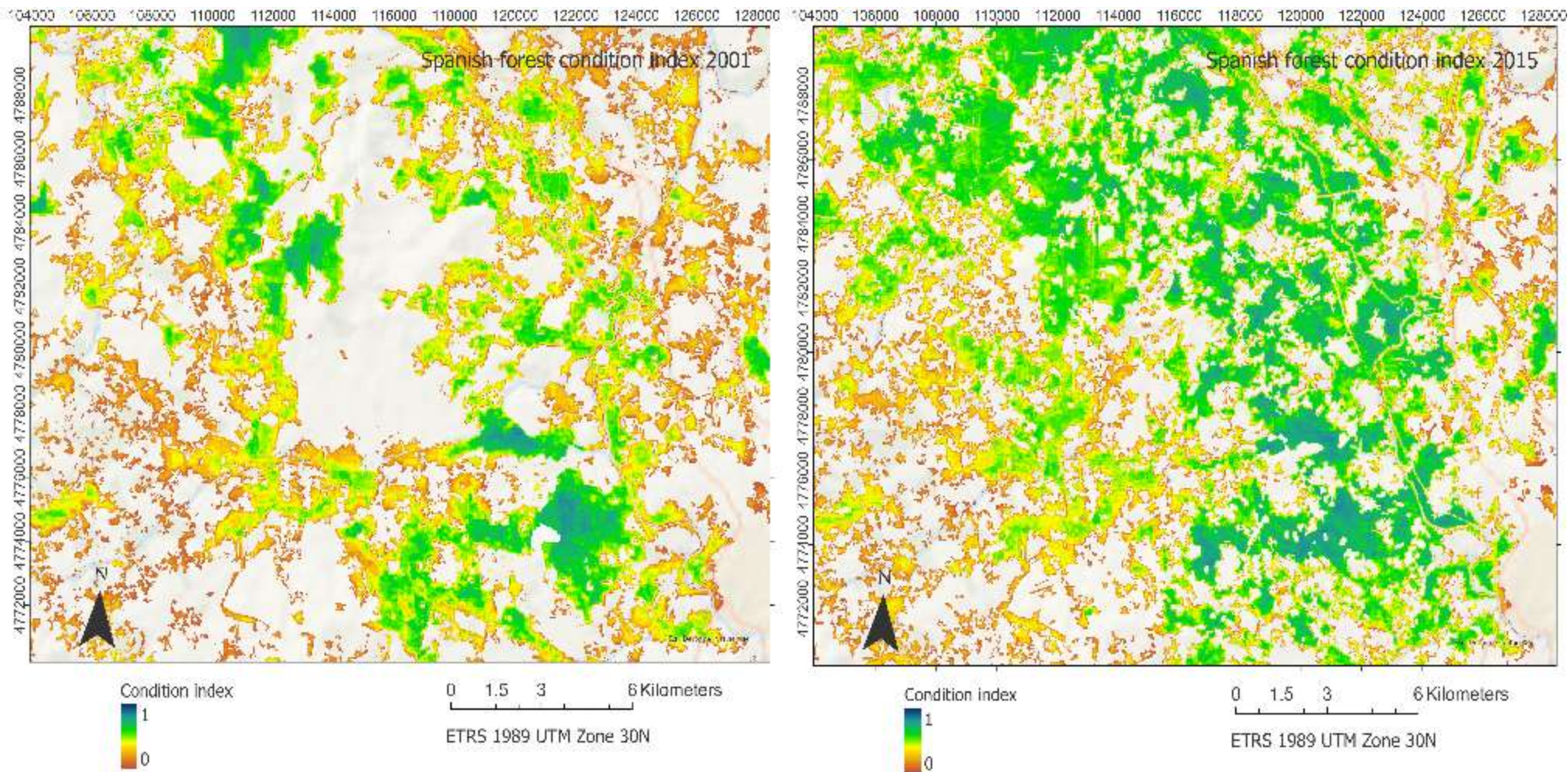


Stage 4: Aggregation



Example of negative trend in the condition index. Sclerophyllous Mediterranean forest

Stage 4: Aggregation



Example of positive trend in the condition index. Atlantic forest

Stage 4: Aggregation

Accounting table

Indicator	2001					2015					Change		
	Value_mean	Ref_Max	Ref_Min	Weight	Value_rescale	Value_mean	Ref_Max	Ref_Min	Weight	Value_rescale			
ndwi	0.20	0.45	-0.15	0.06	0.04	0.25	0.45	-0.15	0.06	0.05	0.60%		
soc	3.99	9.57	0	0.06	0.03	3.89	9.57	0.00	0.06	0.03	-0.09%		
o3	47480.33	69503.61	26361.95	0.07	0.04	36581.01	69503.61	26361.95	0.07	0.02	-1.94%		
acid	0.99	1	0.73	0.07	0.07	1.00	1.00	0.73	0.07	0.08	0.15%		
eutro	0.81	0.96	0.29	0.07	0.06	0.79	0.96	0.29	0.07	0.06	-0.21%		
birds	29.47	45.58	3.83	0.10	0.05	32.97	45.58	3.83	0.10	0.05	0.64%		
flora	7.26	14.33	2.39	0.07	0.03	8.64	14.33	2.39	0.07	0.04	0.89%		
tree	33.58	70.98	0.40	0.17	0.04	34.82	70.98	0.40	0.17	0.04	0.14%		
ndvi	0.30	0.49	-0.09	0.06	0.05	0.34	0.49	-0.09	0.06	0.06	0.60%		
gpp	233.91	380.40	0	0.06	0.05	260.33	380.40	0.00	0.06	0.05	0.53%		
mspa	17.63	20	0	0.06	0.07	18.04	20.00	0.00	0.06	0.07	0.16%		
fad	68.50	93.73	0	0.08	0.06	68.10	93.73	0.00	0.08	0.06	-0.03%		
lm	3.18	4.00	0.47	0.06	0.06	3.71	4.00	0.47	0.06	0.07	1.14%		
Total index						0.65						0.67	2.58%

We test the measurement of the condition accounts on a national (Spain) and European scale.

The methodology used was similar, developing an upscaling of the methodology used for the condition accounts of Spanish forests in European forests.

The results are consistent between the two tests performed.

The main problem we faced in developing these tests was the lack of information for the calculation of any of the indicators used, for some regions such as Macaronesia. The remote sensing data were kind of helpful.

As future work, the results of the condition account are compared with other proxy variables for the condition of ecosystems, such as spatial databases on defoliation or tree death. On the other hand, more intense work will be done on analyzing and looking for patterns on the condition accounts developed.

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