GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO
MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE
CEDEX CENTRO DE ESTUDIOS Y EXPERIMENTACIÓN DE OBRAS PÚBLICAS

JASPERS Networking Platform seminar

Climate Change Adaptation in the Transport Network

Experience from Project Preparation and Network Management

Brussels, 6 December 2017

Identifying climate change hotspots in the Spanish State-owned inland infrastructure network

Alberto Compte
CEDEX

Introduction

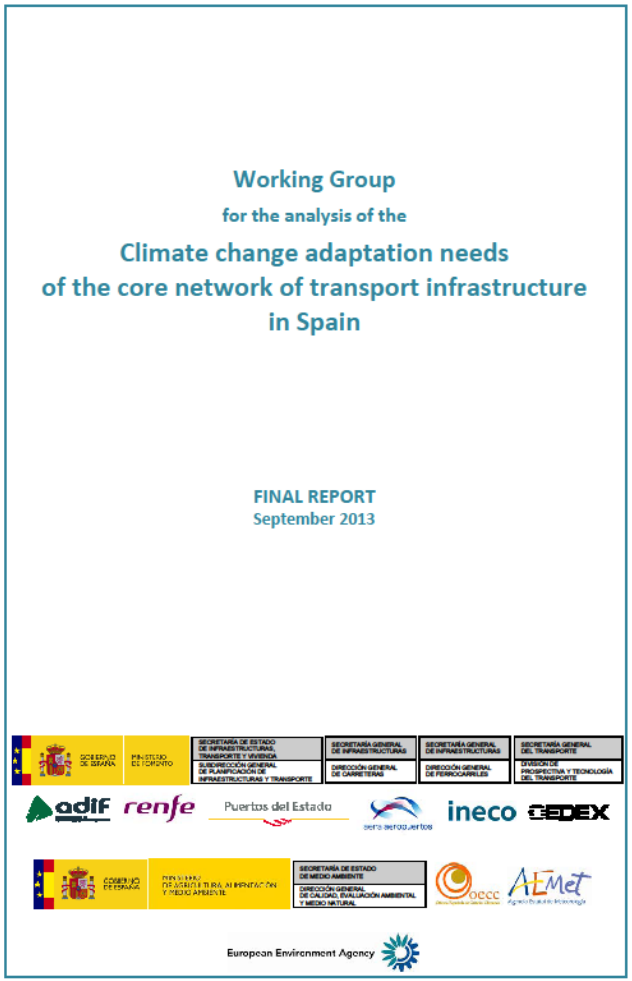
About CEDEX

CEDEX is …

- ✓ **… a public organisation …**
- ✓ **… attached to the Spanish ministries of transport (***Ministerio de Fomento***) and environment (***Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente***) …**
- ✓ **… providing technical assistance and developing research activities according to their interests.**

Introduction

CEDEX and climate change adaptation in transport



Coordination of a working group on adaptation needs of the core transport infrastructure network in Spain (2012-2013)

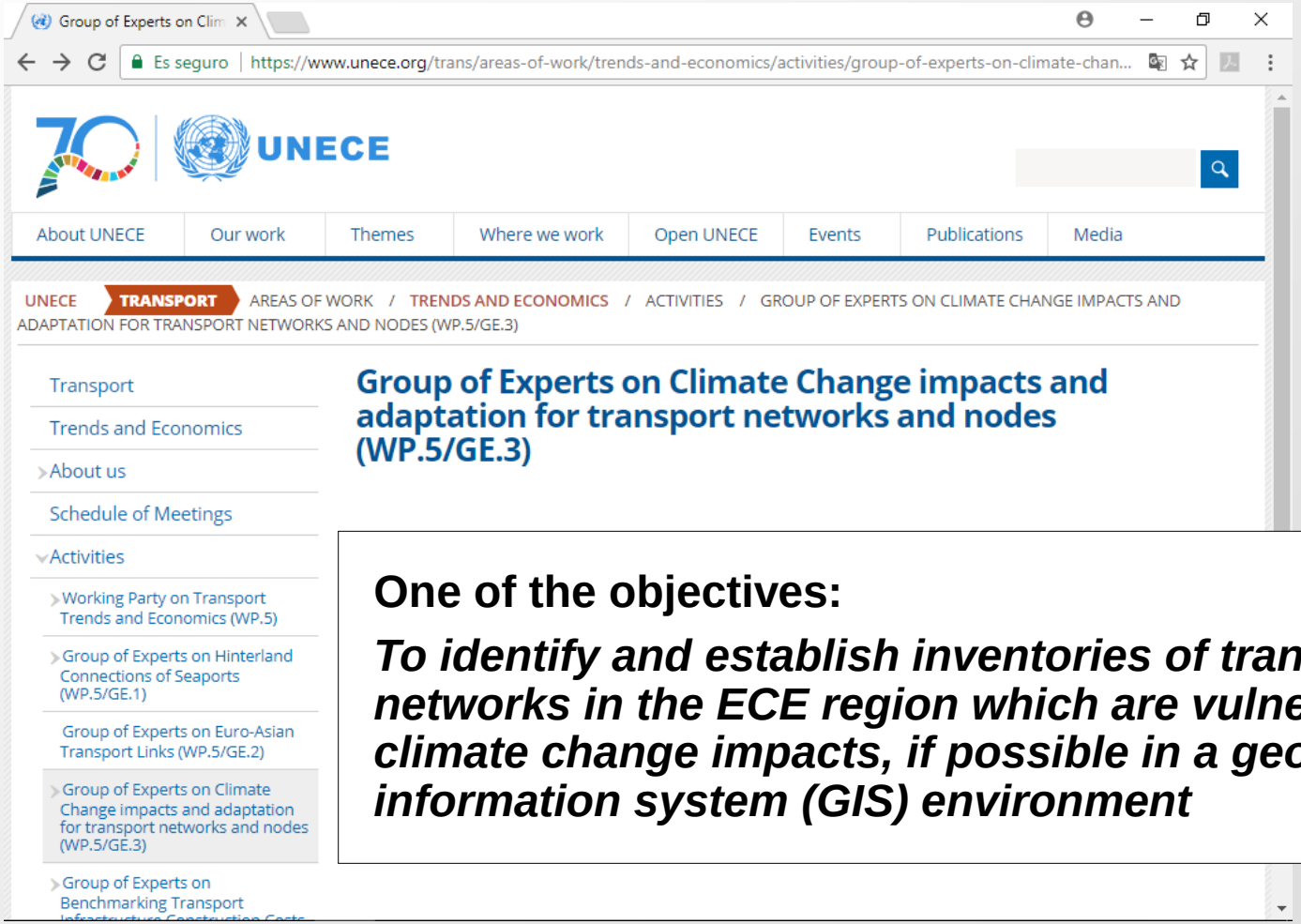
- ✓ **Climate change forecasts considered**
- ✓ **Key impacts expected**
- ✓ **Proposed adaptation measures**

http://www.cedex.es/NR/rdonlyres/872032C9-00FB-4DF4-BFA3-63C00B3E8DF1/122814/ACCITFinalreportSeptember2013.pdf

Introduction

CEDEX and climate change adaptation in transport

Joined in 2016 the UNECE/TRANS/WP.5/EG.3:



One of the objectives:

To identify and establish inventories of transport networks in the ECE region which are vulnerable to climate change impacts, if possible in a geographic information system (GIS) environment

The approach to identify the hotspots in Spain

TO IDENTIFY HOTSPOTS:

Criticality of the transport network

Exposure of the transport network to climate change

Sensitivity of the transport network to climate change

Through the combination , in a GIS environment, of:

- ✓ **The level of criticality of a section of the inland transport network (i.e. the impact of the asset loss).**
- ✓ **The level of exposure of the transport sections to climate change.**
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Criticality of the road network

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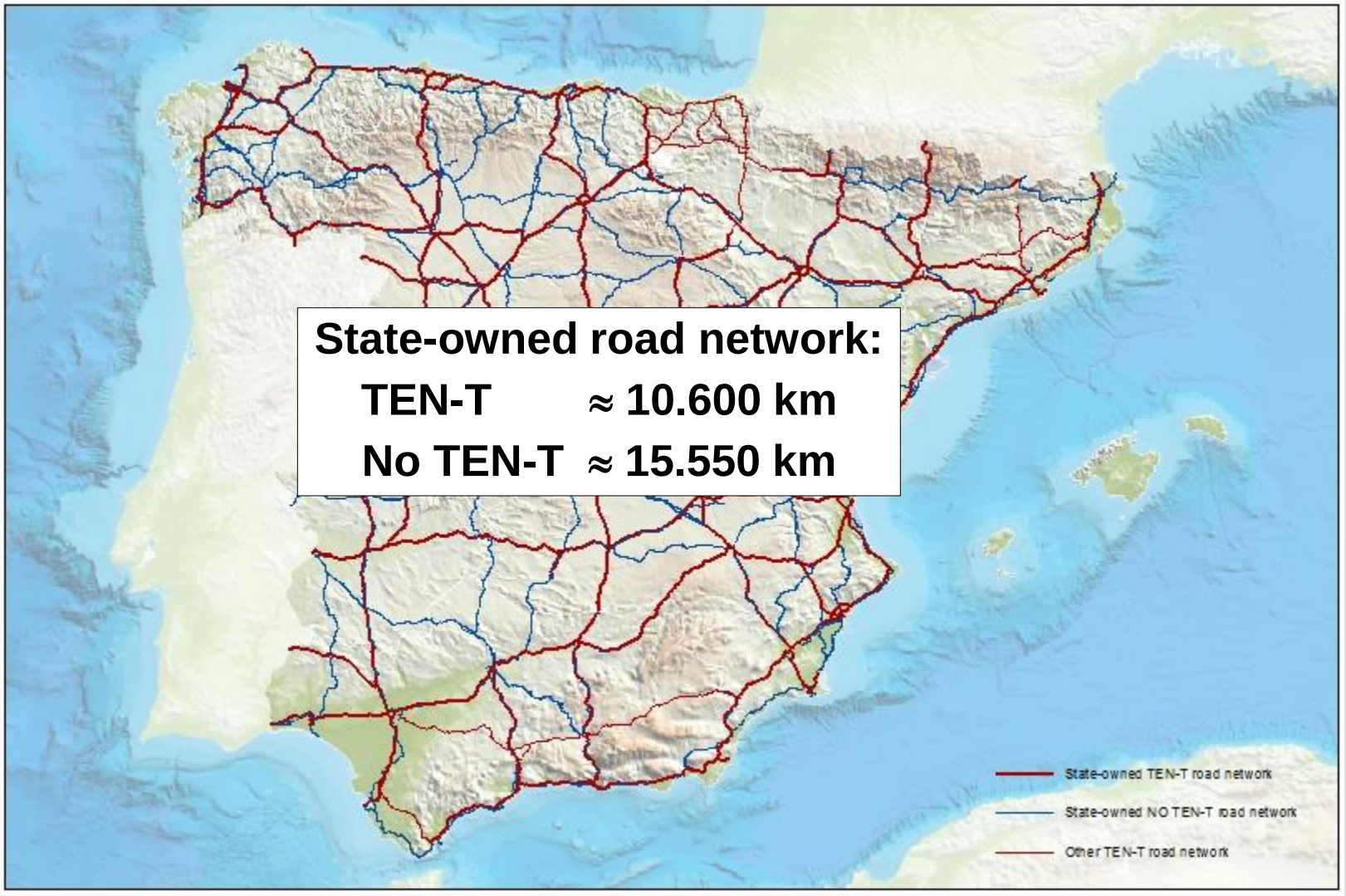
Criticality of the transport network

Exposure of the transport network to climate change

Sensitivity of the transport network to climate change



Criticality of the road network

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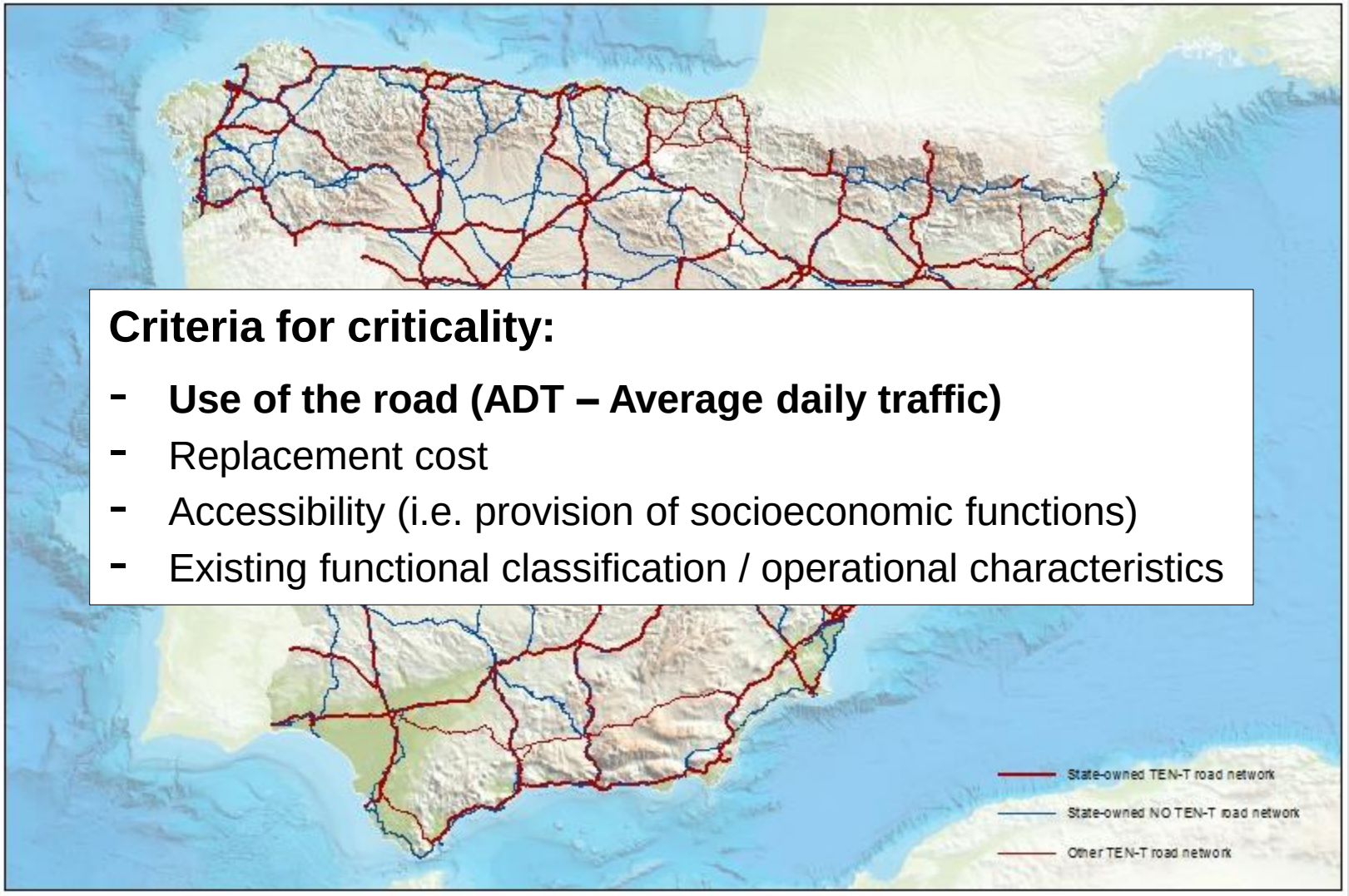
Sensitivity of the transport network to climate change



Criteria for criticality:

- **Use of the road (ADT – Average daily traffic)**
- Replacement cost
- Accessibility (i.e. provision of socioeconomic functions)
- Existing functional classification / operational characteristics

Criticality of TEN-T road network

Use of the road

TO IDENTIFY HOTSPOTS:

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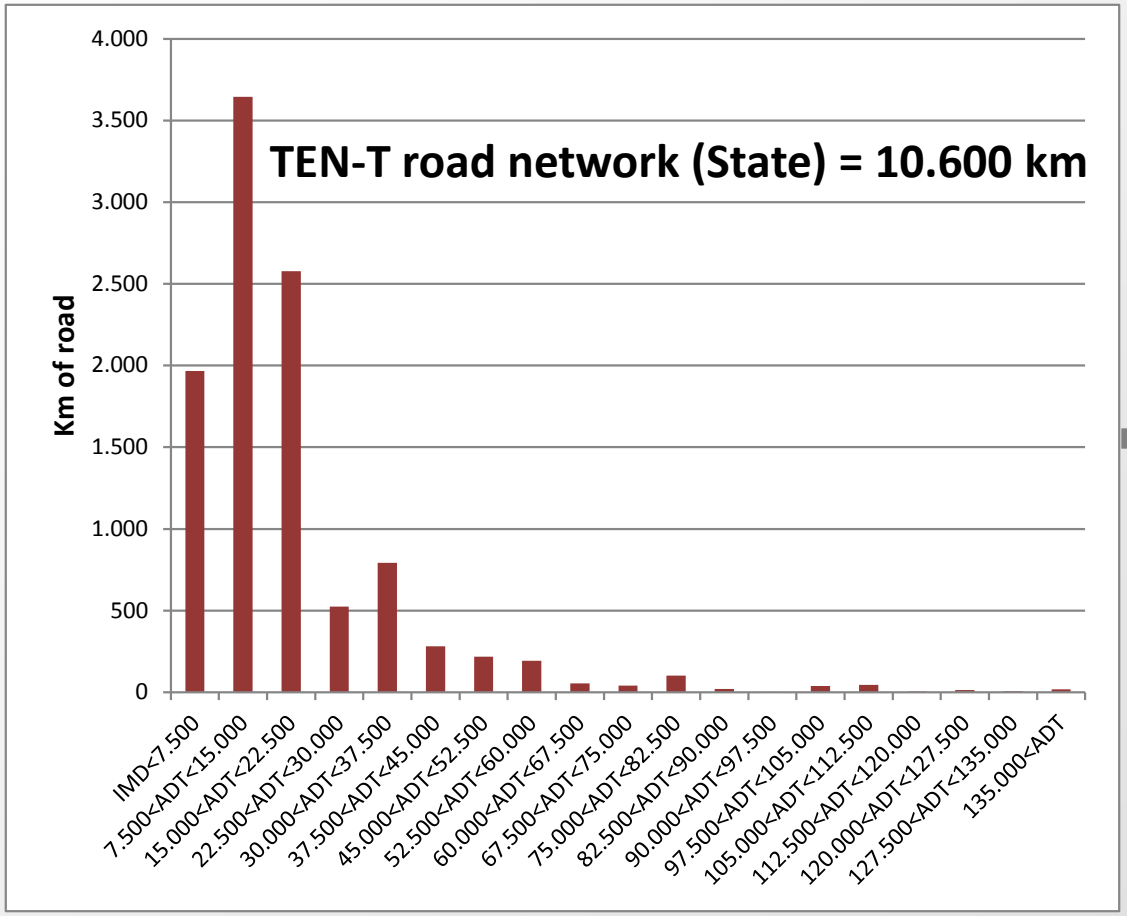
Sensitivity of the transport network to climate change



Grouping according to traffic level

Criticality of TEN-T road network

Replacement cost

TO IDENTIFY HOTSPOTS:

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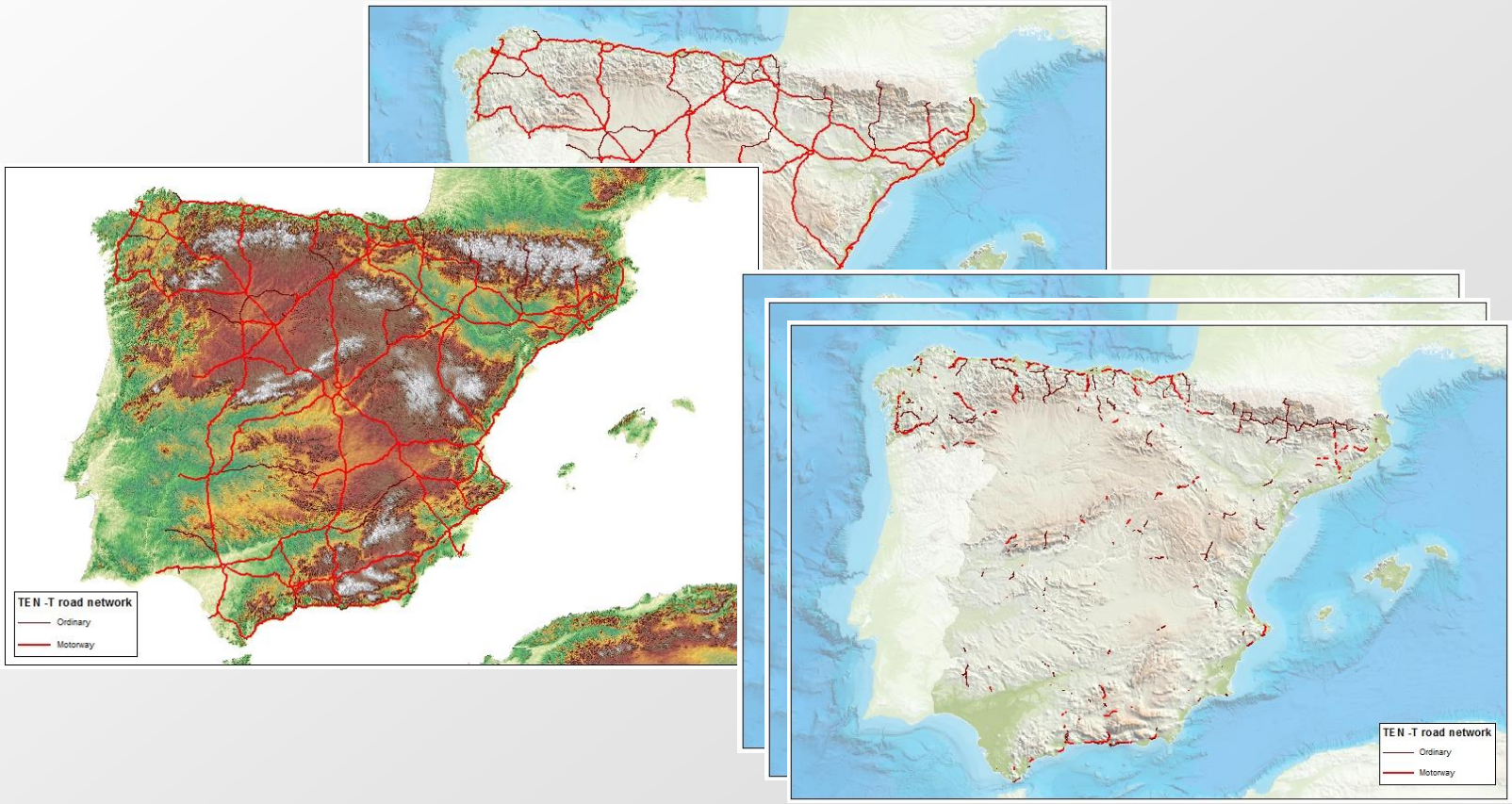
Weighting factor based on average cost of a new road section according to the type of road (ordinary/motorway) and terrain (mountainous/undulating/flat)



Criticality of TEN-T road network

Accessibility (Provision of socioeconomic functions)

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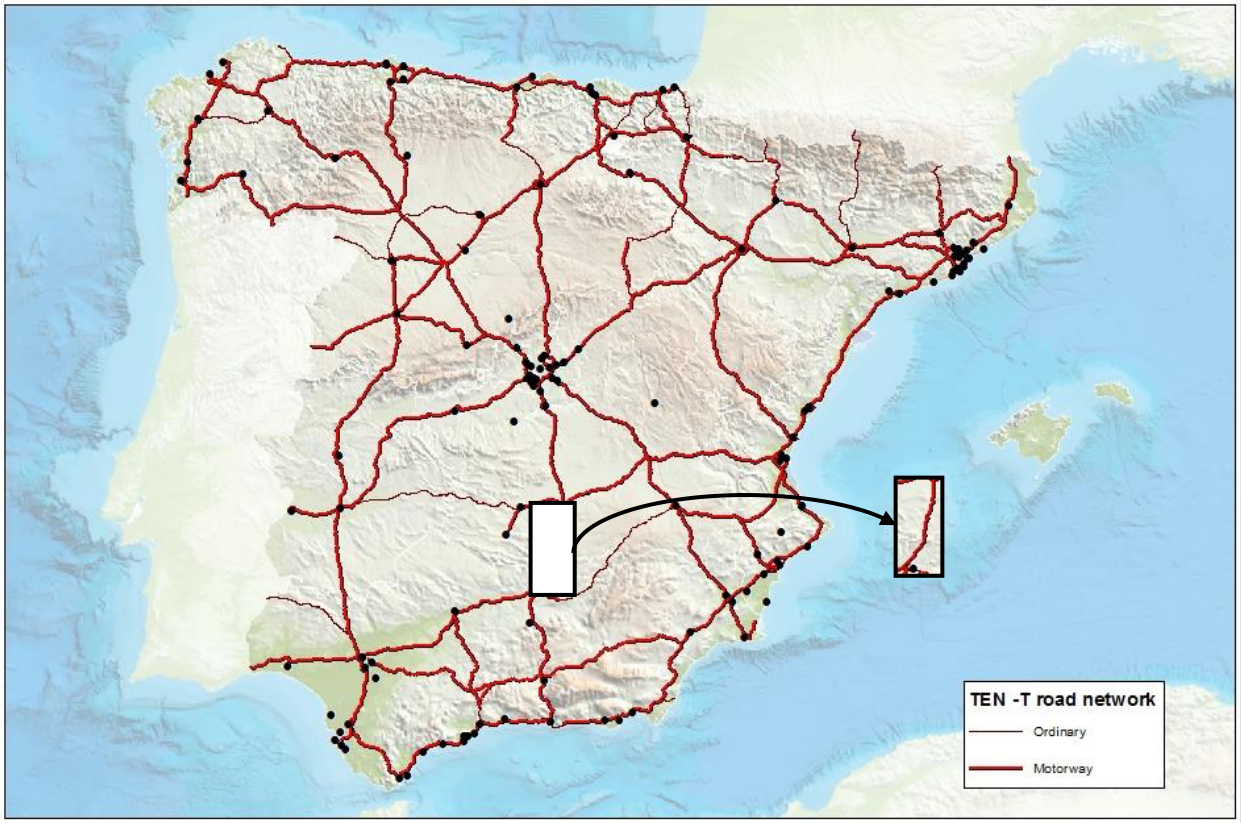
Weighting factor based on an accessibility index for a section



$$Acc\ index = \frac{Acc_{Existing\ situation} - Acc_{Missing\ link}}{Acc_{Existing\ situation}} * 100$$

$$Acc = \frac{P_i * \sum_j \frac{P_j}{t_{ij}}}{\sum_i P_i}$$

Criticality of TEN-T road network

Operational characteristics – Connecting airports

TO IDENTIFY HOTSPOTS:

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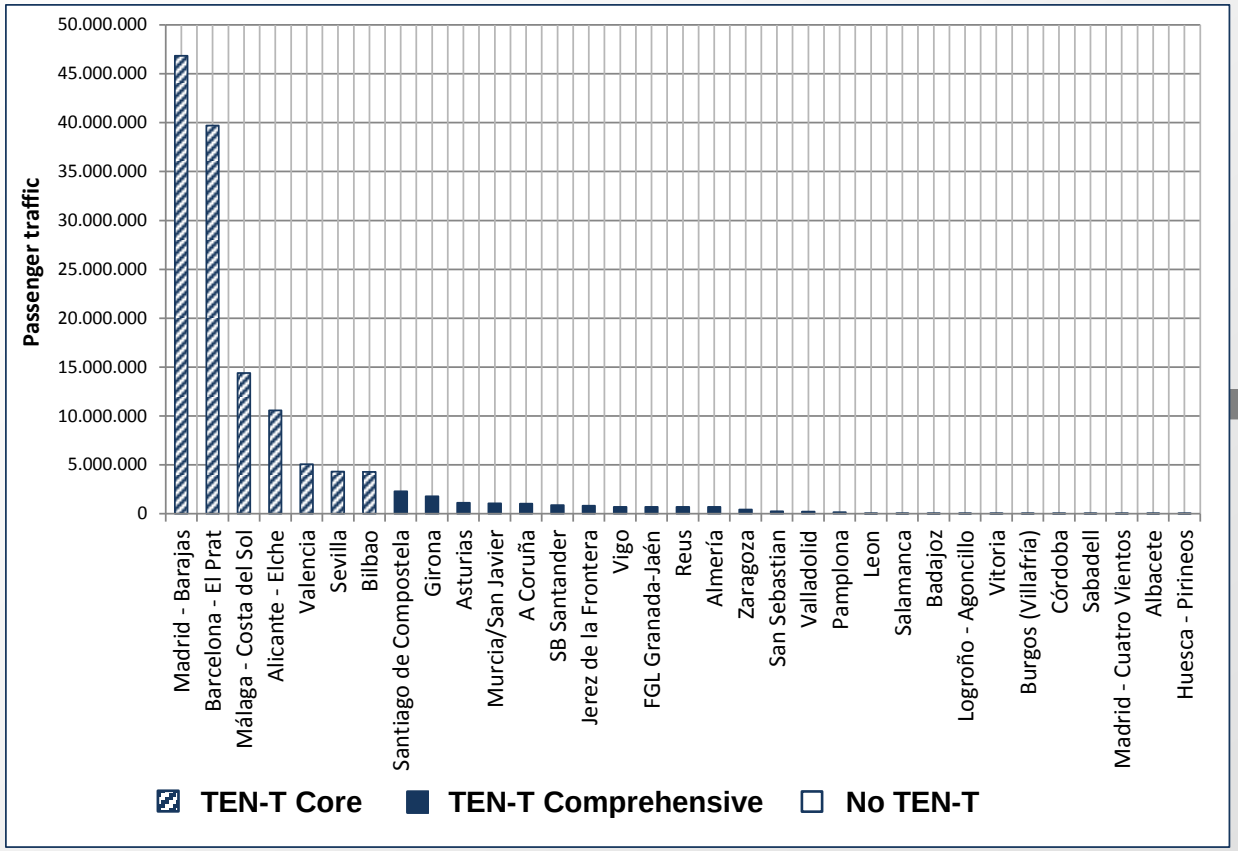
Sensitivity of the transport network to climate change



Passenger traffic
+
TEN-T status

Criticality of TEN-T road network

Operational characteristics – Connecting airports

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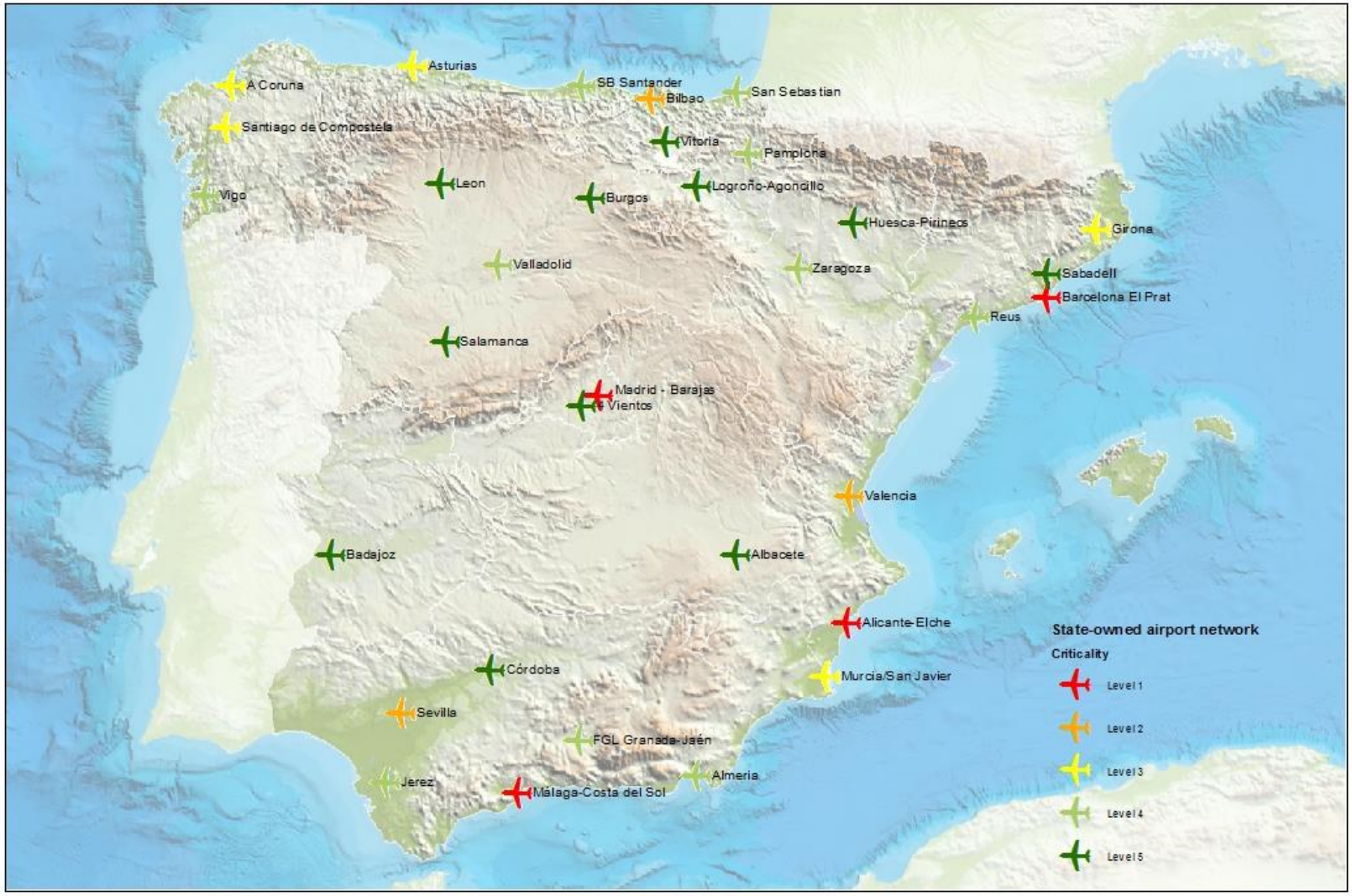

Criticality of TEN-T road network

Operational characteristics – Connecting ports

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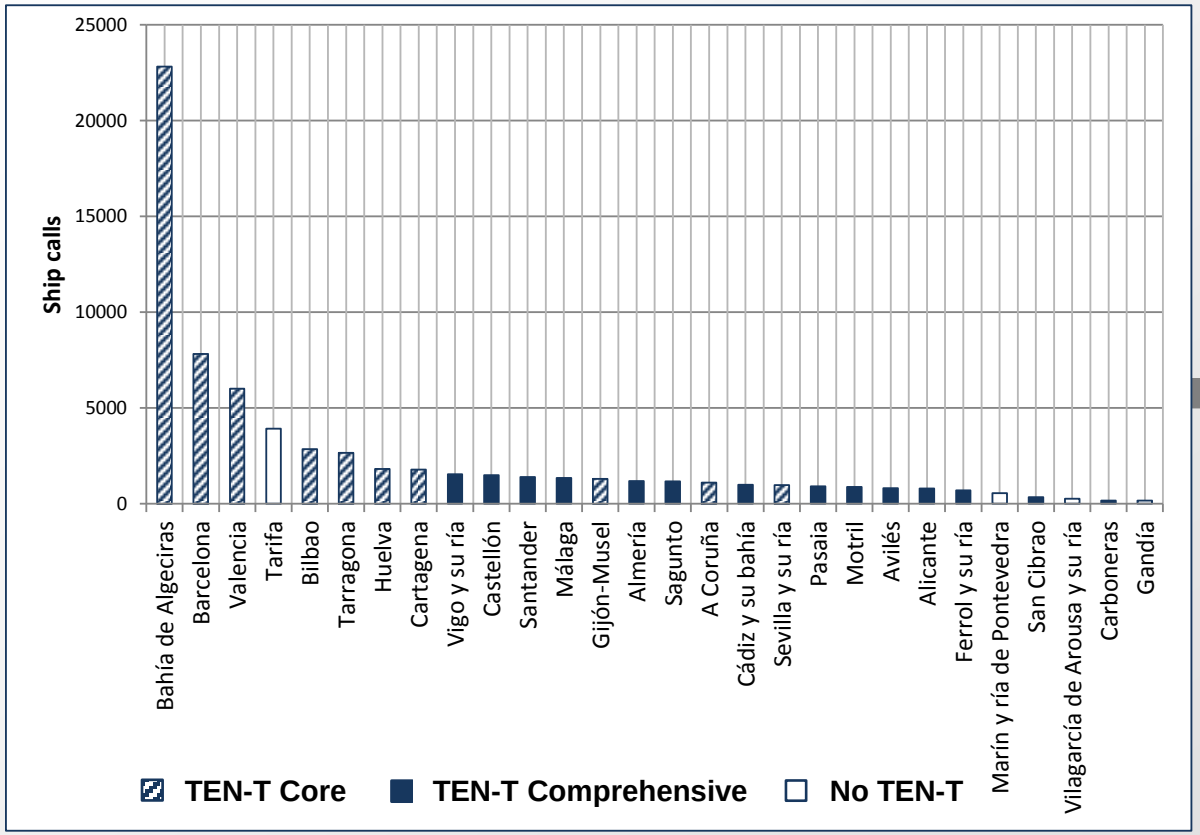

Ship calls
+
TEN-T status

Criticality of TEN-T road network

Operational characteristics – Connecting ports

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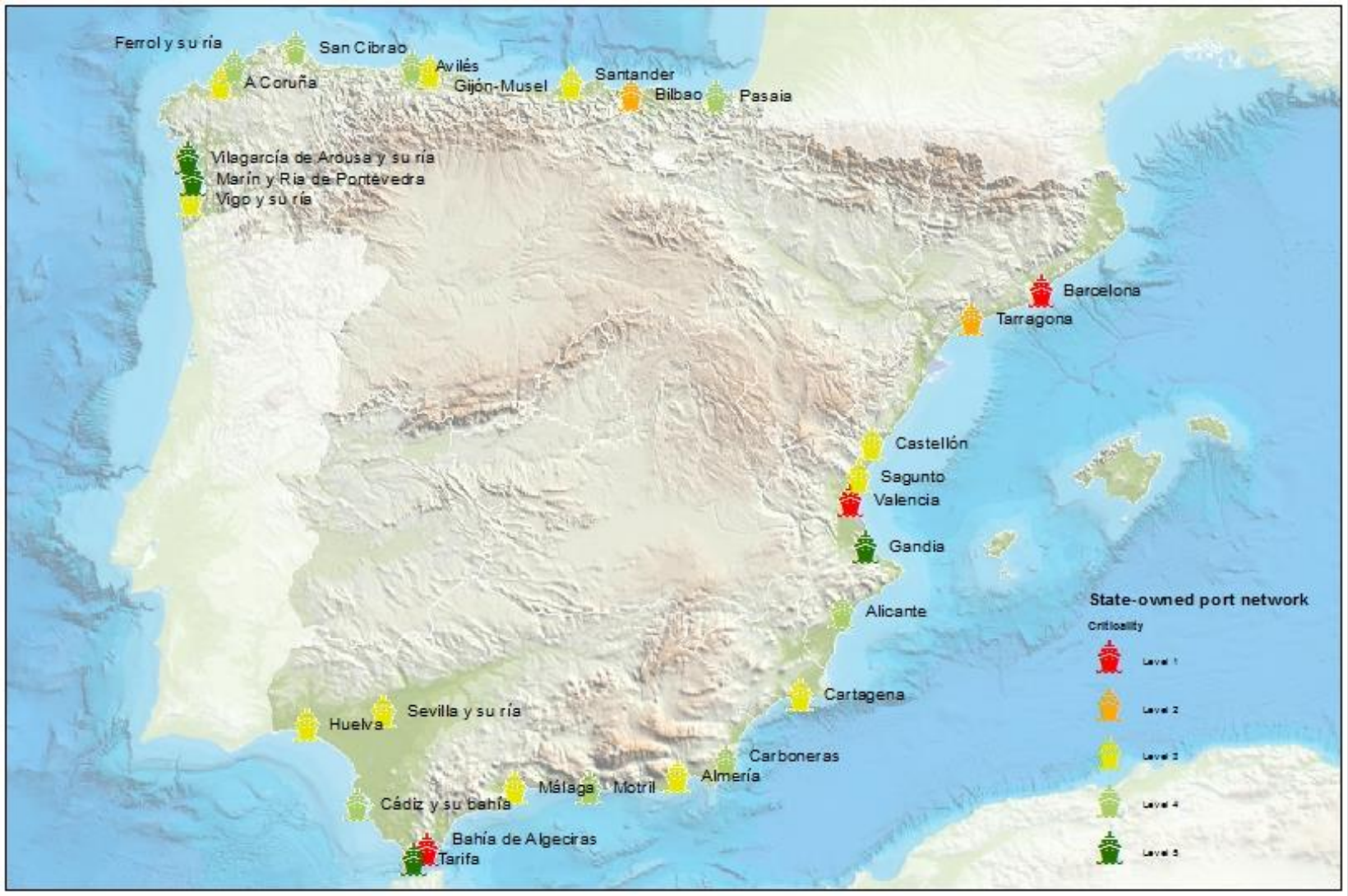


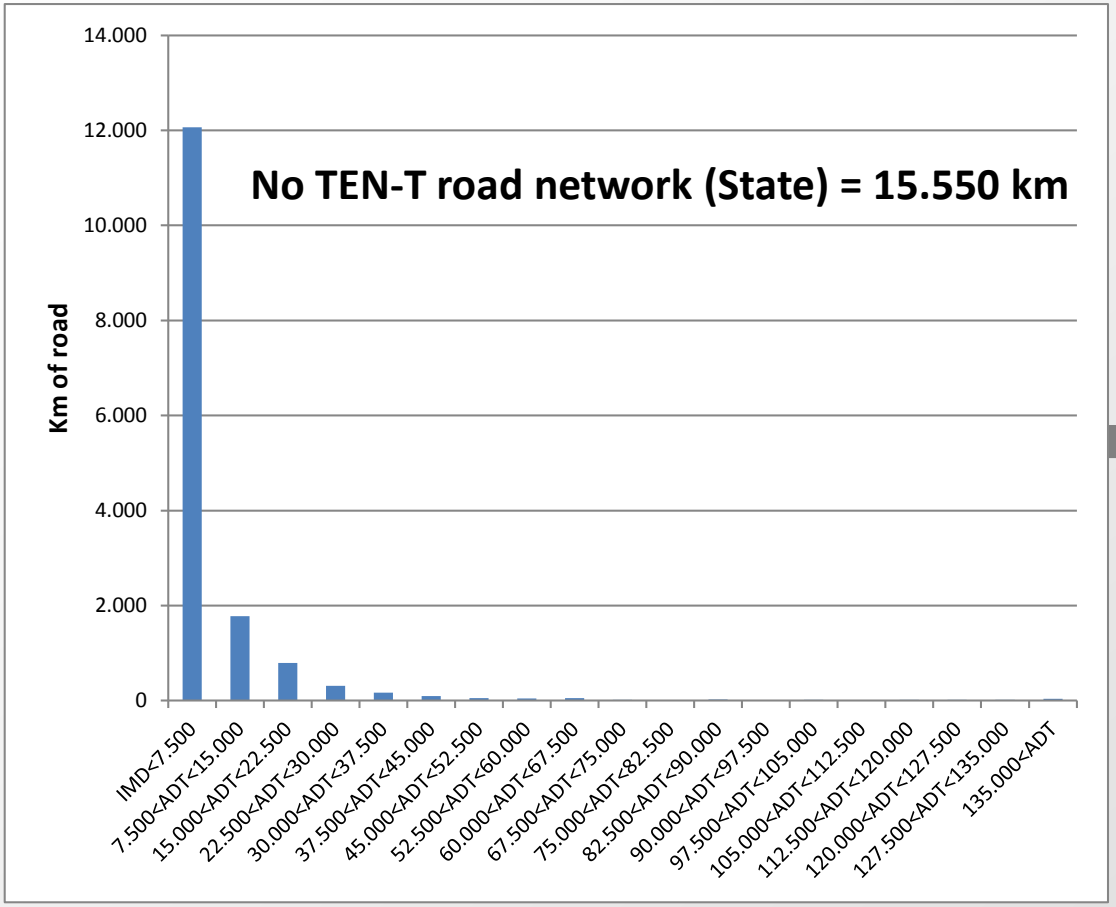
Criticality of No TEN-T road network

TO IDENTIFY HOTSPOTS:

Criticality of the transport network

Exposure of the transport network to climate change

Sensitivity of the transport network to climate change



ADT
+
Replacement cost
+
“No TEN-T”

Criticality of the road network

TO IDENTIFY HOTSPOTS:

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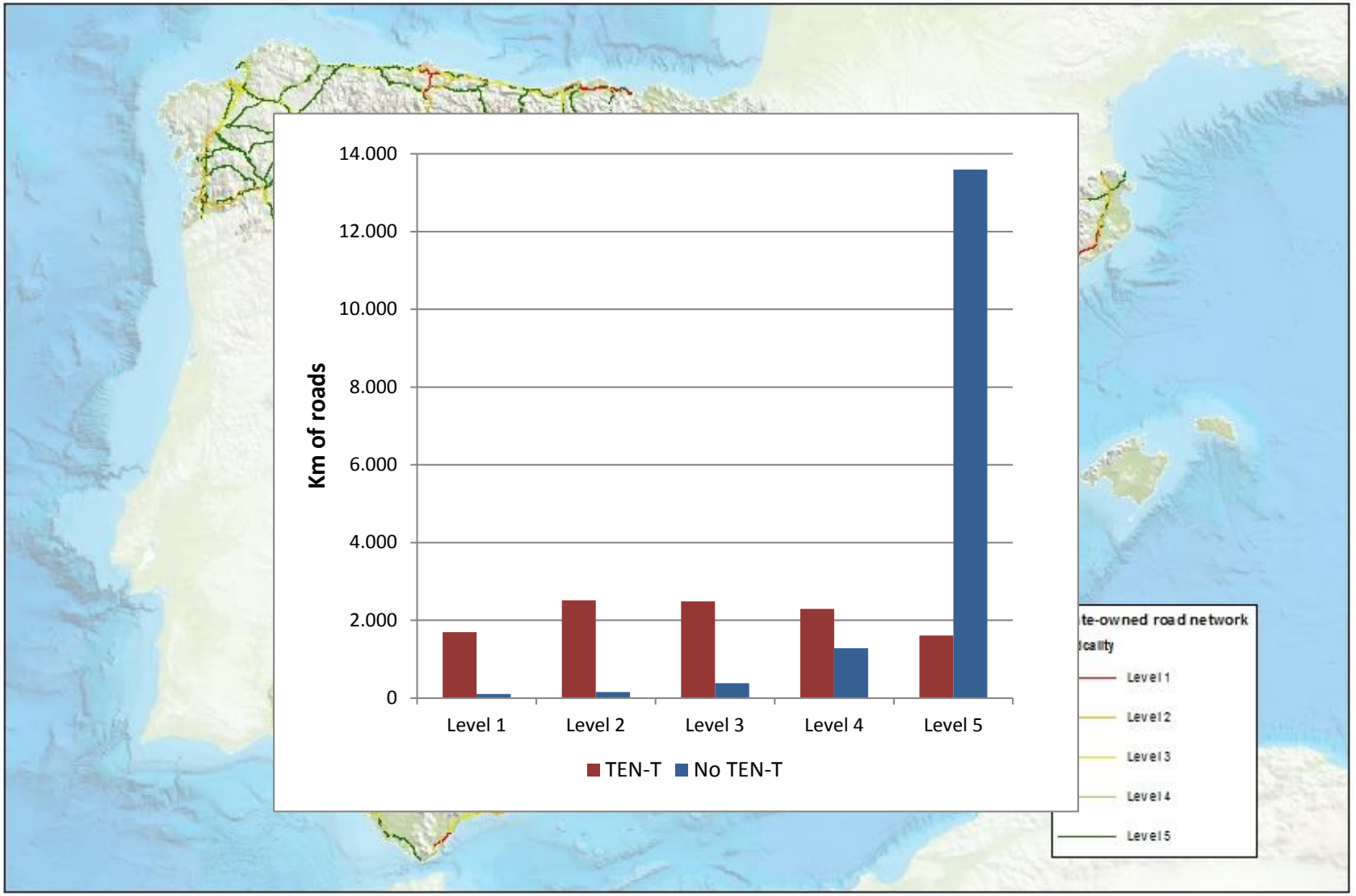


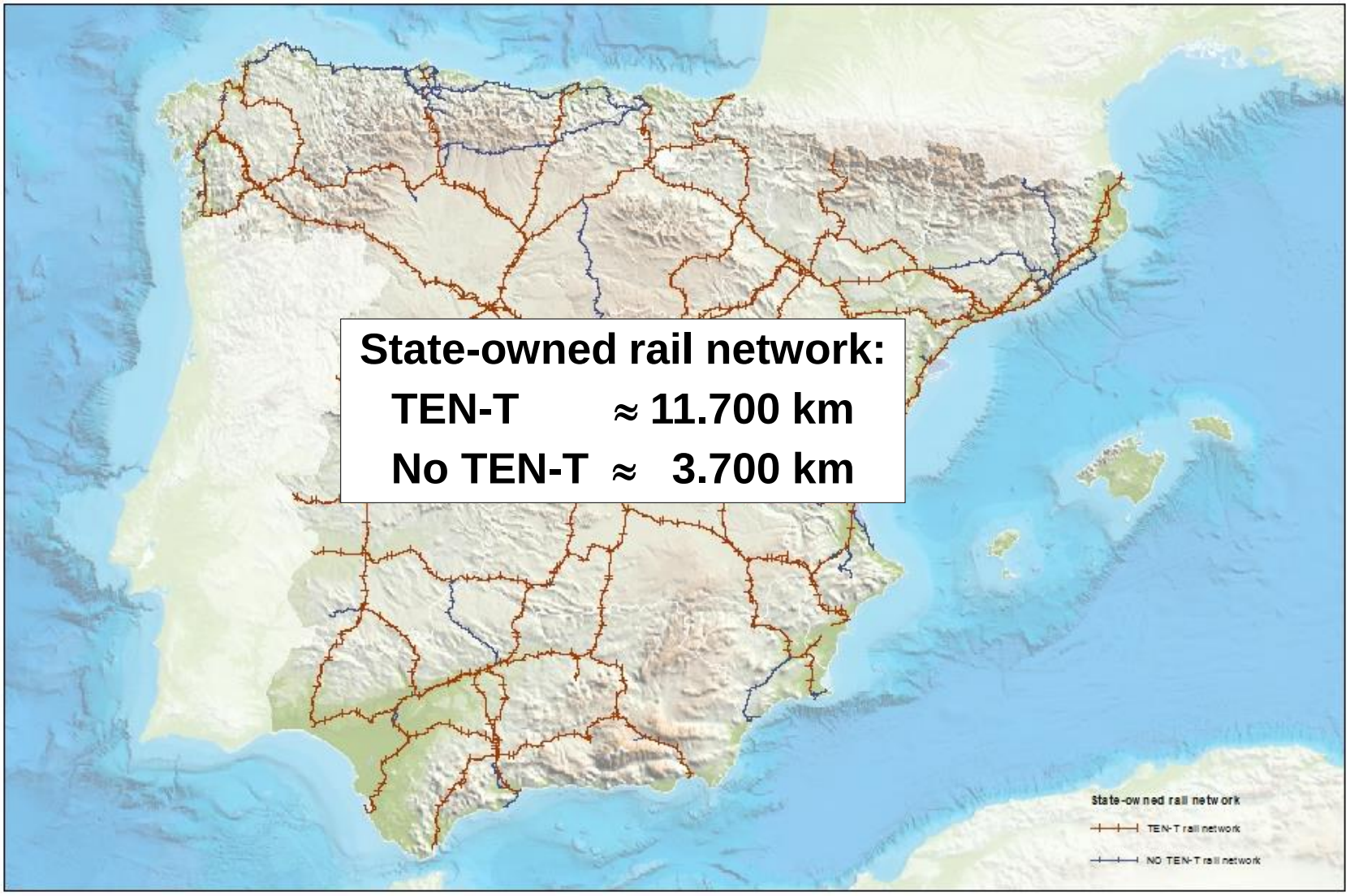
Criticality of the rail network

TO IDENTIFY HOTSPOTS:

Criticality of the transport network

Exposure of the transport network to climate change

Sensitivity of the transport network to climate change



Criticality of the rail network

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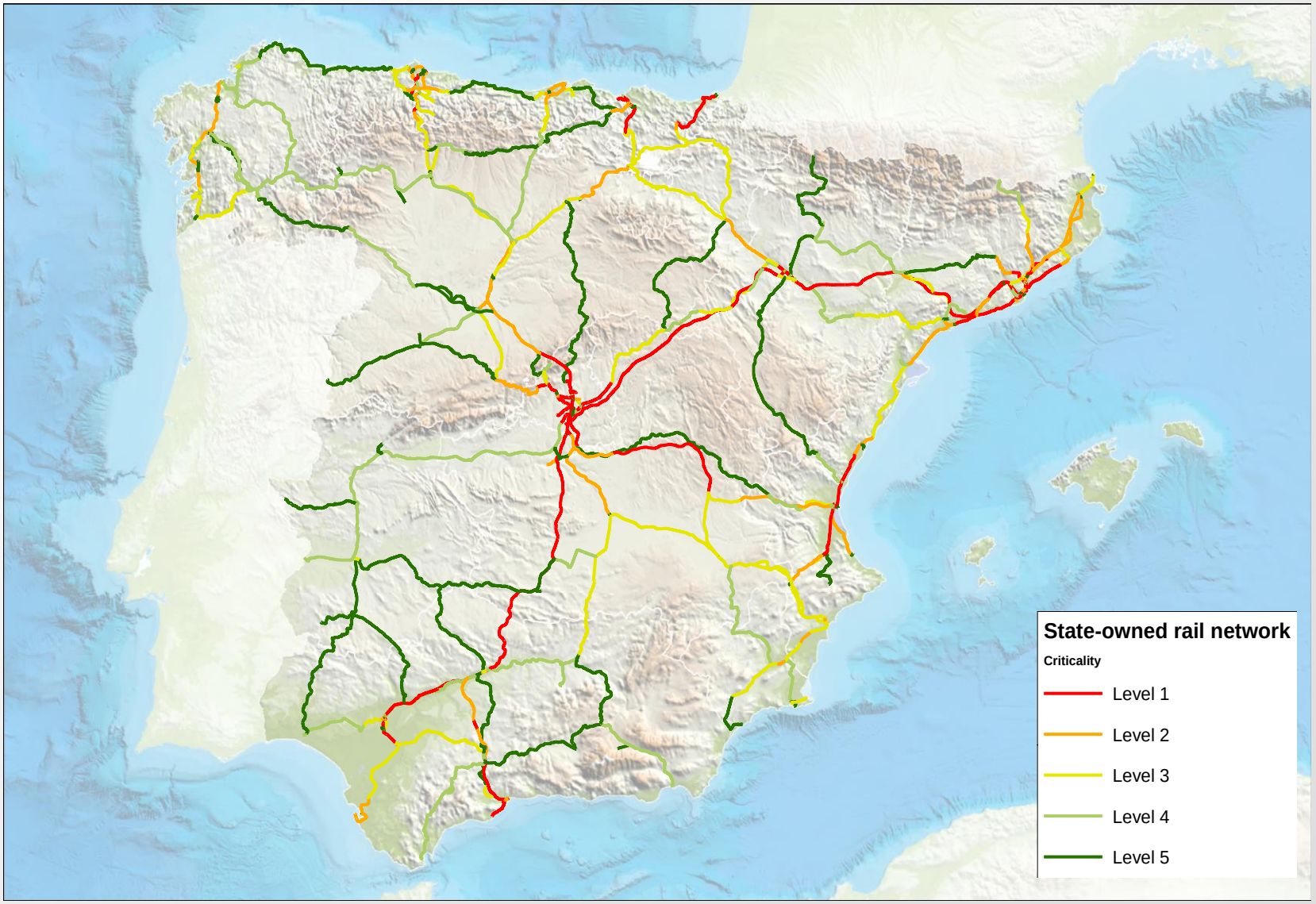
Sensitivity of the transport network to climate change



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Exposure to climate change

Climatic stressors

TO IDENTIFY HOTSPOTS:

Criticality of the transport network

Exposure of the transport network to climate change

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Climatic stressors		Roads	Railways
Air temperature	Mean temperature	●	●
	Daily maximum temperature	●	●
	Diurnal thermal oscillation	●	●
	Frost days	●	●
	Heat waves	●	●
Precipitation	Mean annual precipitation	●	●
	Intensity of extreme rainfall	●	●
	Duration of heavy rainfall	●	●
	Floods	●	●
	Droughts	●	●
Electrical storms			●
Snow		●	●
Flash floods in rivers		●	●
Water table		●	●
Fog	Fog intensity	●	●
	Frequency of intense fog	●	●
Wind	Intensity of extreme winds	●	●
	Frequency of strong winds	●	●
	Wind direction	●	●

Exposure to climate change

Climatic stressors

TO IDENTIFY HOTSPOTS:

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	Floods	●	●
	Droughts	●	●
Electrical storms			●
Snow		●	●
Flash floods in rivers		●	●
Water table		●	●
Fog	Fog intensity	●	●
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	Frequency of strong winds	●	●
	Wind direction	●	●

Exposure to climate change

Climate change scenario/s

TO IDENTIFY HOTSPOTS:

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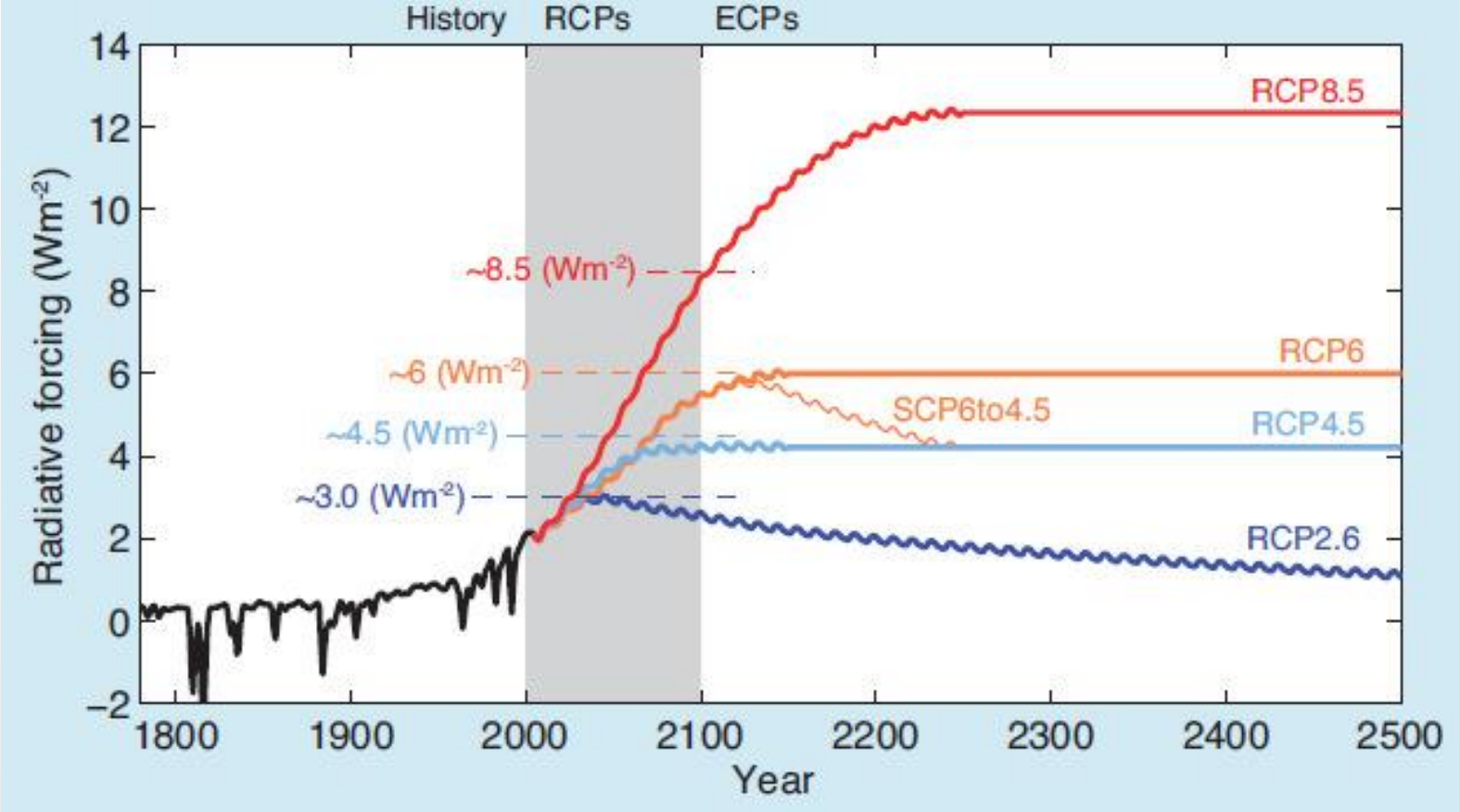
Coherence with the GHG concentration trajectories (RCPs) adopted by the IPCC for its fifth Assessment Report



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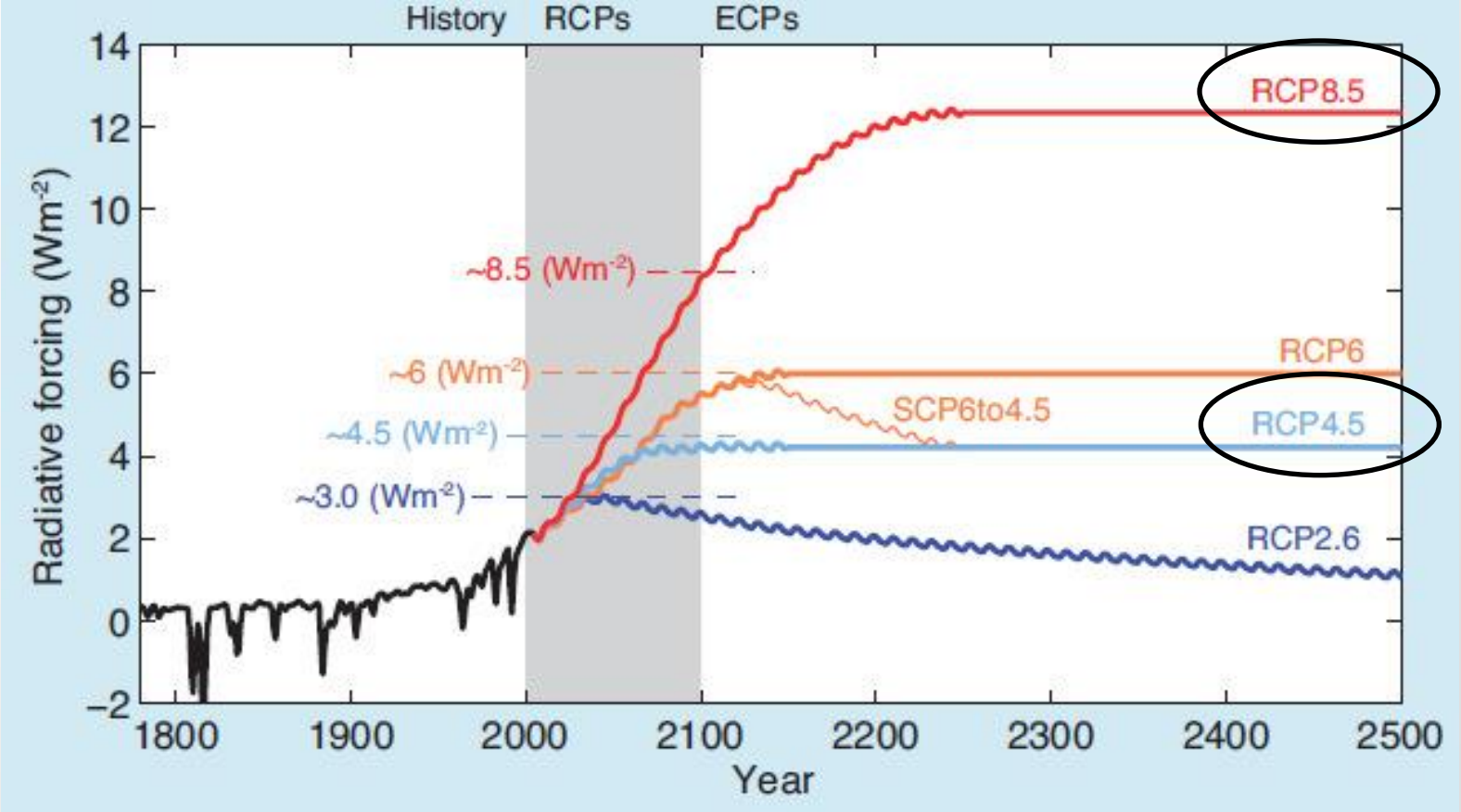

Exposure to climate change

Time horizon

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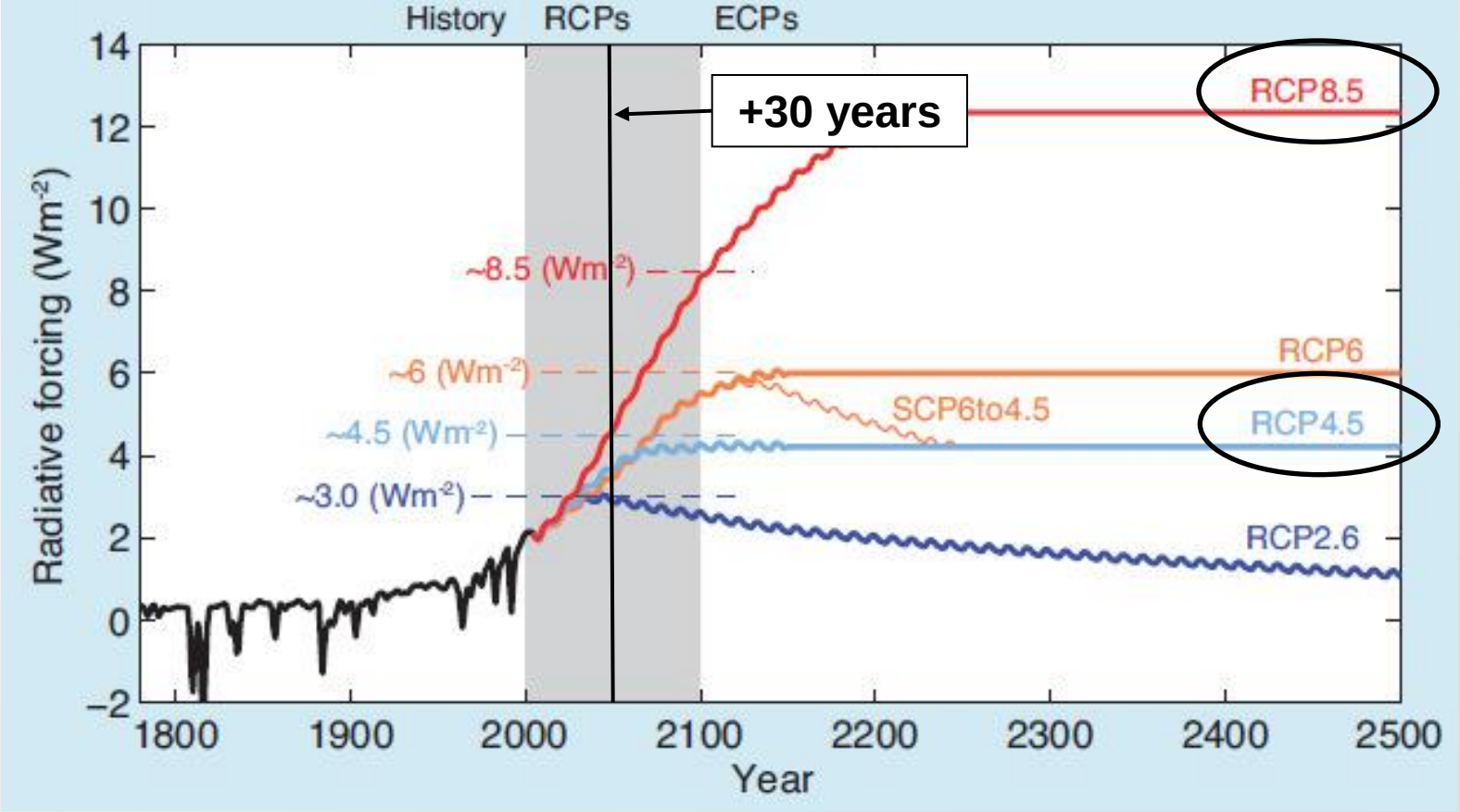

Exposure to climate change

Source of projections

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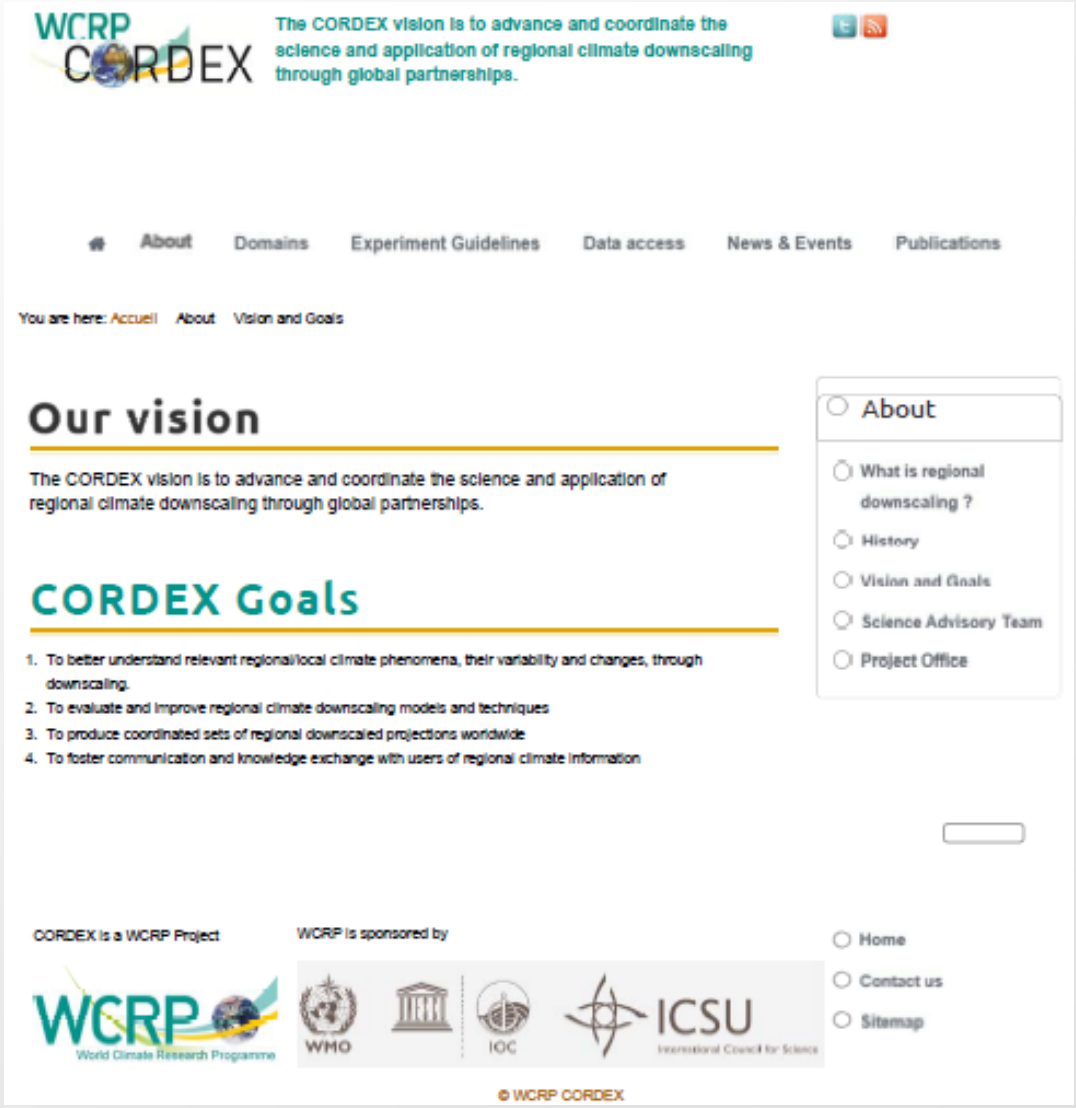

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Exposure to climate change

Climatic stressors

Climatic stressors taken from CORDEX with a resolution of 0.11 degrees and made available through AEMet Agencia Estatal de Meteorología :

- ✓ **Change in maximum temperature**
- ✓ **Change in number of days with minimum temperature below 0ºC**
- ✓ **Change in maximum daily thermal oscillation**
- ✓ **Change in maximum precipitation in 24 hours**
- ✓ **Change in maximum wind speed at 10 m**

Exposure to climate change

Data process

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Criticality of the transport network

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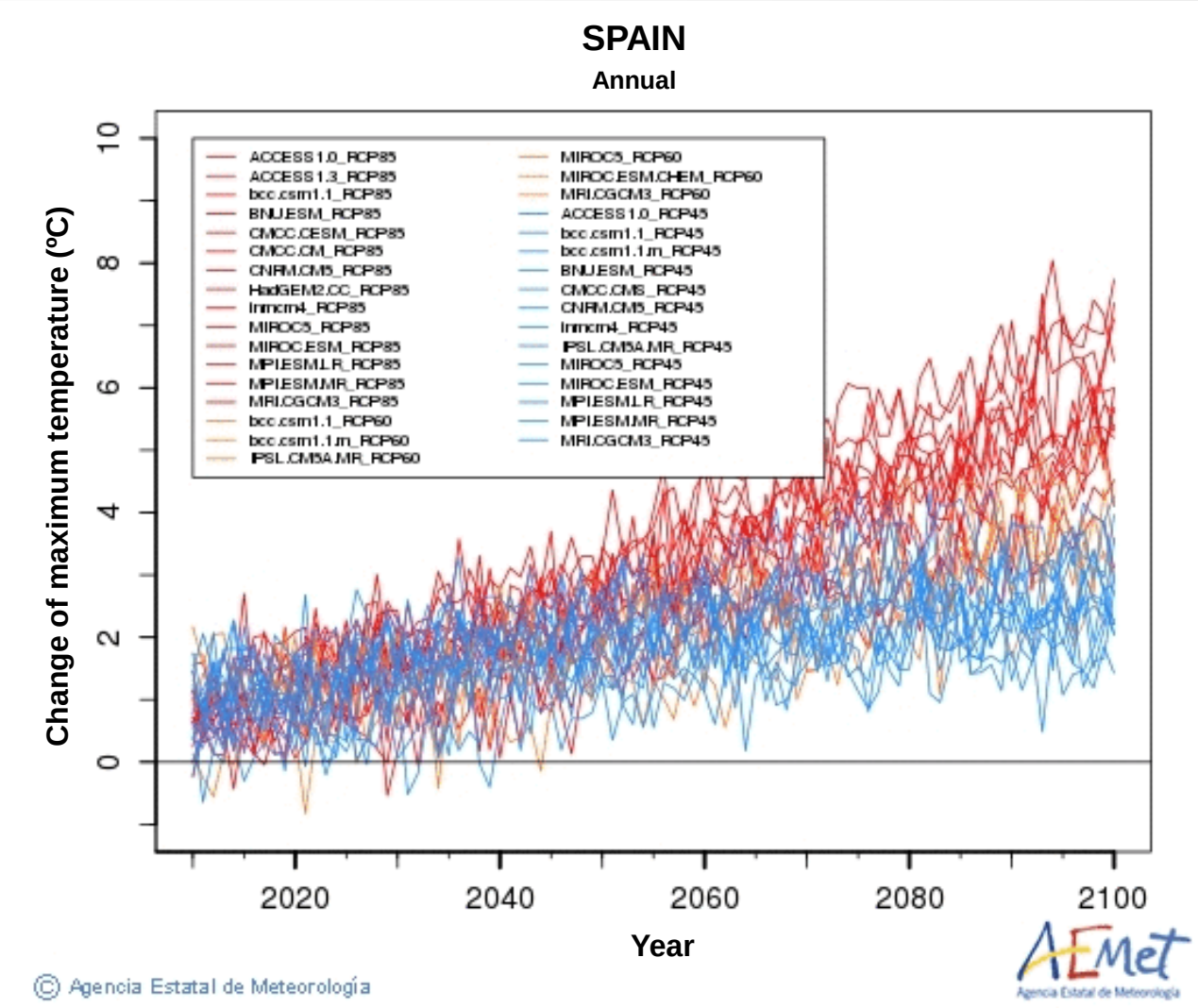

Exposure to climate change

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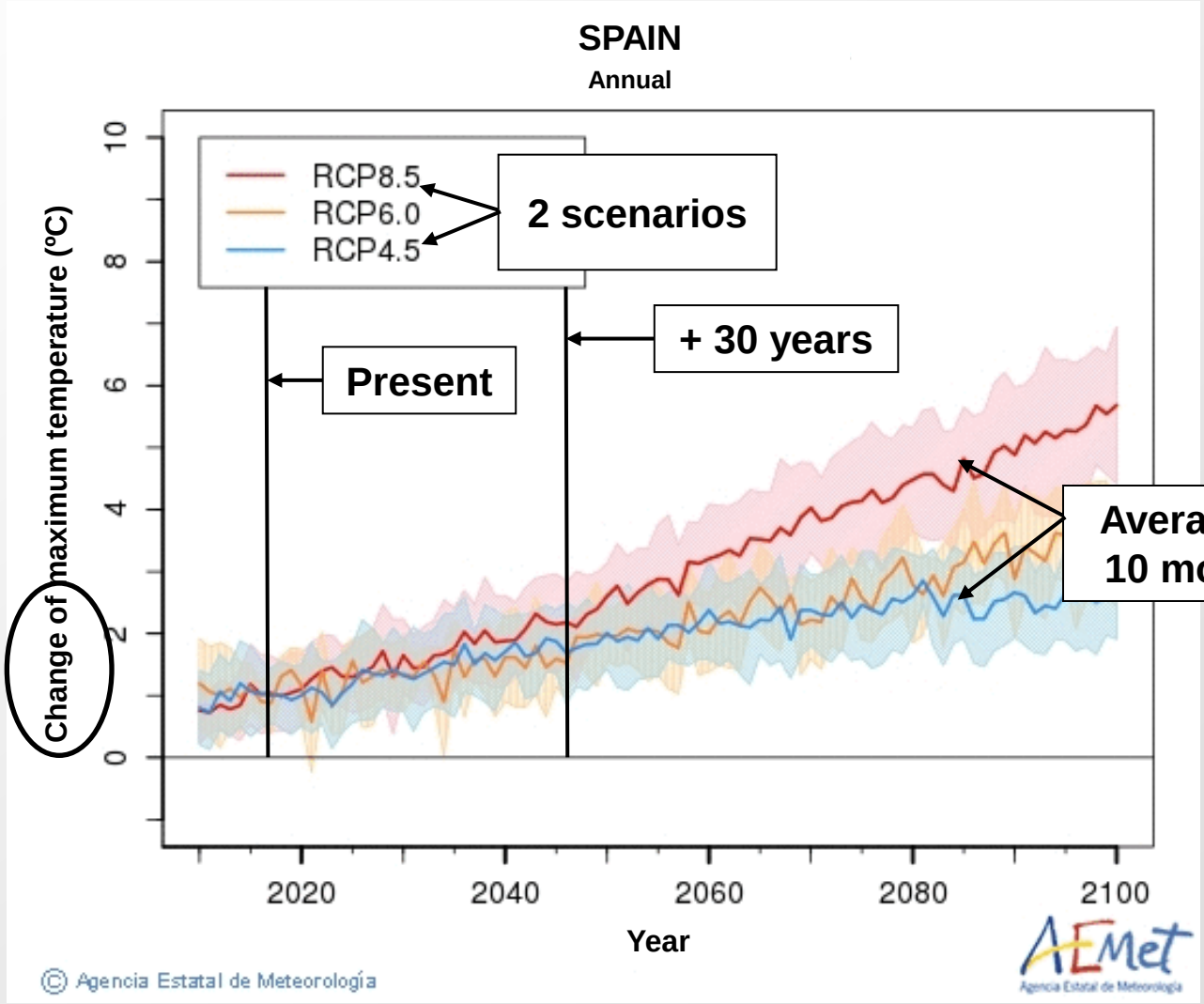

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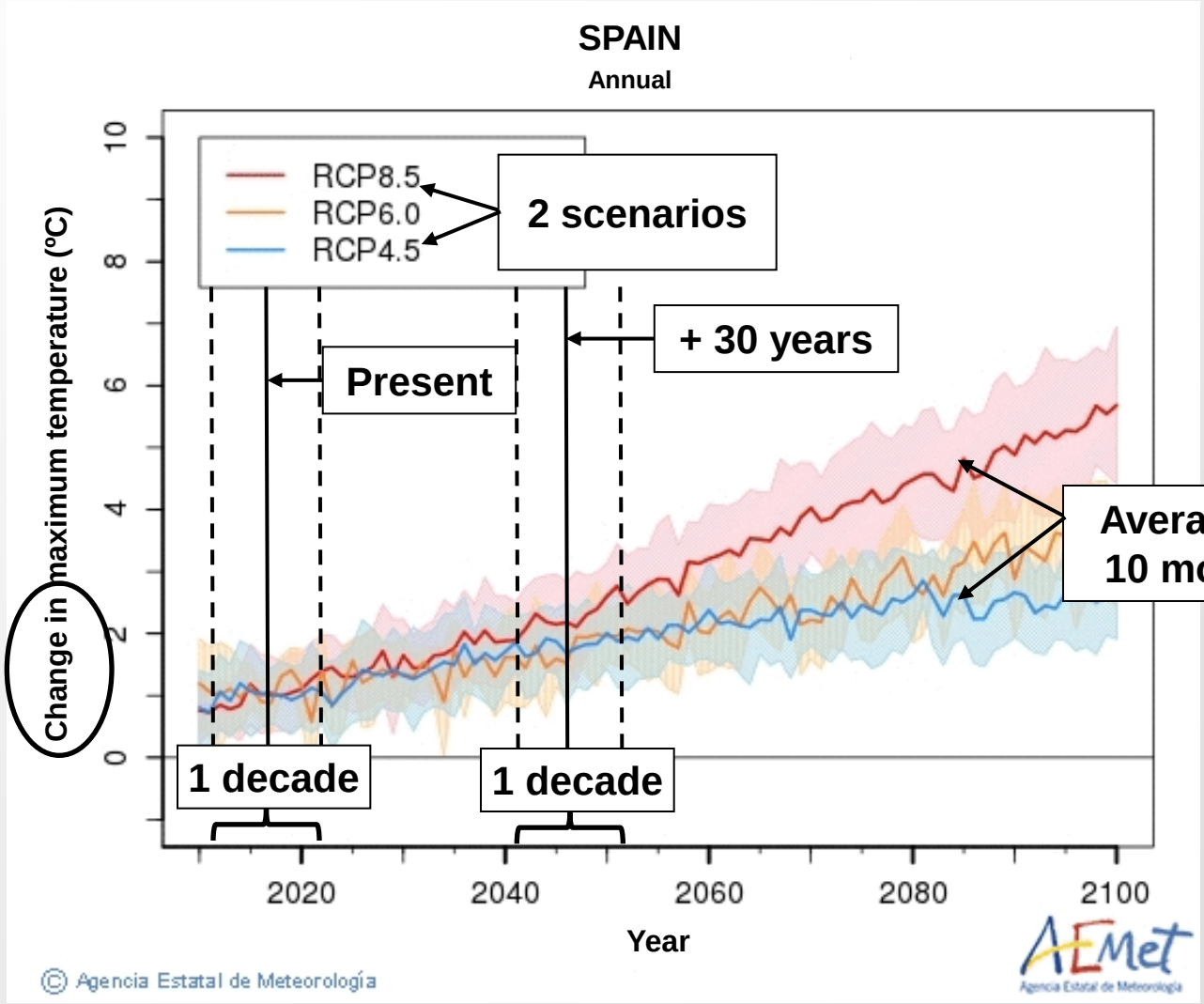

Exposure to climate change

Results of projections

TO IDENTIFY HOTSPOTS:

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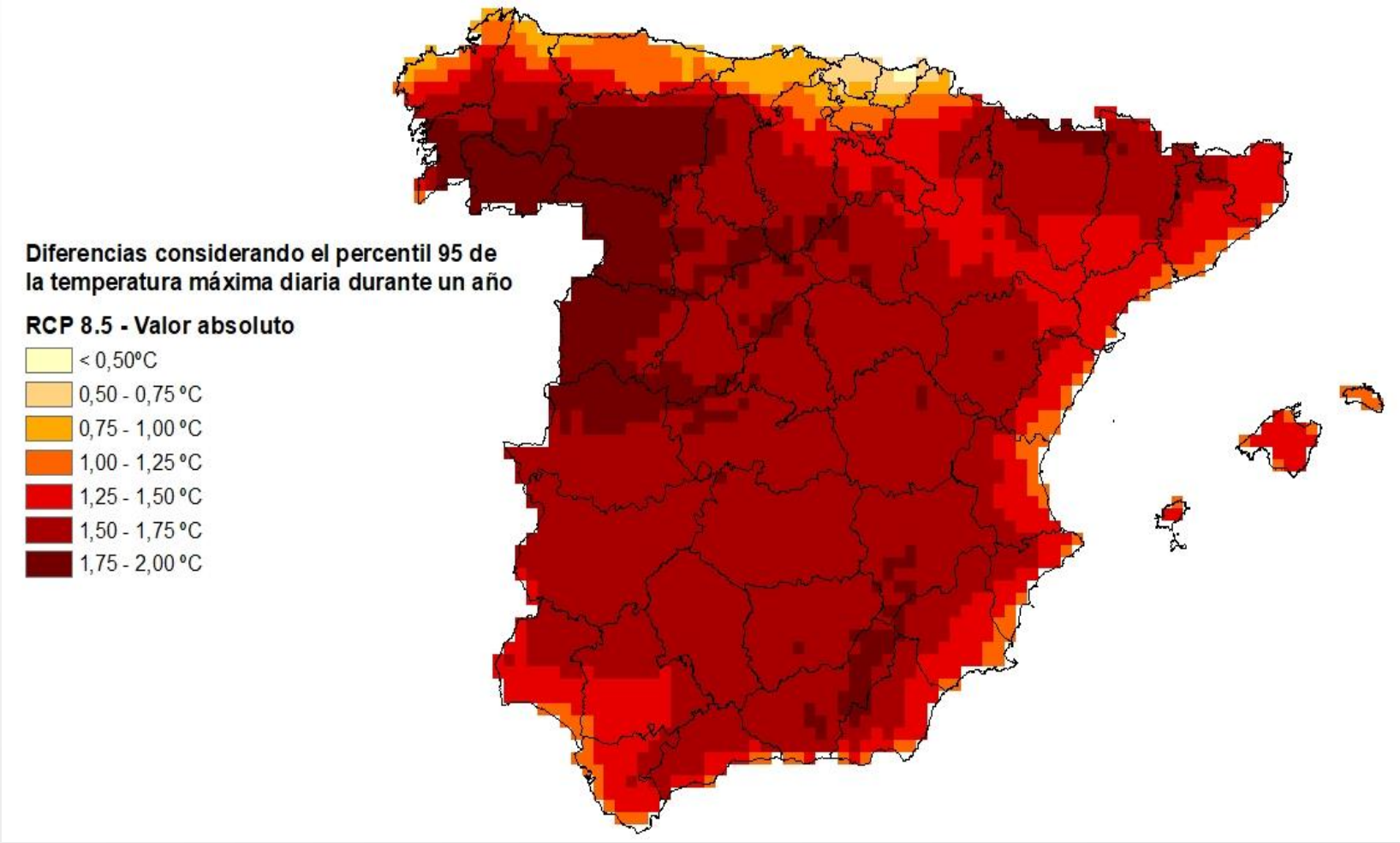
Change in maximum temperature



Exposure to climate change

Results of projections

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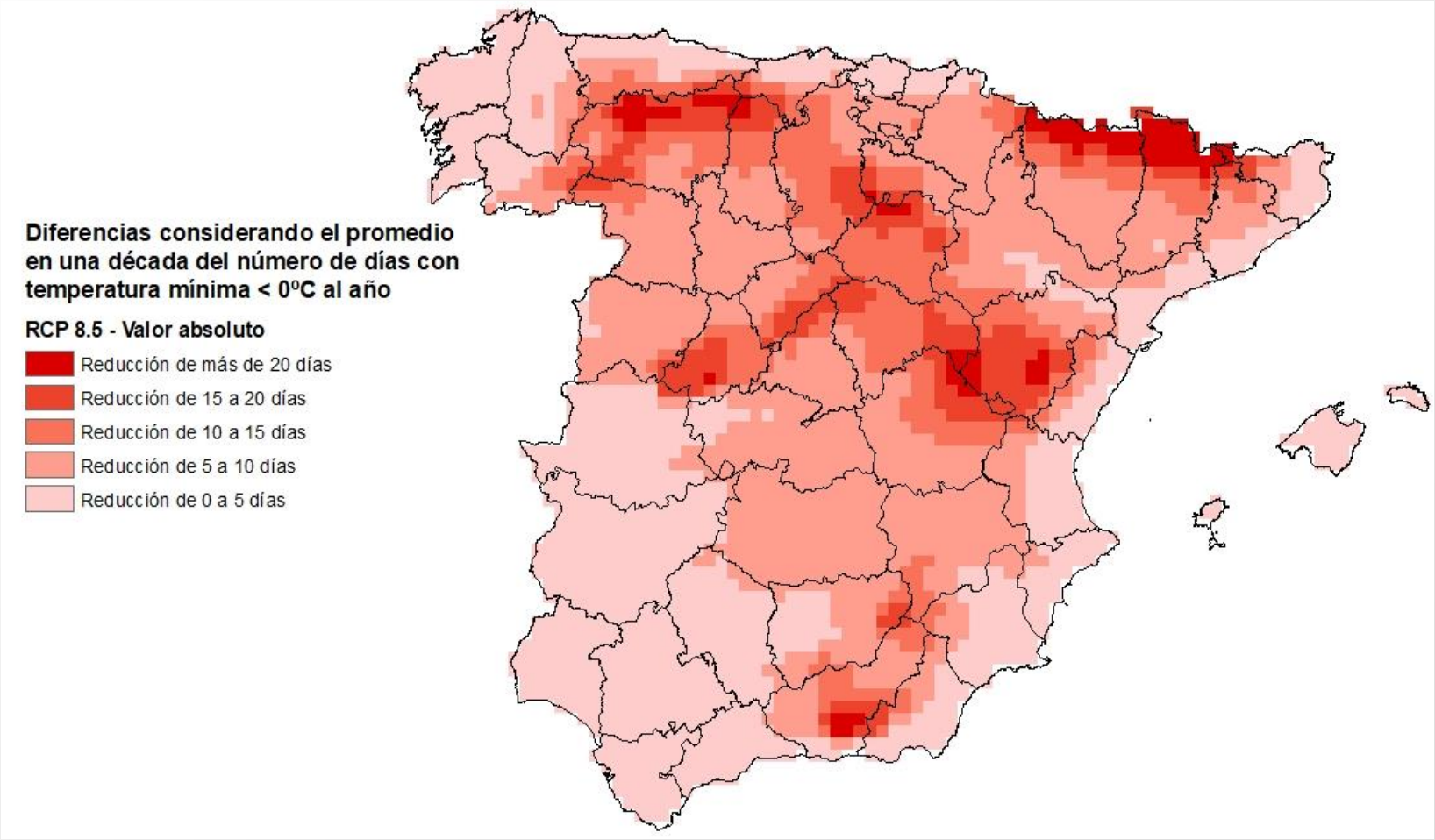
The number of days with minimum temperature < 0ºC always decrease



Exposure to climate change

Results of projections

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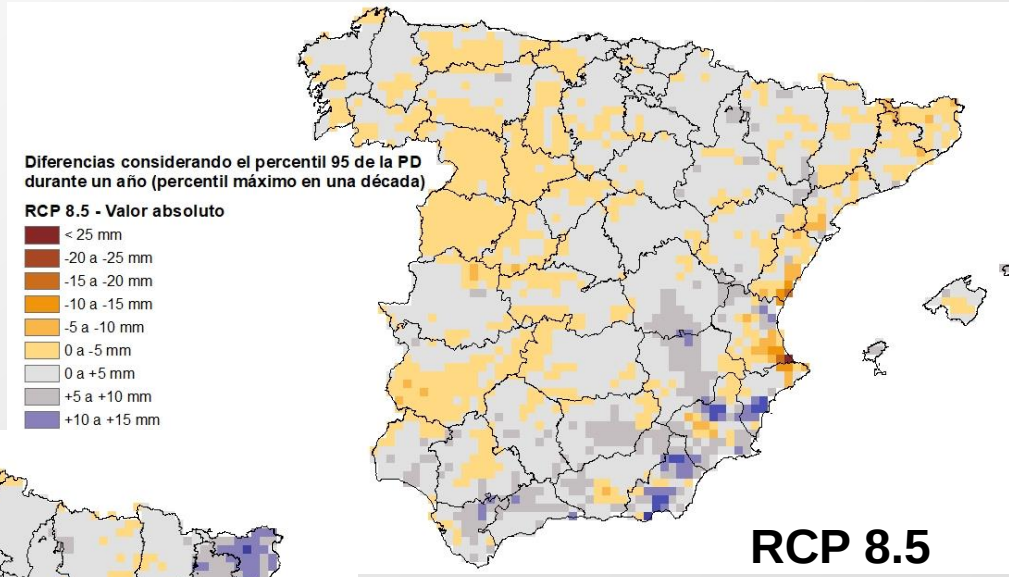
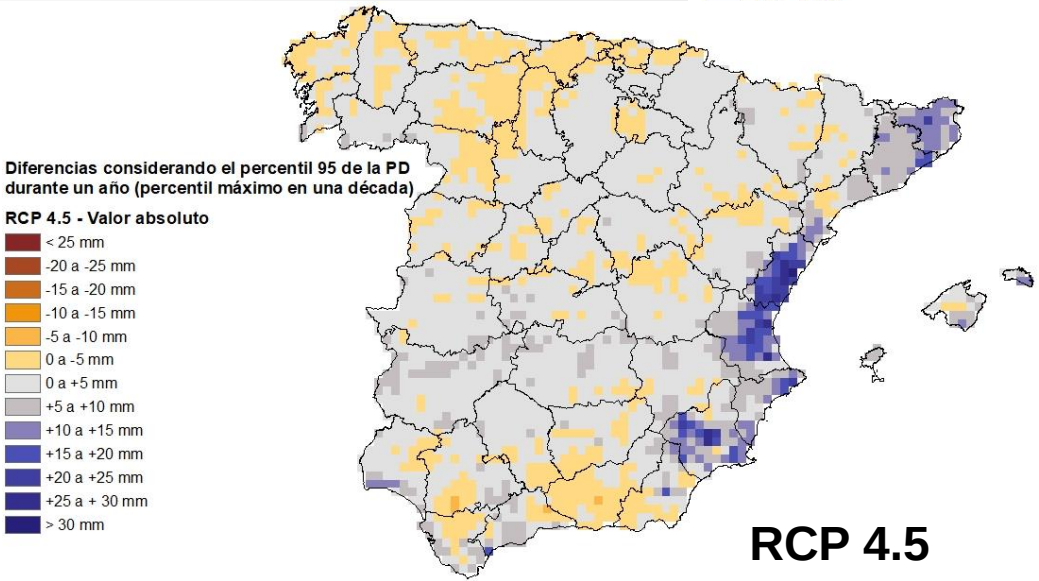
Change in maximum precipitation in 24 h is often worse under RCP4.5



RCP 8.5



RCP 4.5

Exposure to climate change

Results of projections

TO IDENTIFY HOTSPOTS:

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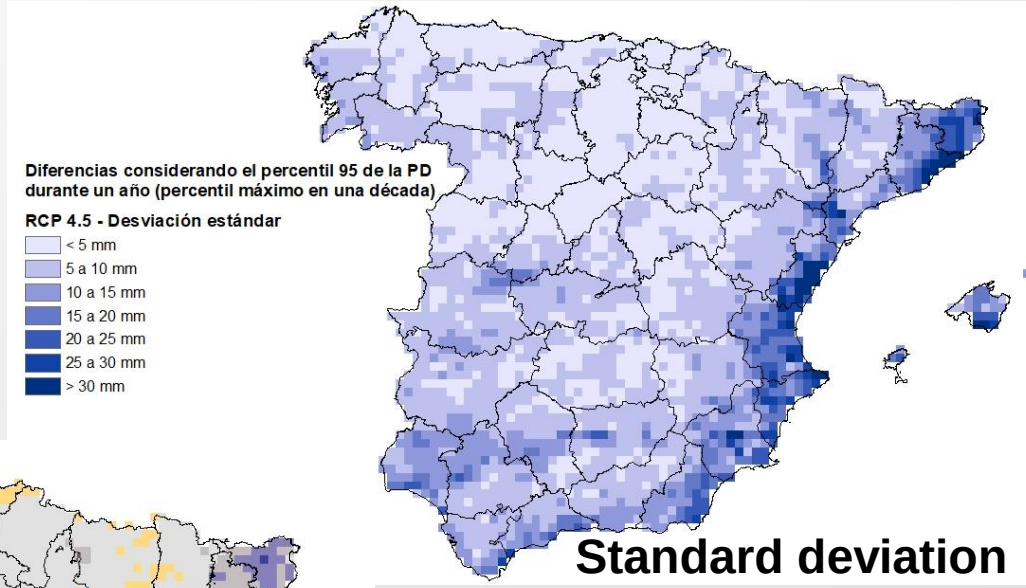
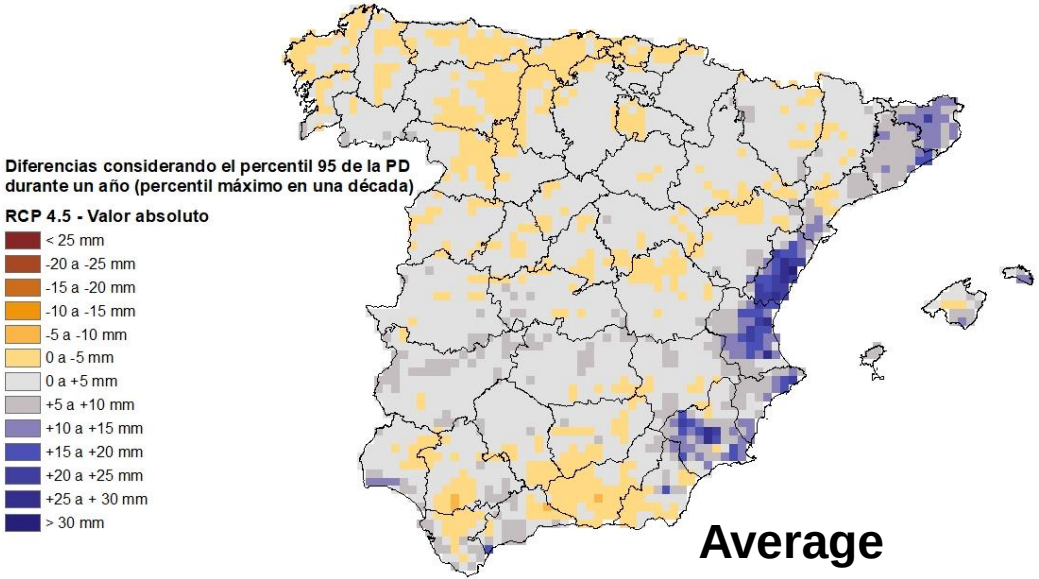
Change in maximum precipitation in 24 h is particularly uncertain



Standard deviation



Average

The approach to identify the hotspots in Spain

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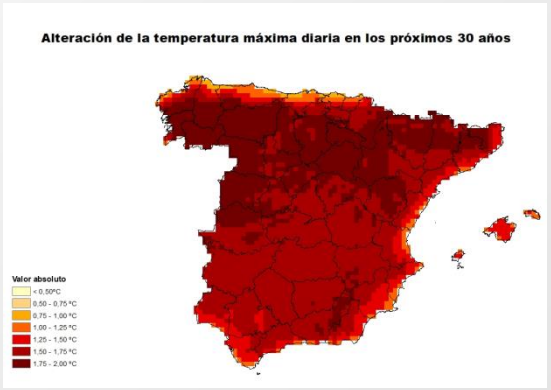
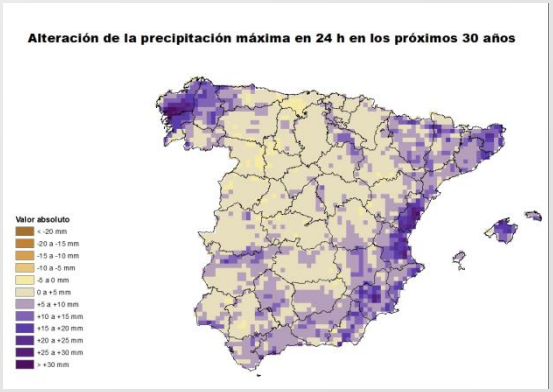
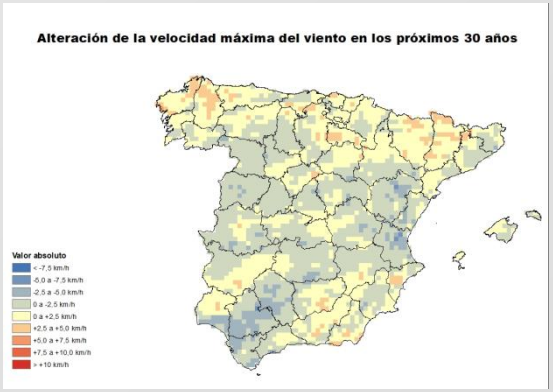
Sensitivity of the road network

Road sections in a province







Climatic stressors

Sensitivity of the road network

RED DE CARRETERAS

SECCIÓN 255			
Carretera:	A-23	Calzadas:	2
Provincia:	Huesca	Longitud (km):	11,9

← **Road section**

Principales impactos relacionados con fenómenos meteorológicos	Nivel del impacto	
	Situación actual	Situación prevista
Deslizamiento de laderas y arrastre de materiales y erosión en taludes por aguas de escorrentía como consecuencia de lluvias intensas		
Erosión de taludes en terraplén junto a cauces como consecuencia de avenidas extraordinarias		
Insuficiencia de capacidad de las obras de drenaje por lluvias intensas		
Erosión de estribos, socavación de pilas y obras de contención, e impactos por arrastre de materiales en obras de fábrica por avenidas extraordinarias		
Aparición de roderas y fisuras no estructurales en el pavimento como consecuencia del incremento de las temperaturas máximas		
Afección a las condiciones de vialidad por insuficiencia de capacidad de desagüe de la superficie de la calzada como consecuencia de lluvias intensas		
Afección a las condiciones de vialidad por incendios en el margen de la vía		
Afección a las condiciones de vialidad por nieve en la calzada		
Otro (especificar)*:		
Otro (especificar)*:		

← **Level of present/future impact**

Scale of the impact (1-10) ↓

ESCALA DE LOS IMPACTOS									
Afección reducida a la circulación y/o a la infraestructura			Afección moderada a la circulación y/o a la infraestructura			Afección importante a la circulación y/o a la infraestructura			
1	2	3	4	5	6	7	8	9	10
La afección a la infraestructura y a su funcionalidad es reducida o inexistente. Su reparación es compatible mediante actuaciones de mantenimiento rutinario. Las condiciones de circulación pueden verse afectadas por limitaciones de velocidad y/o medidas de control de tráfico y/o accesos durante un periodo de tiempo breve (horas).			La afección a la infraestructura y a su funcionalidad es moderada, requiriendo de reparaciones y/o reposiciones modestas. Se pueden producir retrasos a la circulación y requerir desvíos de tráfico que pueden prolongarse de horas a días.			La afección a la infraestructura y a su funcionalidad y/o seguridad es significativa, incluso puede llegar a ser total en algún punto. Su reparación requiere la rehabilitación/ reconstrucción de alguno o varios de los componentes de la infraestructura. Se pueden producir retrasos a la circulación y requerir desvíos de tráfico que pueden prolongarse durante semanas o meses.			

↑ **Main types of weather related impacts**

More Information

For info or further questions on this seminar and the activities of the JASPERS Networking Platform, please contact the JASPERS Networking and Competence Centre at the following email:

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