

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

Working Group
for the analysis of the
Climate change adaptation needs
of the core network of transport infrastructure
in Spain

FINAL REPORT
September 2013

	SECRETARÍA DE ESTADO DE INFRAESTRUCTURAS, TRANSPORTE Y TURISMO	SECRETARÍA GENERAL DE INFRAESTRUCTURAS	SECRETARÍA GENERAL DE INFRAESTRUCTURAS	SECRETARÍA GENERAL DEL TRANSPORTE
MINISTERIO DE FOMENTO	DIRECCIÓN GENERAL DE PLANEACIÓN DE INFRAESTRUCTURAS Y TRANSPORTE	DIRECCIÓN GENERAL DE CARRETERAS	DIRECCIÓN GENERAL DE FERROCARRILES	DIRECCIÓN DE PROSPECTIVA Y TECNOLOGÍA DEL TRANSPORTE

adif renfe Puertos del Estado ineco CEDEX

	MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE	SECRETARÍA DE ESTADO DE MEDIO AMBIENTE		
DIRECCIÓN GENERAL DE CALIDAD, EVALUACIÓN AMBIENTAL Y MEDIO AMBIENTE	OCCE	AE Met		

European Environment Agency

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-40F4-BFA3-63C00B3E8DF1/122814/ACCIIFinalreportSeptember2013.pdf>

Introduction

CEDEX and climate change adaptation in transport

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

The screenshot shows a web browser window displaying the UNECE website. The address bar shows the URL: <https://www.unece.org/trans/areas-of-work/trends-and-economics/activities/group-of-experts-on-climate-chan...>. The page header includes the UNECE logo and a search bar. The navigation menu includes: About UNECE, Our work, Themes, Where we work, Open UNECE, Events, Publications, and Media. The main content area shows the breadcrumb: UNECE > TRANSPORT > AREAS OF WORK / TRENDS AND ECONOMICS / ACTIVITIES / GROUP OF EXPERTS ON CLIMATE CHANGE IMPACTS AND ADAPTATION FOR TRANSPORT NETWORKS AND NODES (WP.5/GE.3). The main heading is 'Group of Experts on Climate Change impacts and adaptation for transport networks and nodes (WP.5/GE.3)'. A sidebar on the left lists various activities, with the selected activity highlighted: 'Group of Experts on Climate Change impacts and adaptation for transport networks and nodes (WP.5/GE.3)'. A text box on the right contains the objective: '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'.

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

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.
- ✓ The level of sensitivity of the transport sections to climate change.

TO IDENTIFY
HOTSPOTS:

Criticality of
the transport
network

Exposure of
the transport
network to
climate change

Sensitivity of
the transport
network to
climate change

The approach to identify the hotspots in Spain

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).**
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Criticality of the 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



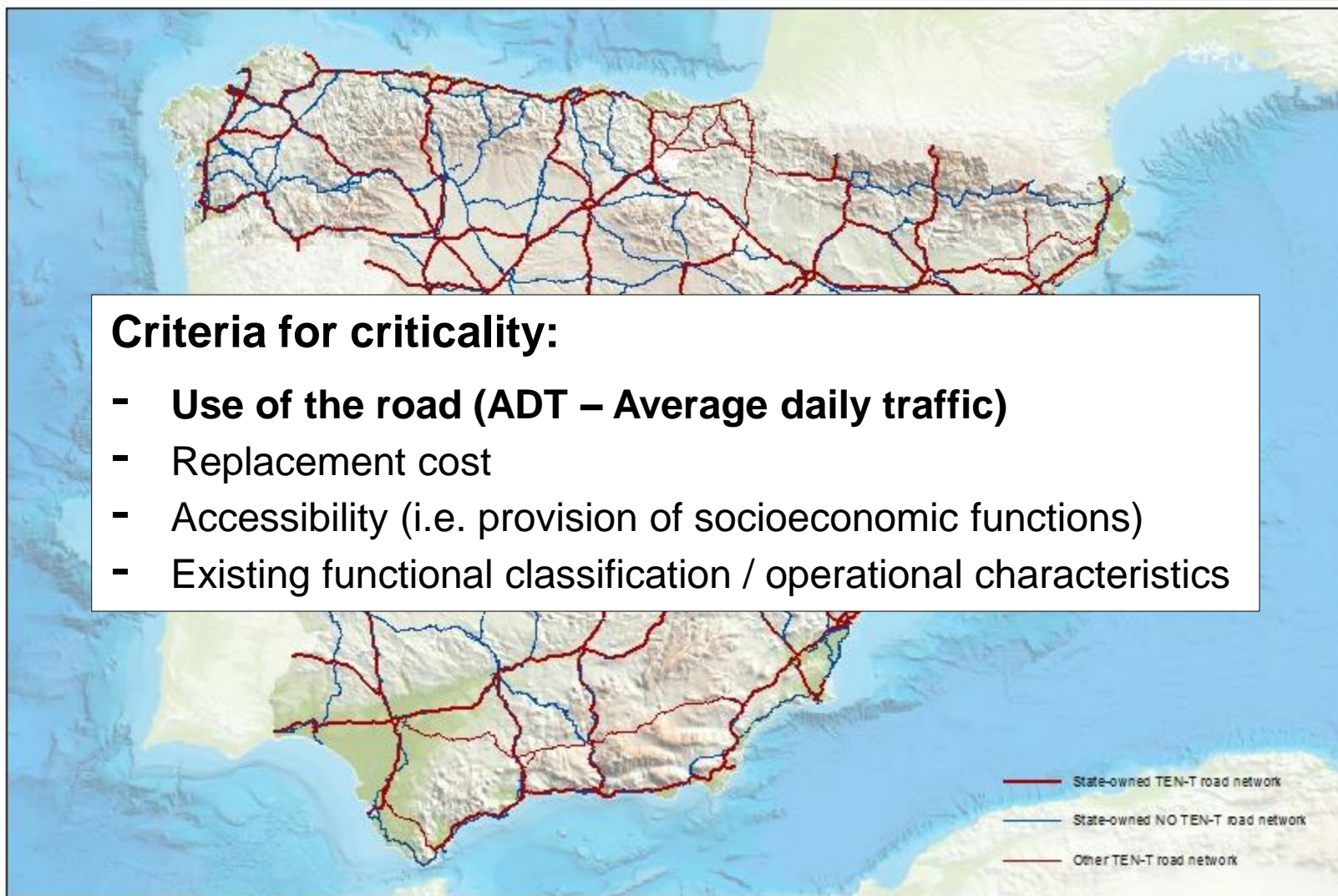
Criticality of the road network

TO IDENTIFY HOTSPOTS:

Criticality of the transport network

Exposure of the transport network to climate change

Sensitivity of the transport network to climate change



Criticality of TEN-T road network

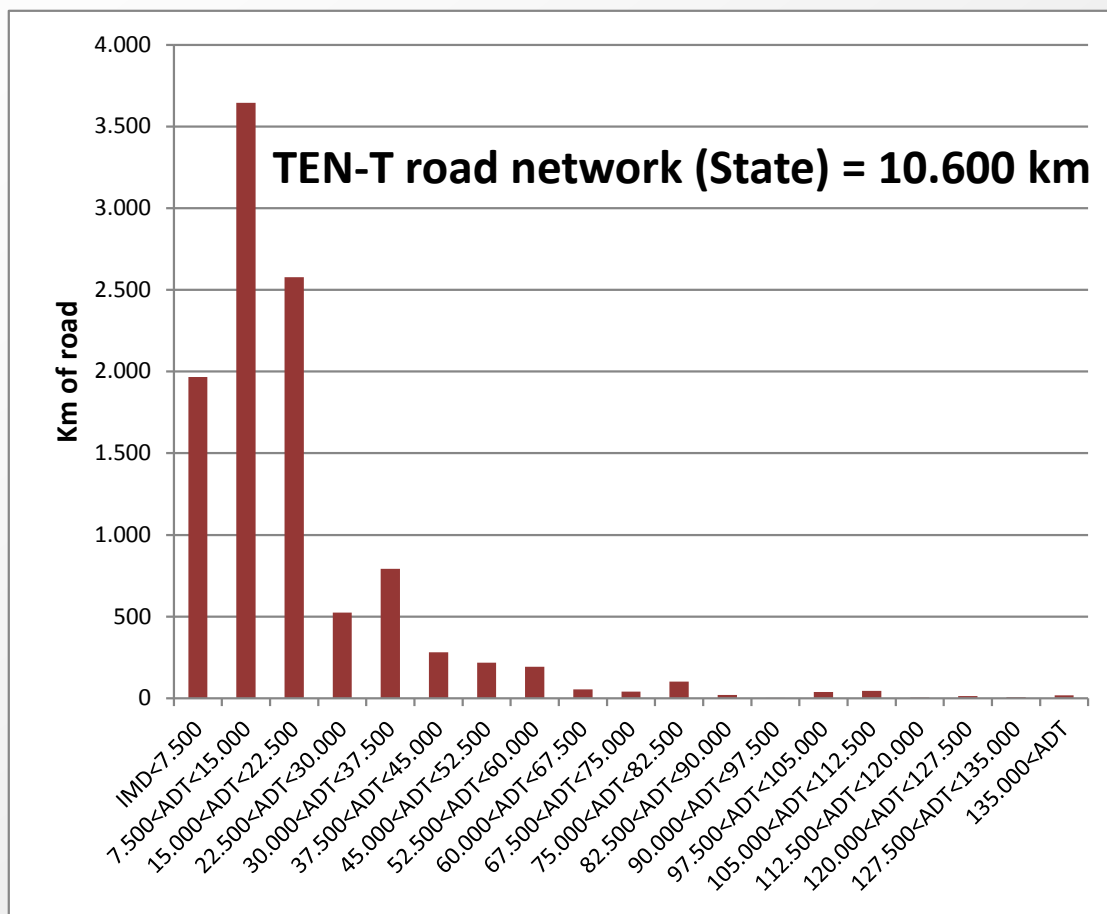
Use of the road

TO IDENTIFY HOTSPOTS:

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Grouping according to traffic level

Criticality of TEN-T road network

Replacement cost

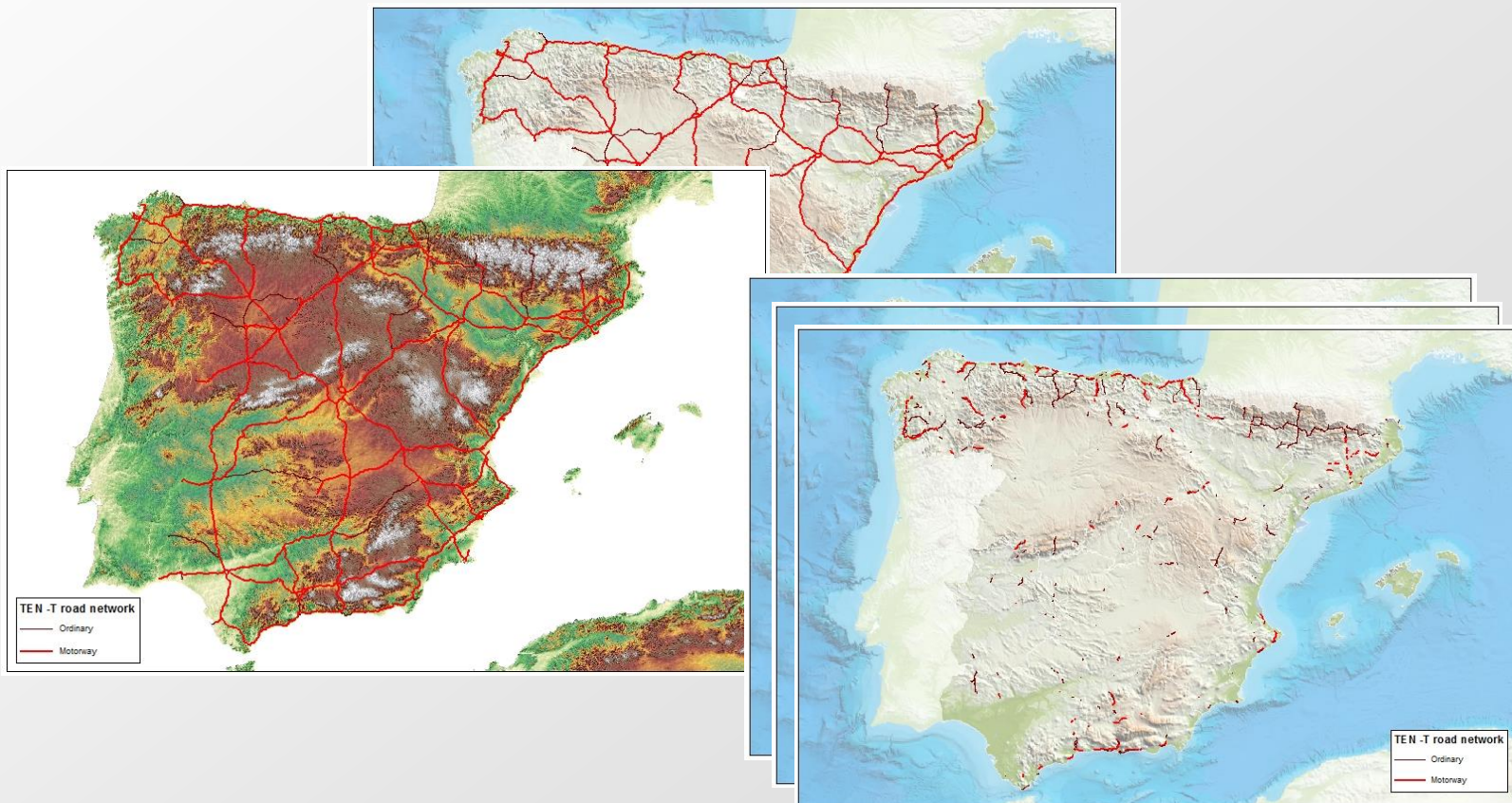
TO IDENTIFY HOTSPOTS:

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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)

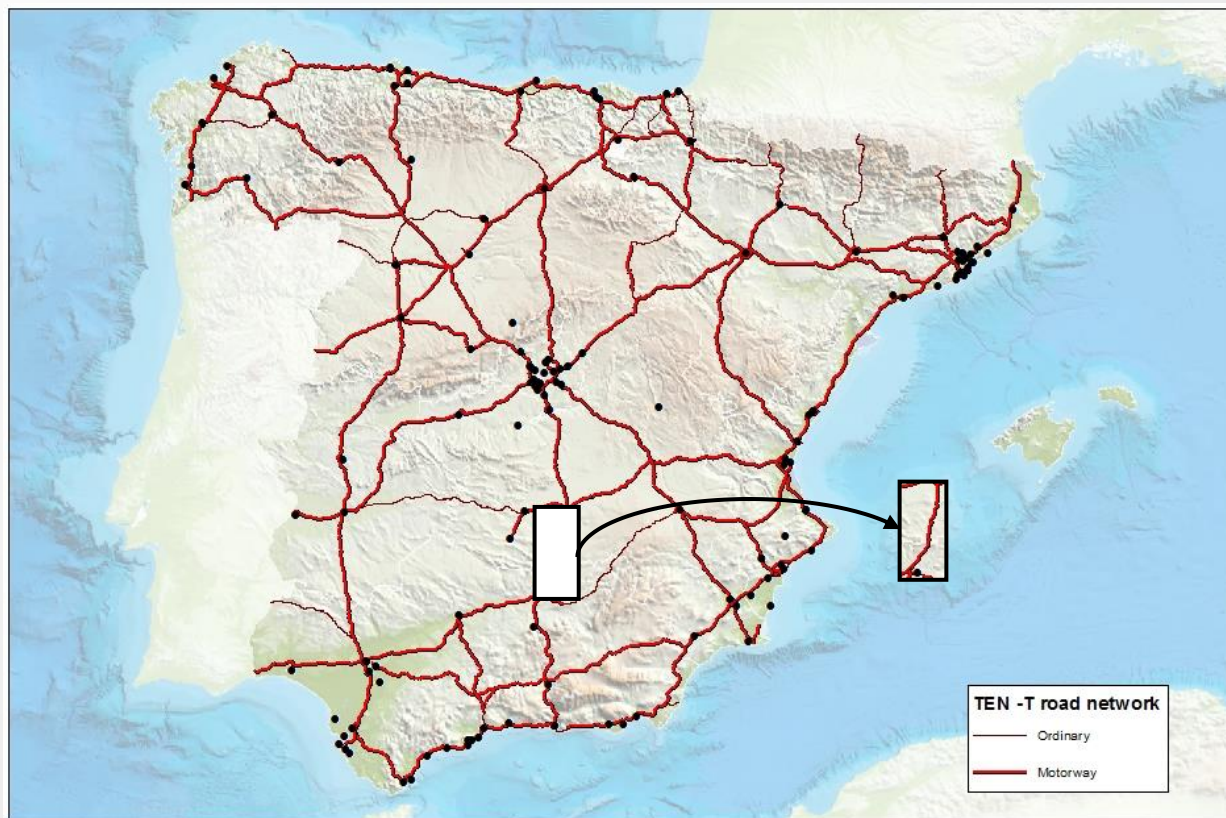
Weighting factor based on an accessibility index for a section

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

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

Criticality of TEN-T road network

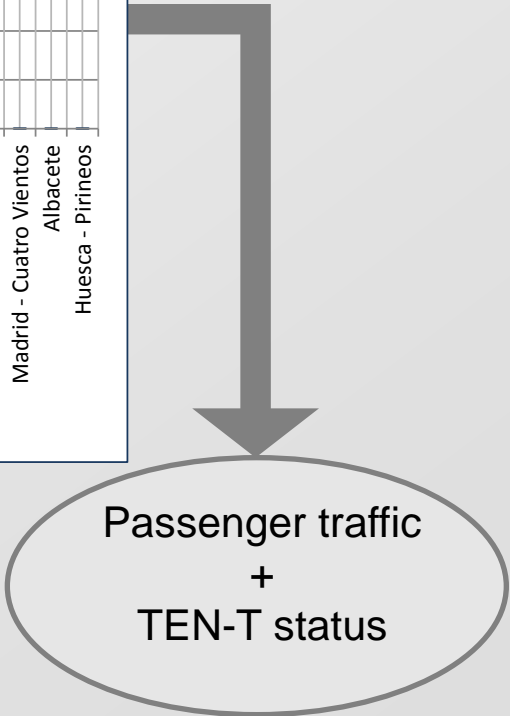
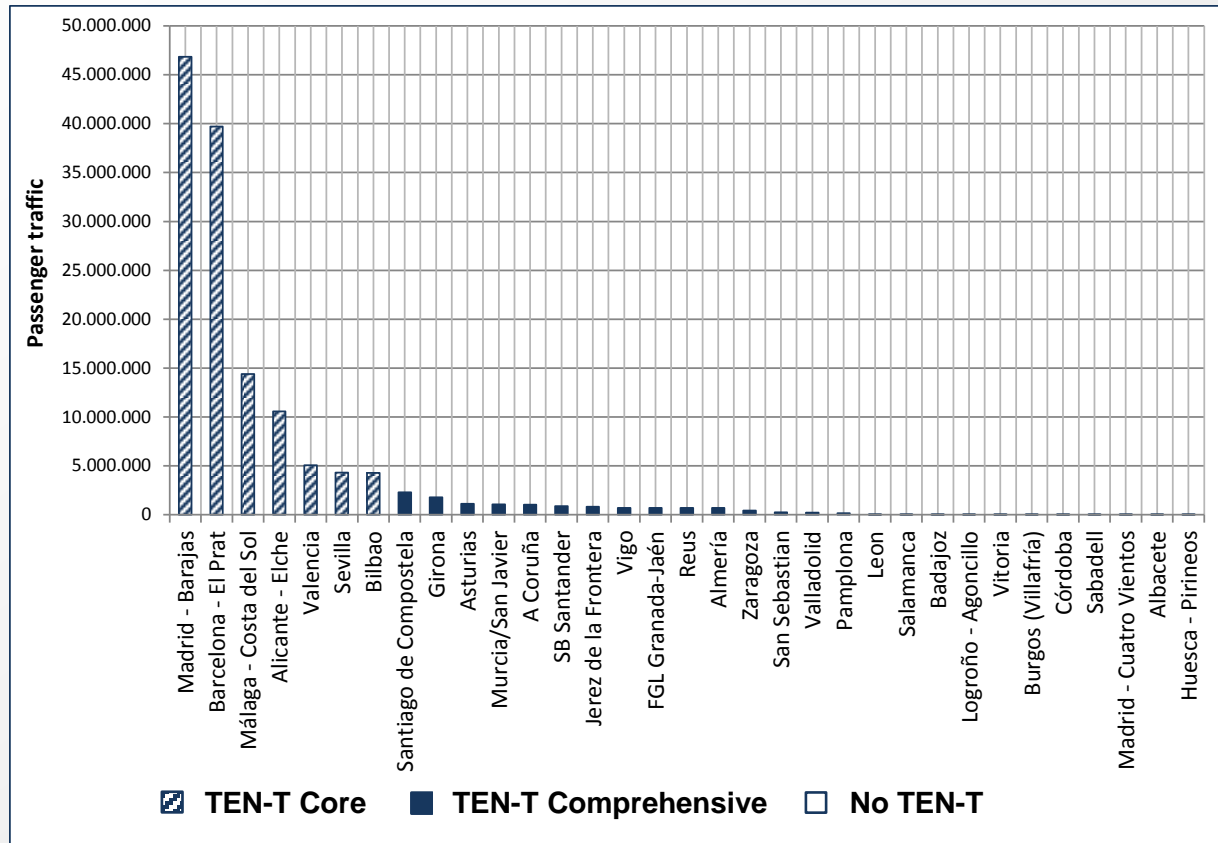
Operational characteristics – Connecting airports

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Criticality of TEN-T road network

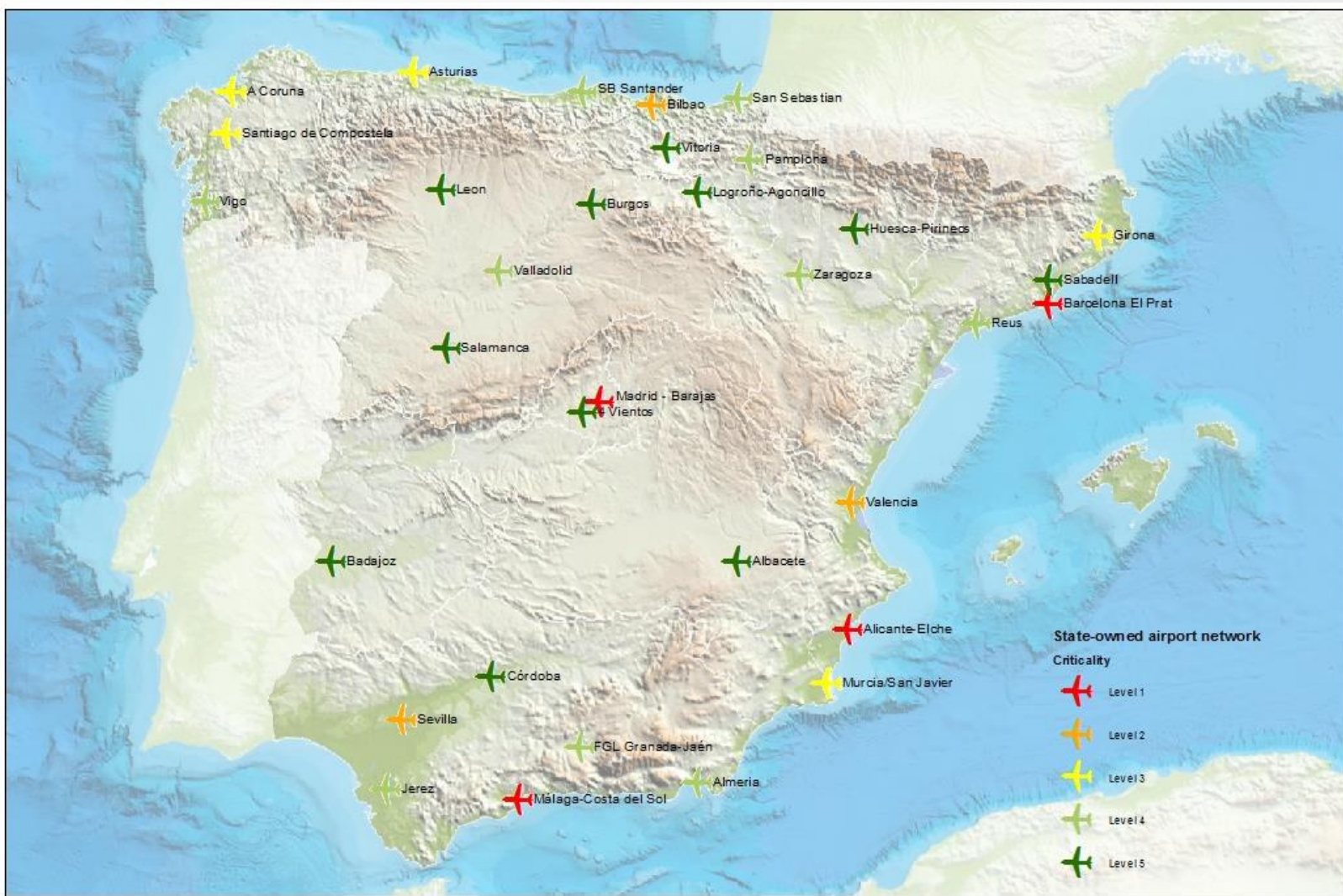
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Criticality of TEN-T road network

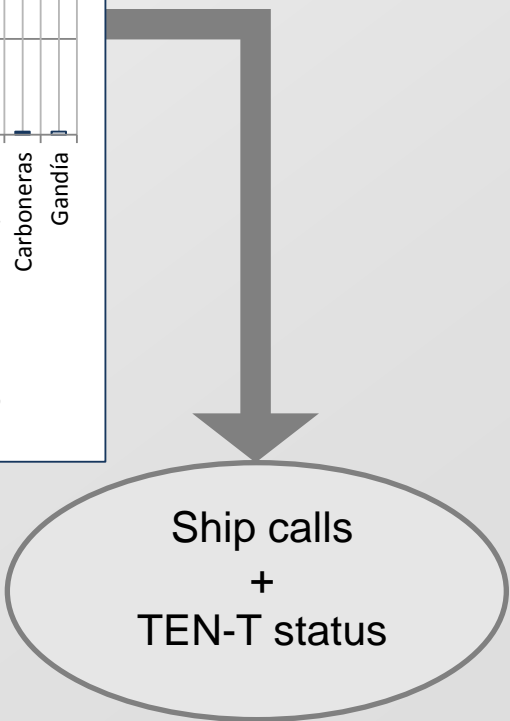
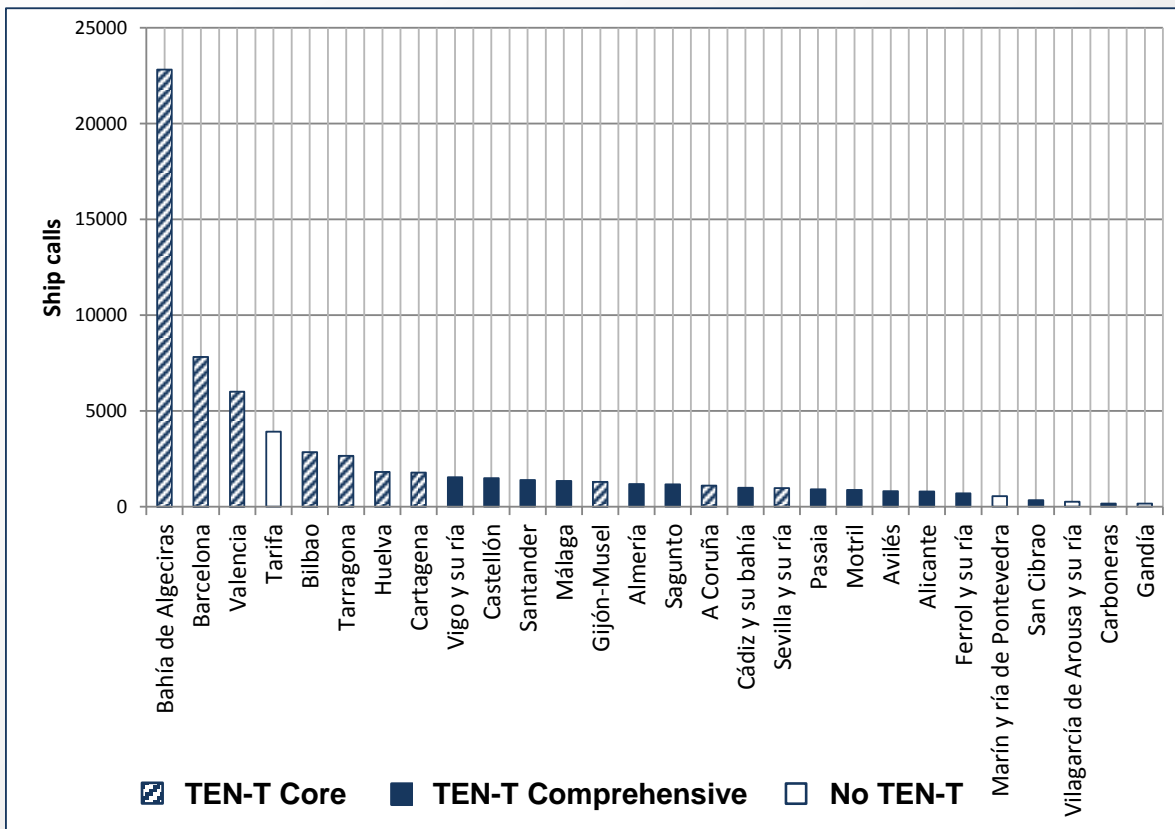
Operational characteristics – Connecting ports

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Criticality of TEN-T road network

Operational characteristics – Connecting ports

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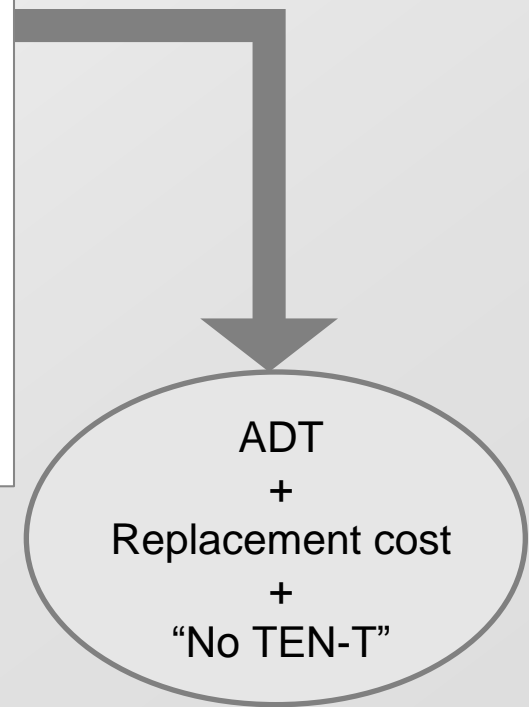
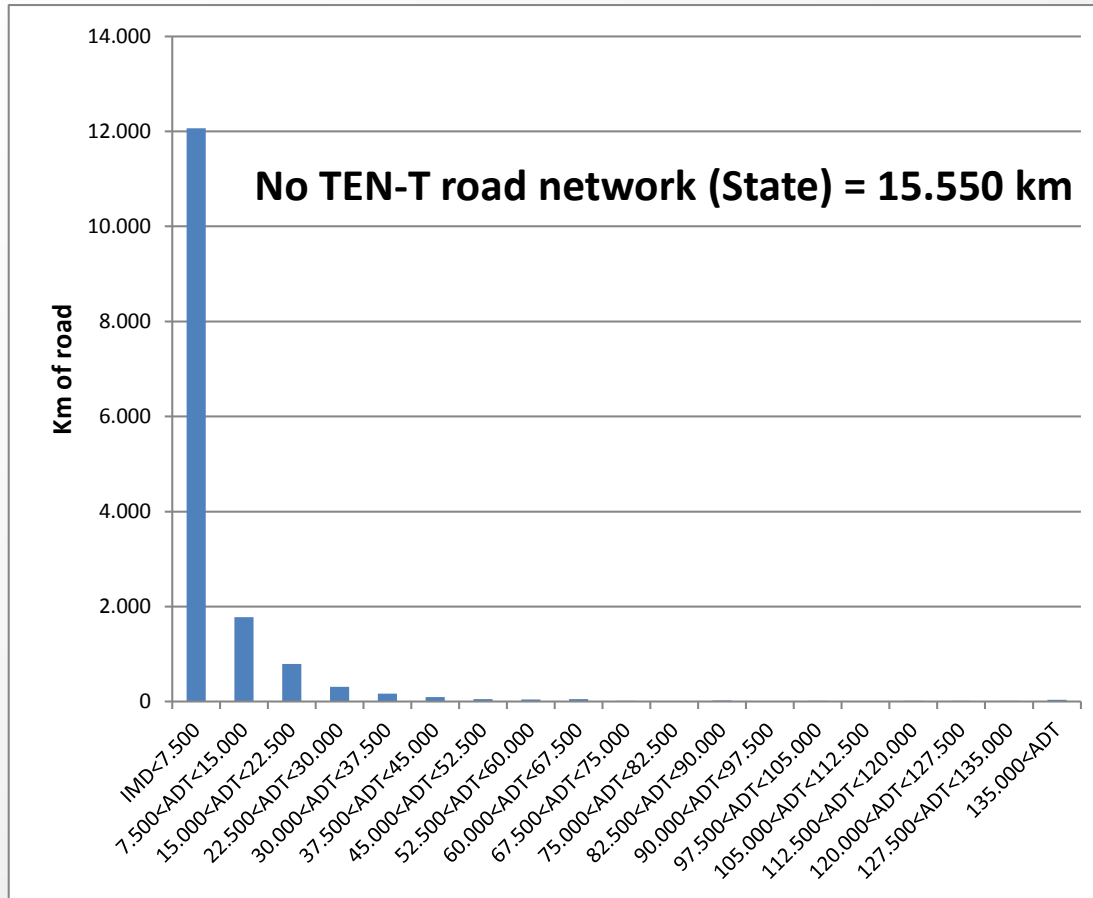
Criticality of No TEN-T road network

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Criticality of the road network

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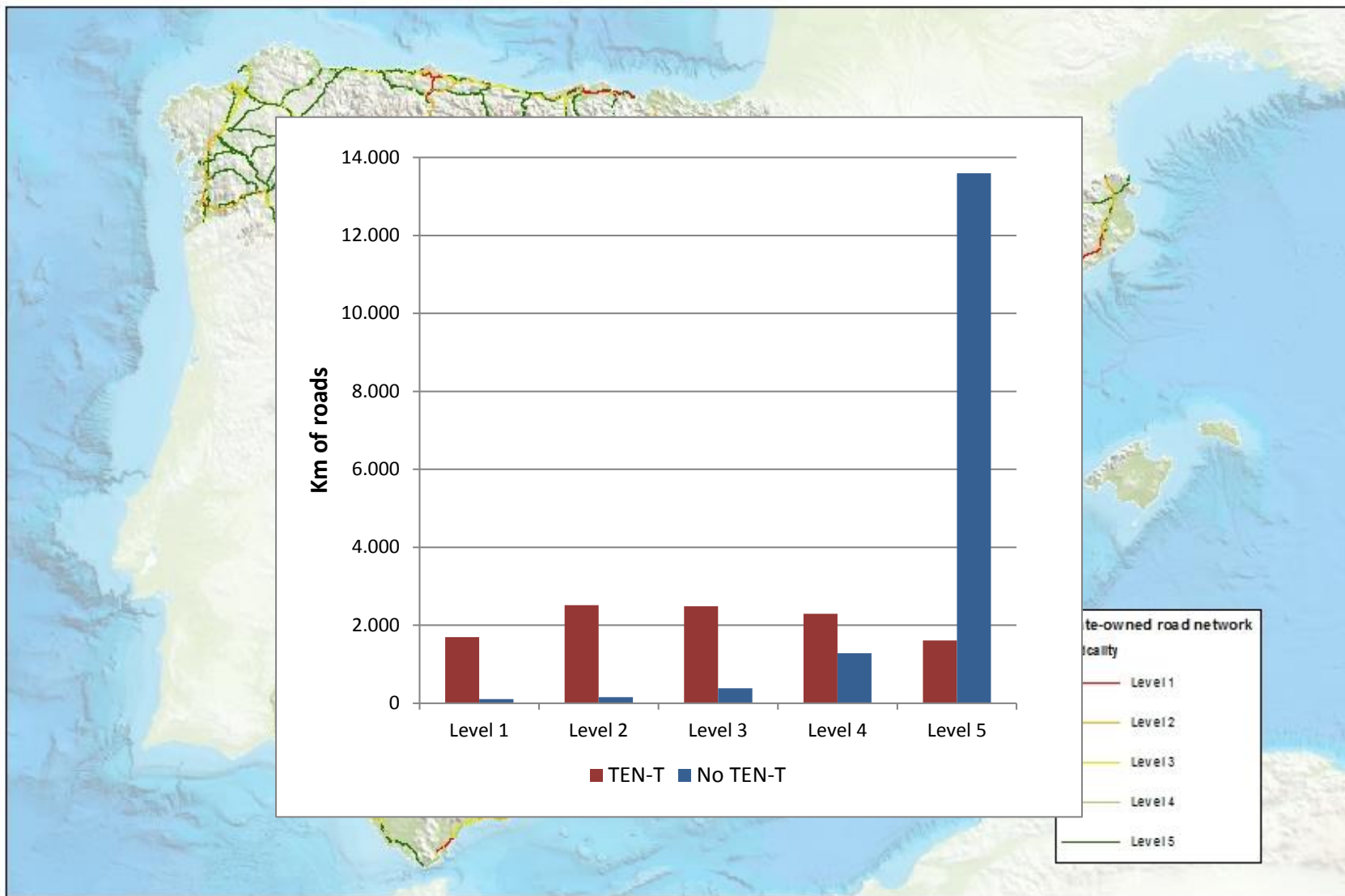
Criticality of the road network

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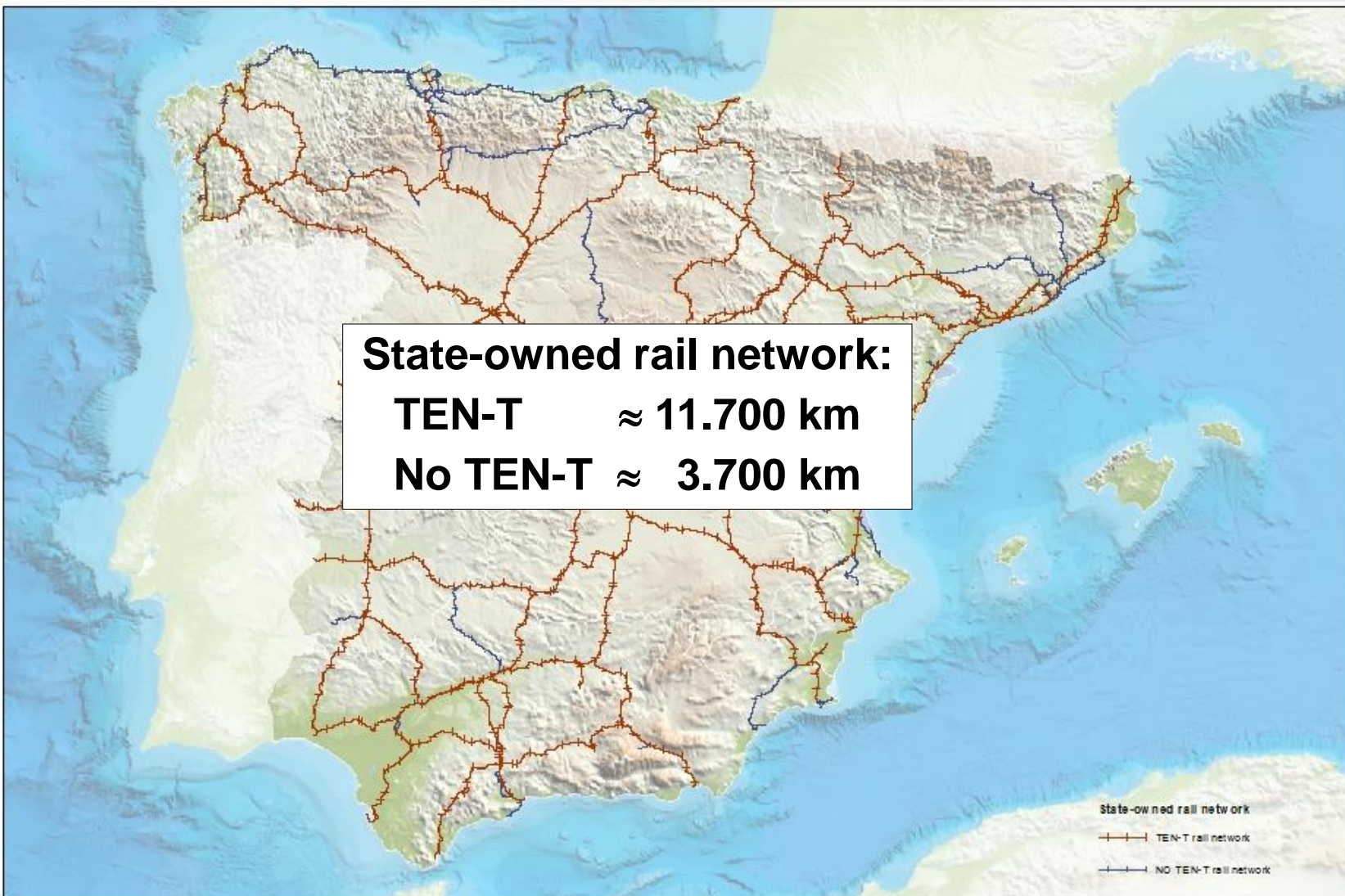
Criticality of the rail network

TO IDENTIFY HOTSPOTS:

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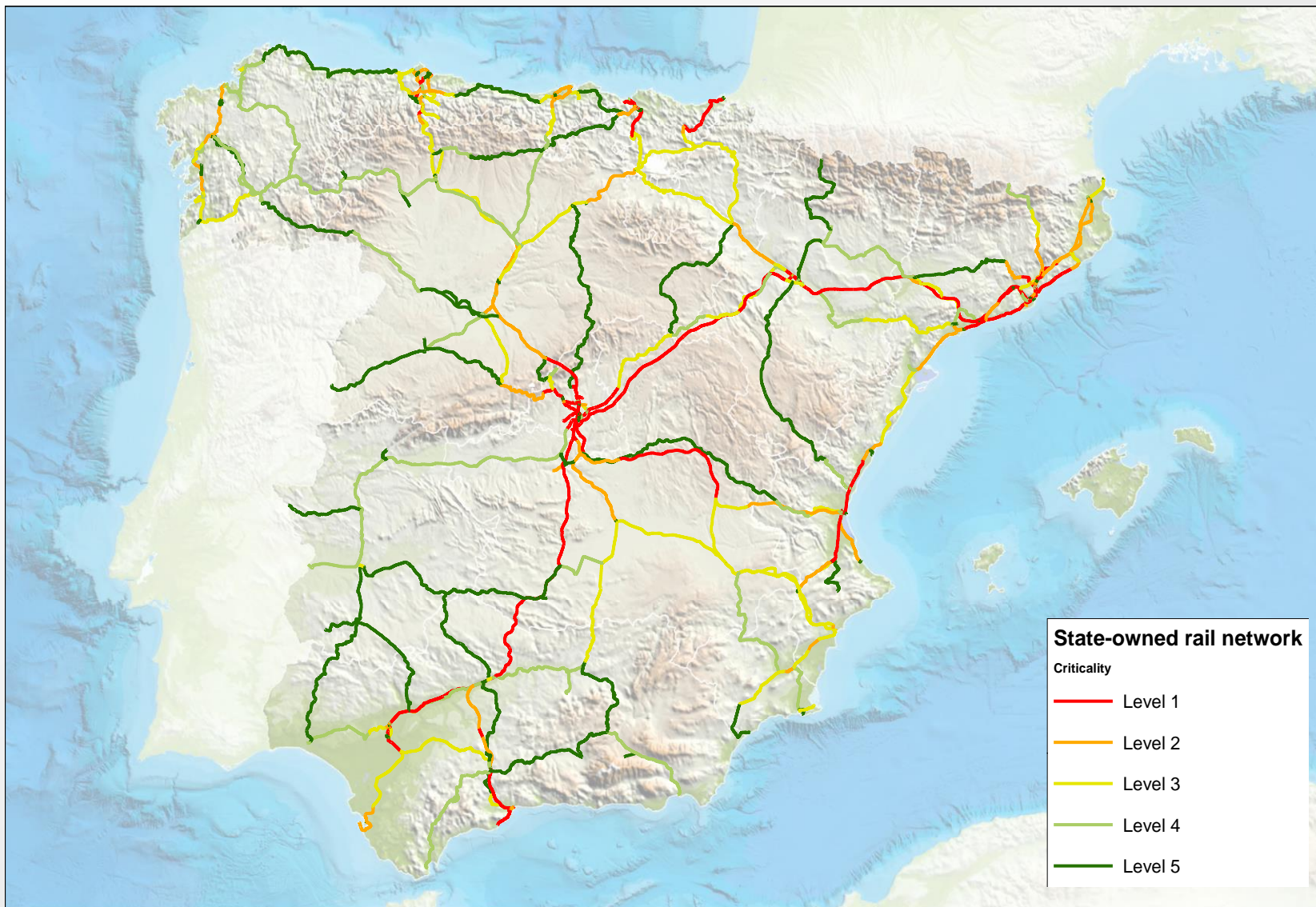
Criticality of the rail network

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State-owned rail network

Criticality

- Level 1
- Level 2
- Level 3
- Level 4
- Level 5

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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

Sensitivity of the transport network to climate change

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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Exposure of the transport network to climate change

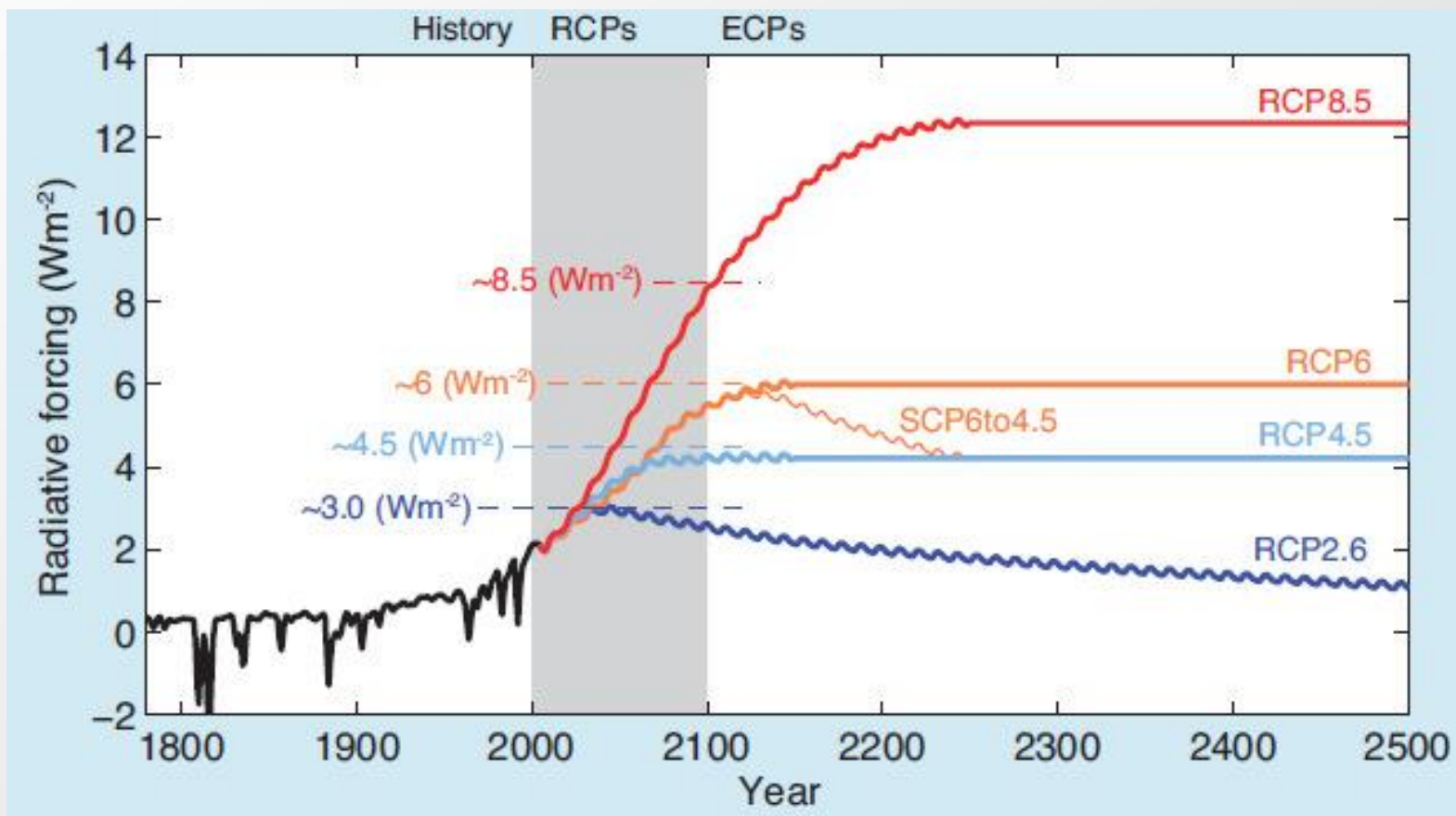
Sensitivity of the transport network to climate change

Climatic stressors		Roads	Railways
Air temperature	Mean temperature	●	●
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	Heat waves	●	●
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	Intensity of extreme rainfall	●	●
	Duration of heavy rainfall	●	●
	Floods	●	●
	Droughts	●	●
Electrical storms			●
Snow		●	●
Flash floods in rivers		●	●
Water table		●	●
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	Wind direction	●	●

Exposure to climate change

Climate change scenario/s

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



TO IDENTIFY HOTSPOTS:

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Exposure to climate change

Climate change scenario/s

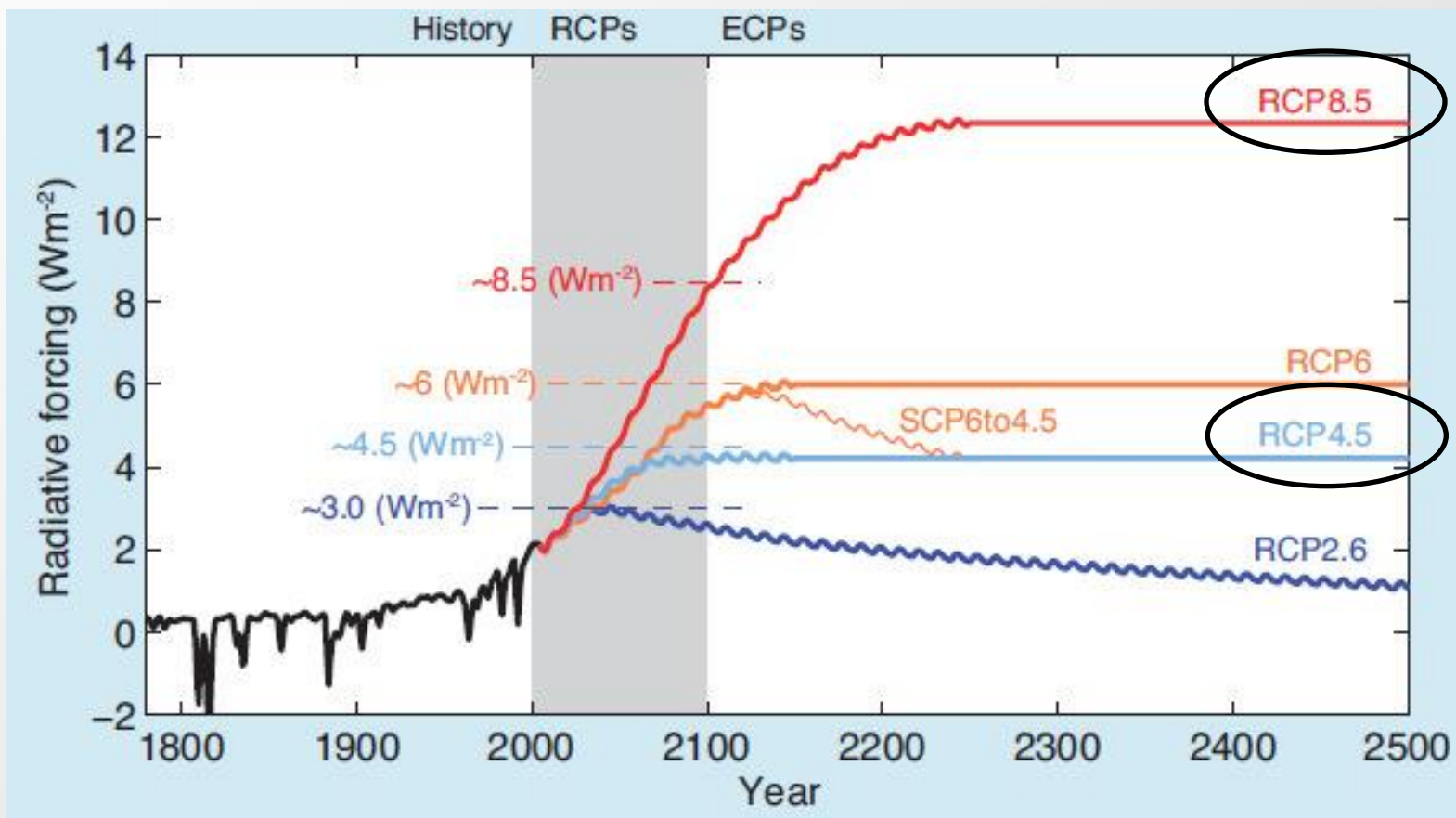
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Exposure to climate change

Time horizon

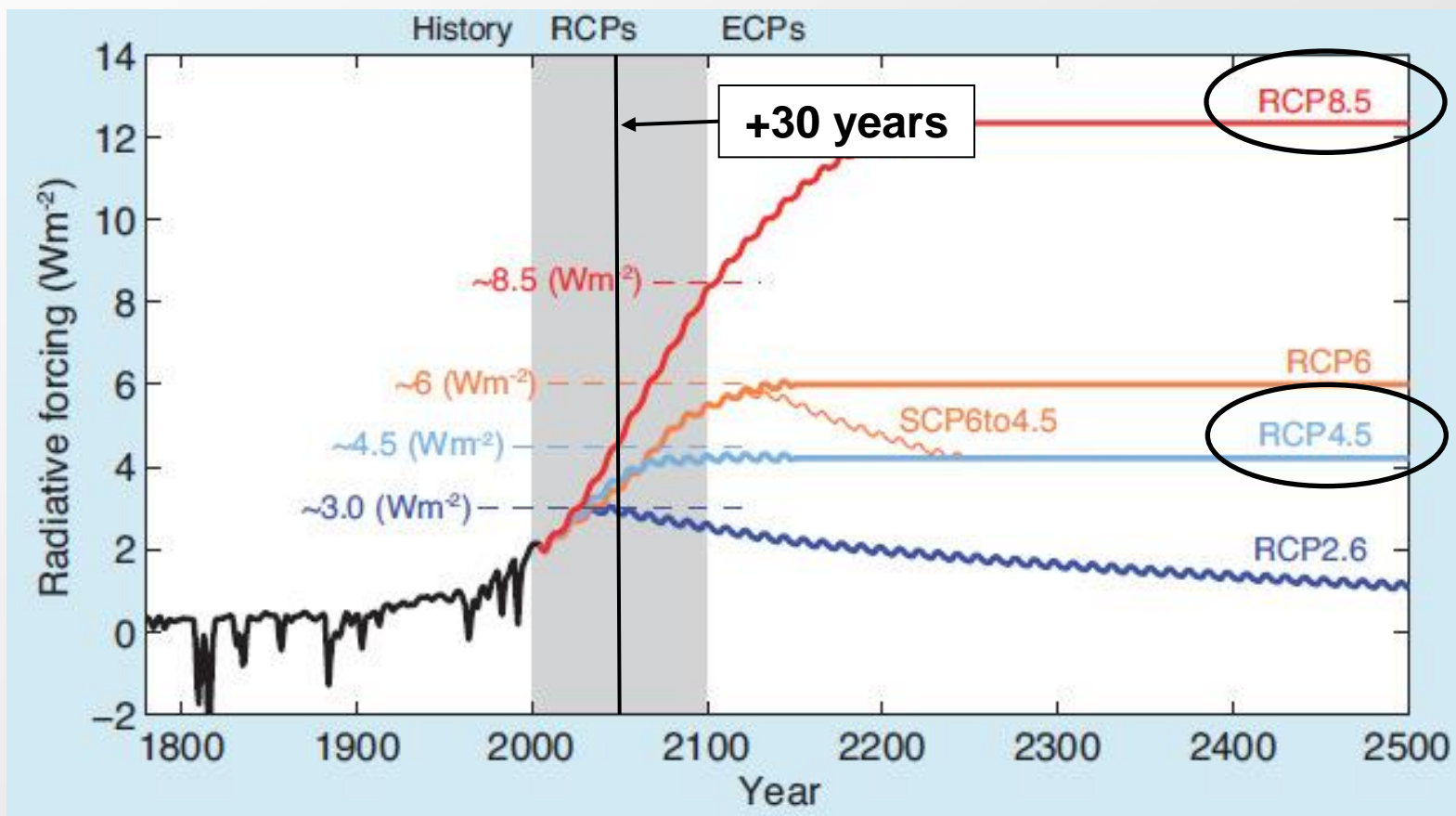
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Exposure to climate change

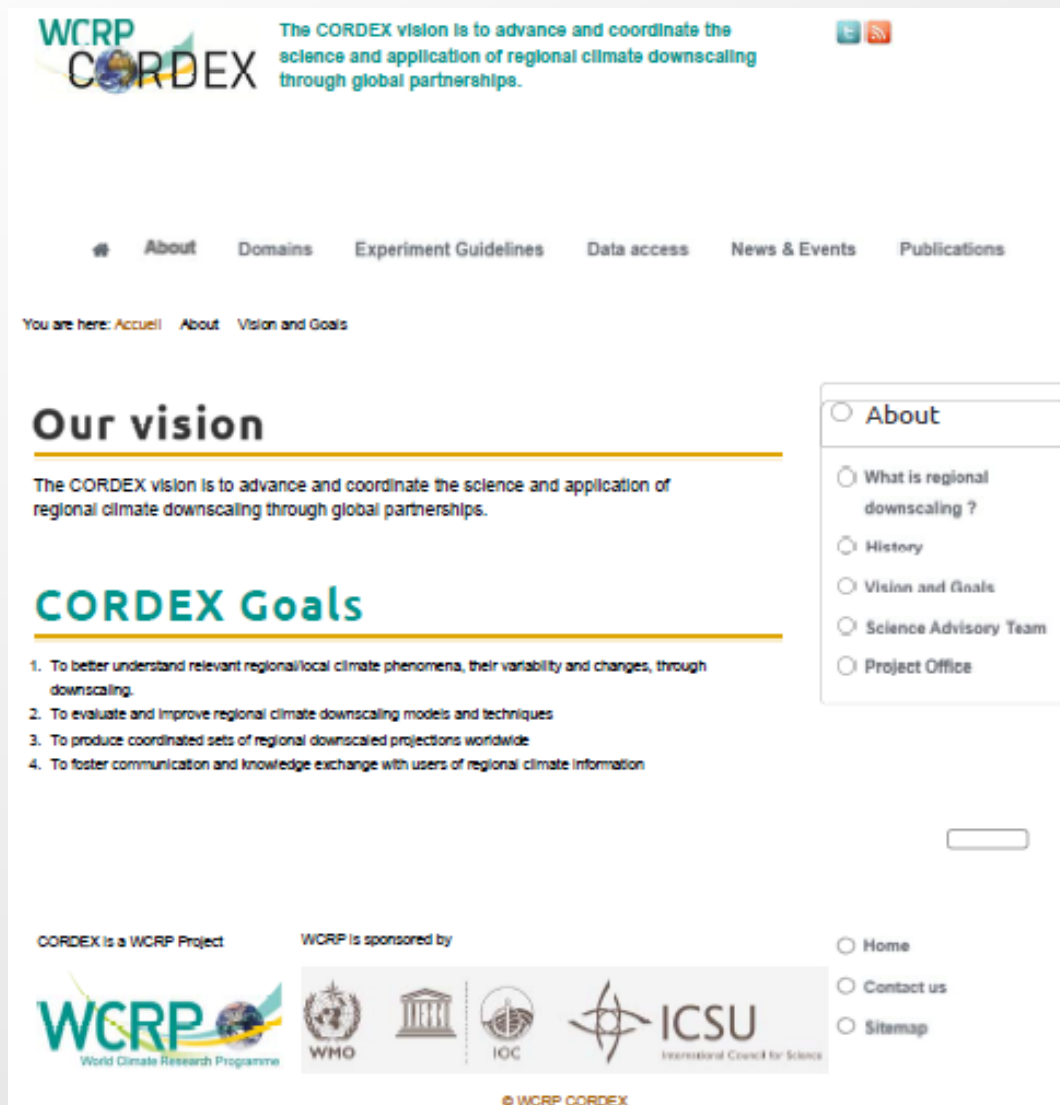
Source of projections

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The screenshot shows the WCRP CORDEX website. At the top, the WCRP CORDEX logo is displayed alongside the text: "The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships." Below this is a navigation menu with links for "About", "Domains", "Experiment Guidelines", "Data access", "News & Events", and "Publications". A breadcrumb trail indicates the current location: "You are here: **Accueil** / About / Vision and Goals".

Our vision

The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships.

CORDEX Goals

1. To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.
2. To evaluate and improve regional climate downscaling models and techniques
3. To produce coordinated sets of regional downscaled projections worldwide
4. To foster communication and knowledge exchange with users of regional climate information

At the bottom of the page, it states "CORDEX is a WCRP Project" and "WCRP is sponsored by" followed by logos for WCRP, WHO, IOC, and ICSU. A footer contains the text "© WCRP CORDEX".

On the right side of the screenshot, there is a vertical menu with the following items:

- About
- What is regional downscaling ?
- History
- Vision and Goals
- Science Advisory Team
- Project Office

At the bottom right of the page, there is another vertical menu:

- Home
- Contact us
- Sitemap

Exposure to climate change

Climatic stressors

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Climatic stressors taken from CORDEX with a resolution of 0.11 degrees and made available through  :

- ✓ **Change in maximum temperature**
- ✓ **Change in number of days with minimum temperature below 0°C**
- ✓ **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

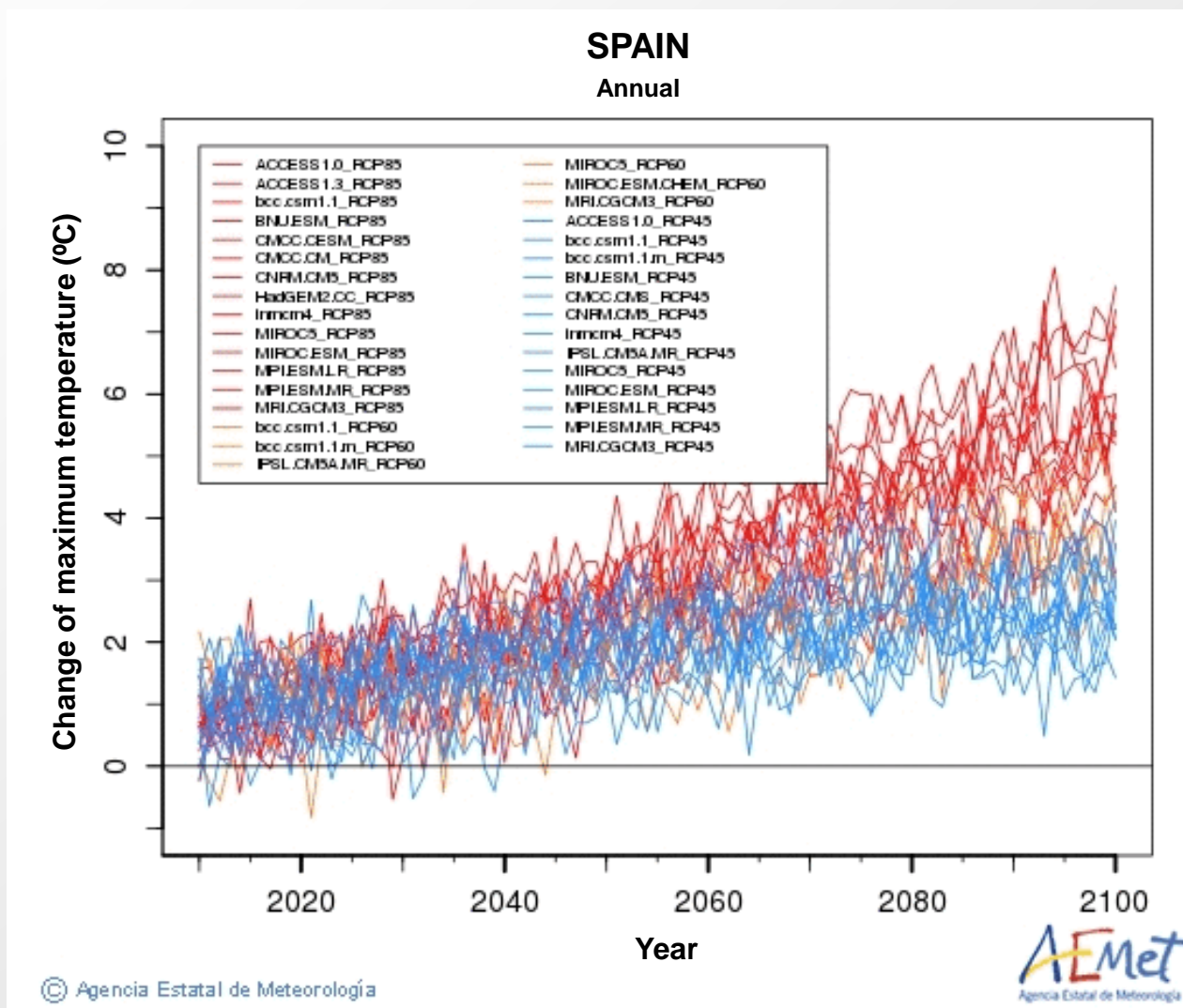
Data process

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Criticality of the transport network

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Exposure to climate change

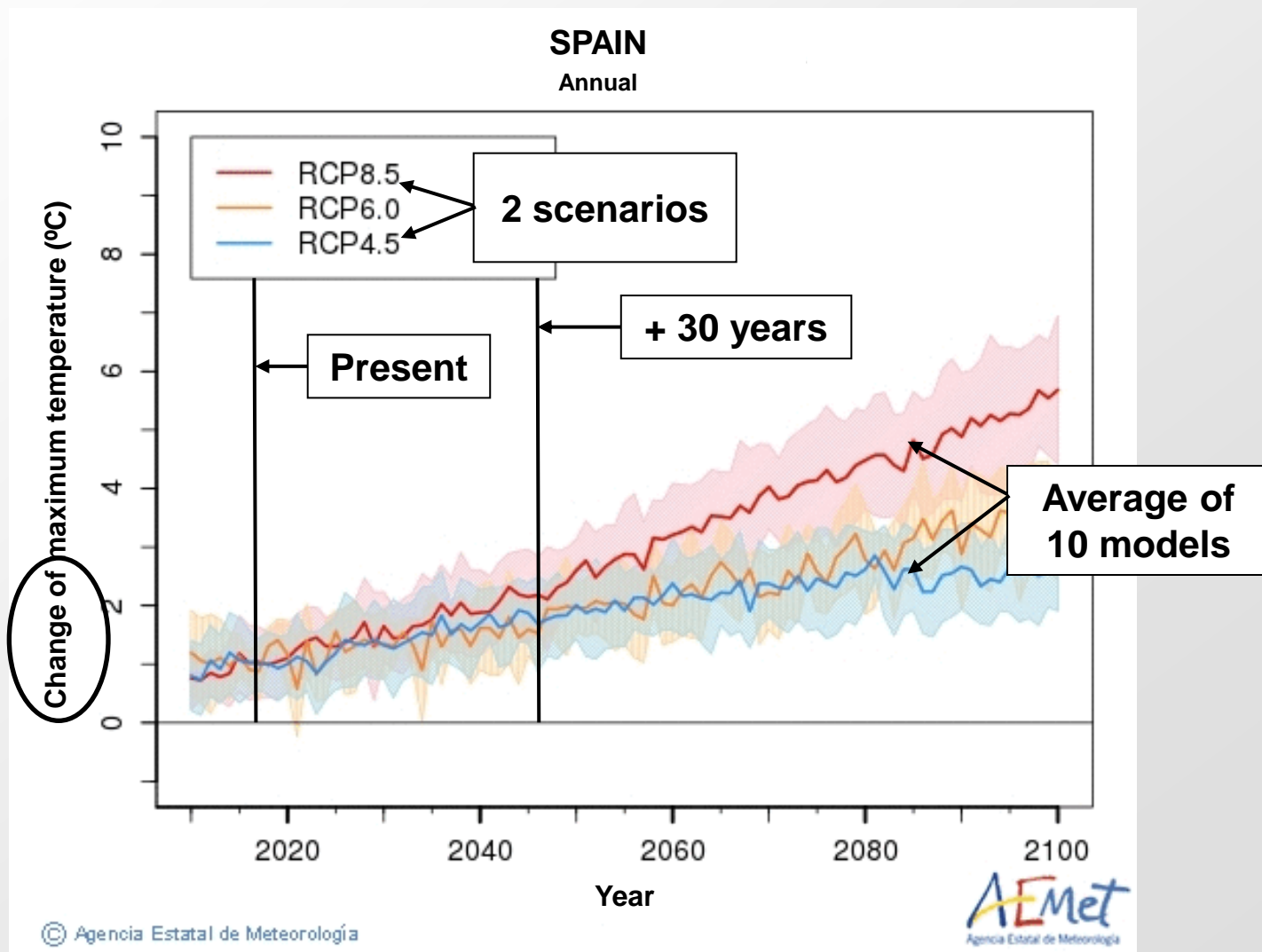
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Exposure to climate change

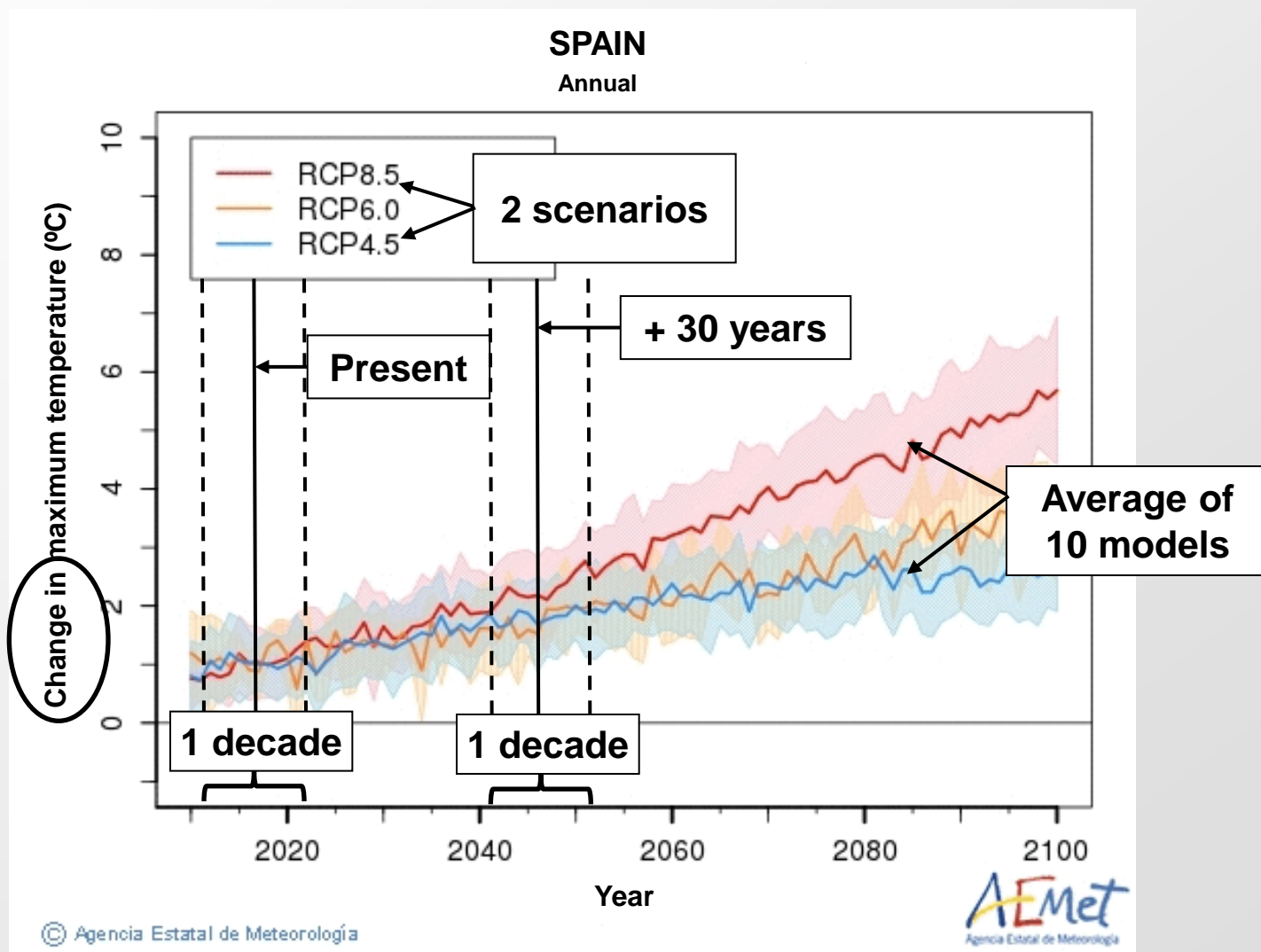
Data process

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Exposure to climate change

Results of projections

Change in maximum temperature

TO IDENTIFY HOTSPOTS:

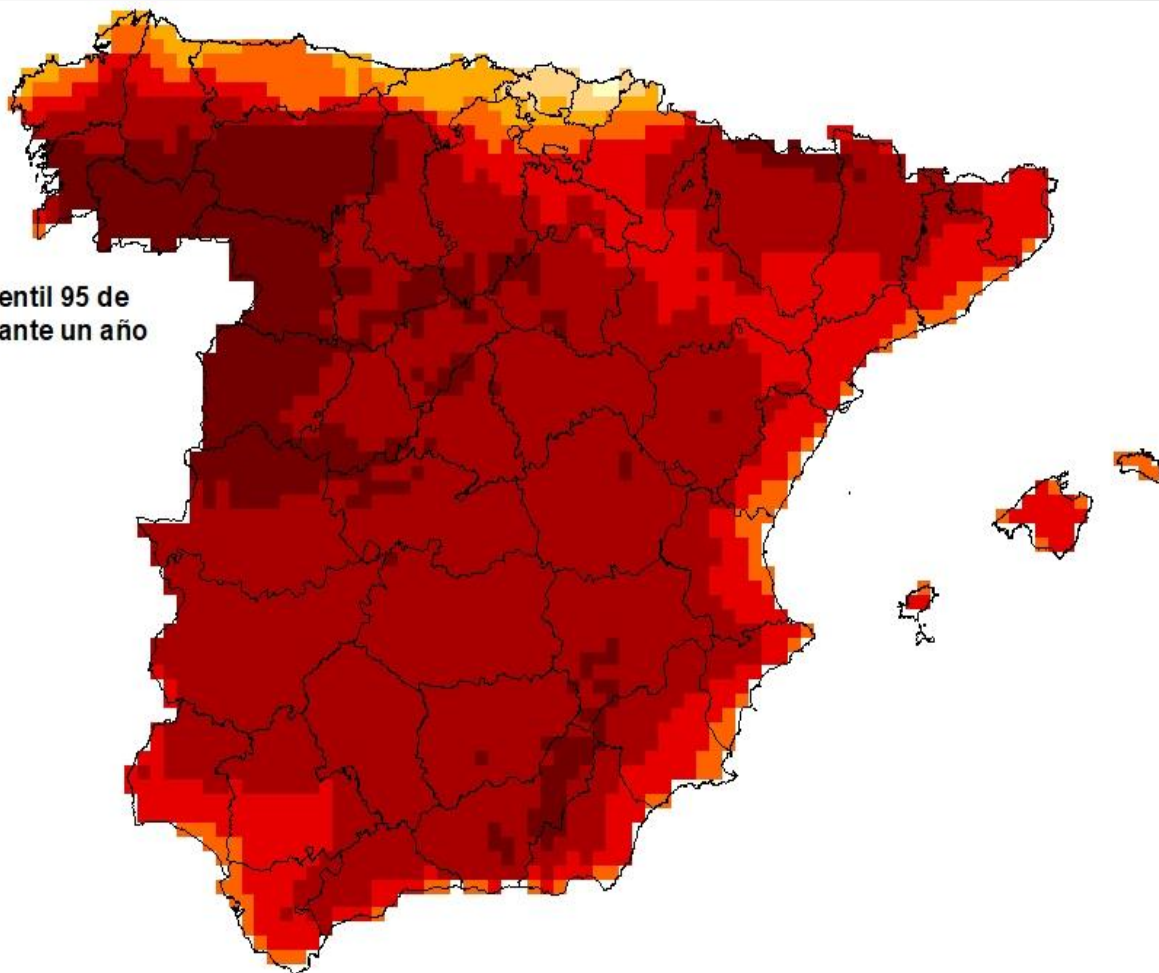
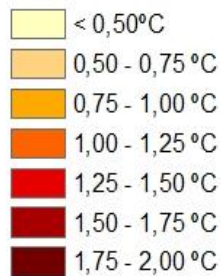
Criticality of the transport network

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Sensitivity of the transport network to climate change

Diferencias considerando el percentil 95 de la temperatura máxima diaria durante un año

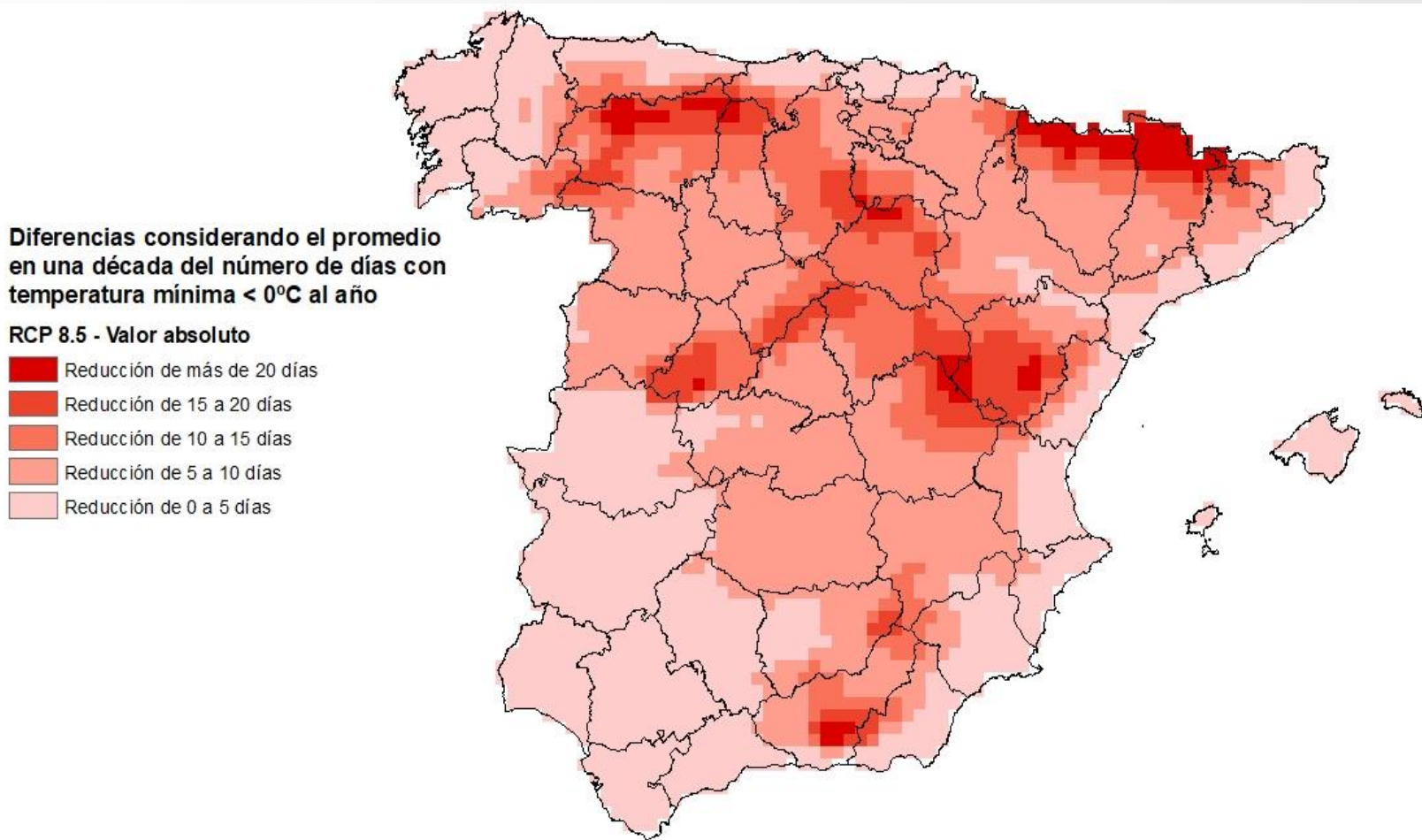
RCP 8.5 - Valor absoluto



Exposure to climate change

Results of projections

The number of days with minimum temperature < 0°C always decrease



TO IDENTIFY HOTSPOTS:

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Sensitivity of the transport network to climate change

Exposure to climate change

Results of projections

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

TO IDENTIFY HOTSPOTS:

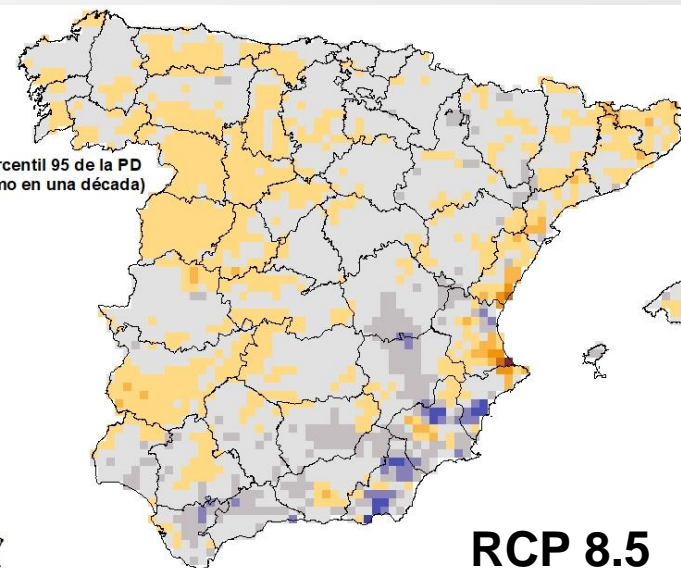
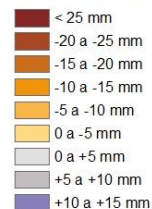
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Diferencias considerando el percentil 95 de la PD durante un año (percentil máximo en una década)

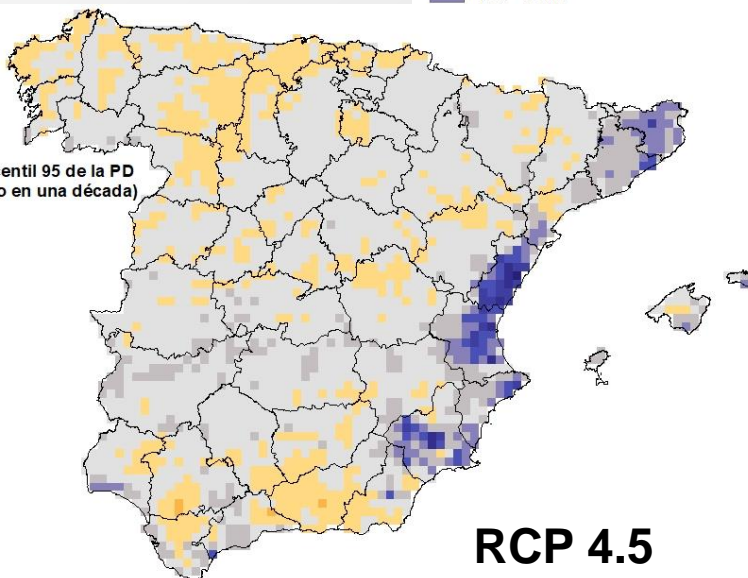
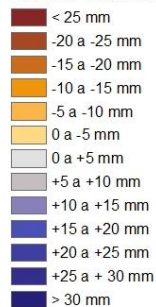
RCP 8.5 - Valor absoluto



RCP 8.5

Diferencias considerando el percentil 95 de la PD durante un año (percentil máximo en una década)

RCP 4.5 - Valor absoluto



RCP 4.5

Exposure to climate change

Results of projections

Change in maximum precipitation in 24 h is particularly uncertain

TO IDENTIFY HOTSPOTS:

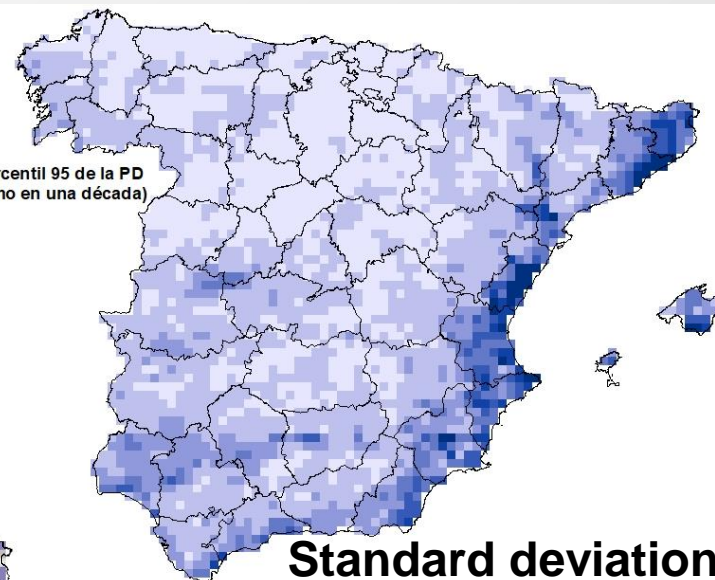
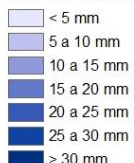
Criticality of the transport network

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Diferencias considerando el percentil 95 de la PD durante un año (percentil máximo en una década)

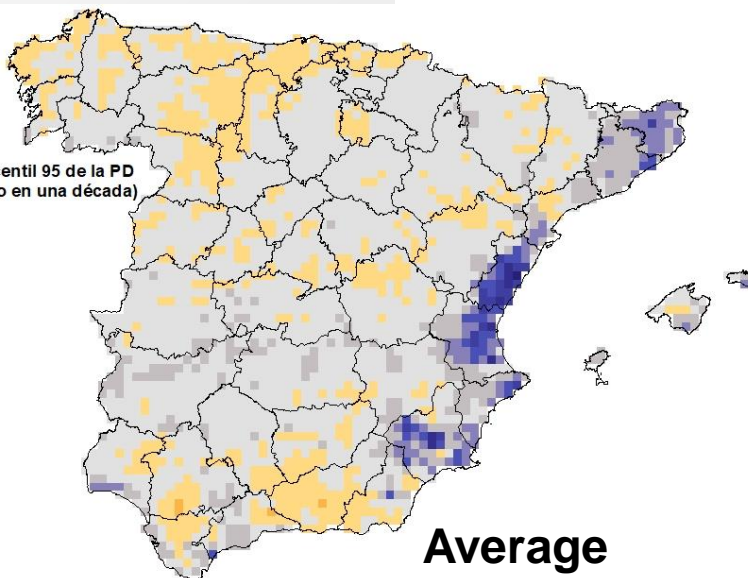
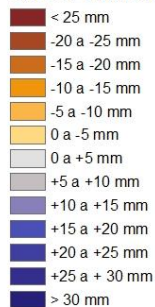
RCP 4.5 - Desviación estándar



Standard deviation

Diferencias considerando el percentil 95 de la PD durante un año (percentil máximo en una década)

RCP 4.5 - Valor absoluto



Average

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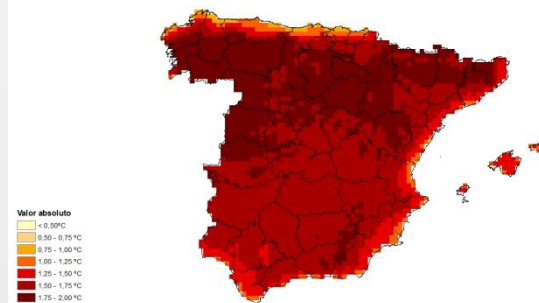
Sensitivity of
the transport
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climate change

Sensitivity of the road network

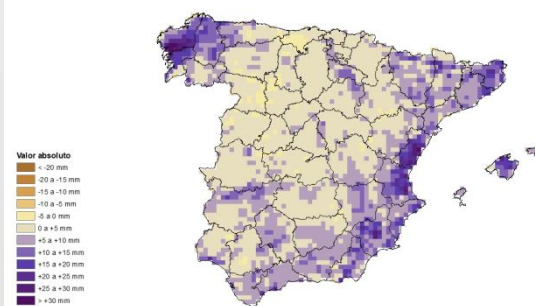


Road sections in a province

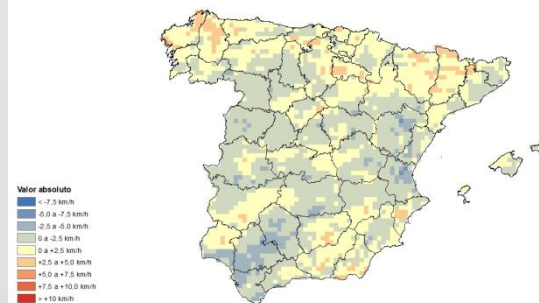
Alteración de la temperatura máxima diaria en los próximos 30 años



Alteración de la precipitación máxima en 24 h en los próximos 30 años



Alteración de la velocidad máxima del viento en los próximos 30 años



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.			La afección a la infraestructura y a su funcionalidad es moderada, requiriendo de reparaciones y/o reposiciones modestas.			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.			
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).			Se pueden producir retrasos a la circulación y requerir desvíos de tráfico que pueden prolongarse de horas a días.			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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