



UNIÓN EUROPEA

JASPERS Networking Platform - Second workshop on Climate Change Adaptation in the Transport Sector



STUDIES ON CLIMATE CHANGE AND RISK ASSESSMENT FOR TWO HIGH SPEED RAIL LINES UNDER CONSTRUCTION IN SPAIN

Brussels, 6 of june of 2019



Una manera de hacer Europa



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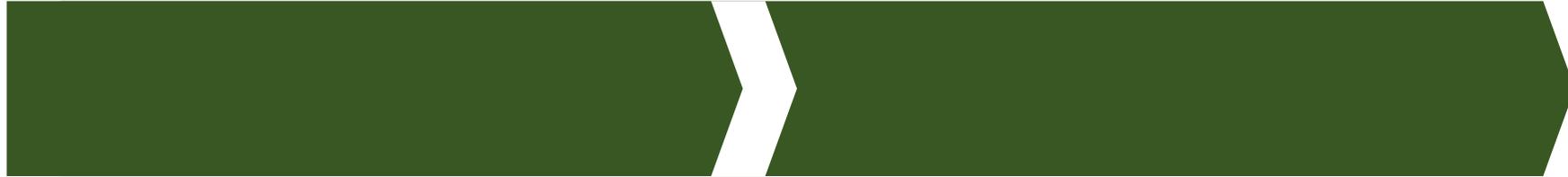
THE RAILWAY SECTOR IN SPAIN

1/02/1941

30/12/1996

1/01/2005

31/12/2013



Formal creation of Renfe

GIF

Creation of GIF as a public enterprise entity attached to the Ministry of Development, which objective is the construction and, where appropriate, administration of new railway infrastructures.



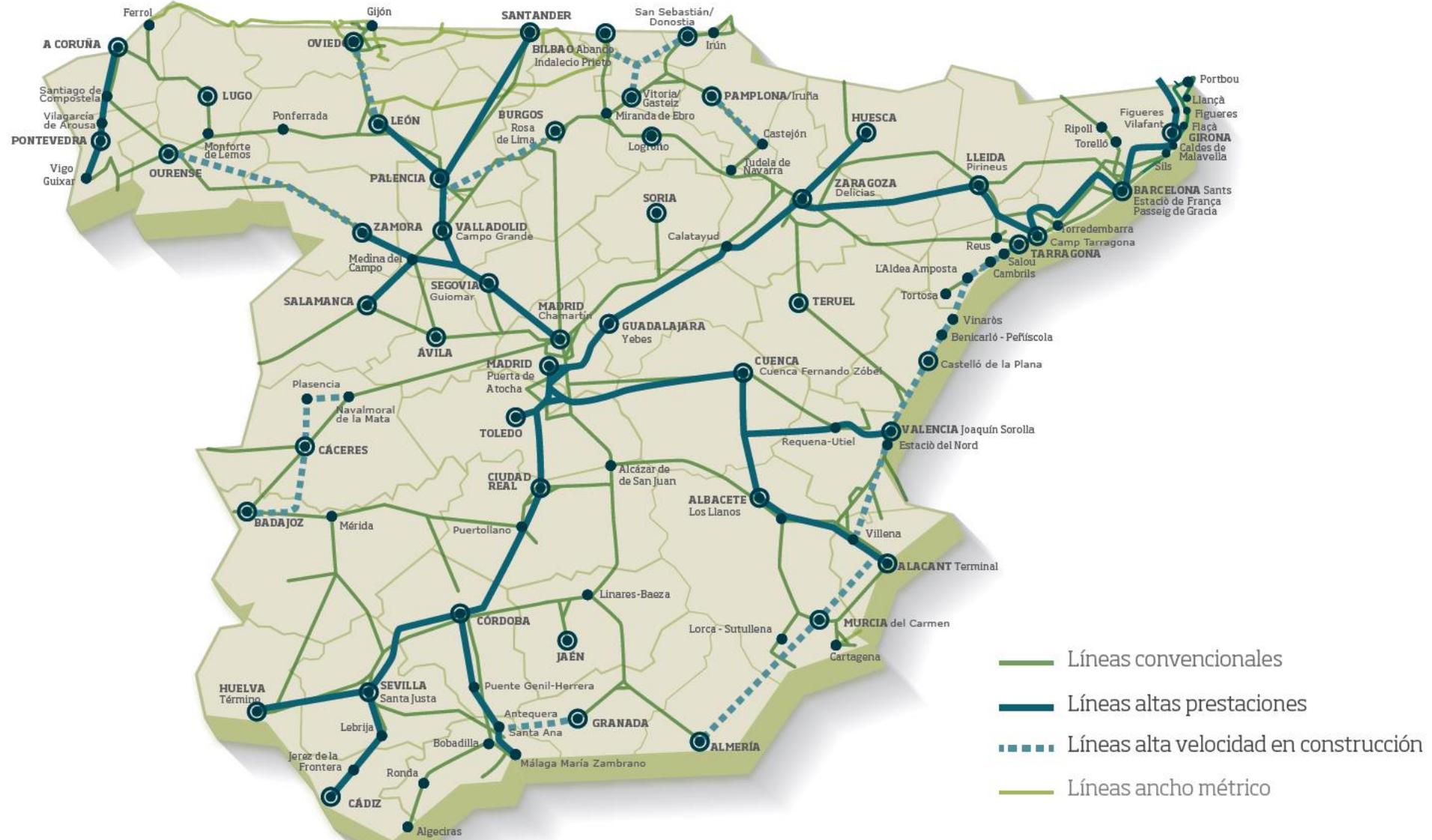
Commercial and legal separation of the Railway Infrastructure Manager and Operators to ensure freedom of access and movement on railway lines.



The division of ADIF into ADIF and ADIF High Speed was carried out on 31 December 2013 after the approval of Royal Decree-Law 15/2013. The effects of the excision are counted back to 1 January 2013.



RAILWAY NETWORK MANAGED BY ADIF AND ADIF ALTA VELOCIDAD



2.- REQUIREMENTS FROM THE EUROPEAN COMISION

2014-2020 is the first programming period when climate considerations are included in the preparation and implementation of programmes and projects.

Focus Areas

Evaluation of GHG Emissions / Carbon Footprint → ADIF already had this analysis done in the CBA.

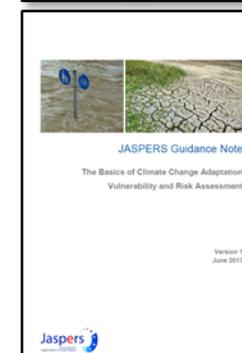
Adaptation Vulnerability and Risk Assessment → ADIF had never done this before.

Reference Documents

- “GUIDANCE on Climate Change and Major Projects” European Commission ([link](#)).
- JASPERS GUIDANCE Note “Compilation of the Climate Change Related Requirements for Major Projects in the 2014-2020 Programming Period” ([link](#)).
- JASPERS GUIDANCE Note “The Basics of Climate Change Adaptation Vulnerability and Risk Assessment” (Version 1. June 2017) ([link](#)).
- “Non-paper Guidelines for Project Managers: Making vulnerable investments climate resilient” European Commission ([link](#)).
- DG Environment – Guidance on Integrating Climate Change and Biodiversity in EIA ([link](#)).

At national level:

- “Climate change adaptation needs of the network of the transport infrastructure in Spain” (September 2013) ([link](#)).
- “Sections of the state-owned inland transport infrastructure network that merit priority attention because of climate variability and change” (June 2018) ([link](#)).



3.- ADAPTATION VULNERABILITY AND RISK ASSESSMENT

3.1 WORK CARRIED OUT

1. In July 2018 ADIF organized a workshop in Madrid with JASPERS in which the presentations were given by JASPERS the Spanish Climate Change Office and CEDEX.

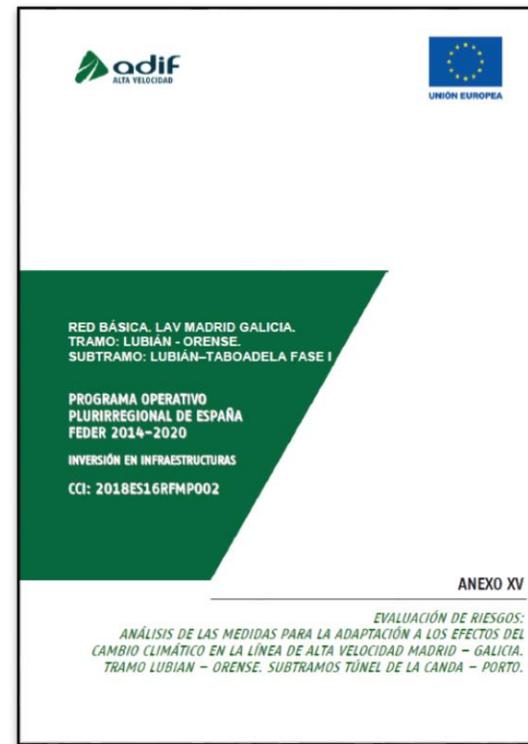
The workshop was attended by 100 people, mostly all of them from ADIF and ADIF AV, but also joined by people from other Spanish public administrations.

2. Methodology for the assessment of vulnerability and risk to climate change of railway projects. CEDEX.

3. Studies on climate change and risk assessment for two high speed rail lines under construction in Spain:

- Antequera-Granada.
- Section Lubian-Orense of the High Speed Line Madrid-Galicia.

These two reports were submitted to the European Commission in December 2018.



METHODOLOGY

Previous Meetings:

- Network Management Center H24 (CGRH24, by its Spanish acronym) → Contingency Plan already implemented in railway lines in service.
- High-Speed Maintenance.
- Construction management team.



Considerations

- Climate change projections considered: from Viewer of climate change scenarios of the Adaptation Climate Change National Platform (AdapteCCa, Ministry for the Ecological Transition). ([Link](#))
- Drainage analysis through the regulation of road drainage 2016, which takes into account the effects of climate change in relation to rainfall (Ministry of Civil Works and Transport). ([Link](#))
- Lifetime of railway infrastructure components.

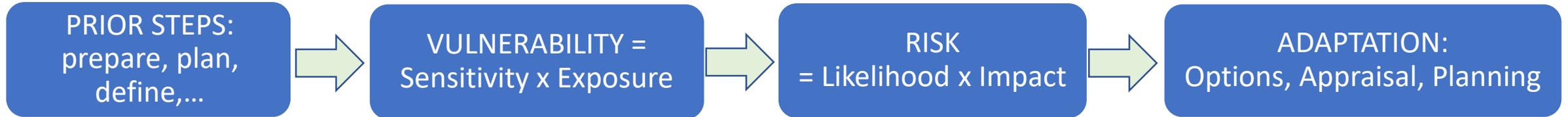


MAIN COMPONENTS OF INFRASTRUCTURE	LIFETIME
PLATFORM - Earth movements, structures*, and tunnels - Drainage system	75 years 30 years
TRACK	30 years
ELECTRIFICATION	50 years
SECURITY AND COMMUNICATIONS SYSTEMS	20 years
STATIONS	50 years

* 25 years for expansion devices and dilatations joints

METHODOLOGY

Evaluation process described by JASPERS



Evaluation process carried out in Spain

The vulnerability to climate change of the Spanish railway network has been subject to assessment over the past few years on two occasions:

- In 2013 on the needs of adaptation to climate change of the transport infrastructure network in Spain, which allowed to make a first identification of the impacts and risks expected from climate change both in the planning and design and operation phase of the Railway System of General Interest.
- In 2018 on Sections of the state-owned inland transport infrastructure network that merit priority attention because of climate variability and change, carried out by CEDEX → the vulnerability of the Railway System of General Interest was assessed to address events of a climatic nature and it was estimated how it could be affected in the future.

Such analysis have allowed ADIF to understand which are the main climatic threats in the railway network, thus, the evaluation process proposed in the vulnerability stage, is met by these two analysis and focuses its attention on the stage **Risk** → a more detailed evaluation of the possible effects caused by climatic events.



METHODOLOGY

PREPARATION

- Scope of the global project.
- Elements affected by variability and climate change.
- Project criticality level: depending on the type of circulation, type of line and orography.
- Time horizon for risk assessment: 80 and 30 years.

RISK ASSESSMENT

- Identification of threats attributed to variability and climate change.
 - - Potential impacts on the components of the railway infrastructure.
 - - Potential impacts on the railway service.
- Climate change projections (AdapteCCA Viewer of climate change scenarios).
- Methodology for Risk Assessment:
 - - Risk to infrastructure integrity.
 - - Risk to the railway service.
- Assessment results.

ADAPTATION

- Identification and appraisal of adaptation measures.
- Adaptation Plan.
- Monitoring of resilience of the Project.

CLIMATE CHANGE ASSESSMENT IN THE HIGH SPEED LINE ANTEQUERA – GRANADA

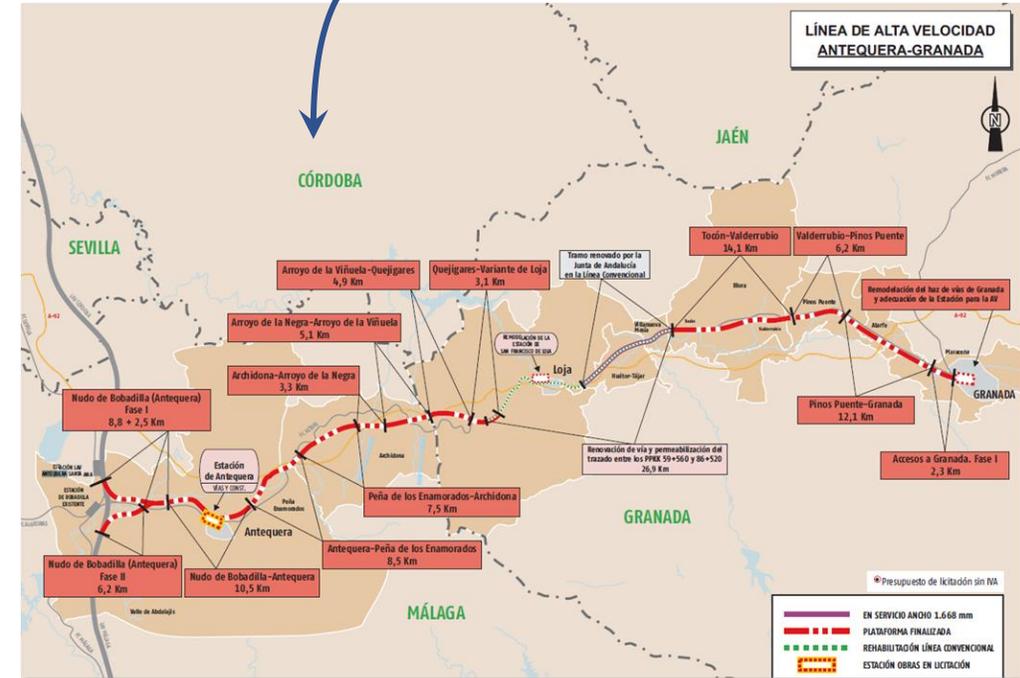
I. GLOBAL PROJECT DESCRIPTION

1. Location: South of Spain between Malaga and Granada regions:

- Higher rainfall in winter and are not usually torrential or frequent. Periods of drought.
- Absolute temperatures: -4,2o C to 37,7o C .
- Maximum wind speed < 100km/h.

2. Line description:

- Total length 122 km.
- Platform:
 - Bobadilla – Riofrío → new platform.
 - Riofrío – Tocón → in the implemented phase I of the HSL the actual platform of the preexisting line that has been renewed will used.
 - Tocón – Granada → new platform.
- Track:
 - Double UIC gauge between Antequera and Archidona.
 - Single track in the rest of the section.
 - In the sections of passage through Loja and Integration in Granada will be used single track with mixed gauge.
- Electrification: alternating current of 25 kV.
- Security systems: ERTMS level 2 and ASFA.
- Communications system: GSM-R.



3. Project components more vulnerable due to variability and climate change

- Platform:
 - Drainage Works.
 - Embankments.
 - Structures foundations erosion.
- Track: Ballasted track (certain points with slab track).
 - Future temperature variation → rail contractions and dilations should be within the throw of the track expansion devices.
- Acoustic screen:
 - Wind + aerodynamic effect due to the trains circulation.

4. Project critical level:

A similar method to the classification of the Railway Network of General Interest (RFIG by its Spanish acronym) to be given priority attention due to variability and climate change has been used to estimate criticality → mixed criterion in which consideration of the functionality of the section prevails, although the cost of the investment made when being constructed is also taken into account

- CBA → Number of circulations.
- Track Gauge: UIC and mixed gauge.
- Trans-European transport network → $\alpha = 1,2$
- Flat and wavy orography → $\beta = 1,2 - 1,5$

Conclusion: medium – high critical level.

II. RISK ASSESSMENT :

1. Impacts with greater potential effect on the Project

- Main impacts on infrastructure components:
 - Insufficiency of the viaduct expansion joint with maximum temperature.
 - Ballast drag and movement due to insufficient capacity of drainage works with heavy rains.
 - No potential impact on electrification components or safety and communications installations has been considered relevant because:
 - These impacts are unusual or not existing in this type of ADIF lines.
 - The usual practices of ADIF for its design, maintenance and line operation.
 - The risk will not increase significantly due to climate change.
- Potential impacts on the railway service:
 - Fire:
 - Produced by external elements: depend on human factors and prevention plans.
 - Inherent to exploitation: Adif drafts an annual Fire Prevention → monitoring and control of hot box detectors and cleaning of the track sides of dried herbs.
 - Strong wind:
 - Negligible effect → it is controlled or mitigated from the Network Management Centre H24 based on the predictions received from the State Meteorological Agency and the speed limitation protocols contained in the Preventive Action Master Plans.
 - Freeze: climate change impacts will be favourable.
 - Heavy rains: the potential impact from failure of adhesion of the train to the track is considered negligible → hardly compromises the quality of the railway service thanks to the meteorological alert systems of Adif.

2. Climatic projections considered:

- From AdapteCCa Viewer of climate change scenarios:
 - Average values of the anomalies for scenario RCP4.5 of the main variables:
 - 95 percentile of the maximum daily temperature.
 - Maximum precipitation in 24 hours.
 - The following values were also obtained, although they have hardly been decisive for this study:
 - Maximum duration of heat wave.
 - Number of days with minimum temperature below 0° C.

3. Risk assessment results:

- Insufficiency of the expansion joint in the viaduct deck:
 - 22 hyperstatic viaducts (of more than 100m) have been analysed.
 - 2 viaducts that may have problems by failure of their expansion joint in the future have been identified and the risk to both the integrity of the infrastructure and the railway service has been assessed.
 - Viaduct over railway line Bobadilla-Granada. Section Granada-Málaga (666m) → in 2098 → low risk.
 - Viaduct over Guadalhorce river and A-92 (2.525m) → in 2048 and 2098 → very high.



- Drag and movement of ballast due to possible insufficiency of drainage works:
 - Criteria for selecting the drainage works analyzed:
 - Works in flood zones.
 - Works of similar characteristics outside flood zones that evacuate the highest flows.
 - Sites where only such drainage works exist on a large land area.
 - Works that have been proven to suffer from terrorization and reduction of useful section.
 - Works that by the effect of the height of the platform do not meet the minimum dimensions established by the norm applied by ADIF.
 - Existing works where the calculation criterion used when they were built is not known.
 - Considered return period: 500 years for railway impact and 300 years for third party impact.
 - 58 transverse drainage works in the flood zone have been analyzed → In 9 sections, associated with the previous structures, it was obtained that there could be risk of ballast movement → 2048 and 2098 → the risk to both the integrity of the infrastructure and the railway service has been assessed.
 - Longitudinal drainage works → are oversized for flows exceeding time horizons 2048 and 2098.



- Unacceptable risks

- . Those risks to infrastructure integrity that are high or very high are considered unacceptable.
- Any risk to the railway service which is not considered to be negligible.
- Unacceptable risks in this project:
 - Insufficiency of the expansion joint in the viaduct deck → the two viaducts previously mentioned.
 - Drag and movement of ballast → only 5 of the 9 sections detected.
- Other impacts do not create risk requiring specific adaptation measures because the risk is acceptable by applying current maintenance and operation practices.
- The years 2048 and 2098 result from the analysis of simulations with the projections of available scenarios and data; however, due to the degree of uncertainty associated with climate predictions, during the maintenance operations it should be monitored and seen when a certain risk is reached, if it is reached.



III. ADAPTATION PLAN :

For each risk rated as unacceptable different adaptation options have been contemplated to reduce the risk to an acceptable value or to be completely eliminated.

- Options contemplated for the two viaducts with insufficient slack at the deck joint, considering the lifetime of the track expansion devices and the structure joint is 25-30 years:
 - Viaduct over railway line Bobadilla-Granada. Section Granada-Málaga (2098):
 - No specific adaptation measure is considered necessary prior to the end of its useful life .
 - The risk will need to be reassessed once action has been taken on these elements.
 - Viaduct over Guadalhorce river and A-92 (2048 and 2098):
 - Risk monitoring to assess if it is necessary to check the impact.
 - If necessary, demolition of the back of the mobile abutment and construction of new joint with change if necessary of the track expansion device.
- In the 5 drainage works with an unacceptable risk → transverse drainage work jacking parallel to the existing one.
- In the remaining 4 drainage works with an acceptable risk, it is considered crucial the cleaning up of any grounding of transverse drainage works.



Where appropriate, the cost of the investment has been estimated from ADIF prices.

CLIMATE CHANGE ASSESSMENT IN THE HSL MADRID – GALICIA: SECTION CANDA TUNNEL - PORTO

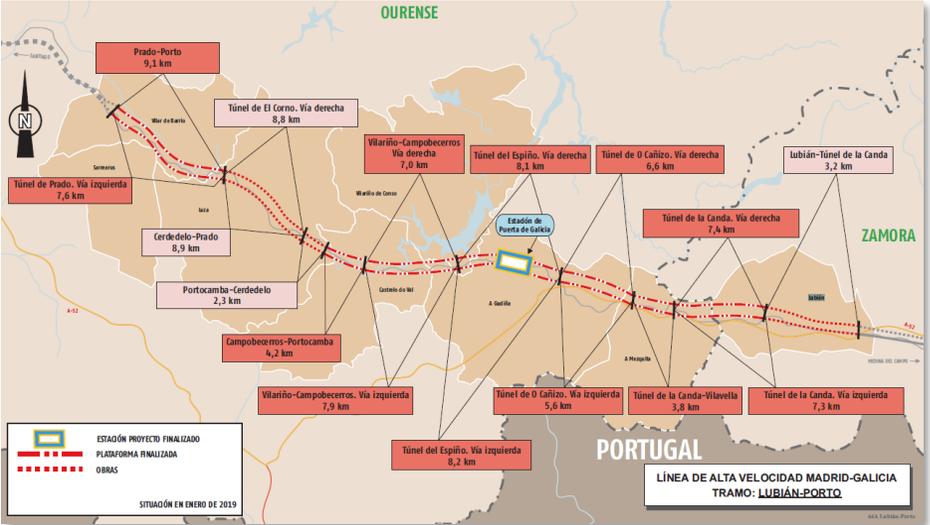
I. GLOBAL PROJECT DESCRIPTION

1. Location: Northwest of Spain, between Zamora and Ourense regions.

- Frequent precipitation throughout the year, autumn being the rainiest season.
- Absolute temperatures: -5°C to $>30^{\circ}\text{C}$.
- No potential flood zones.
- Mountain area.

2. Line description:

- Section Canda Tunnel – Porto is part of the Global Project High-Speed Line Madrid-Galicia that separates from the High-Speed Line Madrid-Valladolid in Olmedo and creating section High-Speed Line Olmedo-Ourense in which this section is integrated.
- Total length Canda Tunnel – Porto: 48,5 km.
- New platform for double track with independent platforms for each track.
- Track:
 - UIC gauge.
 - Ballasted track and slab track in some viaducts and tunnels.
- Electrification: alternating current of 25 kV.
- Security systems: ERTMS level 2 and ASFA.
- Communications system: GSM-R.
- Platform will be finished in 2019.



3. Project components more committed due to variability and climate change

- Platform:
 - Drainage Works.
 - Embankments.
 - Structures foundations erosion.
- Track: is mostly in single slab track.
 - Future temperature variation → rail contractions and dilations should be within the throw of the track expansion devices.
- Other elements: remaining landfills.

4. Project critical level:

- CBA → Number of circulations.
- Track Gauge: UIC.
- Trans-European transport network: $\alpha = 1,2$
- Mountain orography: $\beta = 1,8$

Conclusion: medium critical level

II. RISK ASSESSMENT :

1. Impacts with greater potential effect on the Project
2. Climatic projections considered
3. Risk assessment results:
 - Insufficiency of the expansion joint in the viaduct deck:
 - 10 hyperstatic viaducts (of more than 100m) have been analysed.
 - The risk to both the integrity of the infrastructure and the railway service has been assessed.
 - There are no viaducts that can be compromised by insufficient career on the board in the future.
 - Drag and movement of ballast due to possible insufficiency of drainage works:
 - The risk to both the integrity of the infrastructure and the railway service has been assessed.
 - 23 transverse drainage works in the flood zone have been analyzed.
 - The risk of ballast drag and movement is very low or negligible.
 - Longitudinal drainage works → are oversized for flows exceeding time horizons 2048 and 2098.
 - Unacceptable risks:
 - There are no unacceptable risks.

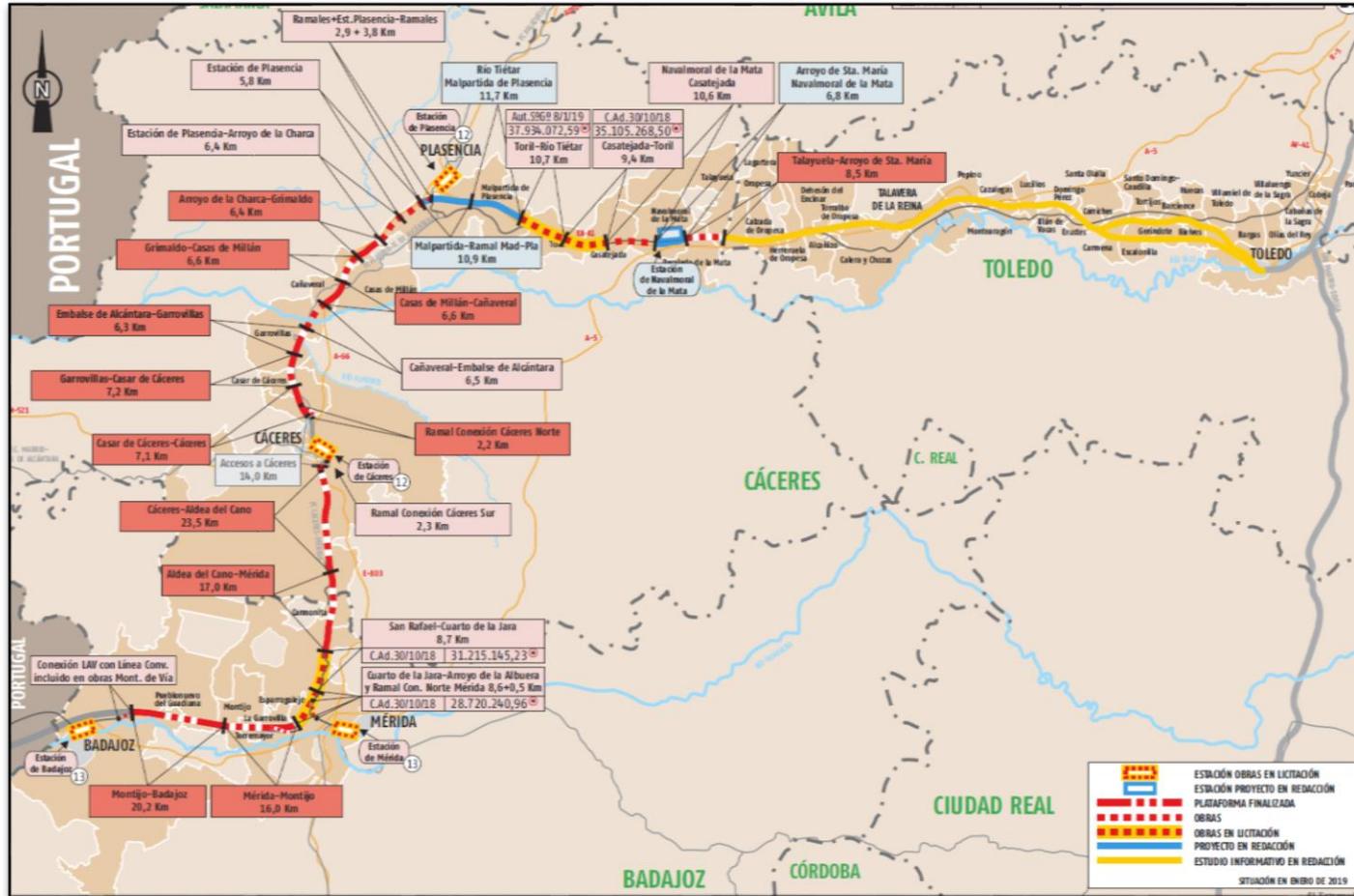


III. ADAPTATION PLAN :

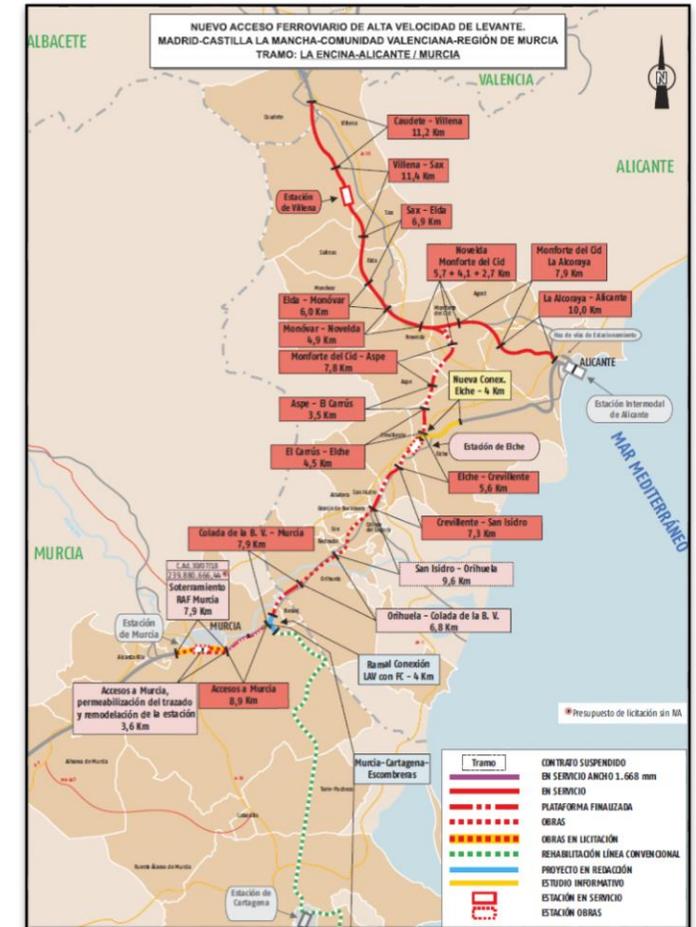
In the absence of sites at risk → no specific adaptation plan required → it is enough with ADIF's maintenance and operation practices.

3.2 ONGOING WORKS

1. Studies on climate change and risk assessment for two high speed rail lines under construction in Spain: Madrid-Extremadura and Monforte del Cid – Murcia.



High-Speed Line Madrid-Extremadura



High-Speed Line Monforte del Cid-Murcia

2. ADIF internal working group to implement CEDEX's report in ADIF's projects internal regulations.



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THANK YOU FOR YOUR ATENTION

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More Information

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