



INTERNATIONAL UNION  
OF RAILWAYS

# REERA



Resilient Railways facing Climate Change

**Global Impact Global cooperation**

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International Union of Railways

# **Fostering close cooperation links**

with all actors in the rail  
transport domain

Preparing and publishing  
**Reports,  
Specifications,  
Guidelines, IRS**

The worldwide  
organisation  
for the promotion  
of rail transport

**200**  
**members**  
on all 5 continents



# **Understanding the business needs**

of the rail community

**Developing  
innovation  
programmes**  
to identify solutions to  
those needs

# 15 years of best practice sharing on Climate change Adaptation and Weather resilience

Adaptation of Railway InfraStructure to Climate Change

<b>ARISCC</b>	<b>Good Practice Overview</b> <i>Please select a value</i>														
Objectives															
Scope															
<b>ARISCC Results</b>	<p><b>Area covered</b></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="background-color: #ffff00; padding: 5px;"><b>Weather Warning</b></td> <td style="text-align: right; padding: 5px;">4</td> </tr> <tr> <td style="background-color: #ffcc00; padding: 5px;"><b>Event Recording/Database</b></td> <td style="text-align: right; padding: 5px;">2</td> </tr> <tr> <td style="background-color: #ffff00; padding: 5px;"><b>Impact Assessment</b></td> <td style="text-align: right; padding: 5px;">5</td> </tr> <tr> <td style="background-color: #ff99cc; padding: 5px;"><b>Vulnerability Mapping</b></td> <td style="text-align: right; padding: 5px;">3</td> </tr> <tr> <td style="background-color: #ff0000; padding: 5px;"><b>Risc Assessment &amp; Risk Management</b></td> <td style="text-align: right; padding: 5px;">9</td> </tr> <tr> <td style="background-color: #0000ff; padding: 5px;"><b>Asset Management</b></td> <td style="text-align: right; padding: 5px;">3</td> </tr> <tr> <td style="background-color: #00ff00; padding: 5px;"><b>Regional Climate Modelling</b></td> <td style="text-align: right; padding: 5px;">2</td> </tr> </table>	<b>Weather Warning</b>	4	<b>Event Recording/Database</b>	2	<b>Impact Assessment</b>	5	<b>Vulnerability Mapping</b>	3	<b>Risc Assessment &amp; Risk Management</b>	9	<b>Asset Management</b>	3	<b>Regional Climate Modelling</b>	2
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<b>Regional Climate Modelling</b>		2													
Final Report (Draft)															
Recommendations															
Guidance Document															
Good Practice															
<b>Overview</b>															
Weather Warning															
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Risc Assessm. & Managm.															
Asset Management															
Reg. Climate Modelling															
Case Studies															
Adaptation of Standards															
References															
<b>ARISCC Partners</b>															
UIC															
DB															
IZT (Project executive)															
ÖBB															



November 2017

## RAIL ADAPT

Adapting the railway for the future



UNIVERSITY OF BIRMINGHAM



INTERNATIONAL UNION OF RAILWAYS

# The RERA Programme

Resilient Railways facing Climate Change



RERA Contingency  
2026



RERA Quake  
2025



RERA Cyber  
2025

Broader Resilience Themes

RERA Temp  
2022-24

RERA Rain  
2022-24

RERA Wind  
2024-26

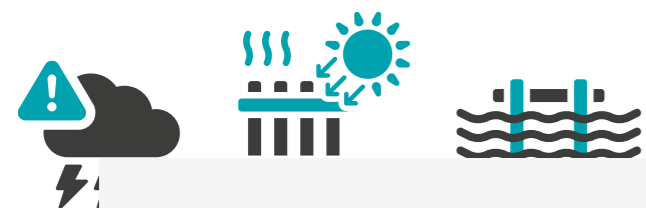
RERA Elec  
2026

Climatic Themes

RERA Hub  
2026 - ∞

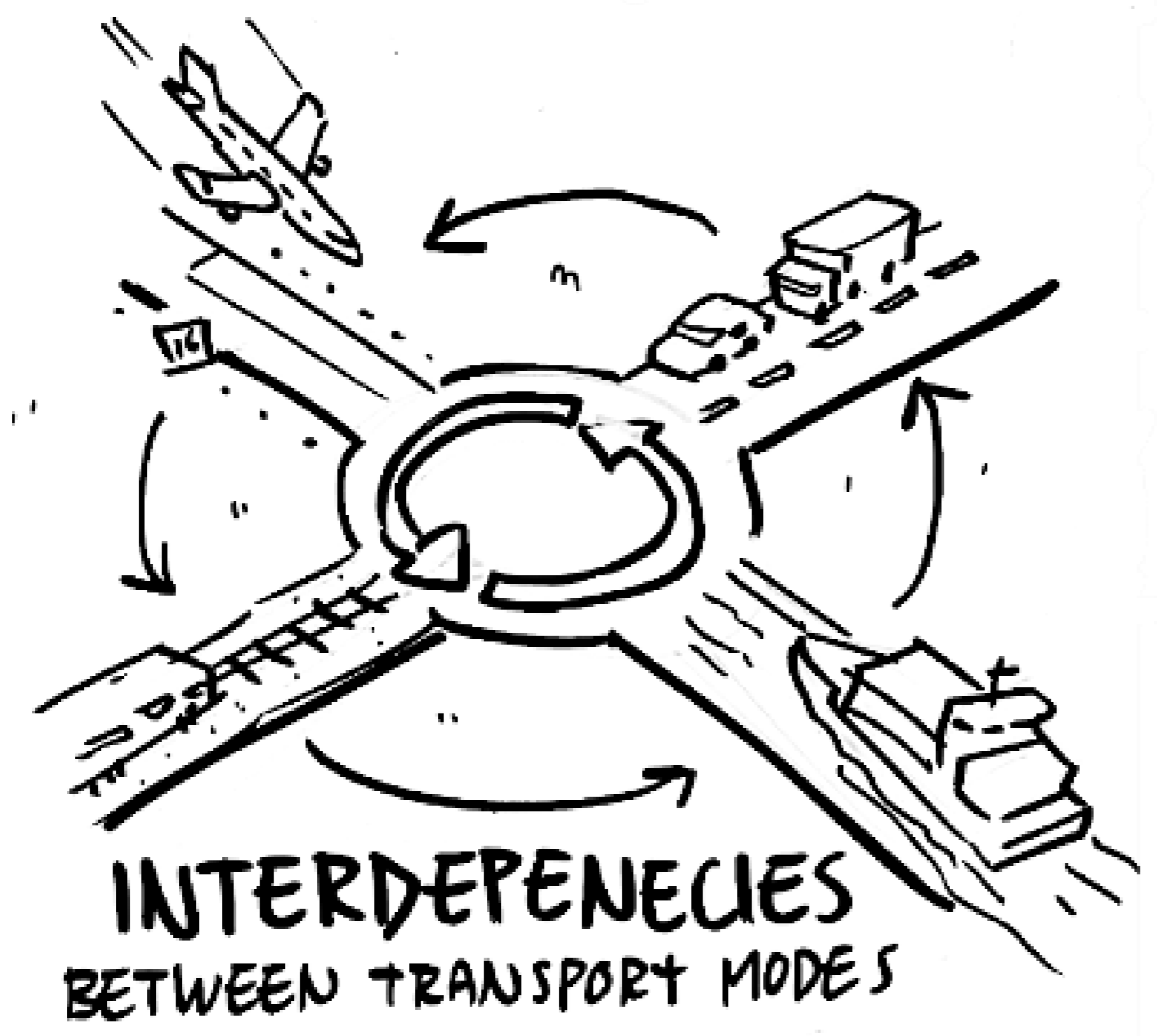
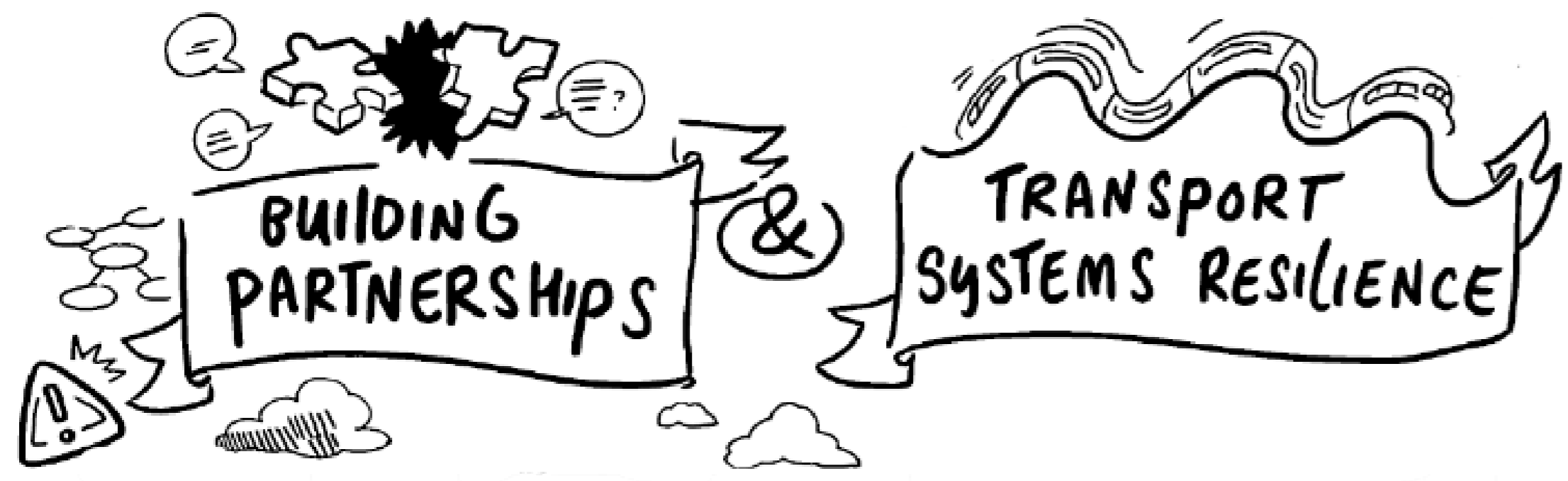
Coordinating and long-term activity

# Global Participation in the RERA Network



Konstantina Kopsalidou	VIOLETA GONZALEZ ALEÑAR (External)	FRECHEDE Laurent (External)	Benjamin Schmitz (Unverified)	Marta Cláudia Lourenço Figueiredo (External)	
Concepcion Toribio Diaz (External)	Lisa Constable (External)	ANDERTON Lucie (External)	PETRONE SARA (External)	Samuel Jones	
Eloot Rikie (External)	CASQUERO SOLER Rosa Deneb (External)	Benoit LAGARDERE (External)	PATRICIO Hugo (Externe) (External)	Annick De Keyzer (External)	
	Jannis Voll (Unverified)	Heman Francisco Lara Fonseca (External)	SORRENTINO Danilo (SNCF RESEAU / Directions Techniques Ré...)		





**KNOWLEDGE-SHARING**



**COLLABORATING AND COOPERATION**

# RERRA

Resilient Railways facing Heavy Rains

## Addressing Extreme Precipitation and Flooding

Examines the vulnerabilities of railway infrastructure to heavy rainfall and associated flooding



Landslide in 2021, Italy



Bridge collapse in 2021, Germany

A structured, three-phase framework:



1. Climate impact analysis



2. Vulnerability, risk and criticality assessment



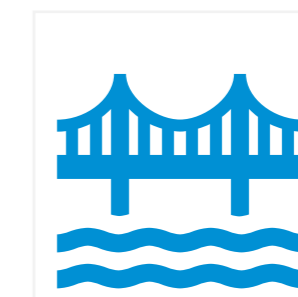
3. Adaptation planning



Integrating enhanced weather forecasting



Improving inspection protocols



Fostering strengthened collaboration



UIC RAIL SYSTEM DEPARTMENT  
Resilient Railways  
facing Heavy Rains  
March 2025



## Resilient Railways facing Heavy Rains



ID	ADAPTATION MEASURE	TYPE OF MEASURE	AREA OF APPLICATION	ASSET	RESILIENCE STAGE				RESILIENCE PRINCIPLE										
					Prevention	Preparation	Response	Recovery	Robustness	Resourceful	Rapid Recov.	Adaptability							
M1	Enhance drainage systems to prevent water accumulation and ensure efficient water flow	Resilient Construction	Hard Measure	Drainage System															
M2	Elevate track bed to minimise risks of waterlogging and flooding	Design Strategy	Hard Measure	Tracks															
M3	Use of corrosion-resistant materials for rails and critical components to protect against water-induced damage	Resilient Construction	Hard Measure	Tracks															
M4	Regular inspection and preventive maintenance to identify vulnerabilities and mitigate risks before severe weather events	Maintenance	Soft Measure	All Assets															
M5	Waterproofing of critical rolling stock components to ensure functionality during heavy rain and reduce water damage	Resilient Construction	Hard Measure	Rolling Stock															
M6	Improve sealing of doors, windows, and joints to prevent water ingress into rolling stock and facilities	Resilient Construction	Hard Measure	Rolling Stock															
M7	Installation of water-resistant braking systems to maintain safe operations under wet conditions	Design Strategy	Hard Measure	Rolling Stock															
M8	Implement waterproof enclosures for electrical systems to protect against water-related failures and malfunctions	Resilient Construction	Hard Measure	Electric Systems															
M9	Elevate and secure electrical installations above potential flood levels to prevent water damage	Design Strategy	Hard Measure	Electric Systems															
M10	Training programs for drivers on how to handle adverse weather conditions and maintain operational safety	Research & Learning	Soft Measure	Driver capabilities															
M11	Simulation exercises to prepare staff and infrastructure for emergency response	Research & Learning	Soft Measure	Driver capabilities															
M12	Real-time weather monitoring systems in driver cabins to enhance decision-making during adverse weather conditions	Monitoring	Operational Measure	Driver capabilities															
M13	Emergency protocols for handling extreme rainfall events	Emergency Management	Soft Measure	Driver capabilities															

Table 1: Example of a routine, design and extreme event for the annual maximum daily precipitation (mm)

	T (Return period)									
	2	5	10	25	50	75	100	150	300	500
Observed	46	61	70	83	92	97	101	106	116	122
	Routine event			Design event			Extreme event			

Table 2: Analysis of future return periods for current magnitudes

		T (Return period)									
		2	5	10	25	50	75	100	150	300	500
SSP2-4.5	Medium-term	46	61	71	83	93	98	102	107	117	124
	Long-term	46	63	74	89	100	106	111	117	128	136
SSP5-8.5	Medium-term	49	64	74	87	96	101	105	110	119	126
	Long-term	47	65	76	92	103	110	114	121	133	141
		Routine event			Design event			Extreme event			

Table 3: Analysis of future magnitudes for defined return periods

		T (Return period)									
		2	5	10	25	50	75	100	150	300	500
SSP2-4.5	Medium-term	46	61	71	83	93	98	102	107	117	124
	Long-term	46	63	74	89	100	106	111	117	128	136
SSP5-8.5	Medium-term	49	64	74	87	96	101	105	110	119	126
	Long-term	47	65	76	92	103	110	114	121	133	141
		Routine event			Design event			Extreme event			

# RERA

Resilient Railways facing High Temperatures

## Most impacted asset



Track  
(ballast, rail, turnover,  
and fastening)



Signalling systems



Electrification system



Locomotive and  
rolling stock

## Most impacted operational aspect



Speed restriction



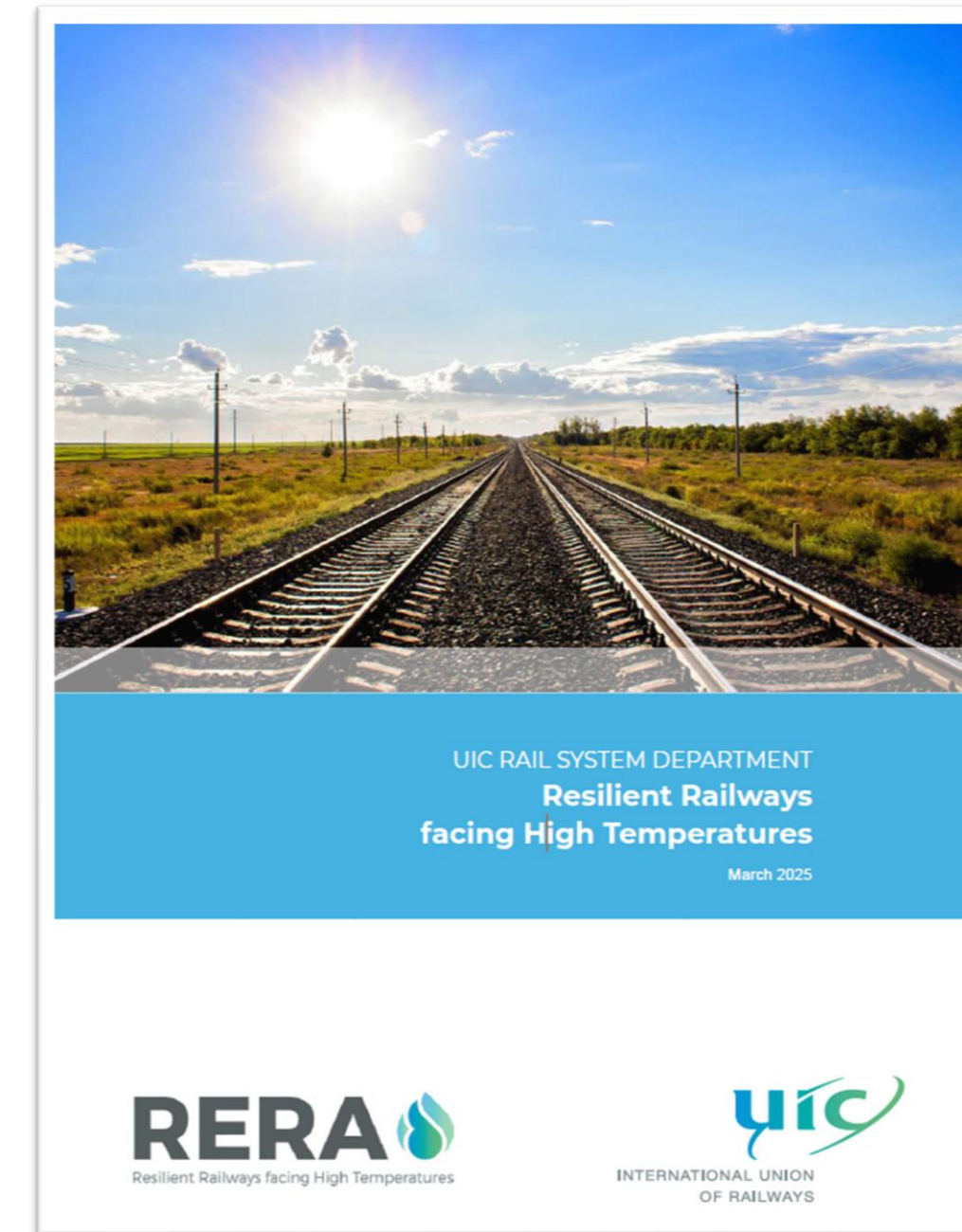
Cancelled operations



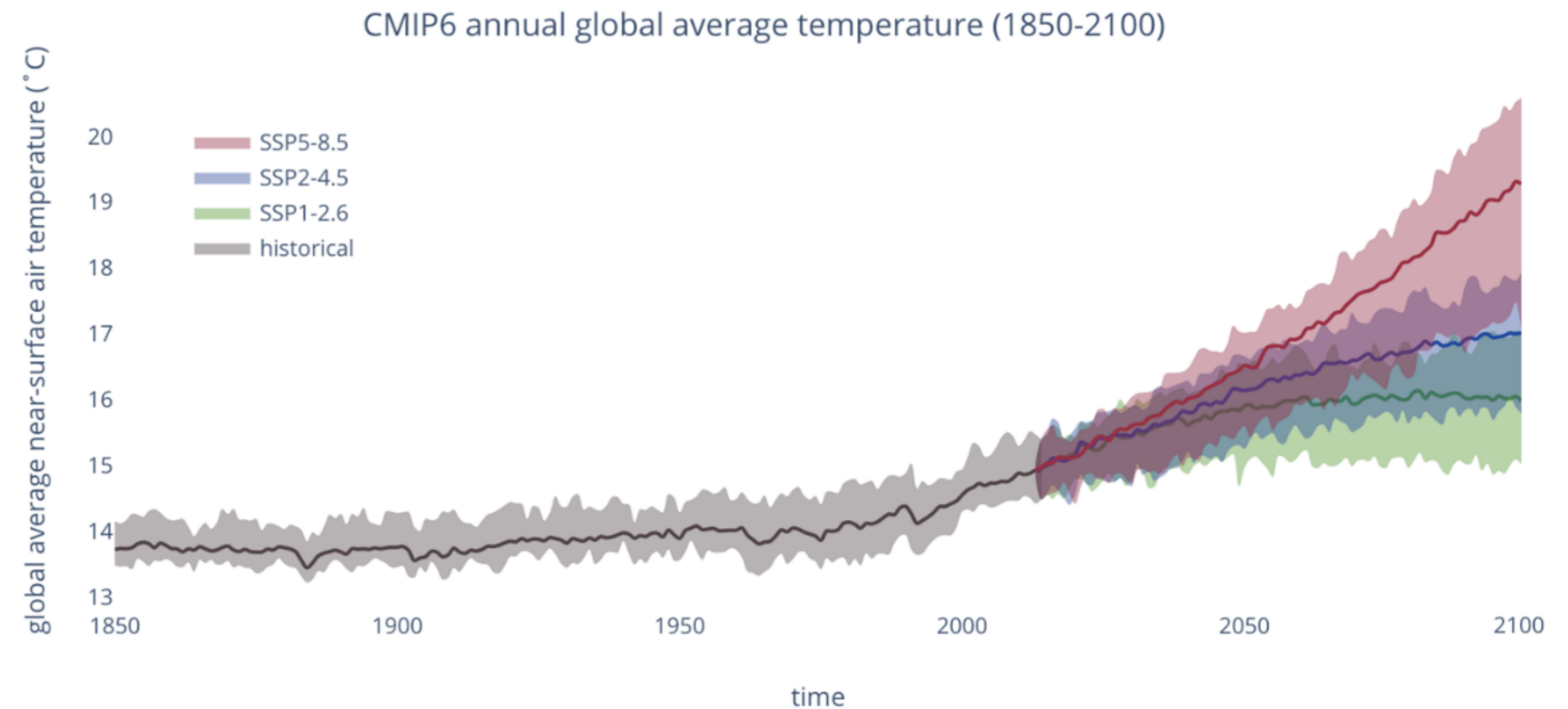
Delayed operations



Passenger comfort

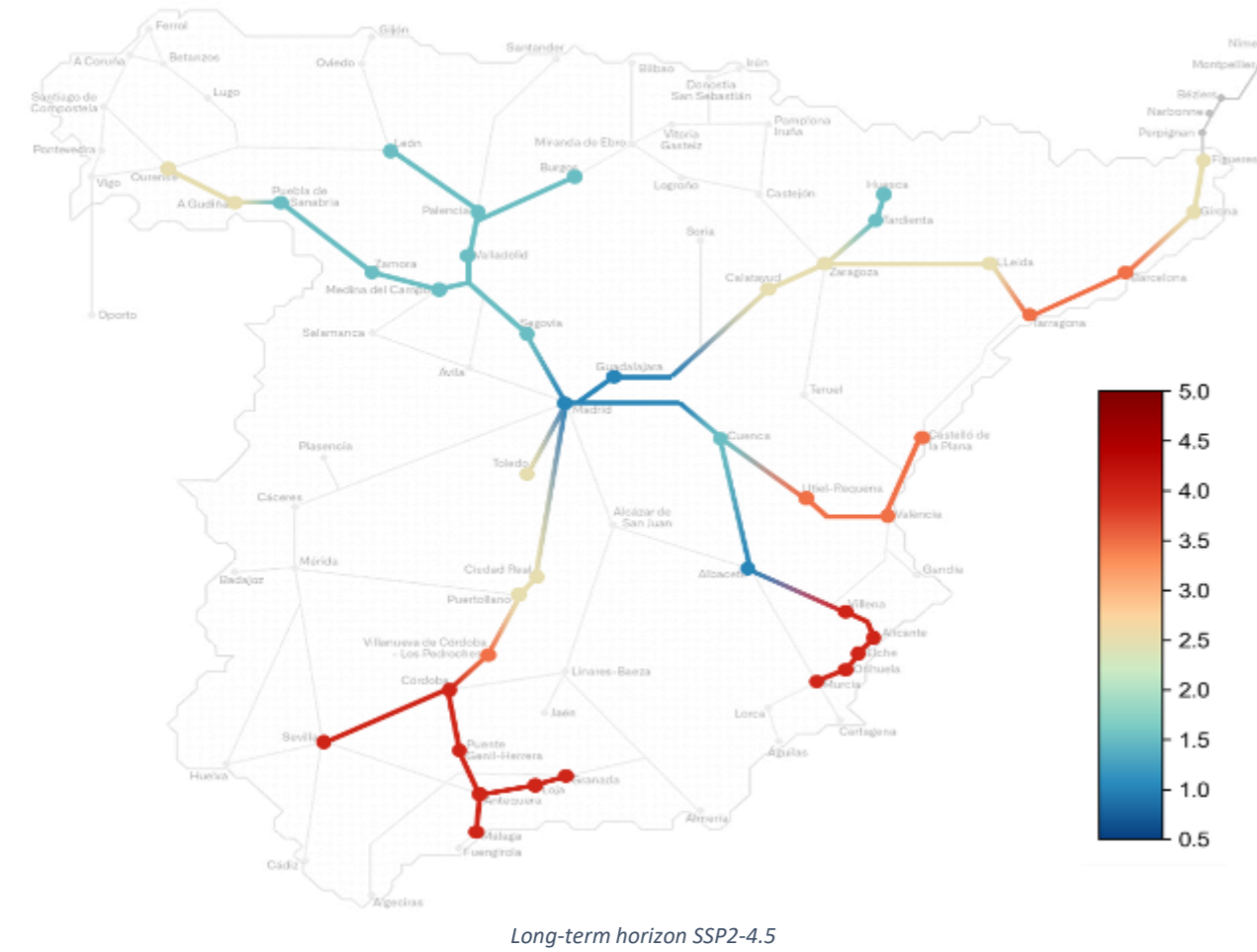


[Resilient Railways facing High Temperatures](#)

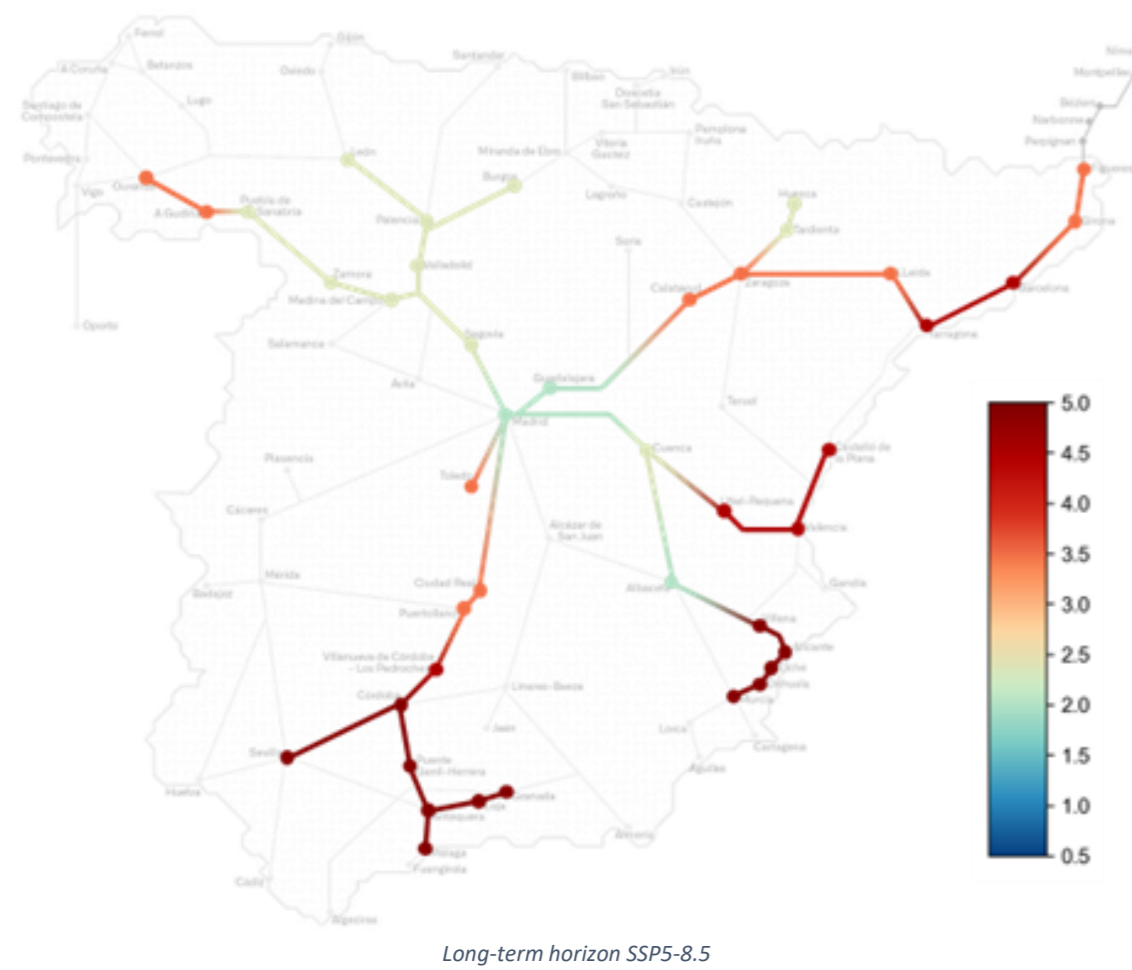


# Managing Extreme Temperatures and Desert Conditions

Focusing on the pervasive impacts of rising temperatures and desert environments including sand contamination

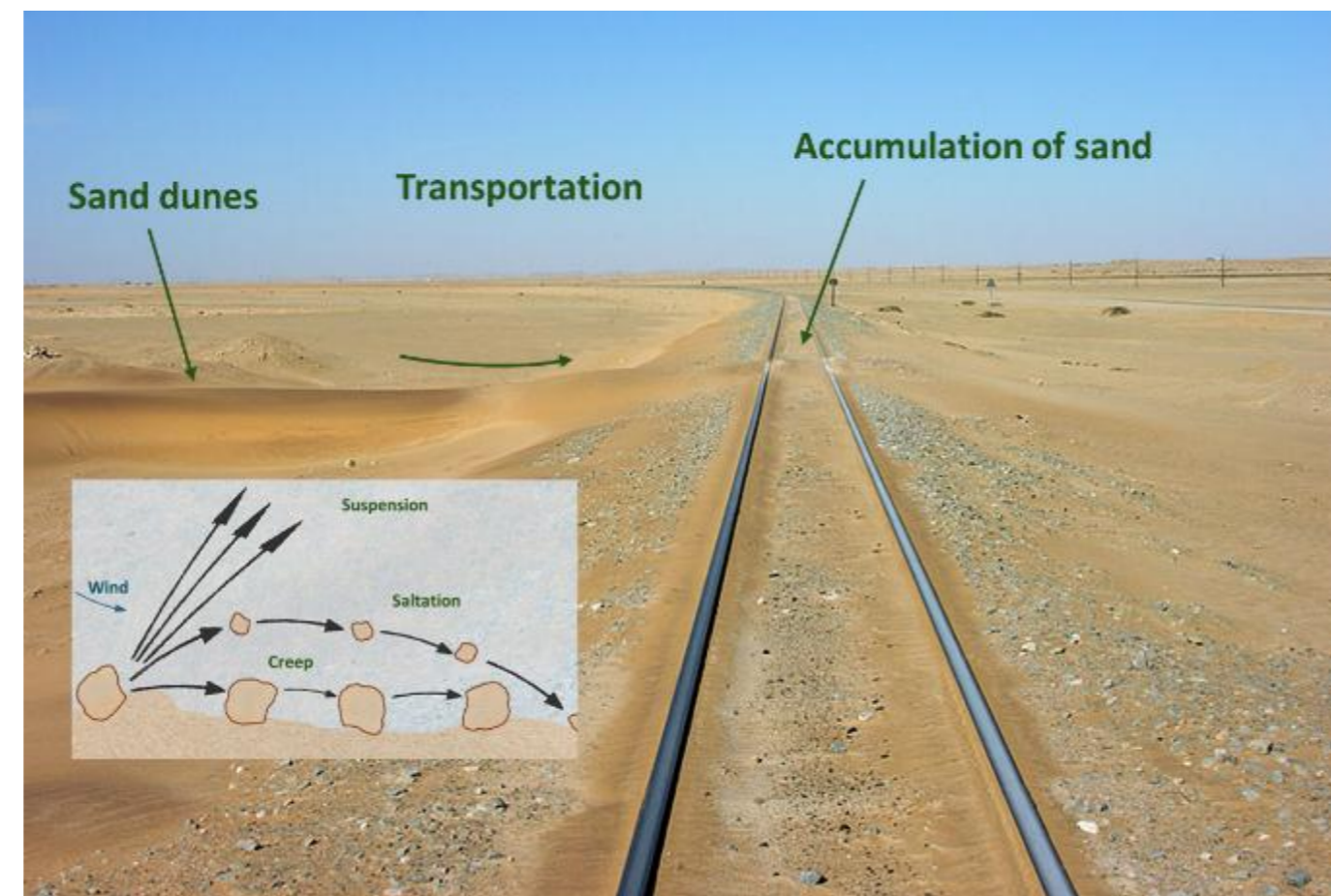


Long-term horizon SSP2-4.5

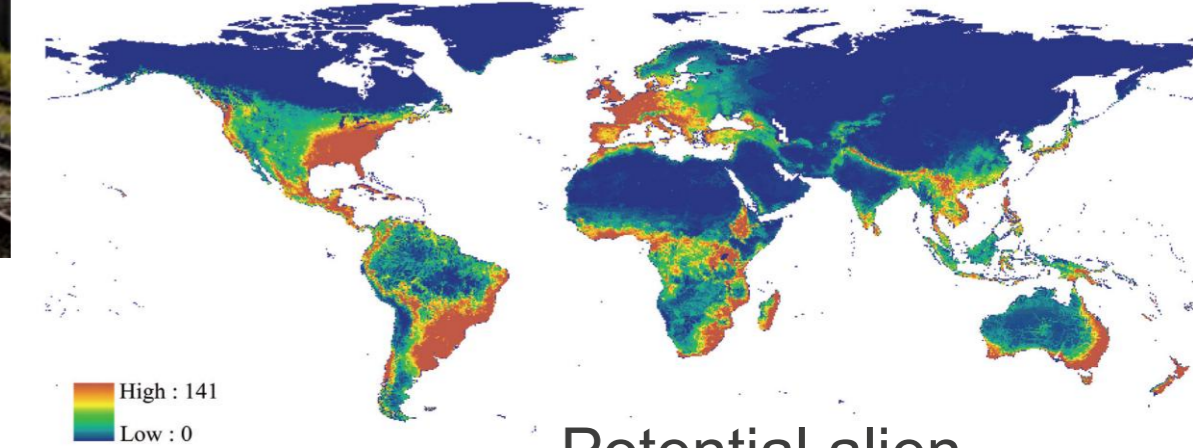


Long-term horizon SSP5-8.5

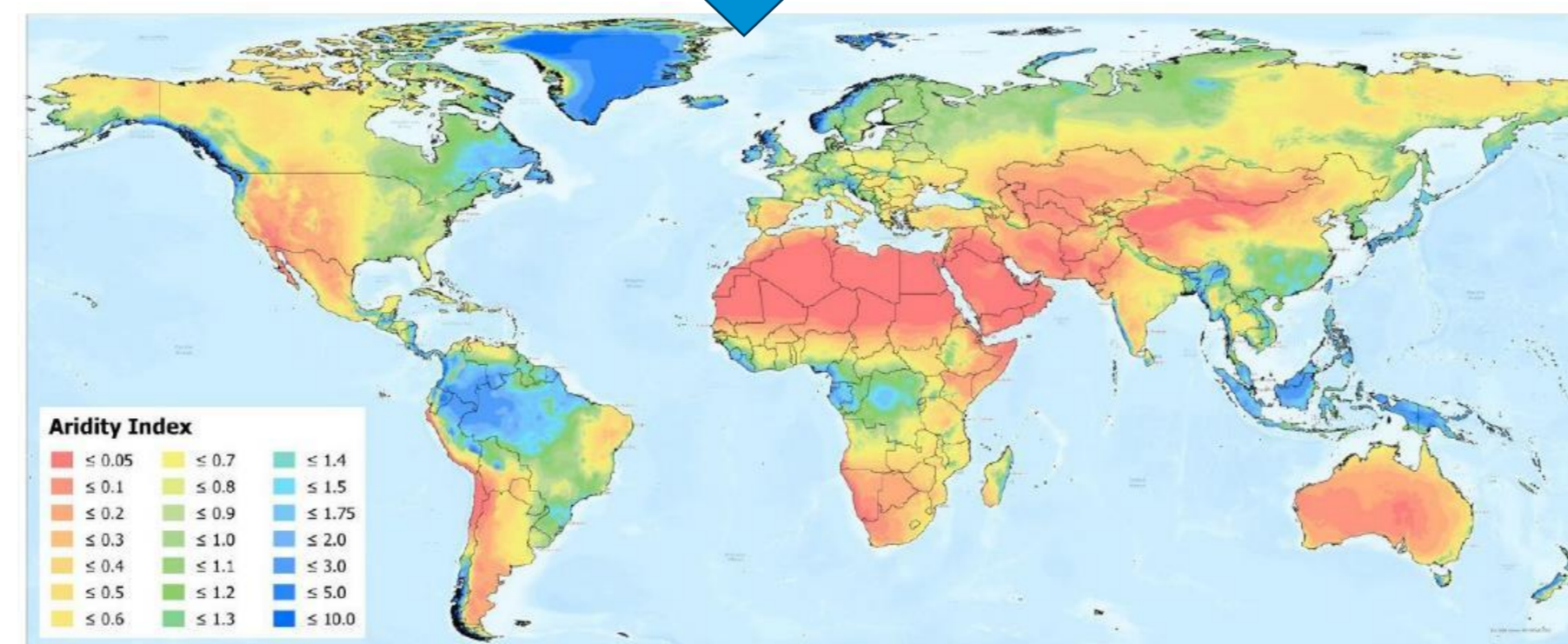
Maps showing Increase in max. temperature for Spain under several CC scenarios



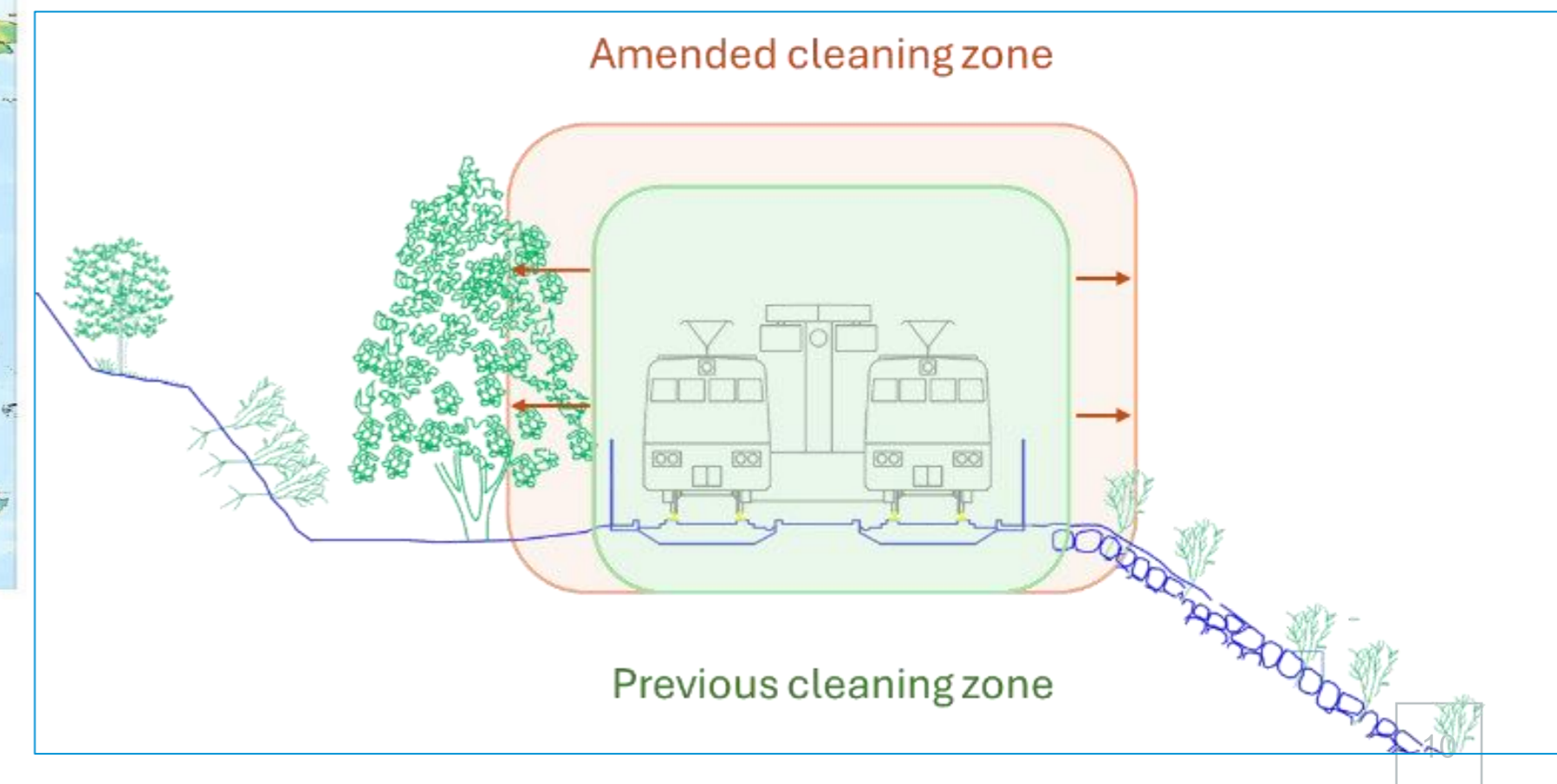
Process of sand contamination and accumulation of sand above the rail head



Potential alien plant invasion hotspots



Aridity Index global distribution – initial indication whether a system might be in a region where sand contamination may occur (lower index->more prone)



# RERA



## Resilient Railways Facing High Winds

### Objectives:

Great Belt Bridge accident (2019) - the ERA started the JNS process to ensure the operation of freight trains against side winds.

### Achievements to date:

Objectives of the JNS coordinated with UIC project - work will be carried out on the cross-wind curves (CWC) of the semi-trailers

### Main tasks:

- A state-of-the art report on wind measuring systems and devices aimed at safety of operations will be elaborated.
- Calculations and tests will be conducted in the wind tunnel, to allow all stakeholders to accurately assess the risk.
- Operational rules for a safe operation (non-structural measures) and structural measures, such as those applied to bridges, will be proposed to ensure safe operations.

Completion June 2027





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# Thank you for your attention



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