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CONNECTA

Technical Assistance for the Deployment of Smart and Sustainable Mobility in the Western Balkans

CONNECTA-TRA-CRM-REG-MOB-07

WORKSHOP no. 4

Resilient Mobility

23/11/2022, Tirana

Climate Resilient Roads

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Context

- Climate Change
- Impacts on Infrastructure
- Adaptation Framework
- Risks and Mitigation Measures
  - Pavement
  - Drainage
  - Bridges
  - Vegetation

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Climate Change is HERE

Scientific evidence indicates that climate change will increase the frequency and intensity of a range of extreme weather events, for example:

- Sea level rise is predicted to result in storm surges in coastal areas
- Heat waves are forecast be more severe, leading to long periods of draught (as seen across Western and Central Europe)
- Precipitation is estimated to increase in intensity (as seen globally).

The increased frequency and intensity of these extreme weather events can have a devastating impact on both human life and physical infrastructure. The impact on road transportation systems can be particularly stark, leading to delays, disruption, damage and potentially failure.

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Climate Change – The impact on Infrastructure

- Exposure to flooding events shortens the life expectancy of highways and roads. The stress of water may cause damage, requiring more frequent maintenance, repairs and rebuilding. Road infrastructure in coastal areas is particularly sensitive to more frequent and permanent flooding from sea level rise and storm surges.

- Higher temperatures can cause pavements to soften and expand. This can create rutting and potholes, particularly in high-traffic areas. Heat waves can also limit construction activities, particularly in areas with high humidity.

- Heavy rains may result in flooding, which could disrupt traffic, delay construction activities, and weaken or wash out the soil and culverts that support roads.

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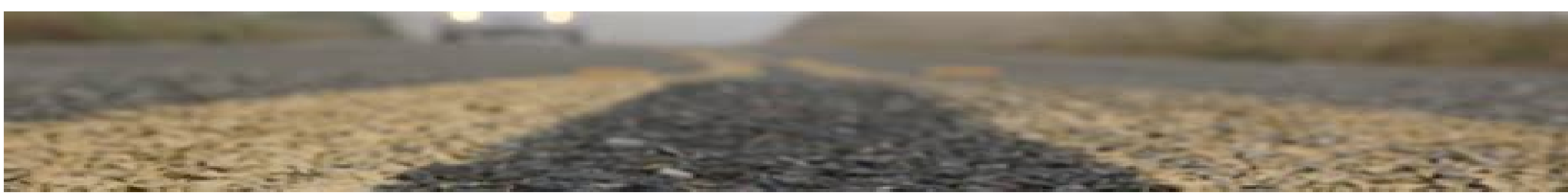
Towards, Climate Resilient Roads

Adaptation Framework

To enable transportation infrastructure to adapt to climate change and minimize the impact of extreme weather events, it is important to understand how roads are planned and managed and to identify weaknesses and strengths in dealing with climate change.

The most cost-efficient way to achieve this is to perform Risk Based Road Asset Management (ISO 55001). This includes:

1. Identifying scope, variables, risks and data with the focus on climate change scenarios for the given territory and exposure and sensitivity analysis of road assets to climate change.
2. Assessing and prioritizing risks. This stage includes vulnerability analysis carried out to identify critical elements of road infrastructure.
3. Developing and selecting adaptation responses and strategies (risk mitigation measures). This stage outlines the identification, selection and prioritization of adaptation responses identified within stages 1 and 2.
4. Integrating results into decision making processes. Namely, the results of the stages 1-3 should be effectively incorporated into asset management and investment plans, traffic management strategies and other strategic documents and standards.



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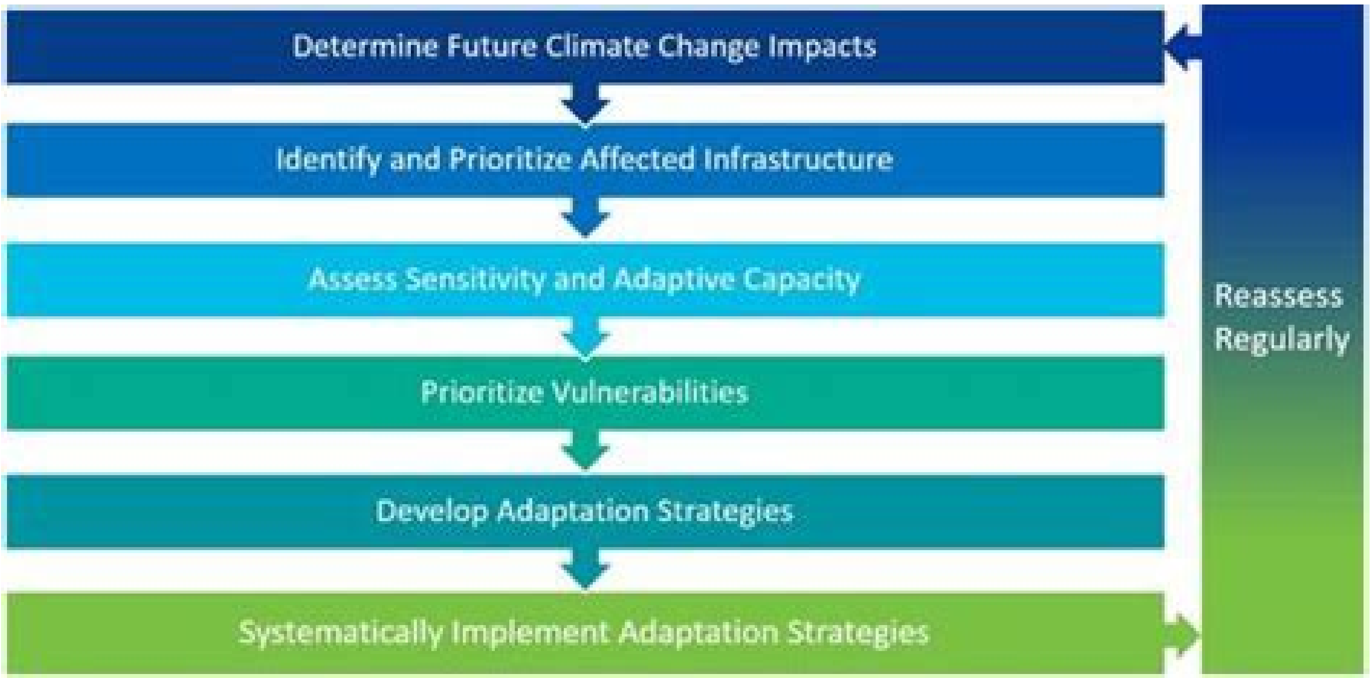
Risk Based Asset Management



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Risks & Mitigation

Road Pavement (1/2)

The main risks to the road surface associated with climate change are, depending on the climate zone, extreme heat and insolation, higher occurrence of heavy rain and temperature fluctuation around the freezing point.
Very high temperatures are manifested by an increased risk of asphalt rutting, flushing and bleeding of bituminous surfaces and/or cracking. As the temperature of the asphalt mixture increases, the binder phase loses stiffness and the irreversible deformations caused by static or dynamic traffic loading will accumulate at a faster rate. Possible solutions include following ones:

- Adjustment of bituminous mixture design (using of binders with higher softening point, including polymer modification of bitumen, selection of stronger aggregate skeleton);
- Adjustment of structural design of the pavement (flexible, semi-rigid and rigid/composite designs);
- Greater use of concrete due to its higher temperature resistance and other advantages (longer lifetime, possibility of increased load, lower need for maintenance) albeit slightly higher purchase costs.
- Changing the design of the concrete pavement mixture to reduce the amount of water required.
- Increase the reflectance (albedo) of the road surface e.g. by means of using bright, coloured elements on the road or reflective coatings of road surfaces.
- Cooling pavements with water.

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Risks & Mitigation

Road Pavement (2/2)

The primary impacts of an increase in frequency in intense precipitation include water damage to asphalt, reduced bearing capacity of lower pavement layers and reduced safety and comfort for the user (less friction, less comfort).

Possible adaptation responses, similar to those coping with temperature fluctuation and higher frequency of freeze/thaw cycles are:

- Use of permeable/reservoir pavements. Water is stored in the pavement structure and infiltrated into the soil or discharged by a drainage system.
- Use of porous top layers that can facilitate the drainage of the water to the sides of the road and prevent aquaplaning.
- For concrete surfaces higher cement contents and lower water cement ratios are recommended.
- Development of hydrophobic coatings suitable for use at the micro-mechanical and or pavement surfacing level.

Towards, Climate Resilient Roads

Risks & Mitigation

Road Drainage

Drainage system capacity should be adapted to higher intensity and frequency of extreme rainfall events and complemented with water retaining facilities (e.g. dams, reservoirs) and structural protection measures (dikes, embankments).

The design for culverts should be adjusted to accommodate higher water volumes within a short period of time. In terms of defining the capacity design of the drainage system, the intensity-duration-frequency curves (IDF curves) should be used, taking into account the influence of climate change and updating these IDF curves with the rainfall characteristics projected in future climate scenarios.

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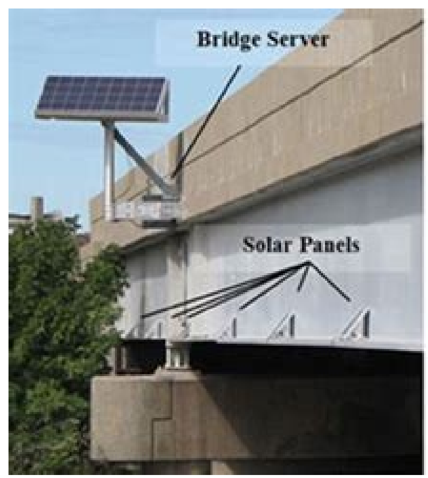
Risks & Mitigation

Bridges

The main climate change concerns relevant to design, construction and management of existing bridge structures are higher occurrence of flooding, higher river discharge, erosion and slope instabilities and temperature fluctuation.

The standards for bridge structures which are currently used show considerable resistance to these effects; nevertheless, the research of new climate-proofed standards is ongoing.

Nevertheless, it is considered necessary to install weather stations and telematics on bridges measuring water level, vibration sensors, traffic regulating equipment etc.



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Risks & Mitigation

Vegetation

Vegetation along roads contributes to environment protection, in particular reducing noise and pollution, and can also have an adaptation function, for example protecting road from direct sunlight.

On the other hand, improper use of vegetation along road can be a risk factor of traffic disruption when extreme weather events occur and may also influence road safety.

The recommendations towards building up climate resilient roads therefore include replacement of mature trees with hedges (using elastic woody plants suitable for and more adapted to a given climate zone) and planting the vegetation at a sufficient distance from the road.

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Questions and Discussion

Any comments/suggestions?

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Thank you!

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