

EIB Jaspers

CAPACITY BUILDING FOR SUSTAINABLE URBAN MOBILITY PLANS

Climate change adaptation and resilience

Stockholm, 5-6 May 2026

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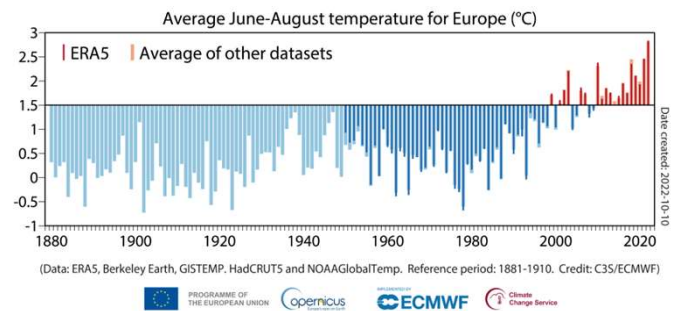
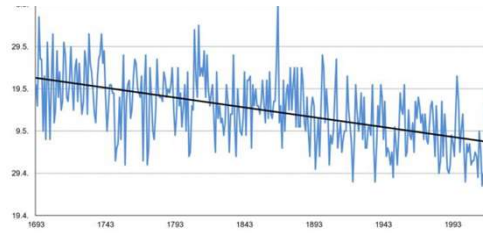
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CLIMATE CHANGE: URGENT CHALLENGE FOR EUROPE

- Since 2020: warmest summers of Europe in decades
- 2023: largest wildfire ever recorded in Europe: 960 km² in Greece (twice size of Athens)
- 2020-2023: Alp glaciers lost 10% of volume
- Last 20 years: heat-related mortality increased by 30%

Decrease of ice break days since 1700 (river Tornio Finland)



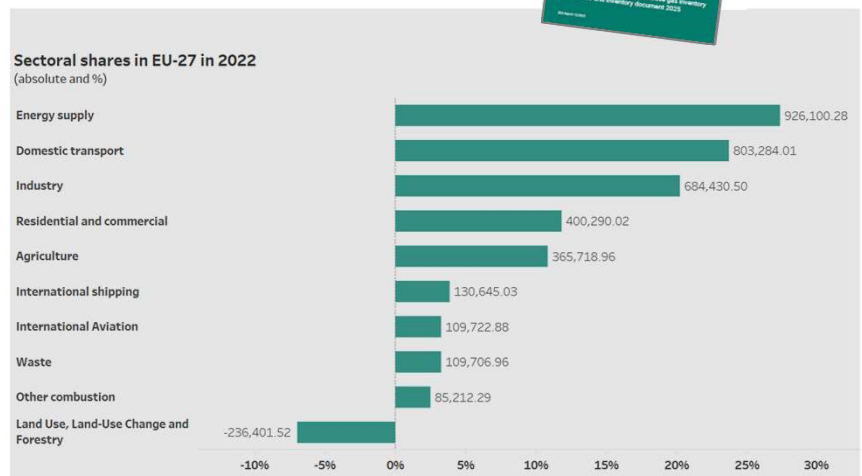
It is clear to all that climate change represents one of our major and urgent challenges nowadays and there are constantly climate disasters occurring that remember this to us. Europe is a very highly exposed continent to climate change impacts, we keep recording warming temperature records every year. Increasing wildfires with record of areas burnt, a heat mortality rate that has increased by 30% in past 20 years...all representing major economic losses and impacts for citizens.

Graph on summer temperature source: https://climate.copernicus.eu/seasonal-review-europes-record-breaking-summer?utm_source=chatgpt.com

Graph on ice breaking days in Finland: <https://www.ymparisto.fi/en/state-environment/climate-change/climate-change-advances>

CLIMATE CHANGE AND TRANSPORT

- Transport is a significant source of GHG emissions
- CO₂-emissions from transport have been rising between 1990-2023
- Only starting to decrease in 2022-2023



Source: Annual European Union greenhouse gas inventory 1990-2023 and inventory document 2025
European Environment Agency (2025)

Transport is a key sector when talking about climate change.

From one side, transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities. And it needs also to be mentioned that transport is the only sector where GHG emissions continue to grow. Within transport, road transport is by far the biggest emitter.

While at the same time, climate impacts are strongly affecting critical infrastructure, including transport, and those are only expected to increase over next decades.

Therefore, it is clear there is need to take climate change action on mitigation and adaptation in transport.

The focus of the present module is on climate change mitigation – decarbonization. While there is another elective module (module 12) which is focused on climate change adaptation-resilience.

Source of report: <https://www.eea.europa.eu/en/analysis/publications/annual-european-union-greenhouse-gas-inventory-2025>

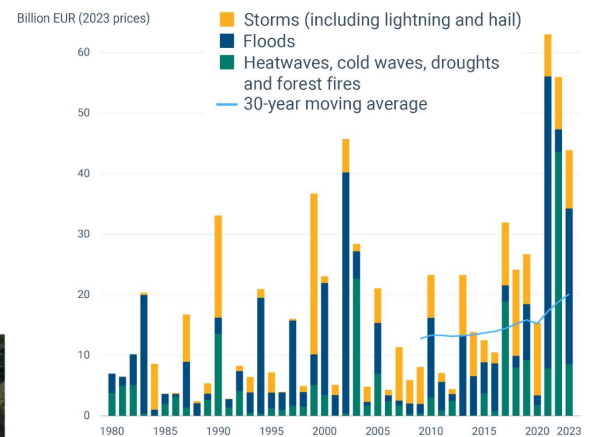
CLIMATE CHANGE: URGENT CHALLENGE FOR EUROPE

- Costs of climate change are immense
- Financial and social
- And rising



Floods Valencia Spain 2024

Mudfloods damaging highway Switzerland 2024



Annual economic loss caused by weather / climate related extreme events in EU

(Economic losses from weather- and climate-related extremes in Europe | European Environment Agency's home page)



Capacity Building for Sustainable Urban Mobility Plans – Climate change adaptation and resilience

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Climate impacts represent major damages, social and overall economic losses. The EEA publishes data on yearly economic losses related to weather- and climate-related extremes. In its latest publication from 2024, It estimated at EUR 738 billion of economic losses during 1980 - 2023 in the European Union. Statistical analyses revealed, that economic losses increase over time and the last three years are all in the top five of years of highest annual economic losses.

Some examples of specific climate events over Europe in recent years are:

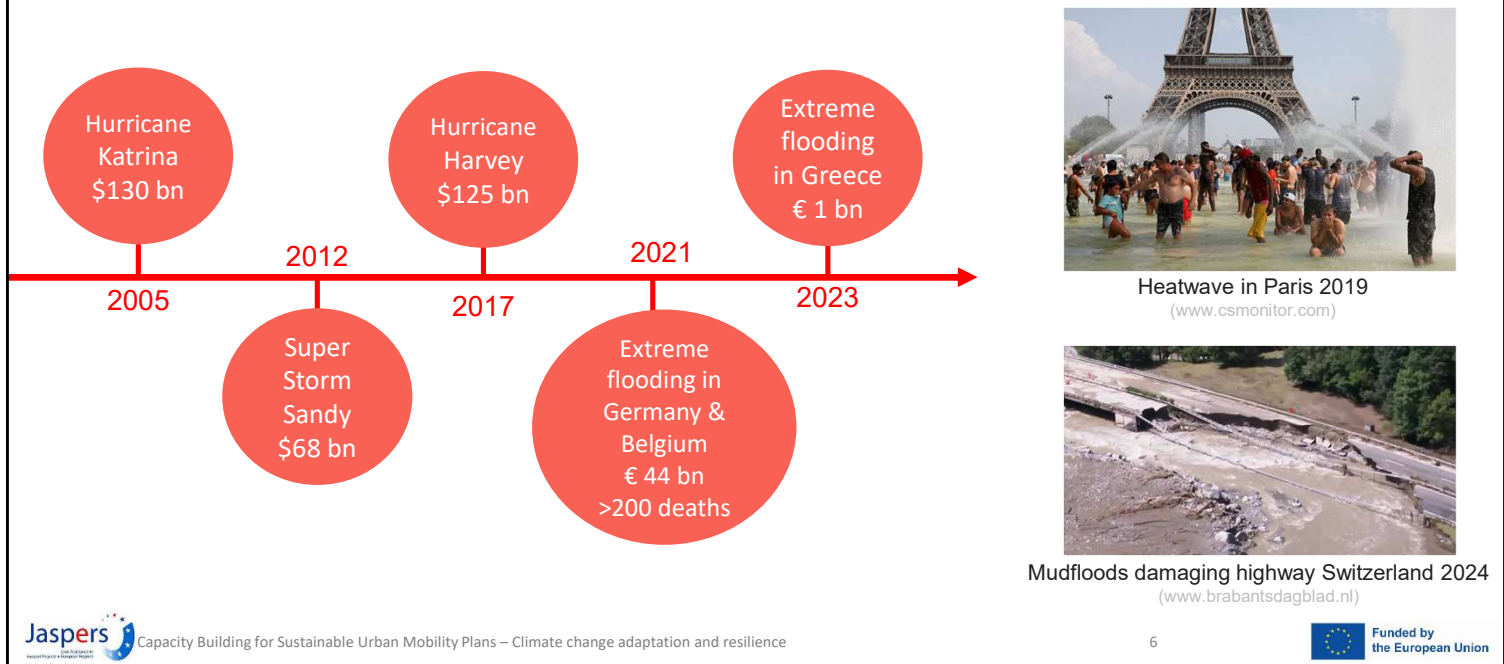
- Extreme precipitation and large-scale floods that took place in Germany and Belgium in 2021 represented EUR 44 billion damage and more than 200 deaths (EUCRA report)

According to the “Climate change impacts and adaptation in Europe” report from 2020: River flood losses would reach nearly EUR 50 billion per year; people exposed to coastal inundation could reach 2.2 million per year, and annual coastal flood losses could climb to EUR 250 billion in 2100.

Climate change effects are only expected to increase over the next decades on critical infrastructure, including energy and transport. Those affect transport systems functionality, safety and sustainability.

New DG-MOVE Study on the financial needs for the adaptation of the TEN-T network (core & comprehensive).

Costs of climate change are immense (financial, social)



2005 Hurricane Katrina: Catastrophic damage was caused over an area roughly the size of the UK with a price tag of \$130 bn and with many Critical Infrastructures being damaged or destroyed.

2012 Super Storm Sandy: It resulted in damages of \$68 bn and impacted the energy, transportation, communications, water and health sectors in the greater New York/New Jersey metropolitan areas.

2017 Hurricane Harvey: Hurricane Harvey was the most significant tropical cyclone rainfall event ever recorded in U.S. history with damages of \$125 bn.

2021 Extreme flooding in Germany: Western parts of Germany have been affected most. The German Ministry of Transport estimated the damage costs on the Germany railway system at € 2 bn. Total costs of the climate change related events are estimated at more than € 30 bn.

2023 Extreme Flooding in Thessaly, Greece: An extreme flooding event affected the wider Thessaly region in Greece, causing severe damages to infrastructures (incl. roads, bridges) houses, and agricultural areas. Costs are estimated at more than € 1 bn.

In addition:

- In 2018, 18 countries reported disaster-related damages to critical infrastructures.
- Estimates show 60% rise in the cost of damages in Europe & Central Asia, due to extreme weather events over the next 30 years.
- Europe is the fastest-warming continent in the world. Extreme heat, once relatively rare, is becoming more frequent while precipitation patterns are changing. Downpours and other precipitation extremes are increasing in severity, and recent

years have seen catastrophic floods in various regions. At the same time, southern Europe can expect considerable declines in overall rainfall and more severe droughts.

Critical infrastructure: those facilities and assets, systems and networks that provide functions we rely on for our way of life. From energy and water supply to information and communication services, from healthcare to transportation, critical infrastructure provides vital support and essential services for economic progress, national security and the functioning and inclusion of communities.

Impacts of climate change: different accents through Europe

NORTHERN EUROPE

- Increased coastal erosion and flooding
- Increased tourism pressure at coastal areas
- Greater winter storms and extreme winds

CENTRAL EUROPE

- Glaciers disappearing
- Reduced snow cover period & Reduced ski season
- Increased frequency and magnitude of floods
- Increase heatwaves with health impacts and severe wild fires

SOUTHERN EUROPE

- Reduced water availability
- Increased drought, forest fires
- Reduced summer tourism, cropping areas
- Increased energy demand in summer
- Increase heatwaves with health impacts

Reference: adopted form "Weather Extremes: Assessment of Impacts on Transport Systems and Hazards for European Regions (FP7 R&D project)"

Significant impacts are expected in the climate of all Europe.

- The southern parts of the continent will be faced with Reduced water availability, Increased drought and forest fires, Reduced summer tourism periods and cropping areas, Increased energy demand in summer and Increase heatwaves with health impacts.
- The central European countries will be faced with Glaciers disappearing, Reduced snow cover period & Reduced ski season, Increased frequency and magnitude of floods and also Increase heatwaves with health impacts and severe wild fires.
- Finally, the northern European countries will face Increased coastal erosion and flooding, Increased tourism pressure at coastal areas and Greater winter storms and extreme winds.

Referring to EU Green Deal strategy, and the connected need for **Sustainable** Urban Mobility Plans as part of the new TEN-T regulation.

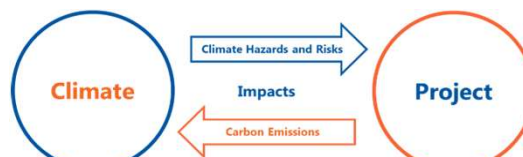
Referring to the Netzerocities Program.

TWO COMPONENTS TO DEAL WITH CLIMATE CHANGE

- **Mitigation** is about dealing with the causes of climate change, by reducing greenhouse gas emissions (GHGs).
(see SUMP training module 'Transport decarbonisation')



- **Adaptation** is about dealing with the inevitable consequences of climate change and attempting to lower the risks
(this SUMP training module)



Capacity Building for Sustainable Urban Mobility Plans – Transport decarbonisation and resilience

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When talking about dealing with climate change, it requires distinguishing its two sides:

- **Mitigation** which is about dealing with the causes of climate change, by reducing greenhouse gas emissions (GHGs); and
- **Adaptation** which is about dealing with the inevitable consequences of climate change and attempting to lower the risks.

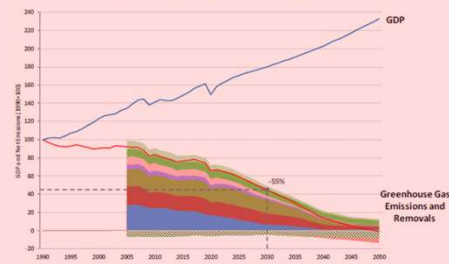
EU RESPONSE: THE GREEN DEAL & CLIMATE OBJECTIVES



Paris Agreement Alignment & EU objectives

Climate Neutrality (Mitigation)

Figure 4.1 – A pathway to climate neutrality in the EU



Source: EIB Climate Bank Roadmap, 2020

Transport:

- By 2050: 90% GHG emissions reduction

Climate Resilience (Adaptation)

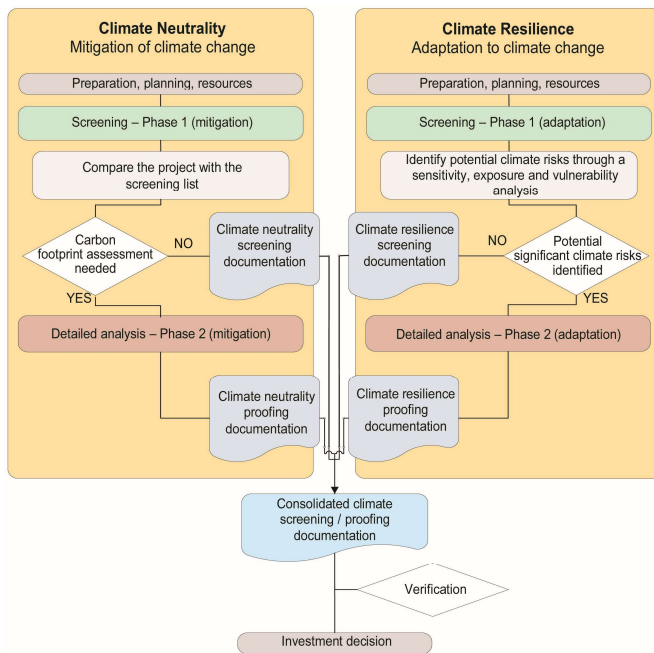
Become Climate Resilient by 2050

Transport: Resilient Mobility

Against all of this, the EU's response has been structured with the European Green Deal. It's a new growth strategy, which aims for resource-efficient and competitive economy with no net GHG emissions by 2050, and where economic growth is decoupled from resource use. Among others, it also seeks to protect the health and well-being of citizens from environment-related risks and impacts by becoming climate resilient by 2050.

In transport, in particular, EU climate objectives are set with GHG emissions reduction target of 90% by 2050 compared to 1990 levels, as well as ensuring climate resilient mobility.

EU Response on climate proofing



✓ “Commission guidance on climate proofing of infrastructure in the period 2021-2027”



✓ Screening step:
Identify potential climate risks

✓ Detailed analysis step:
Climate risk assessment on vulnerability of infrastructure

The requirements for 2021-27 foresee a procedure called “climate proofing” (ref. Art.73 of the new EU Regulation) -> compulsory for all the infrastructure projects with life more than 5 years.

This proofing has to be done according to the “Commission guidance on climate proofing of infrastructure in the period 2021-2027”.

✓ Two pillars:

- Climate resilience and the adaptation to climate change
- Climate neutrality and the mitigation of climate change.

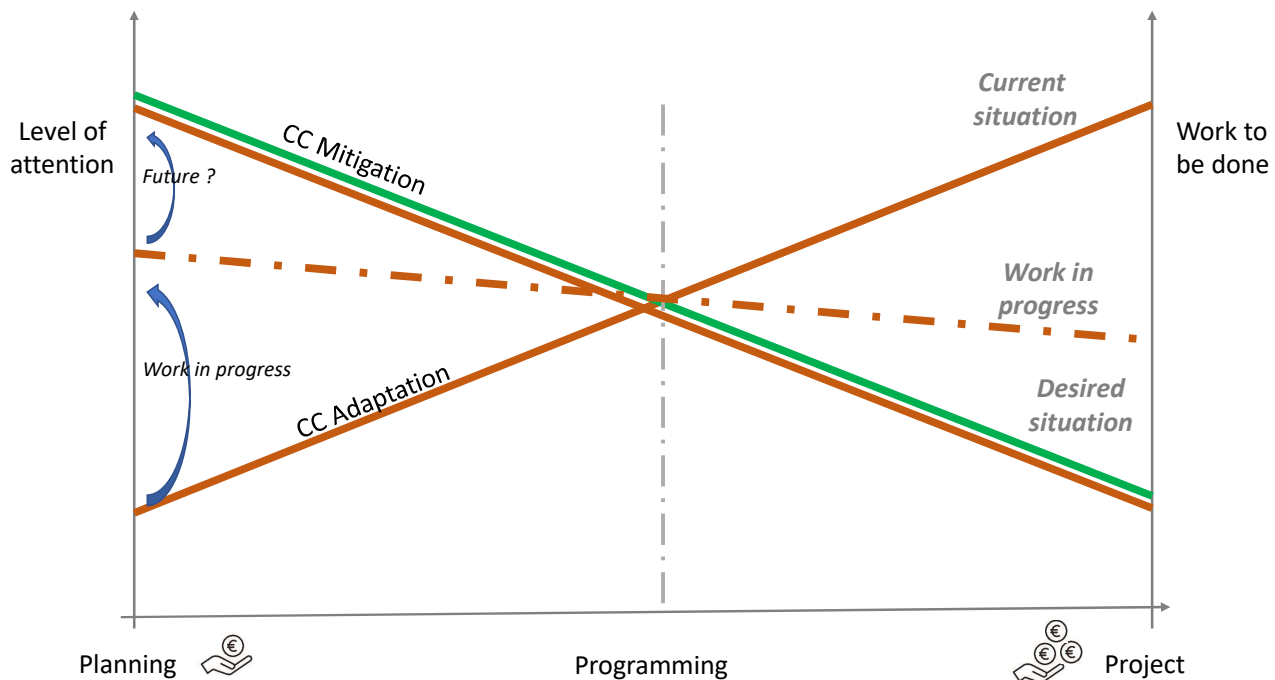
✓ Screening step:

- Identify potential climate risks
- Assess need to quantify GHG emissions

✓ Detailed analysis step:

- Climate risk assessment
- Quantification and monetisation of GHG emissions

Climate Change and Project Cycle – current developments

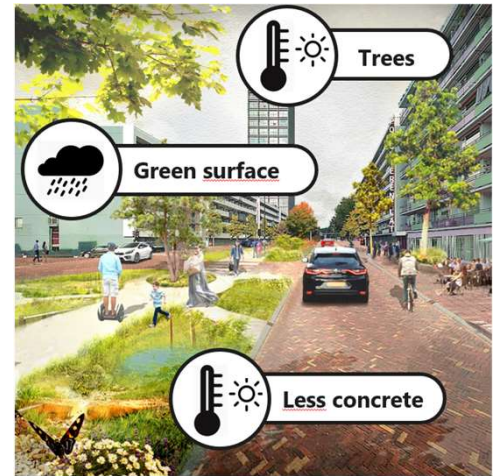


Climate change mitigation has been generally considered earlier in the project cycle (at planning level) where decisions can have a greater impact in this regard; while climate change adaptation is more often only considered at the project level (when the possible options for climate resilience are more limited). Therefore, there is work being/to be done to balance this and consider earlier, from planning level (e.g. when considering location or solutions for all stages of project cycle), which enables increased effectiveness of decisions for climate resilient solutions (see also considerations below).

Considering resilience/CC adaptation **At planning level provides (at least – all also presented in the coming slides)...**

- A set of **reference climate data and climate change forecasts**
- Identification of **main climate hazards, highly exposed corridor/areas & sensitivity levels** of transport systems
- **Mapping/assessment of climate change vulnerabilities**
- Develop **efficient O&M strategy** (incl. adequate financing) to ensure climate resilience of transport, including monitoring, early warning and response systems

Climate change adaptation or climate change mitigation?



In order to ensure that the basic related concepts are clearly differentiated, a quick quiz as a warm-up of the session. Please scan the code and answer this first question:

Is the picture presenting a climate adaptation or mitigation action?

- A. It is a climate adaptation action
- B. It is a climate mitigation action (X)

Climate Change Challenge in Sweden

- Sweden is actively adapting its transport sector to climate change, focusing on flood protection, resilient infrastructure, and reducing emissions by over 70% by 2030 (compared to 2010) to meet 2045 net-zero goals.
- Key strategies include:
 - electrifying road transport & strengthening resilience;
 - implementing resilient sustainable, smart, and autonomous public transport; and
 - securing rail infrastructure against increased temperatures and heavy precipitation.
- National Climate Change Policy – Transport Infrastructure:
 - To create robust and reliable transport infrastructure, climate-related risks must continue to be integrated and managed.



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Key strategies include electrifying road transport, implementing sustainable, smart, and autonomous public transport, and securing rail infrastructure against increased temperatures and heavy precipitation.

National Climate Change Policy – Transport Infrastructure: In the work of creating a robust and reliable transport infrastructure, climate-related risks must continue to be integrated and managed

There is a recognition of need for further work to identify risks and develop action: *‘There is no complete picture of what is required to adapt the transport infrastructure to climate change, and continued work will be needed to identify needs and prioritize measures’.*

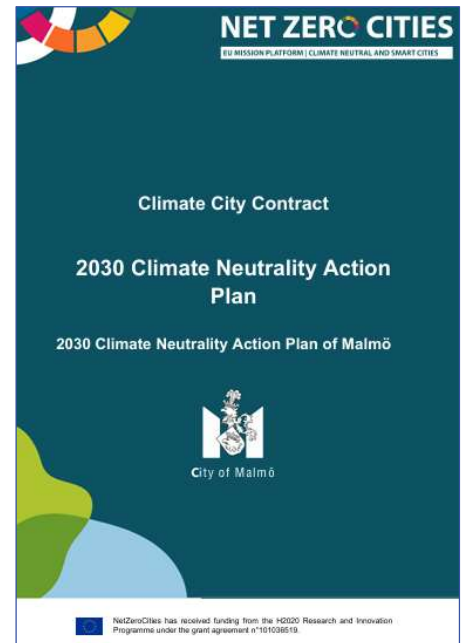
Key climate adaptation strategies for Swedish authorities include the following:

- **Infrastructure Resilience:** *Trafikverket* is modifying infrastructure to withstand extreme weather, particularly for railways, which are vulnerable to snow, low temperatures, and increased rainfall.

- **Action Plans & Regulation:** *Transportstyrelsen* has created action plans (2025–2029) to integrate risk management for climate change into its operations, focusing on safety supervision and infrastructure security.
- **Sustainable Urban Transport:**
 - Malmö climate adaptation actions
 - Cities like Gothenburg are transitioning to electrical buses, trams, and electric ferries, while also utilizing electric freight vehicles.
 - Stockholm has transitioned to a nearly fossil-free bus fleet, integrating wireless charging and advanced logistics.

Climate Change Adaptation in Malmo

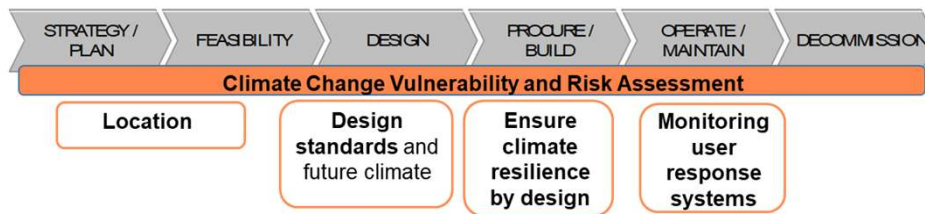
- City of Malmo Climate Adaptation actions as part of its' strategy for climate neutrality by 2030 through a "Climate City Contract 2030 include:
 - **Cloudburst Management** - following 2014 floods, the city has implemented a cloudburst plan focusing on blue-green infrastructure to manage intense rainfall.
 - **Heat Mitigation Approaches** - strategies include using green facades, rooftops, and increased tree canopy to combat heat islands.
 - **Urban Planning** - using a density-based model to limit sprawl, promoting "green and blue" spaces that improve biodiversity and water management.
 - **Collaborative Action** - the City is a UN Resilience Hub and partners with developers for sustainable urban construction.



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Include Climate Resilience early in the Project Cycle



Include climate resilience as early as possible in planning process, gives broader set of resilient options



Small course correction at beginning of process has more impact on final result than course correction at the end

Climate Resilience should be included as early as possible in the project cycle; this will enable to identify a broader set of resilient options and including the most cost-effective ones.

If considered at the planning level, climate resilience considerations might be addressed in all type and stages of the project cycle. Those might be object of consideration at the feasibility studies when analysing location of transport systems (e.g. specific considerations for areas at flooding risks, those might be considered for linear infrastructure but also for location of critical infrastructure such as technical equipment).

For design, specific considerations might be embedded such as criteria related to pluvial/fluviol/coastal flooding for drainage design, bridges capacity and design, etc.

Procurement should ensure implementation of same level of resilience that was planned in design (e.g. importance of specific considerations in design&build).

Operation and maintenance measures are also of high relevance to manage climate risks, for example, user alert and response systems when certain climate hazards occur or limiting transport services/operation when certain weather threshold is reached.

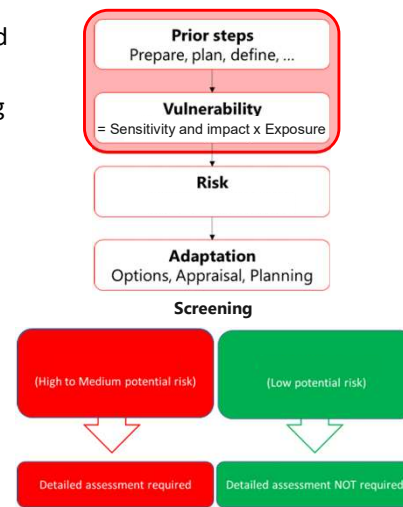
Basis: Climate Change Vulnerability and Risk Assessment

- Identify which climate hazards the transport systems are/could be vulnerable to (potential risks)
- Basis for consideration in defining measures and/or identifying possible climate adaptation measures
- Covers current climate variability and future climate change
- CCVRA is basis of climate resilience proofing for infrastructure projects in EU co-financing 2021-2027 (as in 2014-2020)

Technical guidance on the climate proofing of
infrastructure 2021-2027



Capacity Building for Sustainable Urban Mobility Plans – Climate change adaptation and resilience



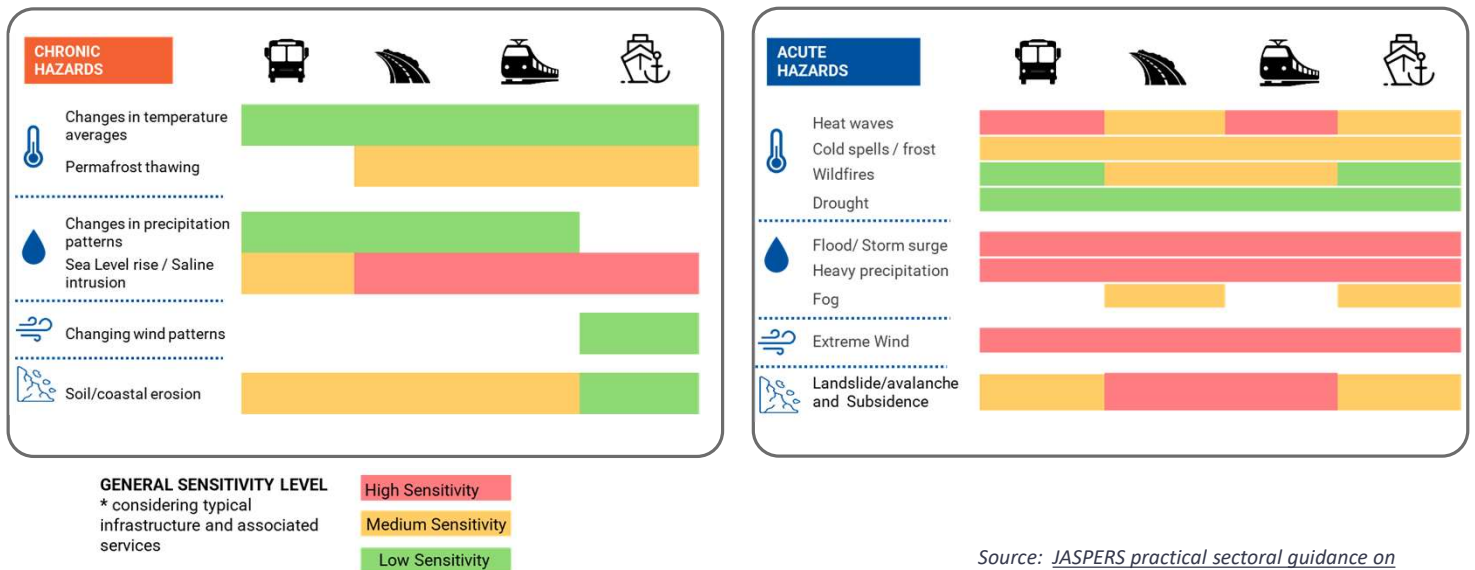
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The Climate Change Vulnerability and Risk Assessment is the basis to mainstream climate adaptation as it will enable to identify which climate hazards the transport systems are/could be vulnerable to, and on that basis, identify potential risks. It covers current and future climate change.

Potential climate risks will need to be object of consideration when defining planning options and measures as part of SUMP development (see later further details). It is also possible that some adaptation solutions are already identified (for example, certain operational and management measures or specific investments needs on infrastructure to increase heat resilience for example).

It is worth underlining that CCVRA constitutes the basis for climate resilience proofing for infrastructure projects in EU co-financing 2021-2027 (it was already required for major projects in EU co-financing 2014-2020). See Technical guidance on the climate proofing of infrastructure 2021-2027 , EC 2021. This guidance signals the relevance of integrating climate change as early as possible in the project cycle in transport and, therefore, preferably at the transport planning/strategies stage (including SUMP).

Climate Vulnerabilities: climate hazards in relation to mobility



Source: JASPERS practical sectoral guidance on climate resilience proofing, JASPERS November 2024

Different climate hazards affect transport systems differently. The tables from the JASPERS practical sectoral guidance on climate resilience proofing (November 2024) provide a general overview of the different sensitivity levels for different transport modes. In the following slide, it will be presented in more detail the principles of the assessment, while the present table already anticipates the logic of results. The list of hazards included is the one recommended in the EU Taxonomy Commission Delegated Regulation UE 2021/2139 on climate change.

All transport systems present high sensitivity levels to extreme precipitation or flooding since those might entail significant damages of infrastructure as well as to the fleets, major disruption and/or suspension of transport services, safety issues for users and operators, etc.

In case of extreme winds, all transport services are also expected to be highly impacted, those will notably be impacts on transport services and operation that might also be related to flying objects, falling trees, broken overhead lines, etc.

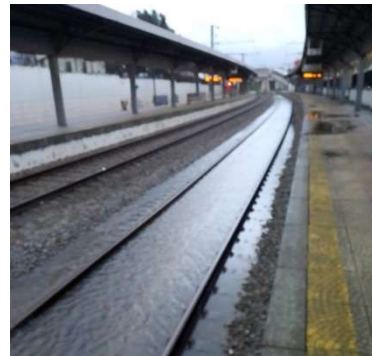
Extreme temperatures and heatwaves are also considered (together with extreme precipitation and flooding), some of the most relevant climate hazards to be considered in the development of SUMP. As it can be seen, those are of high (or medium) sensitivity levels for transport systems and of increasing importance on exposure in many places in Europe.

Therefore, it is encouraged that those are dealt with sufficient detail, including gathering all relevant data on flooding risks maps for example (see further details) and in coordination with all relevant parties. It is important to underline that, often, climate resilience aspects might require measures beyond the scope and/or responsibilities

under SUMP preparation. In this case, it will be important to still identify those risks so those can be

Climate Vulnerabilities: assessing sensitivity

How do climate hazards impact the project?



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Images say more than thousand words.

Those are illustrating the different degree of impacts on the different transport infrastructure and services by different climate hazards. It is important to see and reflect on the different kinds of impacts described previously (i.e. infrastructure damage, impacts on operation/service/functionality...).

Pictures clearly show the major infrastructure damages caused by extreme precipitation and flooding for example, and that will also entail major services disruption as we can see on the railway line, rail or metro station.

Climate Vulnerabilities: assessing sensitivity

How do climate hazards impact the project?

- Infrastructure damage
- Infrastructure operation and functionality
- Operation and maintenance
- Related economic impacts (users, interconnections)

Example sensitivity of a road project in Poland

Scoring principles

Level of sensitivity		Description	Climate Hazard	Damage and destruction of infrastructure (material losses)	Infrastructure operation/functionality and related economic impacts (incl. O&M and road users with related economic impacts)	Overall
0	No / Negligible Sensitivity	No impact	Extreme temperature occurrences (including heat waves)	Medium <ul style="list-style-type: none"> Damage to road pavements; Problems with bridges; Damage to horticultural assets (drying up) and increased need for watering; Increased fire risk 	Medium <ul style="list-style-type: none"> Traffic disturbance and congestion; Increased health and safety risks; Increased maintenance costs 	Medium
1	Low Sensitivity	Local impact	Cold spells	Medium <ul style="list-style-type: none"> Damage to road pavement, concrete structures and electro-mechanical (E/M) equipment; Slope instability and embankment failures 	Low <ul style="list-style-type: none"> Increased winter maintenance costs; Increased safety risks to users and operators (e.g., hazardous pavement conditions due to ice); Traffic disturbance and congestion 	Medium
2	Medium Sensitivity	Wide impact	Extreme rainfall events	High <ul style="list-style-type: none"> Damage to pavement and other road assets (earthworks, drainage systems, structures...); Insufficient drainage and/or retention capacity; Increased slope instability/landslides, mudslides and/or rockslides; Scouring of roads and structures supports; Flooding of pavement surface; Inundation from rivers 	Medium <ul style="list-style-type: none"> Dangerous pavement conditions; Traffic disturbance and congestion including blocking road for long periods; Increased health and safety risks to users and operators; Hazardous pavement surface conditions (slippery) and reduced visibility 	High
3	High Sensitivity	Permanent impact	Snow	Medium <ul style="list-style-type: none"> Changes to soil stability; Reduced/increased need for snow clearing and winter maintenance; Increased risk of ice/snow melting leading to increased runoff and/or flooding; Damage to E/M equipment and other installations; Changing nature and location of avalanche risk 	Medium <ul style="list-style-type: none"> Increased health and safety risks to road users and road operators due to snow and ice; Traffic disruption 	Medium

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The aim of the **sensitivity analysis** is to identify which climate hazards are relevant to the specific type of infrastructure, irrespective of its location.

It assesses the degree to which a type of infrastructure might be affected by a given climate hazard, by type of infrastructure only without considering the specificities of the project location.

Therefore, the assessment will consider:

- infrastructure damage (e.g. buckled rails, landslides),
- impacts on operation/functionality (e.g. suspending train service, passengers transfer to other service lines, blackouts)
- O&M impacts (e.g. increased needs of electricity for air conditioning, increased needs of cleaning and monitoring of drainage condition)
- Economic impacts (e.g. delays on user trips or cancellations, supply-chain impacts)

Climate Vulnerabilities: assessing Exposure

Relevant sources of assessment for current and future exposure:

- Climate projection tools/platforms (e.g. national portals on climate projections)
- Flooding risks maps (and related studies)
- Climate adaptation strategies and/or plans
 - National Adaptation Plan
 - Regional Adaptation Plans
 - Local/municipal adaptation plans

- Do not underestimate available recent meteorological data, local knowledge and evidence of recent climate incidents in the project area!



Maps of exposure: (1) Spain, Pmax, RCP8.5 medium term; (2) Portugal, wildfires, RCP8.5, medium-term.

List of sources also in Annex to [JASPERS practical sectoral guidance on climate resilience proofing](#), JASPERS November 2024

The aim of the **exposure analysis** is to identify which hazards are relevant to the infrastructure location, irrespective of the project type.

Current exposure is generally informed by meteorological data, climate incidents and local knowledge.

For future exposure, it requires of climate projections considerations. The referred sources (notably national platform for climate projections as well as any other relevant studies available from national/regional/local adaptation plans/strategies) will inform this assessment.

The most recent flooding risks maps and/or studies will enable to identify those areas that are at flooding risk (relative to the specific return periods), of specific relevance in urban areas and when those might be affecting existing transport systems and/or might have changed from the time those systems were developed. Flooding risk should also take into account impacts of climate change.

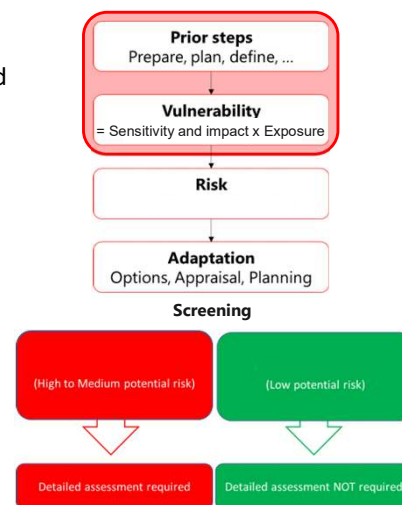
It is underlined the importance of collecting data on climate incidents that have occurred on the covered transport systems/area since those are already illustrating current climate vulnerabilities. It is highly encouraged to undertake register/monitoring of climate incidents (causes and impacts) as it represents sound basis to inform the

assessment and decisions on the adaptation needs.

Basis: Climate Change Vulnerability and Risk Assessment

Summarized:

- Identify which climate hazards the transport systems are/could be vulnerable (sensitivity/impact x exposure)
- Give insight in potential risks
- Basis for further assessment
- And need for climate adaptation measures



Mainstreaming climate resilience in the SUMP development process will enable:

- Gathering a set of reference data on climate data and climate projections relevant to the area covered and of potential use at project level.
- Identification of **main relevant climate hazards** of the area considered (i.e. climate hazards assessed with exposures rated from medium to high) with identification of **highly exposed** corridor/areas/sections (e.g. Identification of existing transport systems that are now located in areas assessed at flooding risks based on most recent maps).
- Identification of **sensitivity levels** of transport systems covered to relevant climate hazards.
- Initial **mapping/assessment of climate change vulnerabilities**.
- Considerations of **criticality levels and adaptive capacity** of transport systems. The different levels of criticality refer to the importance of the considered transport system/section in the broader system. This is of specific relevance when assessing risks levels and defining adaptation measures. Criticality levels will be generally given by aspects such as: traffic levels, redundancy (e.g. availability of other alternative connections), strategical importance, connection to critical services such as hospitals, schools, etc.

Interactive moment

- 10 minute exercise
- In small groups
- Be ready to report summary outcomes in 2 min, so please assign spokesperson



Source: <https://nypost.com/>

Interactive moment

- 10 minute exercise
- In small groups
- Be ready to report summary outcomes in 2 min, so please assign spokesperson
- Question 1: Share which are the climate/weather extremes impacts you have suffered in your SUMP area in recent years?
- Question 2: In relation to these experiences, what are the on-going or planned actions to mitigate those impacts in future?



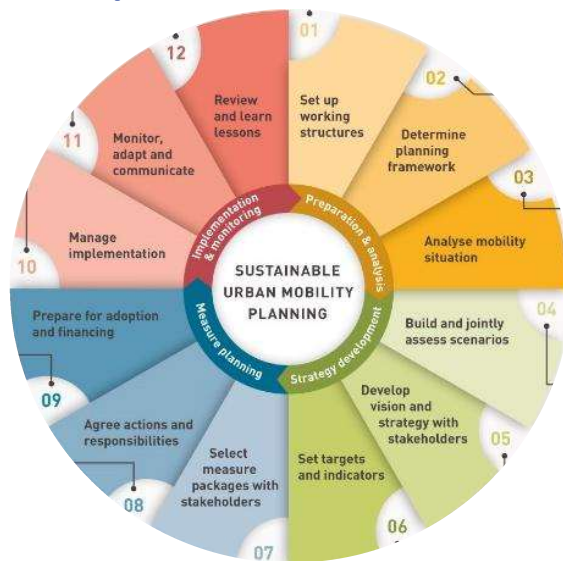
Group Task:

In groups of 3-5 people please spend 10 minutes to cover the following key tasks:

1. Discuss examples of climate-related impacts that you have experienced within your own urban area?
2. What are the current/planned actions to address these impacts?

Be prepared to present your results with the other groups (2 mins)

SUMP Steps and Climate Resilience – Phase 1



PHASE 1: PREPARATION & ANALYSIS

- ✓ Set up working structures & climate change governance
- ✓ Assessing exposure & sensitivities of transport systems to different climate hazards
- ✓ Identifying current and future climate vulnerabilities and potential risks – climate incidents

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Phase 1: Preparation and analysis

Stage 1: Set up working structures: stakeholder Engagement / inter-departemental core team

- a) Engage climate experts, environmental agencies, and communities vulnerable to climate impacts.
- b) Include adaptation experts in the SUMP planning team to provide insights on climate resilience.

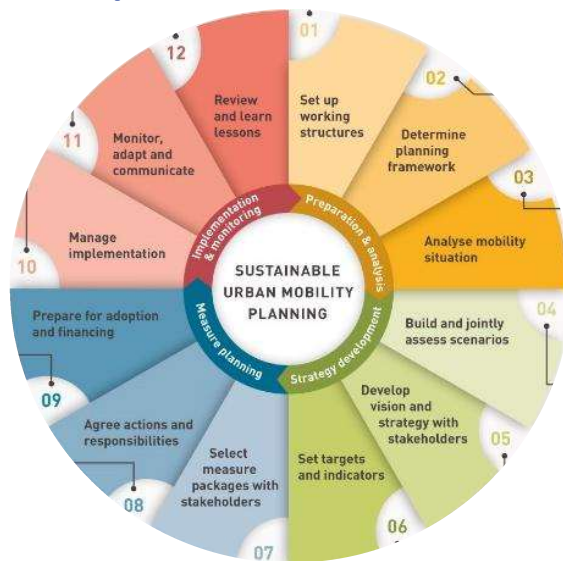
Stage 2: Determine planning framework / preparation

Incorporate climate change adaptation issues to be secured in the working process.

Stage 3: Analyse mobility situation / data collection

- a) Identify key climate risks (e.g., flooding, heatwaves) relevant to the city's transportation system.
- b) Collect data on historical and projected climate impacts on transportation infrastructure.
- c) Use climate models to predict future risks and incorporate these into the transport planning database.

SUMP Steps and Climate Resilience – Phase 2



PHASE 2: STRATEGY DEVELOPMENT

- ✓ Develop a climate resilient vision & objectives - related to acceptable levels of risks
- ✓ Set targets on climate resilience (e.g. related to minimizing climate incidents/vulnerability levels)

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Phase 2: Strategy development

Stage 4 and 5: Build and assess scenarios and develop vision and strategy

Include climate resilience and adaptation issues within scenarios, together with broader sustainability and environmental goals.

Stage 6: Set targets / define indicators

- a) ensure to include goals into the overall vision and objectives of the SUMP, for example, when it comes to the robustness of the network and the availability of alternative routes and modes of transport in case of emergencies
- b) Establish specific objectives for climate adaptation within the urban mobility plan, such as enhancing infrastructure resilience.
- c) Develop indicators to measure progress in climate resilience (e.g., number of climate-proofed infrastructures, reduction in transport disruption due to extreme weather events).
- d) Use these indicators to track and report on adaptation efforts.

SUMP Steps and Climate Resilience – Phase 3



PHASE 3: MEASURE PLANNING

- ✓ Consider climate change resilience criteria in developing/assessing planning options
- ✓ Identify climate resilience measures (e.g. criteria for projects, specific operational measures, specific investments, etc.)
- ✓ Agree on climate resilience actions & implementation responsibilities
- ✓ Prepare SUMP adoption & financing

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Phase 3: Measure planning

Stage 7: Select Measures

Identify long list of measures that enhance resilience (such as flood-resistant road designs, heat-tolerant materials, and improved drainage systems) and adaptation (green infrastructure solutions, such as enhanced public transport, permeable pavements, to mitigate heat and manage stormwater) – the Resilience analysis within SUMP can serve mainly two purposes:

- a. identify needs for interventions on the existing transport network(s) and system(s) to mitigate climate impacts (current and forecast)
- b. identify areas and corridors mostly affected by current/future extreme weather events in order to avoid them if possible and/or be aware of what issues a measure/project placed there will have to deal with (in particular in terms of climate proofing)

Stage 8: Evaluate effects of measures and agree on actions:

Assess the vulnerability of existing and proposed measures to climate impacts (based on indicators from phase 2).

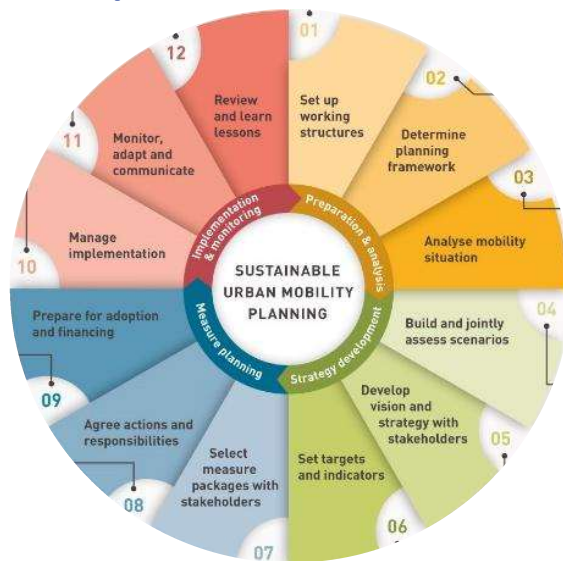
Prioritize measures that provide dual benefits for mobility and climate adaptation. b) Ensure selected measures are flexible and can be adjusted as climate conditions change.

Stage 9: Prepare for adoption and financing

Coordinate with other governments and institutions for subsidies and co-financing, take into account costs for monitoring effects, look after win-win opportunities climate

redundancy measures that simultaneously serve accessibility, strengthening multimodality or other goals of the SUMP

SUMP Steps and Climate Resilience – Phase 4



PHASE 4: IMPLEMENTATION AND MONITORING

- ✓ Monitoring of actions implementation and targets & register of climate incidents
- ✓ Operational measures (incl. user alert & response systems)
- ✓ Crisis Response Plans/Protocols - coordination among administration levels

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Phase 4: Implementation & monitoring

Stage 10: Implementation:

- a) Ensure that climate resilience measures are incorporated into all relevant transport projects and policies.
- b) Train transport authorities and staff on climate risks and adaptive practices.

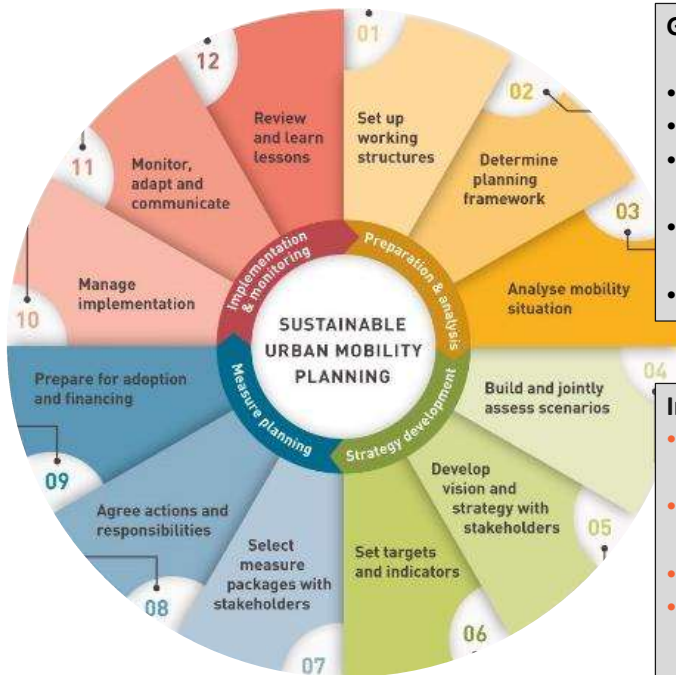
Stage 11: Monitoring and Evaluation:

- a) Continuously monitor the effectiveness of adaptation measures and make adjustments.
- b) Use resilience indicators to evaluate the impact of implemented measures, report progress.

Stage 12: Review and learn lessons

- a) Regularly review and assess the effectiveness of adaptation strategies within the SUMP.
- b) Incorporate lessons learned from extreme weather events.
- c) Update: the SUMP to reflect new scientific knowledge, technological advancements, and evolving climate scenarios.
- d) Ensure continuous stakeholder engagement to address emerging climate challenges and opportunities.

Incorporate climate change adaptation and resilience to SUMPs



General considerations for all phases

- **Collaborate** with other department sectors
- Focusing on win-win-strategies between sectors
- **Align** transport adaptation measures **with city-wide strategies**.
- **Raise awareness among citizens** about the importance of climate adaptation in urban mobility.
- Foster **community involvement** in projects.

Incorporating resilience at planning level provides (at least):

- A set of **reference climate data and climate change forecasts**
- Identification of **main climate hazards, highly exposed corridor/areas & sensitivity levels** of transport systems
- **Mapping/assessment of climate change vulnerabilities**
- Develop **efficient O&M strategy** (incl. adequate financing) to ensure climate resilience of the systems, including monitoring, early warning and response systems



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Some general considerations for all stages of the SUMP planning process.

Intersectoral Coordination

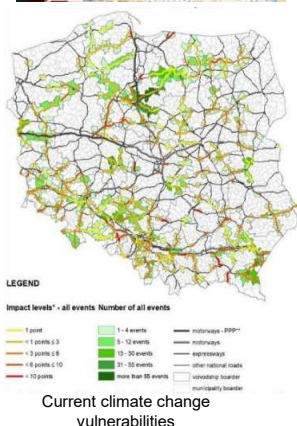
- Collaborate with other sectors (e.g., water, energy, housing etc.) to ensure a holistic approach to climate adaptation. Focusing on win-win-strategies between sectors
- Align transport adaptation measures with city-wide climate resilience strategies.

Public Awareness and Communication

- Raise awareness among citizens about the importance of climate adaptation in urban mobility.
- Foster community involvement in resilience-building activities and projects.

Here we focus on some general actions related to the guidelines for SUMP-developing.

Climate resilience: Polish National Roads



- **2017: Database of extreme weather incidents** (>3,000 over 2004-2016) based on internal survey
- **Mapping current climate vulnerabilities** of identified most relevant climate hazards: exposure (frequency of events) and sensitivity (damages, traffic disruptions)
- **Climate forecasts & workshops** - expert knowledge to assess future climate vulnerabilities
- **Basis for “Business case”**: robust economic justification for adaptation measures based on evidence data on impacts (damages costs & operation disruptions-users impacts)
- **Adaptation Action Plan** proposal: on-going discussions to identify pipeline of investments on climate adaptation considering planned upgrading programs

Source:

<https://jaspers.eib.org/LibraryNP/JASPERS%20Working%20Papers/Roads%20and%20Climate%20Change%20in%20Poland%20a%20case%20study.pdf>

The current climate vulnerability assessment for the Polish national road network was based on GDDKiA internal survey on climate incidents that have affected the network over period of about 12 years (2004-16). The analysis of this data (more than 3,000 incidents), with EIB-JASPERS assistance support, provided following conclusions:

- Identifies current main climate hazards for national road network:
 - Heavy Rain, Strong wind, Heavy snow, Flooding (pluvial/fluvial)
- Majority of incidents occurred on national roads of lower class (not A & S)
- Majority of incidents caused traffic disruptions
- **GIS** is key tool to support vulnerability analysis

Climate resilience: Infraestruturas de Portugal



- Covers road, rail and associated telematics networks
- Stage I: Climate change vulnerability and risk analysis (*completed*)
 - Climate change vulnerability assessment - a structured assessment process
 - Climate change risk assessment for relevant hazards – drawing on a robust GIS tool
- Stage II: Climate Adaptation Action Plan (*on-going*)
 - 3 Pillars: Existing network, future investments, institutional framework
 - Best basis to inform CCVRA for new investments – increased IP capacity to undertake them
 - Identify immediate needs on climate adaptation
 - Governance for climate adaptation plan and stakeholder engagement

<https://jaspers.eib.org/activitiesNP/2022/Third%20workshop%20on%20climate%20change%20adaptation%20in%20transport/3.%20Climate%20change%20resilience%20plan%20for%20IP%20networks-%20M.Pinheiro.pdf>

IP decided to launch the preparation of climate adaptation plan for their networks (road, rail and associated telematics) in 2021, and requested EIB-JASPERS technical assistance.

Stage 1 was conducted with support of Consultancy June 2022 and July 2023.

The results of Stage 1 consist of the following:

Climate change vulnerability assessment includes the following key elements:

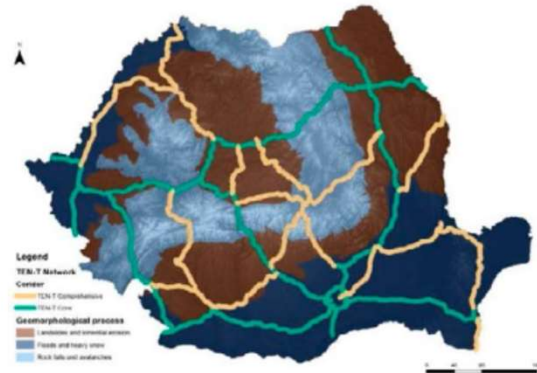
- Based on climate incidents registers
- Climate forecasts considerations
- Identified main climate hazards (wildfires, extreme temperature, flooding, strong winds...)
- Climate change risk assessment for relevant hazards including the following:
 - Probability assessed considering climate forecasts and studies (RCP4.5 & RCP8.5 scenarios and for current/mid-century/end-century)
 - Severity based on IP experts knowledge/experience on impacts (damages and service disruption)

- Build on strong IP GIS tool

Based on Stage I results, IP defined a Climate Adaptation Action Plans structured in 3 main pillars. IP management endorsed the launching of Stage 2 which is currently under development on different actions among different IP departments. It notably includes mainstreaming climate resilience on the basis of Stage I results in preparation of new projects as well as identifying immediate climate adaptation needs of the network (including based on existing/planned improvement works).

Climate change resilience: Romania

- Attention to climate related incidents in the Romanian General Transport Master Plan (2016)
- Real-time information for drivers in case of hazards
- Romania's 1st GIS geo-database developed for transport hazards



flexibility and redundancy, but also reflectiveness, resourcefulness and integration

A redundancy related example stemming from a national-level transportation master plan is that of Romania. The master plan has assessed climate change related impacts and hazards on the national TEN-T road network.

In the Romanian General Transport Master Plan (GTMP 2016) the government gave special attention to climate related incidents and hazards along the country's TEN-T road network (landslides, torrential erosion, rock falls, avalanches, floods and heavy snow)

The project was designed to identify hazards and to supply real-time safe-related traffic information for drivers by mobile application

Within this project a traveler information system has been developed, together with a GIS database that includes detailed information about transport related hazards as a result of climate change impacts. Over an area of 5000 road km, identifying 48 categories of hazards.

Link to the Romanian plan:

[https://www.europarl.europa.eu/RegData/etudes/IDAN/2015/540376/IPOL_IDA\(2015\)540376_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2015/540376/IPOL_IDA(2015)540376_EN.pdf)

Climate change resilience: Nijmegen, The Netherlands

- Project "Room for the River" at Nijmegen (1990-2010)
- Cleared out build areas meant for storage and other uses, allowing more width for the riverbed to accommodate peak flows, without flooding.
- Win-win: Reform and upgrade bridges (buslanes, active modes). Transforming mobility networks. Combining with new urban development and new recreational links



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Redundancy

Climate change measures sometimes require enormous effort. Here is an example from the Netherlands, where the major rivers from the Alps towards the North Sea bring enormous peak loads due to rain and melt water from the Alps. This is Nijmegen, near the German border, where in the period 1990-2010 the project "Room for the River" was implemented.

More width has literally been given to the river bed to accommodate peak flows, without flooding.

This also meant adjusting the bridges between the north and south sides to accommodate the wider river. This task was also used to create new recreational links, more green areas near the water for people to cool off. A new bridge was also built.

Climate change adaptation: Transport for London, United Kingdom

- Transport for London introduced white panels on the capital's buses in its climate-adaptation plans.
- White panels reflect the rays of the summer sun, keeping the vehicles cooler.
- After 10 years, 98,5% of 8.700 buses had white roofs.
- This improved the overall conditions for passengers and drivers as well as reducing fuel consumption for air conditioning systems.



Example of inclusiveness and adaptation

This is an example from London, where a simple measure contributes to the climate adaptability of the mobility system. By applying white roofs to vehicles, indoor temperatures in hot, sunny periods become less dependent on air conditioning alone.

This contributes to the health of travellers, especially vulnerable groups such as the elderly or pregnant women.

so it is an example of climate adaptivity: mitigating the impact of climate change. It is also an example of inclusiveness: measures that help vulnerable groups in particular to remain mobile

TfL have a consistent and structured approach to the management of extreme weather events. This involves using forecasting tools, risk assessments and adverse weather plans. To give their customers the best service they work collaboratively with a range of stakeholders to:

- Manage risks
- Update operational procedures
- Tell customers about changes during weather disruption
- Repair damage quickly after extreme weather events

Other key actions that are being progressed by TfL as part of their climate change adaptation strategy include:

- **Improving climate-related incident reporting:** for London Underground to improve service delivery.
- Ensuring SuDS (Sustainable Urban Drainage Systems) are a default component of project design.
- **Improving understanding of climate risk:** Managing risks through an Enterprise Risk Management (ERM) framework. Also improving understanding of climate risk through our Adaptation Reporting Power, our research programme.
- **Adaptation Reporting Power:** Regular reporting to Department for Environment, Food and Rural Affairs (DEFRA) via voluntary Adaptation Reporting Power (ARP), including a comprehensive Climate Risk Assessment.

Climate Change Resilience in Vienna, Austria

- Established green islands at bus stops – collaboration between City's PT operator 'Wiener Linien' & GEWISTA (outdoor advertising agency)
- 200 climate-adapted bus stops to enhance urban biodiversity and contribute to cooling – sedum mats (green bus stops 1-1.5°C cooler than conventional stops)
- Air conditioned buses (Wiener Linien)
- Shady benches & extension of drinking fountain network
- Pedestrian-friendly, shaded zones in reducing asphalt, adding trees, and installing mist showers.



Source: <https://climate-adapt.eea.europa.eu/en/mission/external-content/pdfs/adaptation-story>

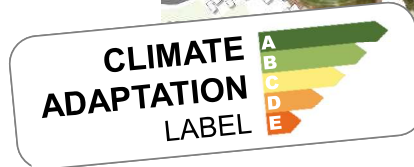
Sources of information for Climate Change Adaptation actions in Vienna, Austria include the following:

https://climate-adapt.eea.europa.eu/en/mission/external-content/pdfs/adaptation-story_kah_vienna_final.pdf/@@download/file

<https://heathealth.info/wp-content/uploads/AC16590612.pdf>

Climate change adaptation: The Netherlands

- Climate adaptation label for street designs: assessment tool to assess the climate adaptation quality of infrastructural solutions and designs
- Predictive value of projects and measures within a SUMP
- This project promotes inclusiveness through cooling streets so that vulnerable target groups can continue to travel.
- It also contributes to redundancy because with more greenery, rainwater infiltrates easily and does not lead to flooding.



Example of Inclusiveness and Redundancy (NL)

Climate change is also affecting the Netherlands: heavy rainfall is more frequent, flooding streets and putting pressure on accessibility and creating unsafe situations. There are also longer, hotter, drier periods in summer, which can cause temperatures to rise in public spaces in situations with a lot of pavement. This creates risks of health effects for vulnerable target groups. There is increasing awareness of making public spaces in cities greener. This ensures that rainwater can infiltrate better without leading to flooding. And that street temperatures decrease during summer periods. So that people can seek coolness

New tools are being designed in the Netherlands to make traffic measures more climate-adaptive. This is important because current climate change in Europe calls not only for good traffic engineering designs, but also for climate-adaptive designs.

In this example: this tool makes it possible to predict the quality of climate adaptivity of a physical redesign (street, square), based on technical drawings (Autocad)

Dealing with Harsh Winter Conditions

Cities addressing mobility in harsh winter conditions in a number of ways:

- **'Winter City' Design:**
 - Designing public spaces to encourage pedestrian (soft) mobility & better lighting helping reduce the negative perception of winter mobility.
 - Adoption of ice-melting technology for roads and pavements - preventing ice accidents & maintaining routes
 - **'Snowless'** Initiative as a sustainable alternative to traditional snow removal methods
- **Public transport enhancements:**
 - Managing higher energy consumption in winter - slow charging overnight at depots to prepare for morning routes & fast-charging on-route to heat driver cabins.
 - Equipped with winter tires and efficient heating systems that operate efficiently to manage energy use.



Climate change adaptation: opportunities of holistic approach

Priority for win-win measures that simultaneously serve multiple goals

- Stronger contribution to integral SUMP goals
- Better support for implementation measures
- More potential sources of financial funds
- More efficient use of financial resources



Win-win with road safety (Bratislava Slovakia)



Win-win with economic vitality (Strassbourg, France)

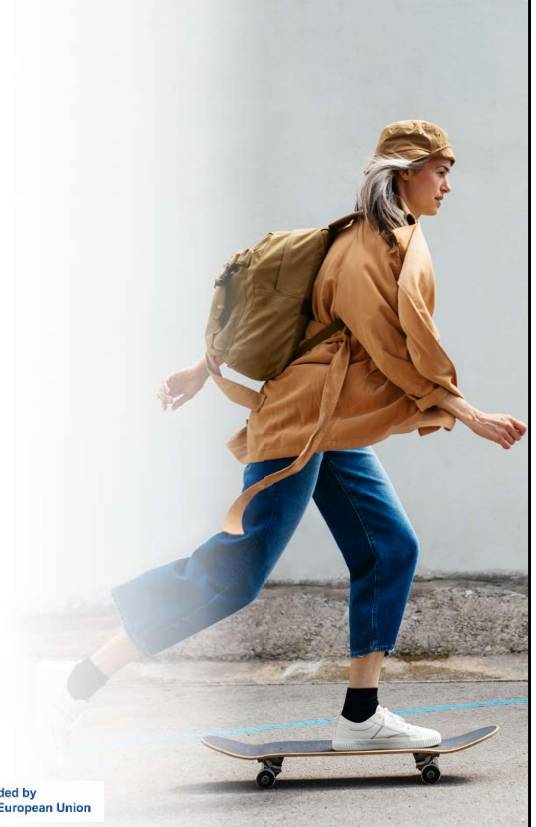


Win-win with health (Finland) and urban space (Barcelona, Spain)



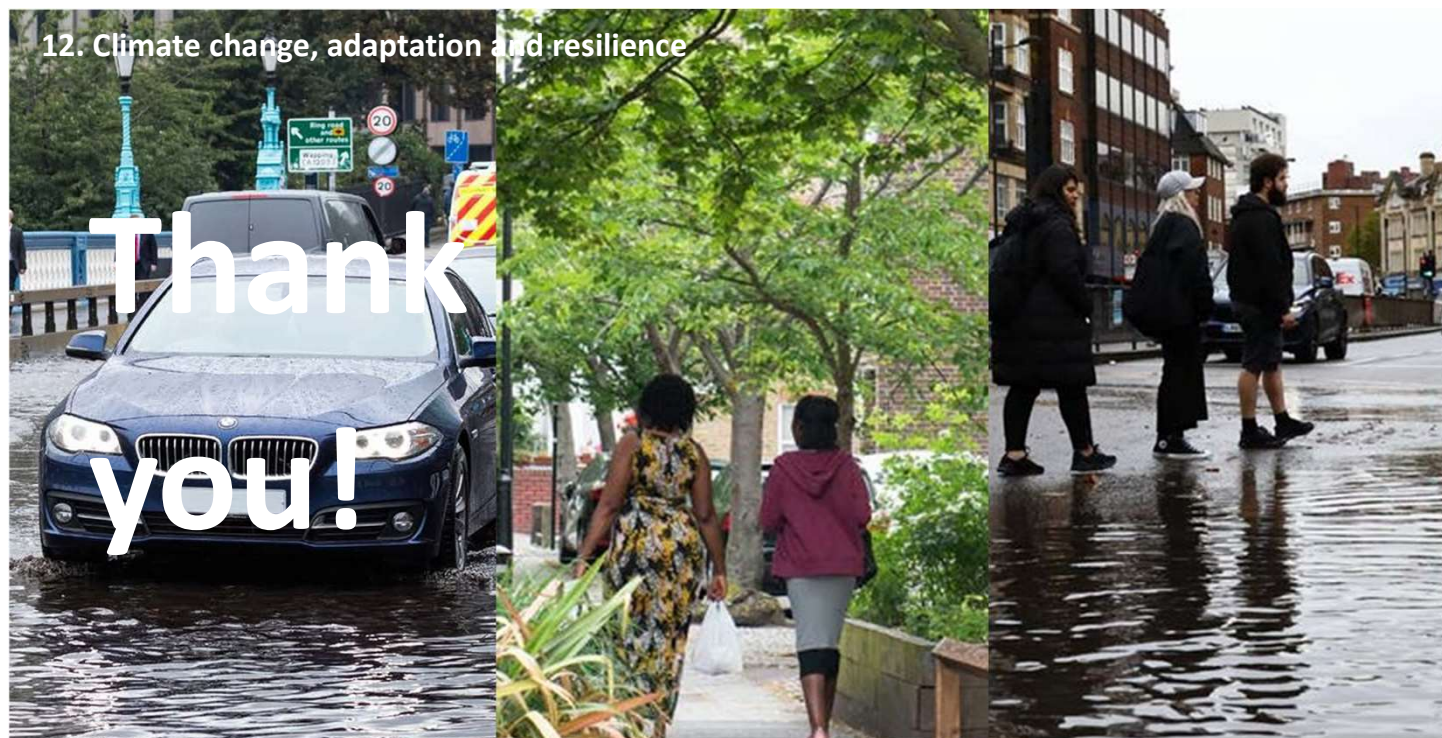
Conclusions

- Within climate-related issues, it is important to differentiate between climate change mitigation and adaptation/resilience.
- How to assess Climate Change Vulnerability in SUMPS and new infrastructure
- Have the issues relating to climate resilience been adequately reflected in all SUMP phases
- Examples and advantages of focusing on win-win opportunities



12. Climate change, adaptation and resilience

Thank
you!



Source: Photos taken from Transport for London (TfL) Climate Change Adaptation Plan 2023