Workshop on project preparation process with reference to EU and WBIF requirements

Climate Change Vulnerability and Risk Assessment

Assen Antov, JASPERS
12 October 2022, Belgrade

European Investment Bank The EU bank

Jaspers Joint Assistance to Support Projects in European Regions

European Commission

Climate Change Vulnerability and Risk Assessment

Purpose	To identify the risks for the project from climate change and formulate measures for avoiding or mitigating the negative impacts
Conditions	There needs to be clarity on the main parameters of the project
Results	Action plan for avoiding or mitigating the negative impacts of climate change
Timing	Preparation as part of the Feasibility Study; implementation of the action plan during project's lifecycle

Legal framework

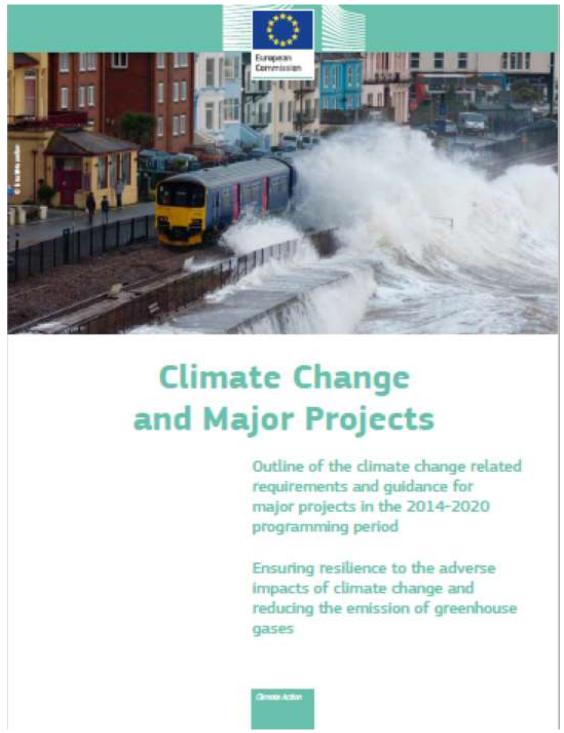
- **Invest EU Regulation** – Article 8(5) stipulates that financing and investment operations shall be screened to determine whether they have an environmental, climate or social impact

- **CEF Regulation** – Article 14(2) requires that 'the assessment of proposals against the award criteria shall take into account, where relevant, the resilience to the adverse impacts of climate change through a climate vulnerability and risk assessment including the relevant adaptation measures'

- **Common Provisions Regulation** – Article 73(2) (j) stipulates that the managing authority in selecting operations shall ensure the climate proofing of investments in infrastructure with an expected lifespan of at least five years

Methodology

- Recommendations for methodology included in EC's "Climate Change and Major Projects" (2016)



- The methodology is reproduced in EC's "Technical Guidance on the Climate Proofing of Infrastructure Investment Projects in the period 2021-2027" (2021)

Definitions and concepts (1)

- **Climate change adaptation** – the process of improving the resilience of infrastructure to climate change

- **Climate change mitigation** – human intervention aimed at limiting the emissions of greenhouse gasses or improving their absorption rates

- **Climate proofing** – includes *both* climate change mitigation and adaptation; one of the three pillars of *sustainability proofing*, i.e.: climate, environmental and social proofing

Definitions and concepts (2)

- **Extreme weather-related events** – the main subject of analysis within the framework of climate change vulnerability and risk assessments (examples to follow)
- Extreme weather-related events result in **negative impacts** on the components of infrastructure (i.e. of the *assets*), as well as on the users (i.e. on the *services*)
- Extreme weather-related events are directly linked to the changes of one or more **climate variables / indices**

  (e.g. maximum volume of precipitation for 1 – 5 days during the year, number of days with snow cover, number of days with precipitation above a certain threshold, number of dry days, number of days with precipitation, average daily / monthly / annual temperature, minimum / maximum temperature, etc.)

Definitions and concepts (3)

- **Vulnerability assessment** – combines *qualitative* measures of the sensitivity of the project to extreme weather-related events and its exposure to the events with the purpose to identify the most important vulnerabilities:

Vulnerability level = Sensitivity level x Exposure level

- **Sensitivity** – a measure of the strength of the negative impacts from the occurrence of an extreme weather-related event. It is determined independent of project's location

- **Exposure** – a combined measure of the *strength and frequency* of occurrence of an extreme weather-related event, considering project's location

Definitions and concepts (4)

- **Risk analysis** – combines (usually) *qualitative* measures of the impact and probability of occurrence of extreme weather-related events, in order to identify the most important risks for the project:

Risk level = Impact level x *Likelihood level*

- **Impact** – a measure of the strength of the negative impact of the occurrence of a risk (i.e. extreme weather-related event)

- **Likelihood** – a measure of the probability of occurrence of a risk (i.e. extreme weather-related event)

Examples

Terrain instability (as a result of intense rainfall)

Examples

Flood

Examples

Damaged road construction (as a result of intense rainfall)

Examples

Damaged road construction (as a result of high river levels)

Examples

Damaged pavement (as a result of freezing-thawing cycles)

Examples

Low visibility (because of fog)

Examples

Destroyed bridge (as a result of foundation scour)

Examples

Damages to property from hail

Examples

Collision of multiple vehicles (as a result of low visibility, because of snow)

Quality criteria:

1.1 How was CC considered in the project preparation process (i.e. as a factor in the option analysis or with an ex-post assessment)?

- It is highly recommended that the CC VRA is integral part of project preparation (i.e. *ex-ante* analysis)
- It is also acceptable to take CC into account at later stages (i.e. with *ex-post* analysis)

1.2 What extreme weather-related events are considered?

- A summary of the extreme weather-related events being analysed

1.3 Is the list of events exhaustive and detailed enough?

- The list needs to cover a sufficiently big set of potential vulnerabilities
- It is critical to specify the link:

cause ⇒ event ⇒ negative effects

- Also critical to explicitly link the extreme event and climate variables

1.4 Are the potential *negative effects* on the project identified for each event?

- The negative effects from the extreme weather-related events must be identified in detail
- The effects on *assets and services* must be separately evaluated
- The assessment must consider the expected *lifetime* of the infrastructure components
- It is possible to consider the effects on separate infrastructure components – e.g. pavement, drainage, structures, accessories, etc.

Examples

Definitions of extreme events

Example 1:

- Extreme temperatures

The definition is **too general** – extremely high temperatures have completely different impacts on the infrastructure than extremely low temperatures.

Examples

Definitions of extreme events

Example 2:

- Extremely high temperatures
- Extremely low temperatures

☺

The more specific definition allows the events to be connected to:

- specific *causes* through meteorological variables (e.g. minimum / maximum temperature for the year, number of days with temperature lower / higher than a threshold, number of hot / cold days, etc.); and
- specific *negative effects* (e.g. higher / lower bitumen plasticity, hence emergence of rutting / cracks; pavement aging; bridge dilation issues; etc.)

Examples

Definitions of extreme events

Example 3:

- Extreme precipitation

Too general definition – rain, snow and hail have different negative effects on the assets and services.

Examples

Definitions of extreme events

Example 4:
- Extreme rainfall
- Extreme snowfall
- Hail

☺

The more specific definition allow the events to be connected to:
- specific *causes* through meteorological variables (maximum rainfall for 1 or 5 days; number of wet days; maximum / average snow cover; number of days with snowfall; number of days with hail; etc.); and
- specific *negative effects* (e.g. reduced visibility; reduced traction; damages to embankments / cuts; increased costs for cleaning of snow; interruptions of operation …)

Examples

Definitions of extreme events

Example 5:

- Extreme snowfall

☺

Causes (defined by observable meteorological indices):

- maximum snowfall for 1 or 5 days
- maximum and average height of the snow cover
- number of days with snowfall
- number of days with snow cover

Negative effects (expressed by the direction of change in economic costs):

- ↓ visibility ⇒ ↑ risk of accidents ⇒ ↑ economic costs
- ↓ traction ⇒ ↑ risk of accidents ⇒ ↑ economic costs
- intensive snowmelt ⇒ excess capacity of drainage systems ⇒ damage to embankments/cuts (⇒ damage to the road structure) ⇒ ↑ repair costs
- ↑ costs for pavement treatment and snow removal
- ↑ emergency response costs
- disrupted operation ⇒ ↑ economic costs

2.1 Is the sensitivity of both *assets* and *services* separately considered?

2.2 With regard to sensitivity of assets, is the *lifetime* of the asset noted and taken into account?

2.3 Is sensitivity also considered from the point of view of *interdependencies*?

- The sensitivity of the *assets, services and the links* between the systems must be evaluated as a minimum
- Even better is to evaluate the sensitivity of the *infrastructure components* and different *aspects of the services*
- The *lifetime* of the assets should me considered in the evaluation

2.4 Are *sensitivity* levels defined?

- Usually 3 levels are defined – *low*, *medium* and *high*
- At this stage, it is not strictly necessary to search for quantitative (objective) measure of the levels

2.5 Is sensitivity determined independent of project's location (that is, independent of its exposure)?

- The sensitivity considers the strength of the negative effects *in case* of occurrence of an extreme weather-related event

Examples

Sensitivity analysis

SENSITIVITY ANALYSIS

Sensitivity table: *(example)*		Climate variables and hazards			
		Flood	Heat	...	Drought
Themes	On-site assets, ...	High	Low	...	Low
	Inputs (water, ...)	Medium	High	...	Medium
	Outputs (produts, ...)	High	Medium	...	Low
	Transport links	Medium	Low	...	Low
	Highest score 4 themes	High	High	...	Medium

The output of the sensitivity analysis may be summarised in a table with the sensitivity ranking of the relevant climate variables and hazards for a given project type, irrespective of the location, including critical parameters, and divided in e.g. the four themes.

To evaluate sensitivity, four categories (themes) are used. The highest occurred level is awarded, which leads to a too conservative analysis. Unclear what the sensitivity levels mean.
(Also, too general definitions of the events.)

2.6 Are the sources of current and future climate data used listed?

2.7 What is the level of aggregation of the data used in the analysis (EU-level, national, regional) and is it adequate?

- The sources of data and climate forecasts must be listed
- The data and forecasts must be sufficiently detailed and to consider the local specifics
- For evaluation of past climate trends, local data must be used
- For evaluation of future trends, it is acceptable to use forecasts and models at macro level (e.g. EU)

2.8 Does exposure adequately take into account the location of the project?

- … i.e. the expected strength and frequency of the extreme weather-related event at the specific location
- *The exposure is likely to be different for different parts of the project!*

2.9 Are present and future exposure determined separately?

- Future exposure must also be evaluated.

2.10 Are exposure levels clearly defined?

- Usually three exposure levels are used

Examples

Exposure analysis

EXPOSURE ANALYSIS

Exposure table: *(example)*	Climate variables and hazards: Flood	Heat	...	Drought
Current climate	Medium	Low	...	Low
Future climate	High	Low	...	Medium
Highest score, current + future	High	Low	...	Medium

The output of the exposure analysis may be summarised in a table with the exposure ranking of the relevant climate variables and hazards for the selected location, irrespective of the project type, and divided in current and future climate. For both the sensitivity and exposure analysis, the scoring system should be carefully defined and explained, and the given scores should be justified.

It is unclear what the exposure levels mean. Considering the higher of the two levels (for present and future exposure) makes the analysis too conservative.

Examples

Definition of exposure levels

Levels of exposure to floods:

- *Low* – unthreatened territory or with flood recurrence interval of more than 100 years
- *Average* – territory with flood recurrence interval between 20 and 100 years
- *High* – territory with flood recurrence interval lower than 20 years

☺

The definition of exposure levels allows unambiguous interpretation and link with quantitative indicators.

2.11 Is the sensitivity vs. exposure matrix unambiguously defined?

- The matrix must reflect the sensitivity and exposure levels and show the resulting vulnerability levels

2.12 Is the ranking of vulnerabilities in accordance with the levels proposed by EC's "Climate Change and Major Projects"?

- Usually three levels are used

Examples

Vulnerability analysis

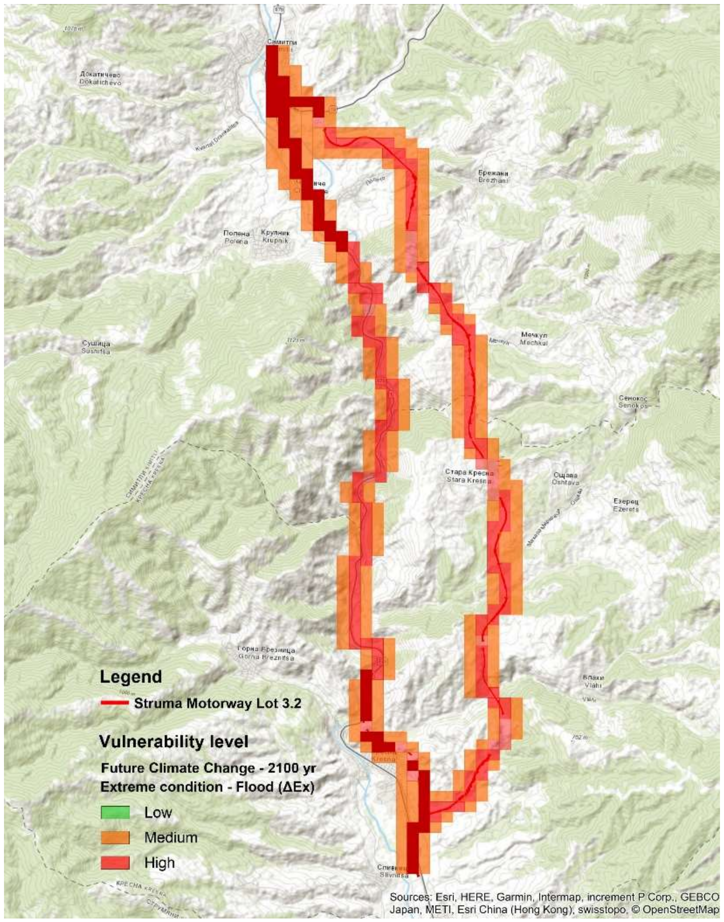
Vulnerability table: *(example)*		Exposure (current + future climate)		
		Low	Medium	High
Sensitivity	Low			
(highest,	Medium		Drought	
4 themes)	High	Heat		Flood

Legend:
Vulnerability level
Low
Medium
High

The meaning of the different vulnerability levels must be defined. The analysis is too conservative – using this methodology projects get classified with medium to high vulnerability to almost all extreme weather-related events

Examples

Vulnerability analysis



☺

Using GIS the future vulnerability is determined for discrete spatial units.

2.13 Common sense check – are there any vulnerabilities that seem under- or overrated?

- An attempt to eliminate *serious errors* and omissions

2.14 Is there a conclusion whether the project is considered vulnerable or not?

2.15 If the project is not considered vulnerable, is this conclusion justified by the vulnerability analysis?

- Using the methodology from “Climate Change and Major Projects”, in reality there is no chance the project is considered non-vulnerable…

3.1 Are the most important vulnerabilities carried to the risk assessment (i.e. the ones with high and medium level)?

- Often consultants continue evaluating *all* vulnerabilities…

Vulnerability table: *(example)*		Exposure (current + future climate)		
		Low	Medium	High
Sensitivity	Low			
(highest,	Medium		Drought	
4 themes)	High	Heat		Flood

3.2 Does the probability scale follow the recommendations of EC's "Climate Change and Major Projects"?

- (Not mandatory)
- The levels must be compatible with the qualitative risk analysis of the project

LIKELIHOOD ANALYSIS

Scale for assessing the likelihood of a climate hazard (example):

Term	Qualitative	Quantitative (*)
Rare	Highly unlikely to occur	5%
Unlikely	Unlikely to occur	20%
Moderate	As likely to occur as not	50%
Likely	Likely to occur	80%
Almost certain	Very likely to occur	95%

The output of the likelihood analysis may be summarised in a qualitative or quantitative estimation of the likelihood for each of the essential climate variables and hazards.
(*) Defining the scales requires careful analysis for various reasons including e.g. that the likelihood and impacts of the essential climate hazards may change significantly during the lifespan of the major project (due e.g. to global warming and climate change). Various scales are referred to in the literature

3.3 How are likelihoods determined and is the method reasonable?

- It is important to determine likelihood levels based on actual statistical data
- “Expert opinion” is not the recommended approach

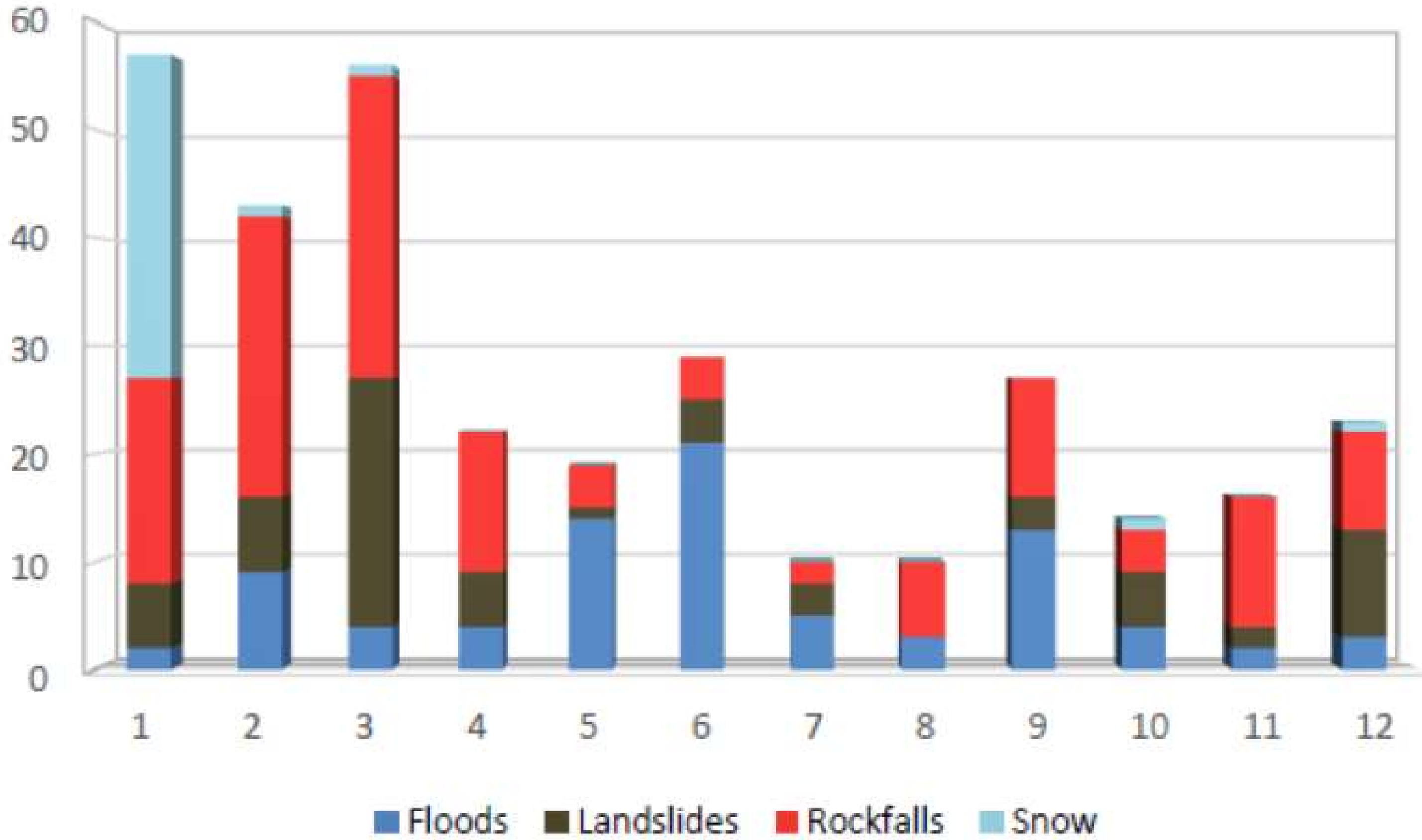
3.4 Common sense check – are there any likelihoods that seem under- or overrated (both in absolute terms and relative to each other)?

- An attempt to identify and address serious errors and omissions

Examples

Data for the frequencies of extreme events

Number of extreme weather-related events on railway infrastructure (2012 – 2017)



Source: National strategy and action plan for climate change adaptation (Bulgaria, 2018)

3.5 Does the severity of impact scale follow the recommendations of EC's "Climate Change and Major Projects"?

- (Not mandatory)
- There are five levels – *insignificant*, *minor*, *moderate*, *major*, *catastrophic*
- The levels must be compatible with the qualitative risk analysis of the project

3.6 Are adequate criteria ("risk areas") taken into account when assessing the severity of impacts?

- The impact level of a risk depends on the values and objectives of the evaluators, i.e. it is subject to *multi-criteria analysis* (or even cost-benefit analysis)
- Risks must be *mutually independent*
- The analysis must distinguish between *risks* and their *effects*
- It is highly recommended that the different impact evaluation criteria ("risk areas") are *quantitatively determined*
- The impact evaluation criteria must also be *mutually independent*
- It is extremely important to define the *strength of occurrence* of each risk, because the impact depends directly on it

Examples

Criteria for evaluation of the impacts of risks

IMPACT ANALYSIS

Scale for assessing the potential impact of a climate hazard (example): Impacts: / Risk areas:	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational					
Safety and health					
Environment					
Social					
Financial					
Reputation					
Overall for the above-listed risk areas					

The impact analysis provides an expert assessment of the potential impact for each of the essential climate variables and hazards.

Too general and ambiguous criteria – what is “Engineering”, and how is it supposed to be evaluated? What exact effects does “Social” represent? Why someone’s reputation is considered of equal importance with the health and safety of the public? What does “Environment” evaluate (the analysis must be focused on how CC affects the project)?

Examples

Criteria for evaluation of the impacts of risks

- Costs for the operators of infrastructure assets (e.g. repairs, emergency response, loss of income, etc.)
- Health and safety (of the users and the personnel of the operators)
- Costs to users because of interrupted services (e.g. increased traveltime, increased operational costs)
- Social impacts (e.g. reduced access to social services, to agricultural land, isolation of communities, etc.)

😐

The negative effects are specific and can be quantified. If they are further decomposed to sub-criteria, it will be possible to quantify most of them in terms of economic costs.

Examples

Data, supporting the evaluation of impacts

Damages to railway infrastructure from catastrophic events (2012 – 2017)

Event	Events (number)	Events with damages (number)	Damages (BGN)	Damage (%)
Floods	84	14	7,007,558	37.8
Landslides	69	6	10,724,672	57.9
Rockfalls	139	14	723,709	3.9
Snow	34	8	78,494	0.4
Total	**326**	**42**	**18,534,433**	**100**

Source: National strategy and action plan for climate change adaptation (Bulgaria, 2018)

3.7 Are the risk areas focused on risks in the project context and are they sufficiently detailed?

- The criteria must evaluate the impacts *on the project*

3.8 When determining the severity of impacts, are existing adaptation measures external to the project taken into effect?

- If there are such measures, they need to be taken into account

3.9 Does the analysis consider any planned adaptation measures ?

- The analysis *must not take* into account adaptation measures, planned or implemented in the project context

3.10 Common sense check – are there any impacts that seem under- or overrated (both in absolute terms and relative to each other)?

- An attempt to identify serious errors and omissions
- Pairwise comparisons of impact levels

3.11 Does the probability vs. severity scale appear unbiased (e.g. not too optimistic?

- It is recommended to work with 3 risk levels
- The risk matrix must be unambiguously defined
- The scale must ensure *weak consistency* between the risk levels and the quantitative interpretation

Risk table:	Overall impact of the essential climate variables and hazards (example)				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Rare				Flood	
Unlikely			Drought		
Moderate			Heat		
Likely					
Almost certain					

3.12 Are risk levels determined correctly in accordance with the risk matrix?

- I.e. if the calculations are correct…

3.13 Common sense check – are there any *risks* that seem under- or overrated (both in absolute terms and relative to each other)?

- An attempt to identify serious errors and omissions
- *Pairwise comparisons of risk levels!*

3.14 Are *prevention and mitigation measures* identified for each risk?

3.15 Are the measures reasonable and realistic?

3.16 How are any *adaptation options* compared?

- *Adaptation options* – possible measures for risk prevention and/or mitigation of impacts
- In the CC VRA context, usually *it is not necessary* to formulate and compare adaptation options, and an action plan can be directly defined

3.17 Is there a detailed and realistic action plan?

3.18 Are the entities responsible for enacting the adaptation options properly identified?

- Perhaps the most important part of the analysis is the identification of *measures to avoid risks and/or mitigate their impacts*
- The measures must be detailed and specific in terms of *scope, responsible entities, time and budget*
- The responsible entities must have the *duty to implement the measures*
- *Following up of the implementation* of the plan must be ensured

3.19 Is there an interpretation of the risk matrix included and does it properly address the levels of *residual risk*?

3.20 Do residual risks appear correctly determined?

3.21 Are there any *significant residual risks* to be left after implementing the adaptation actions?

- There needs to be an explanation how the adaptation measures influence the risks – i.e. the probability of their occurrence and/or their impact
- Verification whether the residual risk levels actually reflect the consequences of the mitigation measures
- Verification whether there are significant residual risks – there must be none

Wider issues

- A good place to start with increasing the adaptation capacity is the development of
  national climate change adaptation strategies and action plans

- Identifying vulnerabilities at project level is problematic. It is much better to develop
  country-wide vulnerability assessments

- For transport networks, it may be feasible to develop
  country-wide criticality assessments

- In order to be able to improve adaptation capacity, it is critical to review and improve
  the data collection and management systems

Coffee break