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ROADAPT
Roads for today, adapted for tomorrow

Guideline: Part B
performing a Quick scan on risk due to climate change

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CEDR Call2012: Road owners adapting to climate change

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Performing a Quick scan on risk due to climate change

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Executive summary

This is the ROADAPT Guideline to the Quick scan method. The Quick scan was developed to quickly and easily determine the effects of climate change on infrastructure. The guideline is based on the RIMAROCC methodology and was verified via 3 case studies.

The Quick scan works towards determining which threats and resulting risks are relevant to the infrastructure and region under consideration and require action from the responsible organisation. As such, the analysis starts by determining the research area boundaries as well as current- and future- climate changes. Subsequently, stakeholders are engaged to provide input during interactive workshops. In total the workshops should not take more than 2 days.

The first workshop focuses on the determination of the boundary conditions of the Quick scan and on relevant climate changes and on the consequences of the, resulting, most relevant threats.
Workshop II determines the risks associated with the identified threats. This is done by making an estimate of the probability of a threat, together with an identification of locations of the high risk threats.
The third workshop focusses on the development of an appropriate action plan for further steps after the Quick scan.

A table with a list of possible threats plays a central role in the different steps. It starts with a longlist of possible threats that will be explored for time horizon, probability and consequences.

The Quick scan method is based on semi quantitative input from relevant stakeholders and makes use of certain probability and consequence classes instead of exact numbers.

1 Introduction

Infrastructures are the backbone of our society. Citizens, companies and governments have come to rely on and expect uninterrupted availability of the road network. Extreme weather is an important factor for the reliability and safety of the road network. At the same time it is generally understood that the climate is changing and that this will have significant effects on the road infrastructure. Since road infrastructure is vital to society, climate change calls for timely adaptation.

Although there are considerable uncertainties involved in both the projections of future climate change and related socio-economic developments and in estimations of the consequences of these changes in transportation needs, there is a constant need for decisions and development of the road transport system. As stated in the CEDR 2012 Climate Change DoRN: *'Road authorities need to evaluate the effect of Climate Change on the road network and take remedial action concerning design, construction and maintenance of the road network.'*

The ROADAPT project is part of this CEDR Call. ROADAPT has an integral approach following the RIMAROCC (Risk Management for Roads in a Changing Climate) framework that was developed for ERA NET ROAD in 2010. ROADAPT aims at providing methodologies and tools enabling tailored and consistent climate data information, a good communication between climate researchers and road authorities, a preliminary and fast quick scan for estimating the climate change related risks for roads, a vulnerability assessment, a socio economic impact analysis and an action plan for adaptation with specific input from possible adaptation techniques related to geotechnics and drainage, pavements and traffic management.

Outputs of the ROADAPT project are guidelines that address all these topics. In the main guidelines an overview of all topics is provided. In five following parts the specific topics are addressed in detail. These five parts are:

A. Guidelines on the use of climate data for the current and future climate
B. Guidelines on the application of a QuickScan on climate change risks for roads
C. Guidelines on how to perform a detailed vulnerability assessment
D. Guidelines on how to perform a socio economic impact assessment
E. Guidelines on how to select an adaptation strategy

The underlying guideline is part B.

2 Quick scan methodology

2.1 Objectives

The objective of the Quick scan is a first (quick) estimate of what the major risks are that can be associated with weather conditions both in the current climate and in the future, together with an action plan for adaptation. The list of top risks allows a road authority to consciously and effectively focus on specific areas in their network and/ or on specific threats. This means that by focusing on the 'top' risks, they are using their resources efficiently.

Consequently, once the major risks have been determined it seems prudent to analyse the risks in more detail, taking the local situation into account: what are the actual consequences? What is the actual probability? Are there any local circumstances that may change these factors? This latter assessment is not part of the Quick scan, but will be addressed in an action plan. The activities in this plan should lead to the actual level of risk and thus also be the basis of a final decision of a road authority if any measures are required.

The RIMAROCC framework (Bles et al., 2010) and the other ROADAPT guidelines provide help for these more detailed analyses.

2.2 Challenges

The main challenge is to reach the objectives via a quick and efficient process that is applicable throughout Europe.

The effects of climate change are variable and the surrounding environment may also differ strongly, as do building designs. This leads to a large variety of subsequent risks. The challenge of this guideline is to determine the relevant threats quickly and efficiently without leading to 'false negatives' i.e. locations where no risks seem present but in reality are relevant.

2.3 Use of RIMAROCC framework

In Bles et al. (2010) a method is described that road owners can use to do a climate change risk assessment. This is done by using 7 steps of the so called RIMAROCC framework (see figure below). These steps facilitate in the identification of risks due to a changing climate, together with the consequences of the risk. When risks are evaluated as being unacceptable for the road owner, risk mitigation has to take place, followed by implementation of action plans and monitoring of results. The RIMAROCC framework provides the general methodology that needs to be used on different levels of analysis (both geographical scale and level of detail).

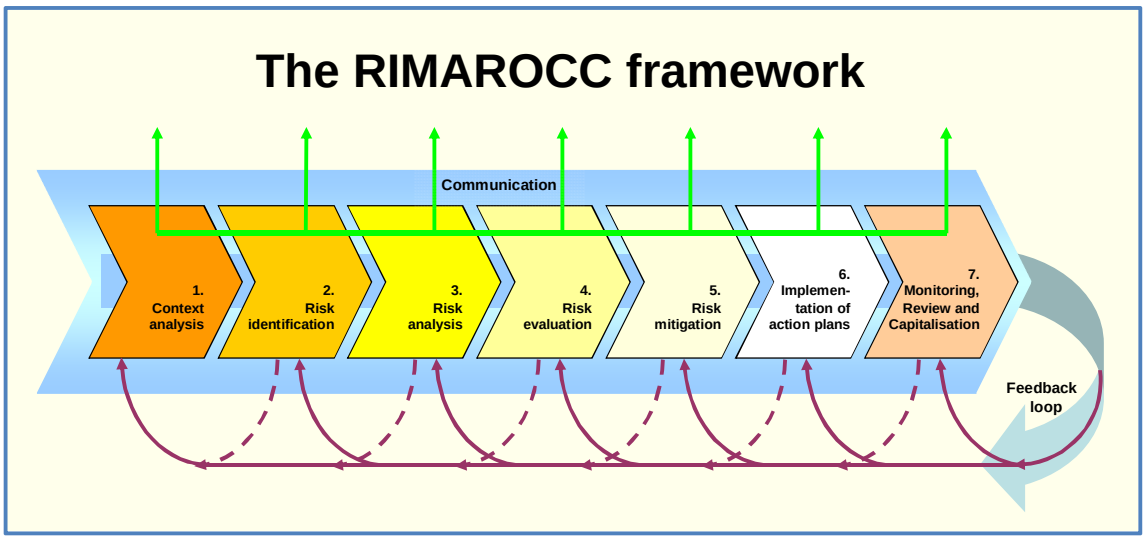


Figure 1: The RIMAROCC framework; bles et al. (2010)

It was felt by NRA's that a specific recommendation was necessary on how to use the RIMAROCC framework in practice in a more simplified form, a so called Quick scanQuick scan.

When performing a Quick scan all main steps in the RIMAROCC framework are being executed explicitly, but with some simplifications, enabling to obtain a first impression on the risks related to climate change. Afterwards one can perform, if seemed necessary from the output of the Quick scan, a more detailed risk assessment on specific risks or locations. The RIMAROCC steps are than followed again but more in depth. This also reflects the iterative character of risk management, visualized by the feedback loop in the RIMAROCC framework.

The Quick scan covers the steps 1 to 5.2 of the RIMAROCC framework. An overview is given in annex II, showing how the RIMAROCC steps compare to the ROADAPT steps. In chapter 3, in the description of the Quick scan steps, always a reference is being made to the specific RIMAROCC step under study. Due to the nature of the Quick scan, being quick and less detailed, no feedback loop takes place during the performing of a Quick scan itself. Also, some steps are in a slightly different order than proposed in the RIMAROCC framework. This is necessary in the Quick scan strategy to come to conclusions fast, with the basic approach to work from coarse steps in the beginning to more defined steps at the end of the Quick scan with minimum resources.

2.4 General description of the Quick scan method

The basis of the Quick scan method is to bring all available knowledge, information and especially experiences of stakeholders together in such a way that a founded first impression of climate (change) risks can be assessed. This implies that no quantitative and extensive analyses will be executed, but that the outcomes rely on the valid input of relevant stakeholders.

The Quick scan method comprises of 3 workshops where the stakeholders interact and provide input. All workshops are preceded by a desktop study processing the results of the

previous workshop and/ or preparing the next workshop. Following the last workshop, the results are wrapped up and provided in a report. This leads to 7 phases:

1. Desktop study before first workshop
2. Workshop I
3. Desktop study between workshop I and II
4. Workshop II
5. Desktop study between workshop I and II
6. Workshop III
7. Analysis of results and reporting

The first workshop focuses on the determination of the boundary conditions of the Quick scan i.e. which climate changes are to be expected, which threats do they influence and what are the consequences should a threat occur. Obviously, this step requires at least general knowledge of to be expected climate changes as these lay at the basis of any threats.

Workshop II determines the risks associated with the identified threats. This is done by making an estimate of the probability of a threat, together with an identification of locations of the high risk threats.

The third workshop focusses on the development of an appropriate action plan for further steps after the Quick scan.

A table with a list of possible threats is a central theme in the different steps. It starts with a longlist of possible threats that will be explored for time horizon, probability and consequences. This helps to reduce the number of relevant threats and to come up with a risk profile at the end of step 5. Step 6 focuses only on a small amount of threats from this table to result in the action plan for adaptation.

The Quick scan is executed in a semi quantitative manner, making use of certain probability and consequence classes instead of exact numbers. This requires a certain mindset of the participants. Also it should be stressed that the used consequence classes and probability classes do not reflect actual consequences or probabilities but are used solely to be able to compare the different risks thus leading to a ‘top priority’ list. Actual consequences and probabilities should be determined (as far as possible) in a location specific and more detailed analysis.

The authors consider it to be very important to use workshops, instead of individual interviews and/or questionnaires. Part of the power of the developed Quick scan methodology lies in the mutual exchange of information and increasing joint awareness. When using an individual approach these benefits are lost. Moreover, there will be a high risk of not reaching uniformity in the answers of the different participants.

2.5 Specific remarks

Climate change
Scenarios are often used to discuss possible climate change. However such projections are based on variables that are in part very difficult to predict e.g. Green House Gas emissions (depends on human actions), eruptions of volcanoes, solar activity, El Niño, etc. Therefore it is impossible to make an exact prediction of the climate change. As a result climatologists work with scenarios which show different climate changes. A reference is made here to Part A of the ROADAPT guideline on the use of data for the current and future climate for road infrastructure.

Prior to the first workshop, the projected climate changes of the scenarios should be known. Either a climate specialist should be present during the first workshop or one should be consulted. During the first workshop, all climate scenarios should be taken into account as this first part of the Quick scan aims to reduce the number of threats from a long list, without wrongly disregarding any threats i.e. keep the climate change projections as broad as possible,

During the second workshop, probabilities are to be given to the most remaining threats. During this part of the Quick scan, a 'worst case' approach is suggested i.e. use the worst climate change scenario.

Workshops
Please note that although the above Quick scan outline is suggested, variations are possible, depending on the organizer's own ideas and the situation. If deemed feasible, the workshops may be combined into two or even one larger workshop. However be aware that some preparation is required between the workshops. In addition, keep in mind that the workshops do require quite some time.

Participants
The fact that the size of the risks are determined based on the assessment of the participants, as opposed to extensive research, also emphasizes the importance of having the right people at the workshop. Experience gained during the case studies show that generalists with experience in varying specialities e.g. engineering, traffic coordination, public affairs, economy, etc provide an effective mix. Depending on the scope of the analyses, the participants should preferably have experience with the scale at which the infrastructure is being looked at. Example: if a network is being analysed at on a country scale, the participants may consist of persons from the national road authority. Similarly, if only a road section is being looked at, then persons from a local road authority may prove more effective.

Workshop I has a focus on the determination of the relevant (to expected climate change) threats as well as on the various aspects (criteria) of the consequences of a threat actually influencing the road.
Concerning the latter, should a certain threat occur, then it may for example influence both the safety of the road and it's users as well as the availability of the road. Also the reputation of the road owner may be effected, amongst others. Therefore it is desirable to invite participants that understand/ have a feeling for the consequences of a threat.

The various aspects that should be taken into account are given below.
- Availability
- Safety
- Effects on surrounding network
- Direct costs
- Reputation
- Environment

Given the above, the following experience/ expertise is suggested:
- Transport expertise (effects on surrounding network, availability and safety)
- Economic expertise (effects on surrounding network, direct costs)
- Road engineering (safety, direct costs, environment)
- Cost expertise (direct costs)
- Traffic control expertise (safety, availability)
- Communication expertise (reputation)

Workshop II has a more technical focus: should a threat occur, how big is the probability that it actually effects the road? And where may such a threat affect the road. Input by the participants on the latter will partially be given based on experience. Therefore it seems reasonable to have participants present that are more closely connected with the road and/ or road maintenance. Suggestions are given below:
- Climate change specialist
- Engineers for specific threats
    - Hydraulic engineer
    - Geotechnical engineer
    - Geologist
    - Pavement engineer
    - Road engineer
- Road asset owner with local experience
- Asset owners of existing hazard protection assets (eg. levee boards)

Workshop III focusses on making an action plan. It seems logical to perform this step with a mix of the above mentioned participants as they are already familiar with the case and methedology.

Also note that it may be beneficial to the efficiency of the Quick scan to work with the same group of participants throughout the process. This may prevent repeating the explanation of the project background, the Quick scan methodology and the results of the previous workshop(s). Moreover the participants get to see the results of previous steps i.e. they feel connected/ responsible for the end result. On the other hand, not all aspects of the workshops may appeal to a broad group and participants may feel that their time is not being used efficiently. It is advised to make a conscious choice on this matter, depending on the character of the group and the nature of the analysis.

Standardisation
Note that the Quick scan methodology is not developed to provide either actual probabilities nor actual consequences. Therefore these factors may not be ‘taken out of the context of the study’, i.e. these main input parameters are needed solely to be able to compare the relative size of the risks of the various threats within the context of the Quick scan. Experience shows that time consuming discussions may occur when this context is not clear to the participants. Therefore these factors need to be determined uniformly and consistently for every threat allowing comparison of the size of the risks.

During the analyses, the highest level risks are focussed upon during following steps and the lower level risks are not looked at in more detail. This is done based on a ranking. However because consequences and probabilities are determined based on the initial assessment by the participants based on their experience, the resulting ranking should be seen as a 'general indication', i.e. one should not focus on the ranking number itself (example: "the risk level is second highest") rather than note that a risk has a higher or lower risk level. This also means that during the analyses, the highest ranking 'lesser risks' should be checked to verify that focus is indeed being given to the proper risks and the 'lower level risks' have been correctly labelled as such.
Furthermore, it may be preferred that the results of various Quick scans can be compared. There will always be a difference since the output is based on the input of different stakeholders. However, the explicit risk based structure of the Quick scan helps to make the results more uniform. This can be improved if some Quick scan steps are executed on a higher level (eg. international level in the case of different national Quick scans that need to be comparable). This is the case for the determination of the (semi quantitative) classes of road importance (step 1.3), probability (step 4.2) and consequences (including weight factors of different consequences; step 2.2).

Requirements for workshop leader
The workshop leader facilitates the effective execution of the Quick scan. It is advisable that he/ she does not participate in the scoring. Moreover he/ she must be familiar with risk management principles, the RIMAROCC framework and the Quick scan steps and reasoning. Also it is advisable that he/ she has experience with multi-criteria analyses. Additionally, if a climate specialist is not present, the workshop leader should be able to explain the concepts of climate, weather and climate change (see also the ROADAPT guideline on the use of data for the current and future climate).

On a more personal note, he/ she should expect discussions concerning the validity of consequences and/ or probability classes (see also the 'Important comment' below). Please note that to keep things short, in some cases discussions must be cut short and/ or not everyone's opinion can be met.

Language
Ambiguity may result from using English definitions of threats, consequence classes and probability classes. It is therefore advised to consider this aspect and use the native tongue of the participants, prior to the first workshop.

3 Description of steps

Step 1 – Desktop 1, prepare Quick scan

Objectives of the step
The goal of this step is to establish the context in which the Quick scan will be performed i.e. determine which threats seem relevant to be studied in the Quick scan based on the current climate and expected climate change given the limits of the network and area under consideration. These actions are taken by the workshop leader in preparation of the 1st workshop.

Proposed sub-steps
To achieve the above mentioned goal, the following sub-steps are recommended:
Step 1.1 - Scope definition
Step 1.2 - Identify risk sources and possibly relevant threats
Step 1.3 - Determine importance of road sections in road network
Step 1.4 - Prepare workshop 1

General recommendations for this step
Please note that in some cases it may prove inefficient or too difficult to perform the desktop study (step 1) without help of the participants. Therefore the steps in the desktop study may be (partly) executed in Step 2.1.

Step 1.1 - Scope definition/ Establish context

a. Objectives	Determination of the road network or road stretch that will be studied during the Quick scan. This also implies the area surrounding the roads that will be part of the quick scan.
b. RIMAROCC reference	Step 1.1: Establish a general context Step 1.2: Establish a specific context for a particular scale of analysis
c. Output	The output will be a map of the area and network under consideration
d. Data collection	The performance of the Quick scan is probably the output of previous research, questions asked by management or in a political context, or elsewhere. There also might be a link with other adjacent projects.
e. Method	The demarcation of the area and network under consideration is mostly a choice. Also take into account if possible re-routing roads should be part of the scope or not. Some recommendations can be made: **Scale** - The Quick scan method can be performed at all levels of analysis (structure/section/network). However, it is recommended to perform the Quick scan on at least the level of a road stretch larger than 50 km, or on a road network level with a total length up to 500 - 1000 km. On a smaller scale it is probably better to do a more extensive assessment from the beginning of the scan. On a larger scale organizational problems might arise (eg. finding people with expertise and experience) **Organizational aspects** – It is recommended to take aspects of ownership / operational responsibilities into account when delimiting the scope. During the Quick scan three workshops will be organized at which the attendance of experienced people is of major importance. When using the property and/or operational boundaries it will be easier to ask / convince people to attend those sessions.

f. Examples

From Portugal case (road of interest in dark blue):

Step 1.2 - Identify risk sources and possible relevant threats

a. Objectives

The purpose of this step is to identify elements which, alone or in combination, have the potential to give rise to a risk. The amount of possible threats that might harm the road is high. This step provides a first rough selection of threats that should be taken into account during the Quick scanQuick scan. Threats that are obviously not relevant can be disregarded in further steps.

The identification of relevant threats is not absolutely necessary to have done before the first workshop (step 2 of the Quick scan). However, if the selection of relevant threats has been made beforehand, the effort during the first workshop will be directly on the right points, saving time and energy for the right discussions.

b. RIMAROCC reference

Step 2.1: Identify risk sources

Step 2.2: Identify vulnerabilities

c. Output

Output of this step comprises a description of relevant threats and related climate variables and their expected time horizons, together with a list of relevant threats that are going to be studied in the rest of the Quick scan.

d. Data collection

The climate and its changes are the driving factor for changes in threats to the road network. Moreover, certain threats are only relevant to certain specific geographical locations. Therefore the climate factors, contextual site factors and infrastructure intrinsic factors should be determined. It should be taken into account that all factors might change, either due to climate change or due to changes in the socio economic context.

Climate factors - Based on observations by general or national meteorological institutes, both the current climate and climate change can be determined. It is only necessary to have a general overview of climate information, together with an estimation of the possible changes in different scenarios in the future. It is not necessary to have detailed climate information with a high spatial resolution for the Quick scan.

Contextual site factors - Contextual site factors provide information about the area surrounding the road. This is relevant for estimation of the occurrence of certain threats.

It is not necessary to compile a dataset of contextual site factors. For the level of detail of a Quick scan, it is enough to have a general overview based on topographical or morphological maps. Later during the Quick scan this will be complemented using the experience of people attending the workshops (especially in steps 2.1, 4.2 and 4.4).

Infrastructure intrinsic factors - These factors provide information about the road/asset themselves. This is relevant for estimation of the occurrence of certain threats.

It is not necessary to compile a dataset of infrastructure intrinsic factors. For the level of detail of a Quick scan, it is enough to have a general understanding of te design of the roads, based on information provided by the road owner or road operator. Most road owners/operators will have a GIS system covering the road network, or an asset management system providing information amongst others on the remaining life span and possibly also on current conditions. Such information can be used. Later during the Quick scan the information will be complemented using the experience of people attending the workshops (especially in steps 2.1, 4.2 and 4.4).

e. Method

In the appendix A, a list of possible threats with additional information is provided. This list can be used as a checklist. The additional information is helpful for determination of the relevance of the threats. For this step the columns dealing with climate factors, contextual site factors and infrastructure intrinsic factors is especially useful. It should be noted that the list of threats is extensive, but in specific cases might not be complete.

Climate variables - For specific recommendations about collecting relevant climate information, reference is made to the ROADAPT guideline for climate services. In the list of threats in appendix A, the relevant climate variables are mentioned. This list can be used to specifically ask a climatologist for information about these parameters. This should be done by the workshop leader prior to the first workshop. Alternatively a climate specialist may be invited to provide an overview of the projected climate changes.

The climate information will be used in the following Quick scan steps. In the current step, it is advised to characterize only those threats as 'not relevant', which are clearly not relevant given the climate information in all scenarios that is provided for the study area. E.g. frost heave is not expected to be relevant in certain areas in the southern part of Europe. It is advised to do this keeping all climate scenario's in mind. In this way, the broadest spectrum of possible climate change effects are taken into account.

It is recommended to take climate variables into account, irrelevant of their expected change. If a climate factor for a certain threat is relevant in today's climate, and might become less relevant in future climate, it still is beneficial to involve related threats in the Quick scan. In this way, the Quick scan provides insight in the increase and decrease of all climate related risks.

Contextual site factors - The list of threats in appendix A, provides a general overview of relevant contextual site factors per threat. By using these factors as a checklist, one can estimate the relevance of threats to be taken into account in the rest of the Quick scan. For instance, landslides are only an issue in areas where hills or mountains are present.

Infrastructure intrinsic factors - The list of threats in appendix A, provides a general overview of relevant infrastructure intrinsic factors per threat. By using these factors as a checklist, one can estimate the relevance of threats to be taken into account in the rest of the Quick scan. For instance, thermal expansion of pavements is only relevant for concrete pavements.

f. Examples

See appendix I

Step 1.3 - Determine importance of road sections in road network (sensitivity)

a. Objectives

The importance of the road is one of the factors that can be taken into account when determining the risk. It stands to reason that closing a minor road has fewer consequences than when a major highway needs to be closed for further use. Therefore the road importance is useful information and should be determined (or gathered).

b. RIMAROCC reference

Step 1.3 – Establish risk criteria and indicators (sensitivity)

c. Output

This sub step provides an allocation of different road importance categories to different road stretches.

d. Data collection

Information that can be used is:

- Traffic intensity
- Economic importance of area surrounding the road
- Redundancy of the road (are alternative routes present)

It is not necessary to have real figures about these three aspects. One can also make use of experience. It is recommended to involve an economist and traffic engineer.

In some cases (national) road owners/ operators already have and use road categories. This subdivision may be used directly or may be used as a basis for a Quick scan specific subdivision.

e. Method

At first, road sections should be identified that provide enough discriminating for assessing the importance. In general, larger cities and/or traffic nodes can be used in this respect.

When road categories already exist, it is recommended to use these categories as the basis. In other cases, the three mentioned factors can be combined using common sense and experience.

It is advised to end with maximum three categories of importance. More categories provide a level of detail that does not suit to the level of detail and uncertainty of the risk assessment. More categories also will cause more detailed analyses to be carried out in the rest of the Quick scan, which will take time that might not be available during the workshops.

Please note that in the experience of the authors the participants often feel that road importance must be considered during the workshop(s). Not addressing road importance during the workshops will most probably lead to discussion somewhere in the process, possibly disrupting efficient progress. It is therefore advised to discuss road importance early in the Quick scan. However in the case studies the

road importance has at the end of the scan not proven to be a significant factor (not discriminative in level of risk). This contradiction is unavoidable.

Whether road importance should be accounted for early in the Quick scan (in the current step 1.3) is another issue. Introducing road importance early on will allow explicit scoring of consequences per road importance category. Example: although the direct costs to repair the consequences of an event may be similar for a road of low importance and of one of high importance, the consequence for 'availability' may differ. On the other hand, this increases the amount of time required for scoring. Use of a computer network may greatly aid such a scoring process.

Road importance can also be introduced later on the in the Quick scan process (in step 6.2), after having focused on the largest risks, then the road importance need only be determined for those risks. This results in a quicker scoring process and more time/ energy to focus on other matters during workshop I.

There is no distinctive argument in the discussion when to introduce the road importance to the method. Most important is that the Quick scan facilitator/leader feels confident with it.

f. Examples

Example from Portugal case

Location	Section name	Judgment criteria		
		Traffic	Economy	Redundan
	Chaves - Vidago	Low	High	Medium
	Vidago – Pedras Salgadas	Medium	Medium	Medium
	Pedras Salgadas – Vila Pouca de Aguiar	Medium	Medium	Medium
	Vila Pouca de Aguiar - Fortunho	Low	Low	Medium
	Fortunho – Vila Real	High	Medium	Low
	Vila Real - Regua	High	High	Medium
	Regua - Lamego	High	High	Medium
	Lamego - Bigorne	Low	Low	Low
	Bigorne – Castro Daire	Low	Low	Medium
	Castro Daire - Carvalhal	Medium	Medium	Low
	Carvalhal – S. Pedro do Sul	Medium	Low	Medium
	S. Pedro do Sul - Viseu	Low	Medium	Medium

Three judgment criteria were used to determine the respective importance of each section: traffic level, economic importance of the section for the surrounding territory, redundancy of the route. Each section was scored low, medium or high regarding the three criteria. A color code was then used to score each section, all criteria merged:

- Green: section of low importance
- Yellow: section of medium importance
- Red: section of high importance

Step 1.4 - Prepare workshop 1

a. Objectives

For the workshop, participants need to be invited and informed. Moreover the workshop needs to be prepared in such a way that time during the workshop can be used efficiently.

b. RIMAROCC reference

None

c. Output

Output of this sub-step mainly comprises of material that is required for the workshop(s):

- Information to participants (eg. presentation)
  - Information on the Quick scan goal and process
  - Scope of the road (network) under consideration
  - Overview of current climate and climate changes
- Maps of road network and area
- List of threats
- Tables that need to be completed during workshop 1

Moreover participants need to be selected and invited for the workshop(s), based on their expertise/ knowledge.

d. Data collection

Results of steps 1.1, 1.2 and 1.3

e. Method

The invitation should state the purpose of the Quick scan, combined with the benefits for the road owner/operator. It should also make clear why the participation of the invitee is especially necessary.

Sufficient thought should be given to what information is provided prior to the workshop. Experience shows that some participants appreciate detailed information whereas others are deterred by abundant texts. A combination may be made consisting of a summary of the most important information and more detailed information for those who are interested and have sufficient time to look at it. In the end this is a matter of culture and common sense; it is not possible to make specific recommendations in this respect.

It is recommended to analyse the consequence criteria (step 2.2) and prepare relevant (scoring) definitions before the start of the workshop. This can be done by consulting specific experts (related to the specific criteria). After this consultation it can be decided to add/change criteria and their definitions. Depending on the experience of the participants it may also prove useful to check beforehand with a selected few participants, if the approach, demarcation and list of threats are sufficiently clear. This is all meant to prevent unnecessary time loss due to unfocussed/ inefficient discussion during the workshop.

f. Examples

None

Step 2 - Workshop 1

Objectives of the step
The goal of this step is to determine the consequences of the threats.

Proposed sub-steps
To achieve the above mentioned goal, the following sub-steps are recommended:
Step 2.1 Agree with participants on Quick scan approach
Step 2.2 Establish consequence criteria
Step 2.3 Estimate the consequences of the threats
Step 2.4 Evaluate the scoring

Please note that in some cases it may prove inefficient or too difficult to perform the desktop study (step 1) without help of the participants. Therefore the steps in the desktop study may be executed instead of Step 2.1. As a consequence the Quick scan may be initiated with a minimal preparation.

General recommendations for this step
The fact that the size of the risks are determined based on the assessment of the participants, as opposed to extensive research, emphasizes the importance of having the right people at the workshop. Generally speaking, it is not necessary to invite specialists with a narrow focus. Generalists (with experience/ knowledge in varying fields e.g. engineering, traffic coordination, public affairs, economy, etc) who understand the consequence of a threat without going into too much detail seem to provide most relevant insights.

It is not absolutely necessary to have a climate change expert participating during the workshops. In that case, the workshop leader should have enough climate change experience to answer basic questions. However should a climate change expert not be present than it is advisable to consult with one prior to the workshop.

Step 2.1 Agree with participants on Quick scan approach

a. Objectives	The objectives, approach, boundary conditions and factors that are (and are not) taken into account during the analysis needs to be agreed upon to prevent discussion and inefficiency in the following steps of the Quick scan. Also during this sub-step the results of the previously executed desktop study are confirmed.
b. RIMAROCC reference	None
c. Output	The output of this step is not as much a tangible product as it is a shared vision and agreement of the scope and approach to the Quick scan.
d. Data collection	Information from previous steps: • Information on the Quick scan goal and process e.g. presentation • Maps of area and network • List of contextual site factors and infrastructure intrinsic factors • Updated reversed table • Overview of current climate and possible changes (all scenarios) • Overview of road importance categories (if it is decided in step 1.3 to take road importance into account in Workshop 1) New information: None

e. Method	Most information may be presented during one or more presentations. If road categories need to be determined, a format should be in place to do so. It is advisable to aim for a limited amount of road categories. Experience shows that determining the amount of road categories and the category of a road section can be done via a group discussion. If the Quick scan operator doesn't have the required time and/or expertise for performing Step 1 before the workshop, it can be done instead of Step 2.1. The workshop duration must of course be adjusted accordingly.
f. Examples	None

Step 2.2 Establish consequence criteria

a. Objectives	The goal of this step is to determine which criteria are to be used for scoring the consequences of a threat. Additionally, discussion of the criteria leads to a shared understanding of what is meant and how the consequences should be scored in the following sub-step 2.3
b. RIMAROCC reference	Step 1.3 - establish risk criteria and indicators
c. Output	The output of this sub-step is a list of weighted criteria that are to be used during the scoring of the consequences.
d. Data collection	-
e. Method	The following criteria are recommended to use: • Availability • Safety • Surroundings (effects on the surrounding road network) • Direct technical costs (costs for management during incident and repair) • Reputation • Environment If deemed necessary other criteria may be added. It seems logical to use the same criteria as the road authority does, should any already be in use. After the criteria have been discussed the criteria need to be given a weight/ importance. This is done by letting every participant divide 21 points over the criteria, representing the importance given by the participant. After adding all the points per criterion, the scoring may then be normalised. Lastly the definitions of the various consequence classes, per criterion should be discussed so as to provide mutual understanding of what is meant and how should be scored. An example of consequence classes is provided in the example below. Obviously these classes may be altered according to the requirements of each case. Availability and Safety are deemed the most important criteria. Despite some differentiation being possible if other consequence criteria are used, experience shows that this has limited effect on the results. Therefore, should time be restricted then the Quick scan may be performed using only the consequences 'availability' and 'safety'.

f. Examples

Selection of proposal for Rotterdam – Ruhr case

Availability

1. A negligible impact on the availability
2. A minimal negative impact on the availability
3. A serious impact on the availability
4. A catastrophic impact on the availability

Safety

1. A negligible impact on the user safety (light material damage), but within acceptable limits
2. An influence that reaches the boundaries of acceptable user safety, with as a consequence a number of extra accidents with temporary loss of health or injuries without absence (material damage, slight injuries)
3. An influence to such extent that the boundaries of user safety are exceeded, with as a consequence a serious increase of the number of accidents with permanent loss of health (serious material damage, heavy injuries)
4. A catastrophic influence on user safety, with as a consequence extra deadly danger during normal use (serious material damage, heavy injuries, casualties)

Surroundings (effects on the surrounding road network)

1. A negligible impact on the use of the local network, a road segment is at stake
2. A minimal negative impact on the use of the regional network, a road section is at stake
3. A serious impact on the use of the regional network, a road stretch is at stake
4. A catastrophic impact on the use of the nationwide network, the road network is at stake

Direct technical costs (costs for management during incident and repair)

1. Less than k€ 25
2. Between k€ 25 and k€ 100
3. Between k€ 100 and k€ 500
4. More than k€ 500

Reputation

1. No to slight loss of reputation (due to proper actions); no complaints
2. Slight to moderate loss of reputation (due to inadequate actions on some aspects), notices in media with attention to (fictive) loss for road users
3. Substantial loss of reputation (due to inadequate actions on a large amount of aspects), reputation has a set-back, notices in media with attention to physical damage / hardships of road users, gets attention in nationwide politics
4. Extreme loss of reputation (due to completely inadequate acting), position of minister at stake

Environment

1. No to slight impact to the (natural) environment directly surrounding the road
2. Slight to moderate impact on the (natural) environment in the near vicinity of the road
3. Major impact on the (natural) environment in the near vicinity of the road
4. Extreme impact on the (natural) environment in the wide vicinity of the road

Step 2.3 Estimate the consequences of the threats

a. Objectives	The objective of this sub-step is to determine which threats lead to the largest consequences, in the case that the threat actually affects the road.
b. RIMAROCC reference	Step 2.3 – identify possible consequences
c. Output	The output of this step is a comparison of how the participants score the consequences of a threat, should the threat actually affect the road.
d. Data collection	Information from previous steps: For this sub-step, the list of threats of step 1.2 is used, together with the road importance categories of step 1.3 and the consequence criteria of step 2.2. New information: None
e. Method	Scoring of the consequences per threat and per road category can be done for every consequence criterion, either in a group discussion or by means of a computer network. The consequences are scored semi quantitatively, using a score of 1 – 4. The consequence criterion scores are then multiplied with the criterion weight and then summarized and normalised. Participants only score those consequence criteria that they feel they have sufficient knowledge of. This underlines the advice to have 'generalists' participate at the workshops. It is important to note that the consequences are scored independently of their likelihood of occurrence. Otherwise people may include perceived probability implicitly in their scoring. Therefore the question to be answered during scoring is: "If this threat occurs, what are the consequences?." This score should reflect that no mitigating measures have been taken to prevent the threat to occur or it's consequences to effect the road. In some cases a small portion of the study area might face very serious consequences, while the majority of the study area has small consequences. If the road importance does not provide differentiation then in that specific case a 'worst case' assessment may be made i.e. the biggest consequence is determined. Should this be deemed necessary differentiation based on location may be introduced at a later stage, It will increase uniformity of the answers of the participants if extra information is explicitly provided for each threat (available in appendix 1). This information consists of the duration of the threat when it has occurred until resume of normal operation and the time between realization that a threat might happen and the threat occurs (warning time horizon).
f. Examples	See appendix III (scoring of consequences in Rotterdam – Ruhr case)

Step 2.4 Evaluate the scoring

a. Objectives	The purpose is to evaluate the scores, in order to check whether the results are in line with expectations. The evaluation of the scoring is mainly required if the scoring of the consequences is done individually. In that case, one other objective of this step is to focus on threats where the scores show a wide spread among participants. Evaluation of the scoring should provide an explanation for the differing scores.

b. RIMAROCC reference	None
c. Output	The output is an agreed scoring of consequences of the threats
d. Data collection	Information from previous steps: In case of individual scoring, the required input for this step is a combined table showing the various participant scores in step 2.3. In case of collective scoring, the output of step 2.3 is directly usable. New information: None
e. Method	By sorting the threats according to the consequence scores it becomes clear which threats have the highest consequences. This can also be done by using a colour scheme. It should be discussed if this list reflects the common understanding of the consequences of the threats. In case of individual scoring, depending on the amount of participants, an overview of the scoring can be provided in a large 'master table'. Alternatively the standard deviation may be calculated and used as indicator for a wide spread in scores. Discussion may lead to new insights and a refining of one's own scoring.
f. Examples	See the colour scheme that is used appendix III (Rotterdam – Ruhr case)

Step 3 – Desktop 2, prepare workshop 2

a. Objectives	Essentially the goal of this step is to have a fresh start for the following workshop with an up to date table of threats containing the scores for the consequences. If possible it is recommended to combine workshop 1 and 2, meaning that this step has to be done during the break in between both workshop parts.
b. RIMAROCC reference	None
c. Output	An updated table of threats is the starting point of the following steps.
d. Data collection	Information from previous steps: Summarized output of workshop 1 New information: None
e. Method	In some cases this step may comprise only of cleaning the table of threats and saving it to preserve the results of the previous phase. If any new threats have been identified during workshop 1, these may be defined properly and added to the table. Lacking formulation may not be a problem for participants of a workshop as they have heard what is meant with a new threat. However, newcomers may need a properly formulated definition. Non-relevant threats may be deleted from the table of threats.
f. Examples	None

Step 4 - Workshop 2

Objectives of the step
Workshop 2 works towards assessment of the risks, based on the consequences of the threats that were previously identified in Step 2. To do this it is required to indicate the probability of the threat actually having an impact on the use of the road network. After evaluation of the risk profile, the top risks will be identified.

Proposed sub-steps
To achieve the above mentioned goal, the following sub-steps are recommended:
Step 4.1 Agree on study method and share status of research
Step 4.2 Score the probabilities of the threats
Step 4.3 Evaluate the scoring
Step 4.4 Evaluate and prioritize the risks
Step 4.5 Identify location of threats

General comments
The fact that the magnitude of the risks is determined based on the assessment of the participants, as opposed to extensive research, emphasizes the importance of having the right people at the workshop. Generally speaking, it is not necessary to invite specialists with a narrow focus. Generalists (with experience in-/ knowledge of varying fields e.g. engineering, traffic coordination, public affairs, economy, etc) who understand the impact of a threat without going into too much detail seem to provide most relevant insights. Inviting the same participants as for workshop I may prove more efficient, as they are already familiar with the Quick scan methodology.

A climate expert may be useful to give some more qualitative estimate of climate variables. However, the authors do not consider it to be necessary to have a climate change expert participating during the workshops. In such situations, the moderator should have enough climate change experience to answer basic questions.

Step 4.1 Agree on study method and share status of research

a. Objectives	The objectives, approach, boundary conditions and factors that are (and are not) taken into account during the analysis need to be agreed upon to prevent discussion and inefficiency in the following steps of the Quick scan. Also during this sub-step the results of the previously executed steps are shared. If the workshops 1 and 2 are on the same day with the same participants, this step can be done very briefly.
b. RIMAROCC reference	none
c. Output	No tangible output is created during this sub-step. However this sub-step works towards a shared vision and agreement of the scope and approach to the Quick scan, as well as acknowledgement of the results of the previous steps.
d. Data collection	Information from previous steps: Summarized results of workshop 1 New information: None

e. Method	Most information may be presented during one or more presentations. This sub-step may be kept to a minimum, should the workshop be conducted on the same day and with the same participants as in workshop 1. Agreement on the scope and approach to the Quick scan should prevent discussions on the results of the scoring. The table of threats, including the scores of the consequences should also be discussed. This should lead to a shared understanding of how the threats have been interpreted and scored. Any special remarks in this respect should also be shared.
f. Examples	None

Step 4.2 Score the probabilities of the threats

a. Objectives	This sub-step aims to determine the probability that the road is affected by the threat. This should take into account, the probability that the threat may occur, combined with the probability that the threat affects the road.
b. RIMAROCC reference	Step 3.3 – evaluate occurrences
c. Output	The output of this step is an estimation of the probability for every threat effecting the road. These are indicated in the reversed table.
d. Data collection	Information from previous steps: For this step the list of threats is used from step 1.2, that might be updated during workshop 1. New information: None
e. Method	Scoring is done using probability classes. The same number of classes should be used as the number of consequence classes i.e. 4. The scoring is done individually using a computer network or otherwise or can be done via group discussion. For every threat a score between 1 – 4 should be given for the probability that a threat may negatively impact the road. This should be done for the current (climate) situation as well as for the future situation. To achieve a uniform scoring there needs to be agreement on the definition of the probability classes. Care should be taken that there is a balanced distribution over the classes. It is important to note that the probability estimated in this step, is independent of the location of the threat. This implies that the choice for class boundaries also relates to the area that is taken into account for a threat to occur e.g. the probability that an event will occur increases when the area in which the event may take place is larger. Examples are given (below) for various probability classes. The probability classes should be discussed and agreed upon. Prior to scoring, it should be discussed which climate scenario is to be used, together with the time horizon, to estimate the probability of a certain threat for the future. For the Quick scan it seems to be reasonable to use a worst case approximation in order to avoid 'false negatives' (unidentified risks). Part of the action plan can later be to further analyze the different scenarios. The probability that a threat may impact the road can often be estimated for the current climate. However, the Quick scan aims to provide estimates for the future climate situation as well. As it is not possible to provide probabilities for a given

climate change to occur it may be beneficial for scoring to indicate the trend per threat: will the probability decrease, remain the same or increase in the future and on what time scale are these changes expected. This information may be provided in the table of threats.

Once there is agreement on the probability classes and how to score a threat, scoring may commence.

It will increase uniformity of the answers of the participants if extra information is explicitly provided for each threat (available in appendix 1). This information consists of the infrastructure intrinsic and contextual factors.

f. Examples

Used probability classes in Rotterdam – Ruhr case:

Prior to scoring, the classes of probabilities need to be agreed upon with the participants (perception and culture will depend the classes). Within the Rotterdam-Ruhr case it was decided that participants felt most sure to estimate probabilities, regarding the probability in the whole of the Netherlands. The probabilities were estimated taking the following question into mind: 'What is the probability that a certain threat occurs on the whole road network in the Netherlands?". This implies that for a flooding risk with a probability of 1:100 years this might for example happen every decade somewhere in the Netherlands. Other ways of defining the probability classes are fine as well, as long as every participant scores with the same criteria and as long as this is taken into mind when performing the risk evaluation (quick scan step 4.4).

- 4 Often — more often than once every 3 years
- 3 Sometimes — once every 3 to 10 years
- 2 Seldom — once every 10 to 50 years
- 1 Very seldom — rare than once every 50 years

Step 4.3 Evaluate the scoring

a. Objectives

The purpose is to evaluate the scores, in order to check whether the outcome does reflect the expectations. The evaluation of the scoring is mainly required if the scoring of the probability is done individually. In that case, one other objective of this step is to focus on threats where the scores show a wide spread among participants. Evaluation of the scoring should provide an explanation for the differing scores.

b. RIMAROCC reference

None

c. Output

The output is an agreed scoring of the probability of the threats

d. Data collection

Information from previous steps:

In case of individual scoring, the required input for this step is a combined table showing the various participant scores in step 4.2. In case of collective scoring, the output of step 4.2 is directly usable.

New information:

None

e. Method

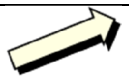
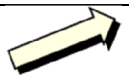
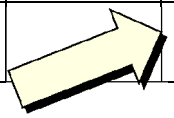
By sorting the threats according to the probability scores it becomes clear which threats have the highest probability. This can also be done by using a colour scheme. It should be discussed if this list reflects the common understanding of the

probability of the threats.

In case of individual scoring, depending on the amount of participants, an overview of the scoring can be provided in a large 'master table'. Alternatively the standard deviation may be calculated and used as indicator for a wide spread in scores. Discussion may lead to new insights and a refining of one's own scoring.

f. Examples

Example of threat list as discussed in the Portugal case:

Threat		Probability in the present situation	Climate change trends	Probability with climate change
Flooding of road surface (assuming no traffic is possible)	Pluvial flooding (runoff after precipitation, rise of groundwater levels)	1	?	1
Erosion of road embankments and foundations	Overloading of hydraulic systems crossing the road	2	?	2
	Erosion of road base	2	?	2
Landslips, avalanches, ground subsidence or collapse	External slides, ground subsidence or collapse affecting the road	3		3
	Slides of the road bed	2		3
	Rock fall	4		4
Loss of driving ability due to extreme weather events	Reduced visibility by fog	4	?	4
Reduced ability for maintenance	Snow removal costs	3	?	3
	Ice removal costs	1	?	1
Susceptibility to wildfires that threaten the transportation infrastructure directly		4		4

Step 4.4 Evaluate and prioritize the risks

a. Objectives

Now that both consequences and probabilities have been determined, the risk levels may be defined. This provides the threats to be compared and ranked. Ranking the threats allows for a choice to be made, which risks to focus on (the 'top [X]') during the remainder of the study.

b. RIMAROCC reference

Step 4.1 – Risk prioritisation

c. Output

A selection of risks/ threats that are the focus for the remainder of the Quick scan.

d. Data collection

Information from previous steps:

For this step the consequence and probability (for future climate) scores in the table of threats from steps 2.4 and 4.3 are needed and combined.

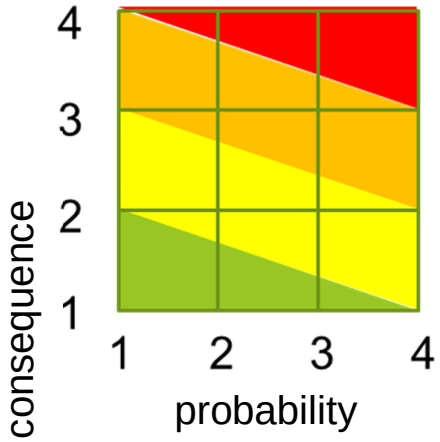
New information:

None

e. Method

As a preliminary approach, the consequence scores may be multiplied with the probability scores (future climate situation). However it is common practice in such analyses not just to look at the result of the multiplication since risks with low probability and high consequences might be overlooked when only multiplying.

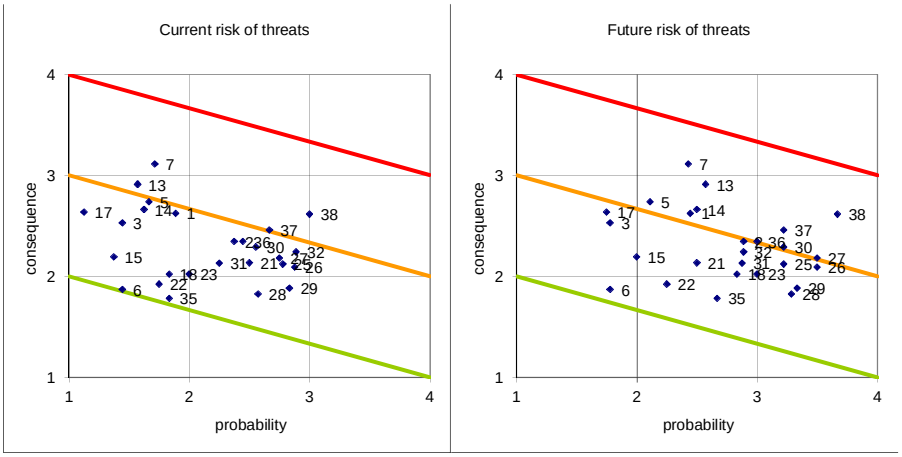
The threats may be plotted in a diagram, such as below. Selection of the risks that are to be examined during the remainder of the study may be done using the colour as basis, i.e. to focus on the 'red' or 'red and orange' threats.



Please note that should a Quick scan be comparable to another scans, the above given matrix should be comparable as well.

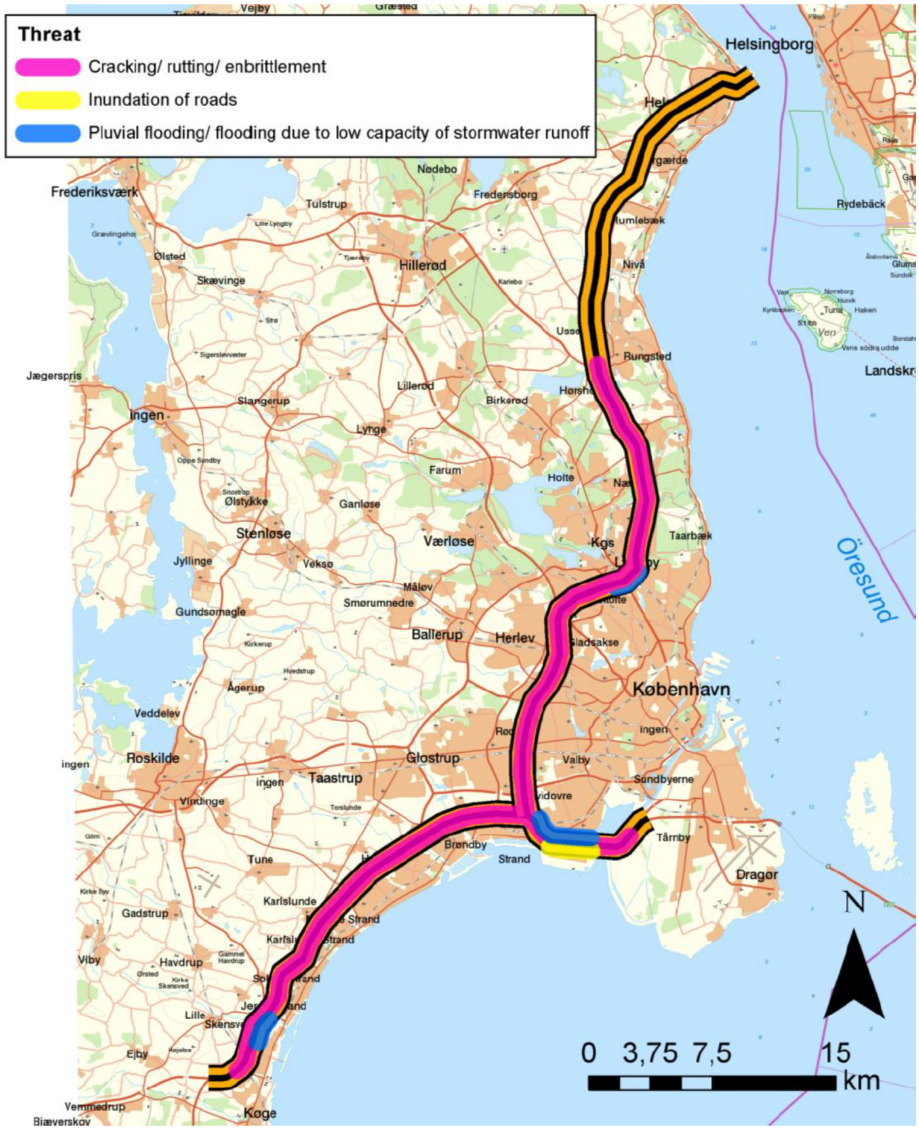
f. Examples

Risk matrices were developed in the Rotterdam – Ruhr case. Based on these matrices a discussion followed on which threats should be considered in the next steps and which could become out of scope.



Step 4.5 Identify location of threats

a. Objectives	The objective of this sub-step is to link the threats to locations in the study area. This provides insight into the areal extent of the threat: is this a threat that is only relevant to one or two sites? Or is this a wide spread threat? Also, the probability of a threat affecting the road may be adjusted according to the location during this sub-step.
b. RIMAROCC reference	Step 2.1 – Identify risk sources Step 2.2 – Identify vulnerabilities
c. Output	The output of this sub-step are maps indicating where climate change poses a significant threat to the road.
d. Data collection	Information on previous steps: For this sub-step, the selection of the major threats and which of these threats can be effectively marked on a map is needed (output step 4.4). Also a number of maps of the study area should be present for marking purposes. New information: None
e. Method	Prior to locating threats on a map it should be determined for which threats this is feasible/ efficient to do during the workshop. For example, for threats that can be attributed to infrastructure intrinsic factors it may be more efficient to determine where these conditions are present in the road network at a later moment using a GIS system combined with road information of the road owner or operator. This is especially the case if there are many vulnerable locations (eg. all locations in the network where storm water runoff systems are present). Depending on the number of threats that are to be marked on a map, this sub-step can be executed in sub-groups or in a group discussion. Simply marking the location where the roads are vulnerable to the threats is sufficient. During the following desktop study this information may be put into a GIS system.
f. Examples	Location of threats in the Oresund case:



Step 5 - Desktop 3, provide a risk overview

a. Objectives	This desktop study essentially is to make a synopsis of the previous workshops and desktop studies. This is done by finalizing the list of threats, together with all gathered information dealing with the threats, and by preparing risk maps.
b. RIMAROCC reference	Step 3.4 Provide a risk overview
c. Output	The output is a final list of threats together with the estimates of probability and consequence (thus, risk) and risk maps showing the location of the main threats on a map.
d. Data collection	Information from previous steps: The main output of the previous steps consist of the list of threats together with the scoring on probability and consequences (step 4.4) and the identified location of threats in step 4.5. New information: However not necessary, might this step been undertaken by using GIS. This implies that digitally information about the roads is necessary in GIS format.
e. Method	In steps 2.3 and 4.2 the consequences and probabilities have been scored by the participants of the workshops. This is preliminary evaluated in steps 2.4 and 4.3. Since input of participants is used, it is important to check for consistency and logicality of the outcomes. This is already done to some extent in the mentioned steps 4.2 and 4.3, but since time is limited during the workshops this can be done more structured. The following questions should be answered: • Are outliers present in the scoring? Some participants could be consequently answering the questions different than other participants. If this is the case it should be checked whether these estimates need to be maintained / changed or removed, by consulting the specific participant. • Are the outcomes logical? This question can be answered with simple questions. For instance, if the intensity of a certain climate variable is likely to increase due to climate change, the probabilities of related threats should have become larger or maybe remain the same but cannot have become smaller. Also, the consequences generally will increase with increasing road importance. With performing such checks one gets an idea about the quality of the results. If things seem to be wrong this should be addressed during workshop 3. After this check the risk matrix of step 4.4 can be finalized. Afterwards, another preparation action for workshop 3 is the making of risk maps. • From step 4.5 the locations of threats are known • From step 4.4 the probability and consequences of different threats for different road importance categories are known • From step 1.3 the locations of different road importance categories are known • By combining this information, the magnitude of risks (using the color scheme of the risk matrix of step 4.4) can be plotted on a map.
f. Examples	None

Step 6 – Workshop 3

Objectives of the step
The main objective of step 6 is to determine an action plan based on the previous results and factors such as urgency and expected impact on life span.

Proposed sub-steps
To achieve the above mentioned goal, the following sub-steps are recommended:
Step 6.1 Step 6.1 Wrap up of previous results
Step 6.2 Determine unacceptable risk; which threats require action?
Step 6.3 Determine action plan
Step 6.4 Step 6.4 Prioritize actions

General comments
For this workshop the participants from the previous workshops that are expected to provide the most relevant input may be invited.

Although this step works towards determination of an action plan related to climate change, reality is that the sequence in which measures are taken will not coincide completely with the level of priority. When measures are actually taken, isoften governed by other planned maintenance: it is simply more economical to take measures when 'other work' and re-routing and such are already planned and machinery and staff is in place. These considerations should be taken into account in the development of the action plan. The derived action plan should therefore be seen as a guide line for adaptation.

Step 6.1 Wrap up of previous results

a. Objectives	This sub-step is keyed to bringing all participants of the third and final workshop up to speed on the previous results and to communicate the goal of the workshop i.e. determine an action plan.
b. RIMAROCC reference	-
c. Output	No tangible output is created during this sub-step. However this sub-step works towards a shared vision and agreement of the scope and approach to the Quick scan, as well as acknowledgement of the results of the previous steps.
d. Data collection	Information from previous steps: The risk maps and table with threats, estimated probability and consequences (thus risk) form the main input for this step. This is accumulated in step 5 of the Quick scan. New information: None
e. Method	If new participants are present a brief outline of the Quick scan methodology may be provided. The information may be presented during one or more presentations. If questions have arisen during step 5, these should be asked at the beginning of workshop 3.
f. Examples	None

Step 6.2 Determine unacceptable risk; which threats require action?

a. Objectives	This sub-step aims to wrap up the discussion on which threats should be included in the action plan.
b. RIMAROCC reference	Step 4.3 – Determine which risks are acceptable
c. Output	The output of this sub-step should be a list of threats that require action in an action plan.
d. Data collection	Information from previous steps: The table with threats from step 5 (and/or the risk matrix), estimated probability and consequences (thus risk) form the main input for this step. Also, the risk maps from step 5 may be used. New information: None
e. Method	In fact, this step is a final evaluation of the outcomes of step 4.4 in which already a prioritization took place. Now, also information on the location of the threats is available which shows the spatial distribution of the risk. The table with threats provides more information on the threats, how it may impact the road and in which time frame. These should be discussed during the workshop, providing the participants with a shared understanding/ agreement of the threats that are to be analysed further as well as allowing for input from the participants.
f. Examples	For the Rotterdam – Ruhr case there were 13 threats marked as important before the start of the last workshop. During the 3rd and last workshop these were reduced to 7 threats that should be further analyzed through the course of the final workshop. This was done, in part by merging several threats that had similar causes i.e. failure of flood defense systems, heavy rainfall. The probability of one threat was (in hindsight) thought to be much lower than scored and thus determined as less important (pluvial flooding).

Step 6.3 Determine action plan

a. Objectives	This sub-step aims to determine which actions should be taken for the threats under consideration
b. RIMAROCC reference	Step 5.1 - Identify options Step 5.2 - Appraise options
c. Output	The output of this sub-step is per threat, a list of measures that may be taken to mitigate the risk
d. Data collection	Information from previous steps: The most important input for this sub-step is the list of main threats that need to be taken action on (output step 6.2), together with all assembled information about these threats. This includes probability, consequences, location and time frame regarding climate change. New information: Additionally, information on the lifespan of various 'parts' of the road e.g. road surface, road bed, guard rails, landslide protection assets, tunnels etc. are needed to execute this step. This information should be provided by the

participants of the workshop; it is not necessary to gather this information before the workshop.

e. Method

This sub-step entails a number of parts. In general, the methodology is used to confront the lifetime of the asset with the expected time horizon for the climate change effect. This enables estimation whether action should be taken during regular maintenance, or whether specific action needs to be identified / developed.

Specific effect of the threat - It should be clear on what part of the road the threat may have an effect. Examples: heavy rainfall may influence the driving characteristics of the road surface but does not influence the structure itself. Whereas a landslide may affect the entire road, including the road base.

Lifespan or maintenance frequency of affected parts of the road - After the road parts have been identified, their lifespan should be determined also e.g. the road surface often has a lifespan in the order of 5 – 10 years whereas the road bed is designed for the lifespan of the road i.e. approximately 50 years. In addition the current age of the road part may be determined.

Critical time horizon regarding damages related to climate changes – It needs to be identified if climate change effects will take place during the lifespan or maintenance frequency of the asset. Therefor the time horizon of the climate change effect should be estimated. Because it is very difficult/ impossible to determine when the relevant climate change effect (e.g. 'sea level rise' or 'more stormy winds') becomes relevant, it is proposed to assume that all assets with a life expectancy that is less than 20 years from now (and are adapted well to the current climate) are not vulnerable to climate change (we assume that the natural climate variability may hide climate changes due to global warming in the near future).

For assets of longer life span, the participants must determine when these damages are unacceptable e.g. when the lifespan is shortened by more than 1/3.

Adaptation action versus regular maintenance - The above factors determine if it is to be expected that the road part requires attention/ maintenance due to climate change sooner before the end of the life span or before the next maintenance period. During the workshop this can be assessed by asking the question to the participants: "Are you willing to accept that the lifespan will decrease by xxx years?" **Determination of adaptation strategy** - If regular maintenance is unacceptable, adaptation measures may be determined. In general, three types of measures are especially worth mentioning within the scope of the Quick scan:

1. Research to reduce uncertainty and/or monitoring to answer: is this a risk now and/ or is the climate changing so that this will become a risk in the future?. In this strategy, it is assumed that risk knowledge has first to be improved before taking specific actions. This may result in better understanding of the current safety margin which provides insight weather the reliability is higher (or lower) than the demanded reliability.
   Here also a reference needs to be made to two ROADAPT outputs being the guideline on performing a GIS-aided vulnerability assessment and the guideline on performing a socio economic impact assessment being parts C and D.
2. Do minimum (traffic management, business as usual). In this strategy, it is assumed that the risk can be managed through the current procedures, and in particular through traffic management (information of drivers, traffic restrictions).

3. Application of mitigating measures. Several strategies are possible within this type of measures.
   a. Update operating procedures to take account of the impact of climate change
   b. Develop contingency plans for being better prepared to manage emergency situations (improving resilience). This is a “reactive” strategy
   c. Strengthening preventive maintenance. This is a “proactive” strategy mainly aimed at avoiding major damage to the infrastructure
   d. Retro-fit investments / strengthening infrastructure. When the integrity of the whole infrastructure is at stake and strengthened maintenance may not be enough, it may be necessary to plan investments for strengthening the infrastructure itself

It is the aim of the Quick scan to gain preliminary insight in the risks due to climate change. The level of detail of the risk assessment in previous steps is probably not enough to identify the specific measures that need to be taken. As an output of the Quick scan, the action plan should provide enough direction to become adapted to climate change in the future. Part of the action plan will be that specific adaptation measures need to be chosen in the future. For the Quick scan it is deemed enough, to have chosen an appropriate adaptation strategy that afterwards needs to be analysed in more detail. However, the ROADAPT overview of adaptation measures, together with the ROADAPT guideline on choosing a strategy will be useful in this step.

f. Examples

See appendix IV for an example of the outcome of step 6 (and result of Quick scan)

Step 6.4 Prioritize actions

a. Objectives

Once the actions have been determined, the last sub-step of the Quick scan is to determine which actions should be executed first. This is done in this sub-step.

b. RIMAROCC reference

Step 5.2 - Appraise options

c. Output

A prioritized list of actions, indicating which actions should be taken first

d. Data collection

Information from previous steps:

This step is a logical continuation of step 6.3.

New information:

No new information is required

e. Method

This last step entails prioritizing of the actions. This is done using common sense. Should monitoring be required, this should probably start on short notice. Other actions may require making financial reservations for measures that need to be taken in the future.

To aid in prioritizing, the participants may be asked to rank the risks by priority level, from those that require the most urgent actions to those that may be addressed at a later stage.

f. Examples

See appendix IV for an example of the outcome of step 6 (and result of Quick scan)

4 Acknowledgement

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Annex I: Table of threats

Threat description		Climate information			Vulnerability factors		Impact	
Threat main	Threat sub	Climate parameter (an increase of the mentioned variable will increase the possibility of the threat happening)	Unit	Time resolution for climate variable	Infrastructure intrinsic factors = road factors that contribute to vulnerability	Contextual site factors = surrounding factors that contribute to vulnerability	Duration of the threat when it has occurred until resume of normal operation	Time between realization that threat might happen and threat occuring (warning time horizon)
Flooding of road surface (assuming no traffic is possible)	flooding due to failure of flood defence system of rivers and canals, caused by snowmelt, rainfall in the catchment area, extreme wind	Temperature (in the catchment area)	number of days with average temperature above 0 ˚C	days	Road surface level (lower = higher vulnerability)	Rivers, canals, low lying areas	weeks - months	minutes - days
		Extreme rainfall events (long periods of rain in the catchment area)	mm/day	several days - week				
		Extreme wind speed, wind direction	m/second	hours-days				
	pluvial flooding (overland flow after precipitation, increase of groundwater levels, increase of aquifer hydraulic heads)	Extreme rainfall events (heavy showers)	mm/h	minutes - hours	Earthworks, bridges, culverts, drainage	Valley floors, low lying areas	days - weeks	hours - days
		Extreme rainfall events (long periods of rain)	mm/day	several days - week				
	Inundation of roads in coastal areas, combining the effects of sea level rise and storm surges	Sea level (rise)	cm	day	Road surface level (lower = higher vulnerability)	Coastal areas	days - weeks	days
		Extreme wind speed, wind direction (-> storm surge)	m/second	hours-days				
	Flooding from snow melt (overland flow after snow melt)	Temperature	number of days with average temperature above 0 ˚C	days-weeks	Culverts, ditches	Hilly and mountaineous areas, altitude, latitude	days - weeks	hours - days
Erosion of road embankments and foundations	Overloading of hydraulic systems crossing the road	Extreme rainfall events (long periods of rain)	mm/day	several days - week	Culverts	Valley floors, low lying areas	week - months	hours
		Extreme rainfall events (heavy showers)	mm/h	minutes - hours				
		Thaw (for rapid ablation of snow)	˚C	days				
	Erosion of road embankments	Sea level (rise)	cm	day(s)	Earthworks, culverts (higher vulnerability where culverts cross the road), road embankment materials	Valley floors, low lying areas	week - months	minutes - days
		Extreme wind speed, wind direction (-> storm surge)	m/second	hours-days				
		Extreme rainfall events (heavy showers)	mm/h	minutes - hours				
		Extreme rainfall events (long periods of rain)	mm/day	several days - week				
	Bridge scour	Sea level (rise)	cm	day(s)	Bridges	Rivers, canals, low lying areas	months	hours - days
		Extreme wind speed, wind direction (-> storm surge)	m/second	hours-days				
		Extreme rainfall events (heavy showers)	mm/h	minutes - hours				
		Extreme rainfall events (long periods of rain)	mm/day	several days - week				

Threat description		Climate information			Vulnerability factors		Impact	
Threat main	Threat sub	Climate parameter (an increase of the mentioned variable will increase the possibility of the threat happening)	Unit	Time resolution for climate variable	Infrastructure intrinsic factors = road factors that contribute to vulnerability	Contextual site factors = surrounding factors that contribute to vulnerability	Duration of the threat when it has occurred until resume of normal operation	Time between realization that threat might happen and threat occuring (warning time horizon)
Landslips and avalanches	External slides, ground subsidence or collapse, affecting the road (including eg. embankments aside the road)	Extreme rainfall events (long periods of rain)	mm/day	several days - week	Earthworks, pavements, drainage, foundation	Natural slopes, underground cavities, loss of vegetation	days - months	seconds - hours
		Extreme rainfall events (heavy showers)	mm/h	minutes - hours				
		Drought (consecutive dry days)	(consecutive) days	multiple days-months				
	Slides of the road embankment	Extreme rainfall events (long periods of rain)	mm/days	several days - week	Earthworks, cut and fill slopes, retaining walls, embankment materials (clay/silt = higher vulnerability), slope angle (higher slope angle = higher vulnerability)	Hilly and mountaineous areas	weeks - months	seconds - minutes
		Extreme rainfall events (heavy showers)	mm/h	minutes - hours				
		Drought (consecutive dry days)	(consecutive) days	multiple days-months				
	Debris flow	Extreme rainfall events (heavy showers)	mm/h	minutes - hours	Drainage, embankment vegetation, erosion protection works	Mountainous areas, loss of vegetation	days - months	seconds - minutes
	Rock fall	Extreme rainfall events (long periods of rain)	mm/day	several days - week	Manmade cracks: road cut/blasting, rock fall protection works	Mountainous areas	days	seconds - minutes
		Extreme rainfall events (heavy showers)	mm/h	minutes - hours				
		Frost-thaw cycles (number of days with temperature zero-crossings)	number of days	days				
	Snow avalanches	Snowfall	mm/day	day-weeks	Distribution of avalanche protection works	Mountainous areas, avalanche tracks	days - weeks	seconds - days
		Frost-thaw cycles (number of days with temperature zero-crossings)	number of days	days				
		Temperature	mm/day	days-weeks				
Loss of road structure integrity	Impact on soil moisture levels (increase of watertable), affecting the structural integrity of roads, bridges and tunnels	Seasonal and annual average rainfall	mm/season mm/year	season-year	Pavements, bridges and tunnels	low lying areas, high watertable	days - weeks	days - months
		Sea level (rise)	cm	years				
		Extreme wind speed, wind direction (-> storm surge)	m/second	hours-days				
	Weakening of the road embankment and road foundation by standing water	Seasonal and annual average rainfall	mm/season mm/year	season-year	Earthworks, pavements	Rivers, canals, low lying areas	weeks	hours - weeks
	(Unequal) settlements of roads by consolidation	Drought (consecutive dry days)	consecutive days	multiple days-months	Pavements	soft ground layers	months	months
	Instability / subsidence of roads by thawing of permafrost	Thaw (number of days with temperature zero-crossings)	number of days	days	Pavements	frozen ground	days - weeks	days - months
	Uplift of tunnels or light weight construction materials by increasing watertable levels	Seasonal and annual average rainfall	mm/season mm/year	season-year	Tunnels, Deep lying sections, light weight materials	High watertable, soft soil	months	seconds - months
		Sea level (rise)	cm	day(s)?				
		Extreme wind speed, wind direction (-> storm surge)	m/second	hours-days				
		Extreme rainfall events (long periods of rain)	mm/day	several days - week				

Threat description		Climate information			Vulnerability factors		Impact	
Threat main	Threat sub	Climate parameter (an increase of the mentioned variable will increase the possibility of the threat happening)	Unit	Time resolution for climate variable	Infrastructure intrinsic factors = road factors that contribute to vulnerability	Contextual site factors = surrounding factors that contribute to vulnerability	Duration of the threat when it has occurred until resume of normal operation	Time between realization that threat might happen and threat occuring (warning time horizon)
Loss of pavement integrity	Cracking, rutting, embrittlement	Maximum and minimum diurnal temperature	°C	days	Flexible pavements, type of surface and binder course, pavement age		days	days
		Temperature (heat waves)	number of consecutive hot days					
	Frost heave	Frost	°C and number of days	days		Soft ground layers, high ground water table	weeks - months	days
	Aggregate loss and detachment of pavement layers	Frost	°C and number of days	days	Flexible pavements, type of surface course, pavement age		days	days
	Cracking due to weakening of the road base by thaw	Frost-thaw cycles (number of days with temperature zero-crossings)	number of days	days	Pavements		weeks - months	days - weeks
	Thermal expansion of pavements	Maximum and minimum diurnal temperature and number of consecutive hot days (heat waves)	°C and number of (consecutive) days	days	Concrete pavements		days	days
	Decreased utility of (unimproved) roads that rely on frozen ground	Frost-thaw cycles (number of days with temperature zero-crossings)	number of days	days	Unpaved roads		weeks - months	days - weeks
Loss of driving ability due to extreme weather events	Reduced visibility	Fog days	Number of days	day			hours - day	seconds - minutes
	Reduced visibility during snowfall, heavy rain including splash and spray	Snowfall or rainfall	mm/hour and mm/day	hour-day	Closed pavements (no porous pavements), presence of storm water runoff		minutes - day	seconds - minutes
	Reduced vehicle control	Extreme wind speed (worst gales and wind gusts)	m/second				hours - day	seconds
	Decrease in skid resistance on pavements from slight rain after a dry period	Drought (consecutive dry days)	consecutive days	multiple days-months	Pavements		minutes - hours	seconds - hours
	Flooding of road surface due to low capacity of storm water runoff	Extreme rainfall events (heavy showers)	mm/hour	minutes - hour	Closed pavements (no porous pavements), presence of storm water runoff		minutes - hours	minutes
	Aquaplaning in ruts due to precipitation on the road, splash and spray	Extreme rainfall events (heavy showers)	mm/hour	minutes - hour	Closed pavements (no porous pavements), presence of storm water runoff		minutes - hours	minutes
	Decrease in skid resistance on pavements from migration of liquid bitumen	Maximum and minimum diurnal temperature and number of consecutive hot days (heat waves)	°C and number of (consecutive) days	days	bitumen		hours - days	minutes
	Icing and snow	Snowfall	mm/day	days			hours - days	seconds - hours
		Hail	mm/day	days				
		Frost and rainfall	°C and mm/day	days				

Threat description		Climate information			Vulnerability factors		Impact	
Threat main	Threat sub	Climate parameter (an increase of the mentioned variable will increase the possibility of the threat happening)	Unit	Time resolution for climate variable	Infrastructure intrinsic factors = road factors that contribute to vulnerability	Contextual site factors = surrounding factors that contribute to vulnerability	Duration of the threat when it has occurred until resume of normal operation	Time between realization that threat might happen and threat occuring (warning time horizon)
Reduced ability for maintenance	Reduced snow removal planability	Snowfall	number of days	days-season			day - months	weeks - months
	Reduced ice removal planability	Frost	°C and number of days	days			day - months	weeks - months
	Impact on shoulder maintenance: increased vegetative growth	Temperature	°C	days	shoulder vegetation		days - weeks	days
	Impact on road works: decreased time window for paving	Maximum and minimum diurnal temperature and number of consecutive hot days (heat waves)	°C and number of (consecutive) days	days	Pavements		days - weeks	days
Pollution aside the road after incapacity of storm water runoff system of the road		Extreme rainfall events (heavy showers)	mm/hour	minutes - hour	Closed pavements (no porous pavements), presence of storm water runoff, shoulder vegetation		minutes - hours	seconds - hours
Susceptibility to wildfires that threaten the transportation infrastructure directly		Drought (consecutive dry days)	consecutive days	multiple days-months		Forest cover	hours - days	hours - days
Damage to signs, lighting fixtures, pylones, canopies, noise barriers and supports		Extreme wind speed (worst gales and wind gusts)	m/second	seconds-hours	Signs, lighting fixtures, pylones, canopies, noise barriers, supports		hours - weeks	seconds - hours
Damage to energy supply, communication networks (eg. pylones) and/or matrix boards by wind, snow, heavy rainfall and/or lightning		Extreme wind speed (worst gales and wind gusts)	m/second	seconds-hours			days - weeks	seconds - hours
		Snowfall	mm/day	days				
		Extreme rainfall events (heavy showers or long periods of rain)	mm/day	hour to days				
		Lightning	number of discharges	hour to days				
Trees, wind mills, noise barriers, trucks falling on the road		Extreme wind speed (worst gales and wind gusts)	m/second	seconds-hours	Noise barriers	Trees, mills	hours - day	seconds - hours

Annex II: RIMAROCC steps and ROADAPT steps compared

			context analysis			risk identification			risk analysis				risk evaluation			risk mitigation				implementation of action		monitoring, review & capatalisation			
		RIMAROCC steps	Establish a general context	Establish a specifif context for a particular scale of analysis	Establish risk criteria and indicators adapted to each particular scale of analysis	Identify risk sources	Identify vulnerabilities	Identify possible consequences	Establish risk chronology and scenarios	Determine impact of risk	Evaluate occurances	Provide a risk overview	Risk prioritisation	Compare climate risk to other kinds of risk	Determining which risks are acceptable	Identify options	Appraise options	Negotiating with funding agencies	Present action plans	Develop and action plan on each level of responsibility	Implement adaptation plan	Regular monitoring and review	Re-plan in case of new data or delay in implementation	Capitalisation on return of experience on both climatic eventes and progress of implementation	Continuous communication
	ROADAPT steps		1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.4	5.5	6.1	6.2	7.1	7.2.	7.3	7.4
Desktop 1, prepare Quick scan	Scope definition/ Establish context	1.1	X	X																					
	Identify risk sources and possible relevant threats	1.2				X	X																		
	Determine importance of road sections in road network (sensitivity)	1.3			X																				
	Prepare workshop 1	1.4																							
Workshop 1	Agree with participants on Quick scan approach	2.1																							
	Establish consequence criteria	2.2			X																				
	Estimate the consequences of the threats	2.3						X																	
	Evaluate the scoring	2.4																							
	Desktop 2, prepare workshop 2	3																							
Workshop 2	Agree on study method and share status of research	4.1																							
	Score the probabilities of the threats	4.2									X														
	Evaluate the scoring	4.3																							
	Evaluate and prioritize the risks	4.4											X												
	Identify location of threats	4.5				X	X																		
	Desktop 3, provide a risk overview	5										X													
Workshop 3	Wrap up of previous results	6.1																							
	Determine unacceptable risk; which threats require action?	6.2													X										
	Determine action plan	6.3														X	X								
	Prioritize actions	6.4															X								

Annex III: Threats, scored on probability and consequence

Nr.	Threat		availability		safety		surroundings		direct cost		reputation		environment		consequences		future probability	future risk		current probability	current risk	
			major import.	important	major import.	important	major import.	important	major import.	important	major import.	important	major import.	important	major import.	important		major import.	important		major import.	important
1	Flooding of road surface (assuming no traffic is possible)	flooding due to failure of flood defence system of rivers and canals	3,4	3,6	1,8	1,6	4,0	3,2	3,3	2,3	2,6	2,2	1,5	1,3	2,6	2,4	2,4	6,4	5,9	1,9	5,0	4,6
2		pluvial flooding (overland flow after precipitation)	3,5	3,0	1,3	1,3	4,0	3,8	2,5	2,0	2,3	2,3	1,0	1,0	2,3	2,1	2,9	6,8	6,2	2,4	5,6	5,1
3		Inundation of roads in coastal areas, combining sea level rise and storm surges	3,4	3,2	2,0	2,0	3,3	3,3	3,5	3,0	2,5	2,5	1,0	1,0	2,5	2,4	1,8	4,5	4,3	1,4	3,7	3,5
5	Erosion of road embankments and foundations	Overloading of hydraulic systems crossing the road	3,3	3,3	2,3	2,3	3,7	3,7	3,5	3,5	3,0	3,0	1,3	1,3	2,7	2,7	2,1	5,8	5,8	1,7	4,6	4,6
6		Erosion of road embankments due to water beside the road during flooding	2,0	2,0	1,7	1,7	2,3	2,0	2,5	2,5	2,3	2,3	1,3	1,3	1,9	1,8	1,8	3,3	3,3	1,4	2,7	2,7
7		Bridge scour	3,7	3,7	3,0	3,0	3,7	3,7	4,0	4,0	3,7	3,7	1,3	1,3	3,1	3,1	2,4	7,6	7,6	1,7	5,3	5,3
13	Loss of road structure integrity	Impact on soil moisture levels, affecting the structural integrity of roads, bridges and tunnels	3,6	3,8	2,8	2,8	3,5	3,3	3,5	3,5	3,5	3,5	1,0	1,0	2,9	2,9	2,6	7,5	7,5	1,6	4,6	4,6
14		Weakening of the road embankments by standing water	3,4	3,5	2,5	2,5	3,0	2,8	3,0	3,0	3,0	3,0	1,0	1,0	2,7	2,7	2,5	6,7	6,7	1,6	4,3	4,3
15		(Unequal) settlements of roads by consolidation	3,3	3,0	1,8	1,8	2,0	1,8	2,5	2,5	2,0	2,0	1,0	1,0	2,2	2,1	2,0	4,4	4,2	1,4	3,0	2,9
17		Uplift of tunnels or light weight construction materials by increasing water levels	3,8	3,8	2,0	2,0	3,0	2,8	3,0	3,0	3,3	3,0	1,0	1,0	2,6	2,6	1,8	4,6	4,5	1,1	3,0	2,9
18	Loss of pavement integrity	Cracking, rutting, embrittlement	2,8	2,8	1,7	1,7	2,0	2,0	2,5	2,5	2,3	2,3	1,0	1,0	2,0	2,0	2,8	5,7	5,7	1,8	3,7	3,7
21		Cracking due to weakening of the road base by thaw	3,0	3,0	1,7	1,7	2,0	2,0	3,5	3,5	2,0	2,0	1,0	1,0	2,1	2,1	2,5	5,3	5,3	2,5	5,3	5,3
22		Thermal expansion of pavements	2,7	2,7	1,7	1,7	1,7	1,7	2,5	2,5	1,7	1,7	1,0	1,0	1,9	1,9	2,3	4,3	4,3	1,8	3,4	3,4
23		Thermal expansion of bridge expansion joints	3,3	3,3	1,0	1,0	3,0	3,0	1,0	1,0	2,0	2,0	1,0	1,0	2,0	2,0	3,0	6,1	6,1	2,0	4,0	4,0
25	Loss of driving ability due to extreme weather events	Reduced visibility due to fog	2,7	2,7	2,7	2,7	1,7	1,7	1,0	1,0	1,0	1,0	1,0	1,0	2,1	2,1	3,2	6,8	6,8	2,8	5,9	5,9
26		Reduced visibility during snowfall, heavy rain including splash and spray	2,5	2,5	2,8	2,8	1,5	1,5	1,0	1,0	1,3	1,3	1,0	1,0	2,1	2,1	3,5	7,3	7,3	2,9	6,0	6,0
27		Reduced vehicle control due to extreme wind	2,8	2,8	2,8	2,8	1,8	1,8	1,0	1,0	1,0	1,0	1,0	1,0	2,2	2,2	3,5	7,6	7,6	2,8	6,0	6,0
28		Decrease in skid resistance on pavements from slight rain after a dry period	2,0	2,0	2,3	2,3	1,7	1,3	1,0	1,0	1,3	1,3	1,0	1,0	1,8	1,8	3,3	6,0	5,9	2,6	4,7	4,6
29		Flooding of road surface due to low capacity of storm water runoff	2,0	2,0	2,3	2,3	1,7	1,7	1,0	1,0	2,3	2,3	1,0	1,0	1,9	1,9	3,3	6,3	6,3	2,8	5,3	5,3
30		Aquaplaning in ruts due to precipitation on the road, splash and spray	3,0	3,0	2,5	2,5	2,0	1,8	2,0	2,0	1,5	1,5	1,0	1,0	2,3	2,3	3,2	7,4	7,3	2,6	5,9	5,8
31		Decrease in skid resistance on pavements from migration of liquid bitumen	2,5	2,5	2,5	2,5	2,0	1,8	2,0	2,0	1,5	1,5	1,0	1,0	2,1	2,1	2,9	6,1	6,0	2,3	4,8	4,7
32		Icing and snow	3,3	3,3	2,3	2,3	1,3	1,3	1,5	1,5	1,3	1,3	1,0	1,0	2,2	2,2	2,9	6,5	6,5	2,9	6,5	6,5
35	Reduced ability for	Impact on road works: decreased time window for paving	2,5	2,5	1,5	1,5	2,0	2,0	1,0	1,0	1,7	1,3	1,0	1,0	1,8	1,8	2,7	4,8	4,7	1,8	3,3	3,2
36	Susceptibility to wildfires that threaten the transportation infrastructure directly		3,3	3,3	2,3	2,3	2,3	2,3	1,0	1,0	1,0	1,0	1,7	1,7	2,3	2,3	3,0	7,0	7,0	2,4	5,7	5,7
37	Damage to signs, lighting fixtures and supports due to wind, lightning and/or rainfall		3,0	3,0	2,8	2,5	2,3	2,3	3,0	3,0	1,8	1,8	1,0	1,0	2,5	2,4	3,2	7,9	7,7	2,7	6,6	6,3
38	Trees, windmills, noise barriers falling on the road due to wind		3,3	3,3	3,0	3,0	2,5	2,3	2,0	2,0	1,3	1,3	1,3	1,3	2,6	2,6	3,7	9,6	9,5	3,0	7,9	7,8
		factor for criteria	0,32		0,31		0,11		0,05		0,06		0,15									

Annex IV: Example of end product of Quick scan, the action plan

Actieplan Rotterdam - Ruhr							
Threat	Part of road threatened	Life cycle/ maintenance period	Acceptable life cycle shortening	Maintenance strategies in place	Strategy	Priority	Remarks
1/3 Flooding due to failure of flood defence system of rivers and canals	whole road, including pavement	20 - 50	less relevant; at the moment of flooding the whole road cannot be used	-	5, 6		Prevent flooding and should this occur any way, repair ASAP
5 Overloading of hydraulic systems crossing the road	everything above culvert i.e. the whole road, including pavement	50 - 100	0	inspect culvert (presence of detritus and/ or erosion) by NRA (Rijkswaterstaat) and/ or waterboards NB if damage is noted during inspection, then you're already too late and major damage has occurred!	1, 3, 4, 6	2	#3. do inspection pre- and post rainy season; inspect culverts
7 Bridge scour	the bridge (and thus the whole road)	50 - 100	0	sounding around bridge foot for erosion pits; inspection of the road on top of the bridge	1, 3,4,6		#1. find out what the present inspection entails (type of inspection/ frequency)? #1: check if the used design standards still suffice ragarding climate change?
13 Impact on soil moisture levels, affecting the structural integrity of roads, bridges and tunnels	embankment (and thus the whole road)	20 - 50	0	starts with design standards (distance to groundwater level); drainage maintenance is generally speaking insufficient; if problems are detected during road inspection then you're too late and major damage has occurred	1, 3,4		If high soil moisture levels occur only sporadically then the impact on the life cycle is small; if for longer periods (years) then larger impact. Mitigating measures should be taken based on their (cost) effectiveness. #1. check design, #1. vegetation may provide a clue for changing soil moisture content (during inspections), #3. inspect drainage and apply proper maintenance procedures
14 Weakening of the road embankments by standing water	embankment (and thus the whole road)	20 -50	0	-	1, 2, 5		This is a point of research at the moment
26 Reduced visibility during snowfall, heavy rain including splash and spray	pavement + road shoulder + drainage	7 - 20	0	inspection of pavement (clogging and wear), road shoulders/ sides and drainage (ARAD); cleaning of shoulde; maintenance of darinage	3, 2, 1	1	Relates to maintenance level; #3 keep contractor to contractual (maintenance) requirements
38 Trees, noise barriers or wind mills, falling on the road due to wind	not relevant; the road(part) is not necessarily damaged. However the road may not be used while detritus is on the road			inspection of surrounding trees; maintenance of trees	2, 1, 3	3	#1 determine where risks for falling branches etc is relevant; #3 keep contractor to contractual (maintenance) requirements

STRATEGIES
1. Research and/ or monitoring to determine uncertainties
2. Do minimum – solutions in business as usual e.g. trafiic mana
3. Improve current maintenance scheme eg frequency,
4.Retro-fit solutions/ strengthen infrastructure
5. Develope contingency plans
6.Future proof building