29th Japan Road Congress
International Symposium

Risk Management for Roads in a Changing Climate (RIMAROCC): a European Methodological Approach

Yves Ennesser: EGIS, France

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The Context of RIMAROCC

- **"ERA-NET ROAD – Coordination and Implementation of Road Research in Europe" is a Coordination Action funded by the 6th Framework Program of the EC. The ENR partners were Austria, Denmark, Finland, Germany, Netherlands, Norway, Poland, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom**

- **"Road Owners Getting to Grips with Climate Change" was a trans-national joint research program initiated by ERA-NET ROAD**

- **A call for proposals was launched in March 2008. Nineteen proposals were jointly evaluated and 4 projects selected covering the topics:**
  - Winter maintenance (IRWIN)
  - Pavements (P2R2C2)
  - **Risk management/analysis (RIMAROCC),** and
  - Drainage (SWAMP)

The Purpose of RIMAROCC

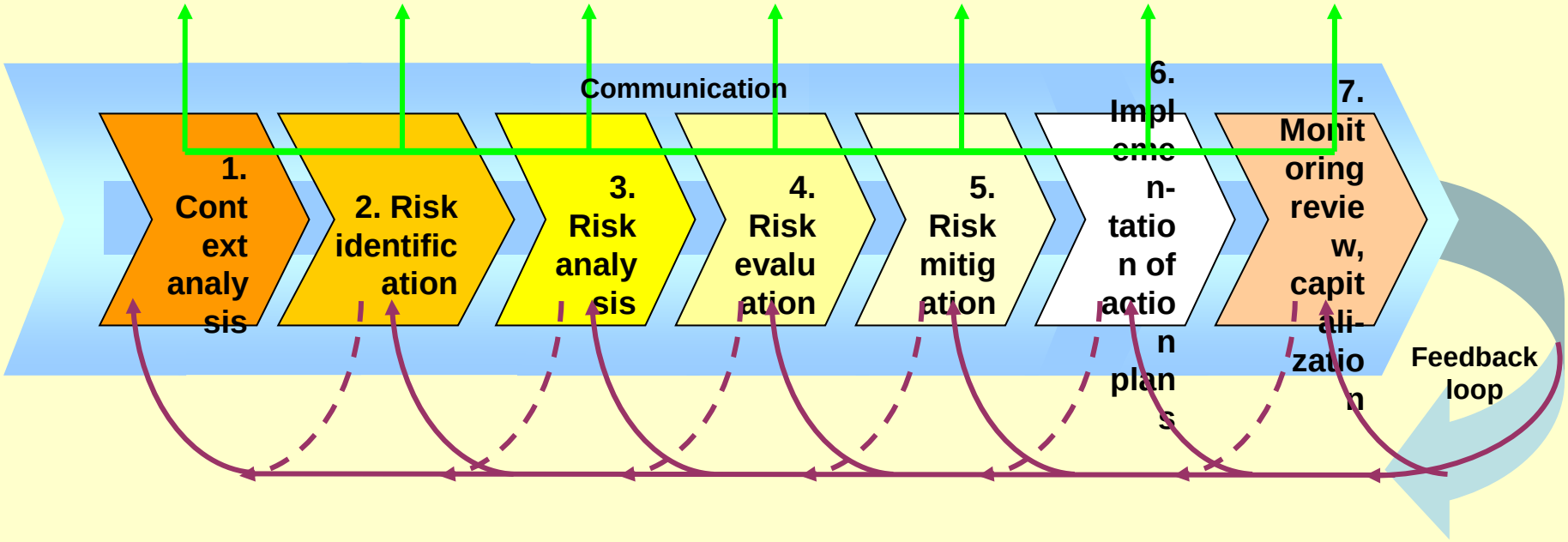
To develop a common method on risk analysis and risk management for roads with regard to climate change in Europe

Project team

- **SGI: Swedish Geotechnical Institute (Sweden)**
- **Egis: Engineering, Project Development, and motorway Infrastructure Operations (France)**
- **Deltares: Research and Engineering in Water, Soil and Infrastructure (Netherlands)**
- **NGI: Norwegian Geotechnical Institute (Norway)**

The RIMAROCC Method

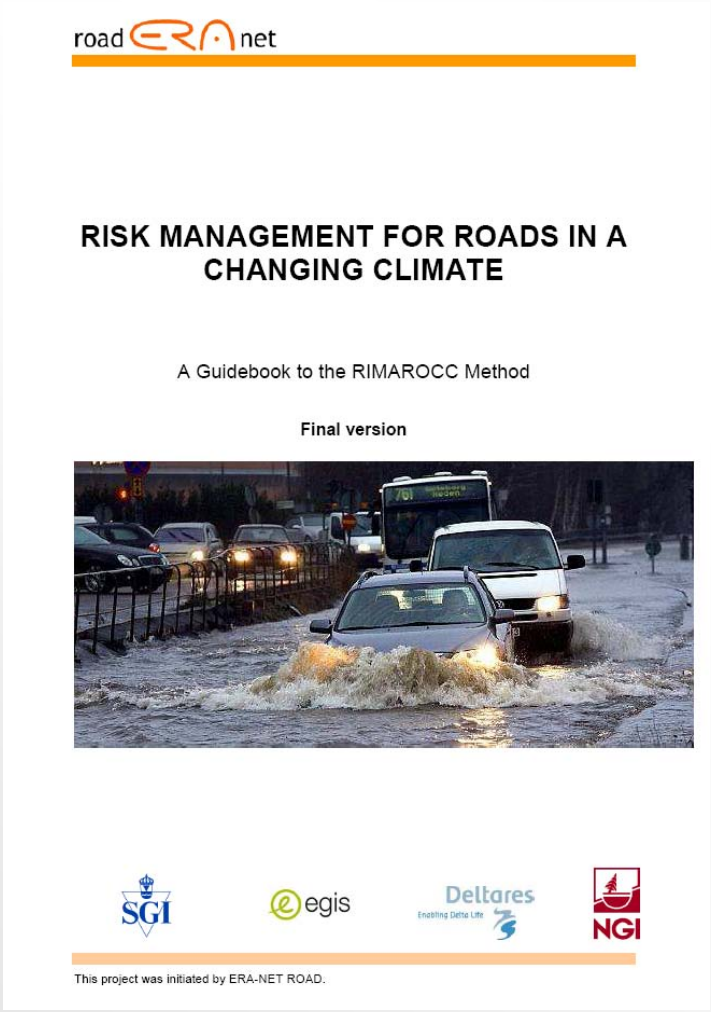
- Consists of seven steps
- Is in line with ISO 31000
- Is designed to be compatible, and to operate in parallel with existing methods
- Is designed for road risk management at all operational and geographical levels (structure, section, network, territory)



How to use RIMAROCC?

1. Guidebook to the RIMAROCC Method
2. Case study Network level, France
3. Case study Network level, The Netherlands
4. Case study Section level, Norway
5. Case study Structure level, Sweden
6. Technical background report

A Guidebook



Part 1- Basis for climate and risk management

Part 2 - Method and Guidance

part 3 - Case studies

Basis for Climate ...

Extreme	Draught	Extreme
Critical		

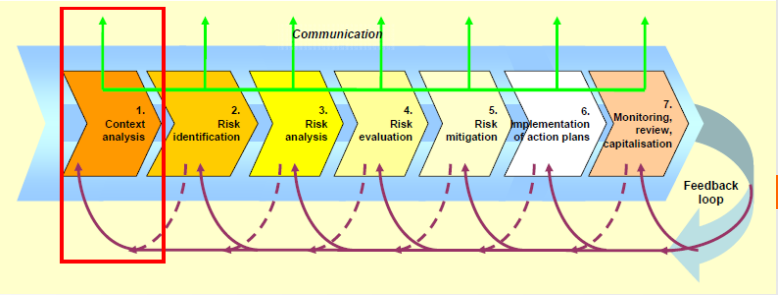
- weighted according to their importance for the road sector (1: useful to 4: of primary importance)

- the amount of expected change is estimated, from significant increase ++, to significant decrease --

Method and Guidance

The RIMAROCC method consists of seven steps, each with a number of sub-steps. All steps are presented in the same way, starting with a summary of the step and a list of the sub-steps. The sub-steps are structured as follows:

a) Objectives – describing the objectives of the sub-step
b) Output – describing the outcome of the sub-step
c) Method – presenting the recommended methods or procedures
d) Data collection – describing what data is needed to perform the sub-step and how to obtain it.
e) Examples – each sub-step is provided with an example to improve the readability. More examples can be found in the case studies.



Step 1 – CONTEXT ANALYSIS

1. Objectives

By establishing the context, the authority responsible for the climate risk management study articulates its objectives, defines the external and internal parameters to be taken into account when managing risk, sets the scope and risk criteria for the remaining process, and defines the area under study.

2. Sub-steps

The context analysis is structured into three successive sub-steps:

- Establish a general context
- Establish a specific context for a particular scale of analysis
- Establish risk criteria and indicators adapted to each particular scale of analysis

The general context is the same whatever the scale of analysis (structure, section, network, area). It differs when addressing particular scales.

road ERA net

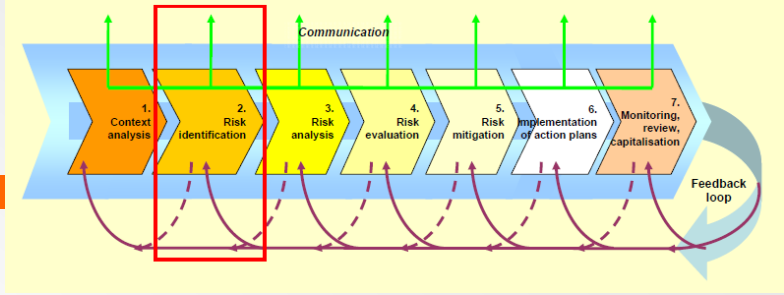
Example: the specific context for a network scale analysis

Example: risk criteria and indicators for a section scale analysis

Risk criteria and indicators on the section scale are presented in three tables. The first table shows criteria for categorising exposure, the second table shows criteria for assessing vulnerability and the third table shows criteria for assessing consequences.

Criteria for assessing exposure

Criteria for assessing exposure	**Low**	**Medium**	**High**	**Very high**
E1:Frequency of key climate conditions/past extreme events	<0.001/yr	0.001/yr-0.01/yr	0.01/yr-0.1/yr	> 0.1/yr
E2: Exposure duration	Hours	Days	Weeks	Months
E3: Exposed area	Small area			Large area
E4: Exposed objects/people	Small number			Large number



Step 2 – RISK IDENTIFICATION

1. Objectives

The risk manager should identify sources of risk, areas of impact, unwanted events (including changes in circumstances) and their causes and potential consequences. The aim of this step is to generate a comprehensive list of risks based on events that might stop, degrade or delay the normal operation of the road system, or create trouble or damage in the exposed area.

2. Sub-steps

Sub-steps are proposed in relation to the risk definition. Risk is an unwanted event which is characterised as:

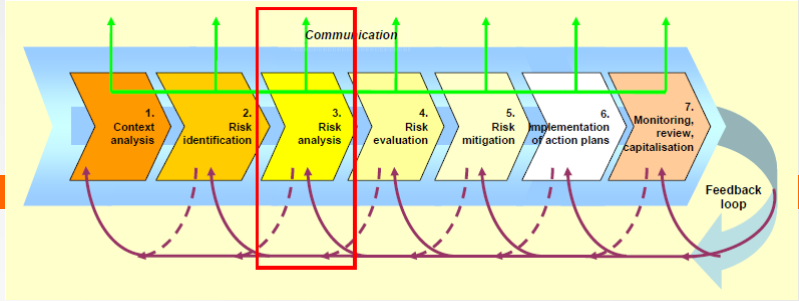
Risk = function of [Threat, Vulnerabilities, Consequences]

This step is therefore structured into three sub-steps:

- **Identify risk sources or factors (threats)**
- **Identify vulnerabilities**
- **Identify possible consequences**

Example of vulnerabilities analysed on a network scale

Section	Length in km	Age / design standards	Traffic (veh./ day)	Exposure to climate events		Sensitive elements in the infrastructure
				Current situation	With CC (estimates) *	
AX-1	10-15	< 1960	60,000 – 70,000	Overflow for Q10	+ 10 % additional flow	Undersized drainage system
AX-4	25-30	1960-1970	40,000 – 50,000	Extreme wind speed > 120 km/h	+ 5 %	Bridge showing structural defects
AY-1	20-25	1980-1990	20,000 - 30,000	Average seasonal rainfall: 500 mm	+ 5 %	Hydromorphic grounds
AY-2	20-25	1980-1990	20,000 – 30,000	Average number of frost days: 20	- 5 %	Pavement cracks



Step 3 – RISK ANALYSIS

1. Objectives

Risk analysis involves developing an understanding of the risks. The risk analysis provides input to risk evaluation, serves as a decision basis for risk treatment, and for selecting the most appropriate risk treatment strategies and methods.

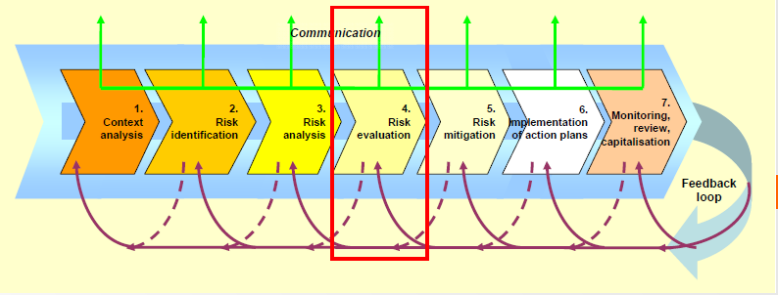
2. Sub-steps

- Establish risk chronology and scenarios
- Determine the impact of risk
- Evaluate occurrences
- Provide a risk overview

Example of risk overview at the structure scale

All risks are scored using criteria in order to characterize the risk magnitude. The risk table below summarises the probability, exposure, sensitivity and consequence indicator scores for each risk scenario.

Risk scenario	Probability for risk scenario (year-1)	Exposure			Sensitivity				Consequences				
		Duration E1	Area E2	People/Object E3	Speed S1	Information S2	Knowledge S3	Standard S4	Persons C1	Property C2	Environ. C3	Financial C4	Intangible C5
R1: Extreme rain + flooding	0,08	2	2	2	4	2	1	1	2	3	1	1	1
R2: Extreme rain + collapse	0,02	2	2	2	4	2	1	1	3	3	1	2	1
R3: Spring flood + flooding	0,08	2	2	2	2	2	1	1	2	3	1	1	1
R4: Spring flood + collapse	0,02	2	2	2	2	2	1	1	3	3	1	2	1



Step 4 – RISK EVALUATION

1. Objectives

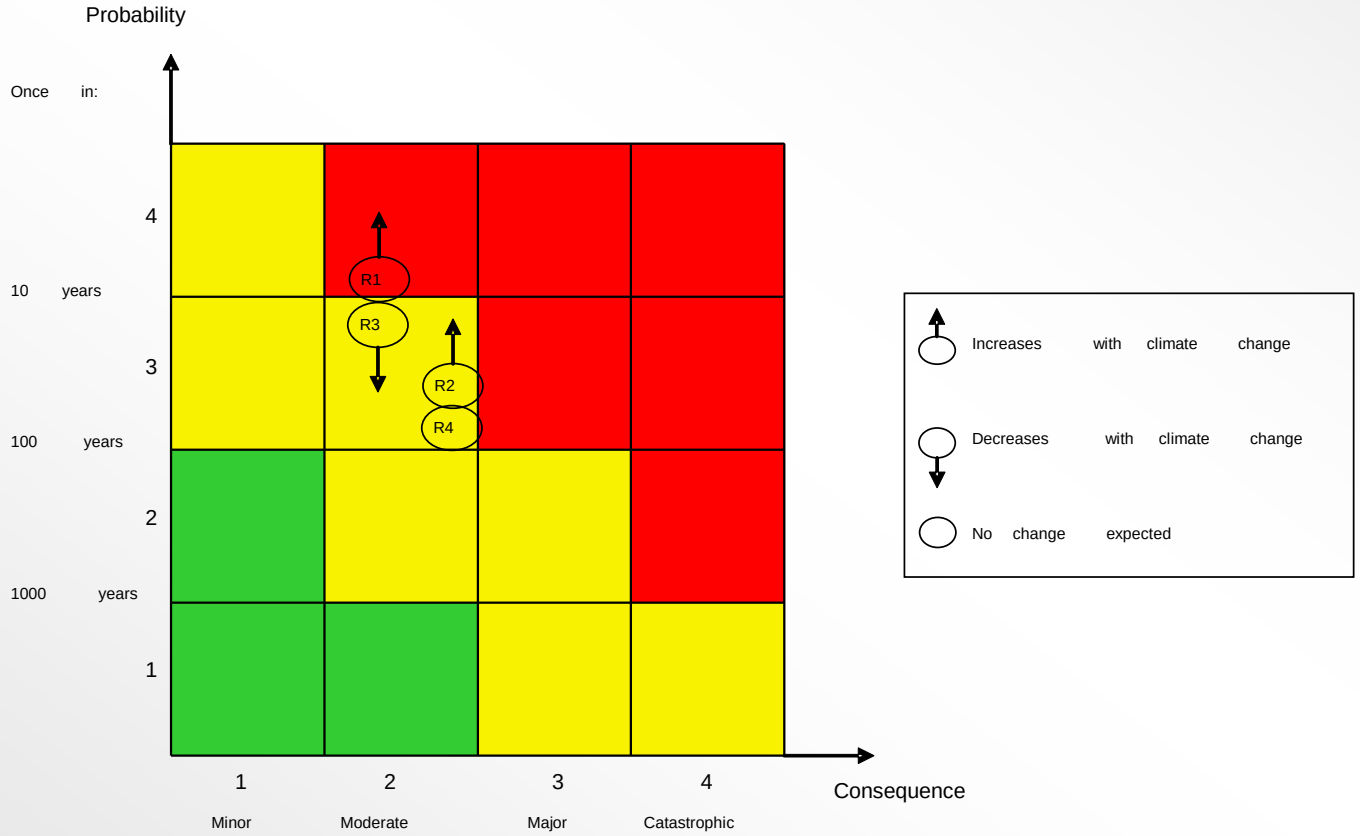
The purpose of risk evaluation is to assist the risk manager in making decisions, based on the outcome of the risk analysis, about which risks need treatment and the priorities for treatment implementation. Risk evaluation involves comparing the level of risk found during the analysis process with risk criteria defined when the context was established. Based on this comparison, the need for treatment can be considered.

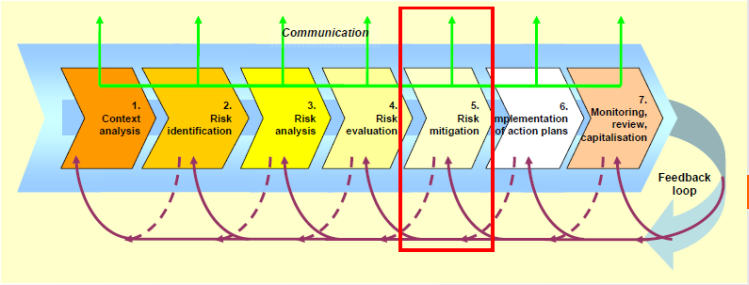
2. Sub-steps

- Risk prioritisation
- Compare climate risk to other kinds of risk
- Determine which risks are acceptable

Example of risk prioritisation at the structure scale

Risk matrix with probability and weighted consequences indicated for four risk scenarios.





Step 5 – RISK MITIGATION

1. Objectives

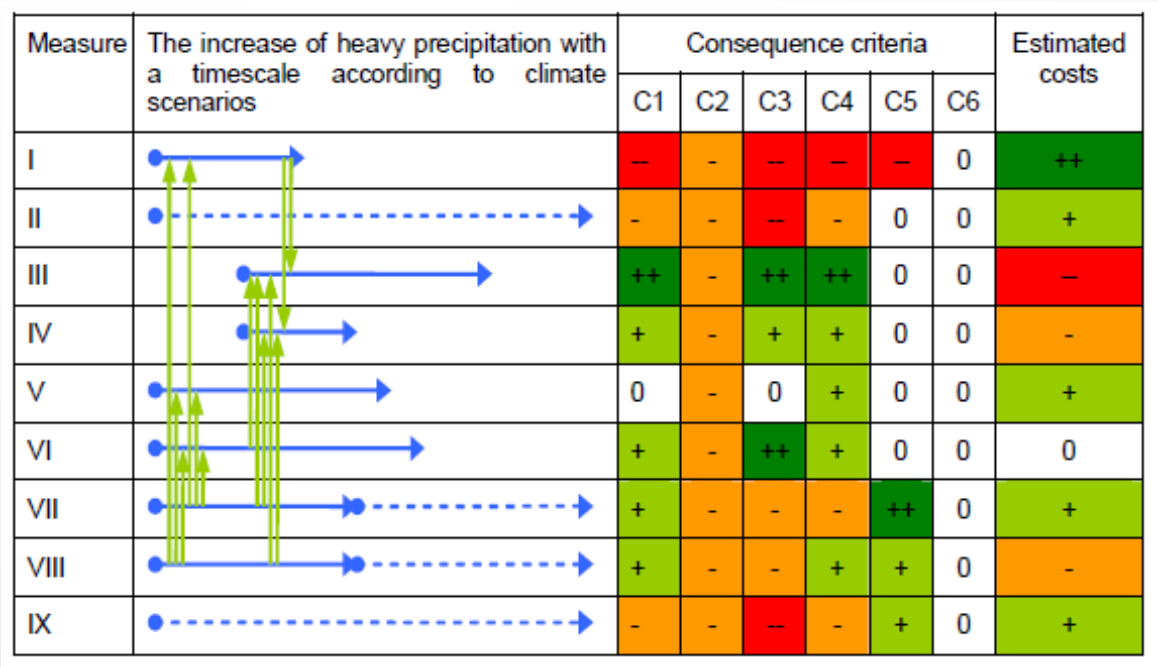
Risk mitigation involves identifying, appraising and selecting one or several options for modifying the non-acceptable risks. A combination of the identified measures can be changed into a strategy for the coming years in order to cope with climate change and keep risks acceptable. This step also includes securing financing as well as documenting in an action plan how the chosen adaptation measures will be implemented.

2. Sub-steps

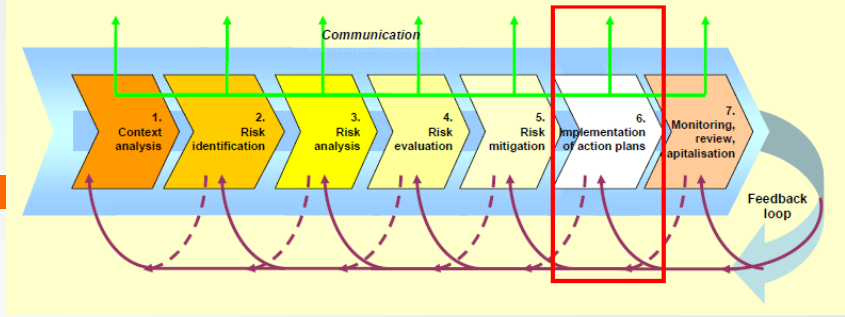
- Identify options
- Appraise options
- Negotiation with funding agencies
- Present an action plan

Example of mitigation option appraisal on a section/network scale

The strategy sheet example below is based on assumptions but gives a good insight into how the adaptation tipping point in a strategy analysis sheet can be used to choose a strategy, as a combination of several related measures. The x-axis is the time scale, and. The measure's tipping point is where the blue arrow ends. At present **the blue arrows show the timeframe for which each measure is effective**, measures I, V, VI, VII and VIII are applicable. Measures III and IV will only become effective after climate change has already developed. **The green arrows show the possibilities of changing from one measure to another measure**. The effects of each measure on the consequence criteria are scored as described above, as are the implementation costs.



Measure	The increase of heavy precipitation with a timescale according to climate scenarios	Consequence criteria						Estimated costs
		C1	C2	C3	C4	C5	C6	
I		–	-	–	–	–	0	++
II		-	-	–	-	0	0	+
III		++	-	++	++	0	0	–
IV		+	-	+	+	0	0	-
V		0	-	0	+	0	0	+
VI		+	-	++	+	0	0	0
VII		+	-	-	-	++	0	+
VIII		+	-	-	+	+	0	-
IX		-	-	–	-	+	0	+



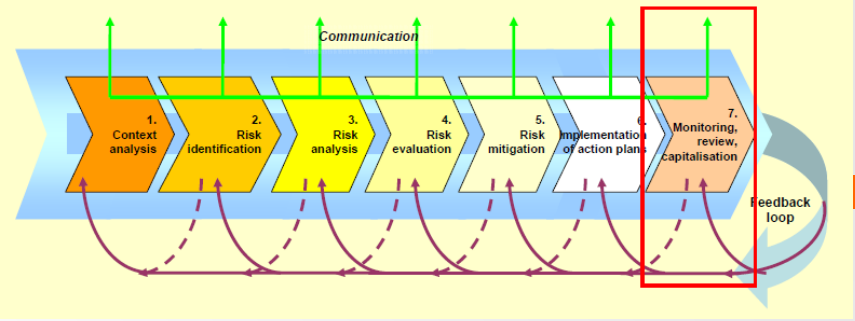
Step 6 – IMPLEMENTATION OF ACTION PLAN

1. Objectives

In this step the action plan is presented in detail; responsibilities for implementation are addressed; resources are allocated; performance indicators are selected. All these elements being specified, the action plan is implemented. This is a strategic step which involves stakeholders from several departments: roads, civil security, finance, etc. Network and territorial scale analyses require information on which geographical units of the road organisation should be involved.

2. Sub-steps

- Develop an action plan on each level of responsibility
- Implement an adaptation action plan



Step 7 – MONITORING, REVIEW & CAPITALISATION

1. Objectives

Since risk management is a learning process this step aims to monitor and review the implemented actions and to capitalise the knowledge gained through climatic events and implementation of action plans.

2. Sub-steps

- Regular monitoring and review
- Re-plan in case of new data or delay in implementation
- Capitalisation of return of experience on both climatic events and implementation progress

Thank you for your attention

RIMAROCC Reports
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Presenter's contact

yves.ennesser@egis.fr