Project Nr: TR80A 2008:72148

Co-operation level: Common Obligation

RIMAROCC: Risk Management for Roads in a Changing Climate

Start date of project: 01.10.2008
End date of project: 31.07.2010
Duration: 22 Months

Monitoring Progress Report 2

Reporting period from 01.12.2008 to 05.30.2009

This report is prepared by the Contractor of the research project and presented to the Project Executive Board.

Project Executive Board:
AT, Federal Ministry of Transport, Innovation and Technology (BMVIT)
DE, Federal Ministry of Transport, Building and Urban Affairs (BMVBS)
DK, Ministry of Transport, Danish Road Directorate (DRD)
ES, Centre for Studies and Research in Public Works (CEDEX)
FI, Finnish Road Administration (Finnra)
IE, National Roads Authority (NRA)
NL, Directorate of Public Works and Water Management (RWS)
NO, Norwegian Public Roads Administration (NPRA)
PL, General Directorate of National Roads and Motorways (GDDKiA)
SE, Swedish Road Administration (SRA)
UK, Department for Transport, Highways Agency (HA)

Project Leader: SE, SRA
Programme Executive Chair: AT, BMVIT

Contractors:
SE, SGI (Coordinator)
FR, EGIS
NL, Deltares
NO, NGI
## Objectives

Describe the objectives of the project stated in the MoU and any modifications introduced later (not more than ½ page):

The objective of the proposed project is to develop a common ERA-NET ROAD method for risk analysis and risk management with regard to climate change (we agree with the view in the GfA, that a common method i.e. a systematic way of structuring and calculating is more needed at this point than a model – a numerically based tool for detailed calculations and e.g. simulations). The purpose is to support decision making concerning adaptation measures in the road infrastructure. To facilitate the work of end users the method will be based upon, or at least be compatible with, general existing methods for risk analysis (and management) within the ERA-NET ROAD funders and other relevant methods. Specific improvements of existing methods will be developed where they are necessary to effectively deal with climate change.

The project is focusing on Topic 2 in the call, Risk Analysis – with risk assessment, risk management in cost-benefit analysis and level of acceptable risk, and Topic 5, Risk management Options. This integrated approach will greatly facilitate the consistency of methodological deliverables and the work of end users among road authorities.

A specific attention will be given to both new road design and improvement/maintenance/operation of existing roads. The project will take into account the present knowledge of future climate evolution (short, medium and long-term) and the design life of roads and structures; at the same time it will add value and qualities today. The architecture of the methodologies will be designed to facilitate their easy-updating when new knowledge appears and to facilitate the complementary responsibilities of the various concerned organisations.

Appropriate coordination with research organisation responsible for topics 1, 3 and 4 are very worthwhile for effectiveness.

## Technical Description

Describe the items of technical work, the mode of operation, possible subdivision in Working Groups and how management is organised (no more than 2 pages):

The project is directed by a Project Management Group with representatives from all partners. The project management group will meet regularly when needed, and at least every six months. The specific Electronic Board Room at Deltares is be used to facilitate concurrent engineering, i.e. for identification and classification of risks via expert sessions.

An ERA-NET Steering Group is formed to follow the project.

The project is organised in 6 Work Packages, each with a responsible WP-leader. All WP:s are connected, but specifically W1 and WP2 respectively WP4 and WP5.
Four specific workshops are planned. The workshops will be coordinated in time and place to minimise travel and time consumption.

**Workshops:**
- With Road Authorities – in WP1
- With risk-researchers - in WP2
- With climatologists – in WP3
- Presentation of examples to experts and Road Authorities –in WP 6

### Participation and coordination

**Project Steering Group (PSG)**

Project Manager:
Ása Lindgren, SRA, Sweden

Members:
- Alberto Compte, CEDEX, Spain
- Geoff Richards, HA, UK

**Contractors**

Chair, Secretary:
Bo Lind, SGI, Sweden
Chalmers Vasa, Hugo grauers gata 5 B
Tel., +46 31 778 65 66
email bo.lind@swedgeo.se
Fax., +46 31 7785940

Members:
- France, Michel Ray, EGIS
- The Netherlands, Thomas Bles, Deltares
- Norway, Frode Sandersen, NGI

**Meetings of the Contractors and PSG:**
13-14 October 2008 SGI, Göteborg, Sweden
Report on Results (so far)

Objective/Milestone: | Assessment
---|---

1. **Partner Presentation of our organisations**
   A Project Management Group has been formed: SGI, Bo Lind; EGIS, Michel Ray; NGI, Frode Sanderson; Deltares, Thomas Bles.

2. **WP 1, The Listening process**

Workpackage 1, the listening process, has been completed, including the workshop in Oslo in March 2009.

The workshop did focus on key actual needs of the ERA-NET Road partners and the necessary functions of the Rimarocc risk management method. The purpose was weighting the importance of different functions with regard to the needs and the design objectives.

The workshop used a Value Engineering approach – that is a systematic process by a team to increase the value of a project.

One of the concrete outcomes of the listening process was a list of important functions and design qualities of the Rimarocc methodology. Examples of key Functions and design Objectives are:

**E.g. Key Functions:**
- F12 - The method should make it possible to identify risk factors (climate factors, infrastructure intrinsic factors, site factors)
- F14 - The method should make it possible to determine risk levels and their critical loads (risk factor graded risk level)
- F15 - The method should make it possible to define the level of acceptable risks (acceptable vs non-acceptable risk)
- F16 - The method should make it possible to prioritize roads and structures according to the risks (graded list)
- F28 - The method should be a framework to calculate socio-economic costs and benefits (costs of physical structures, personal and societal costs)
- F29 - The method should be a framework to estimate mitigation efforts/measures (through cost – benefit analysis)
- F210 - The method should be a framework to prioritize mitigation efforts/measures (criteria and hierarchy)

**E.g. Key Design Objectives:**
- Common way of identifying and preventing problems with the road infrastructure due to climate changes
- Consider specific features of the European countries (risk of flooding, snow, wind …).
- Already Implemented in existing organisations
• “Method” (i.e. a systematic way of structuring and calculating)
• “Robust” method able to cope with climate change uncertainty and with various scales of project (structure, section, network)
• Dealing with both new road design and improvement/maintenance/operation of existing roads
• Taking account of the present knowledge of future climate evolution (short, medium and long-term) and the design life of roads and structures
• Release of a short report for practical use (rather than a theoretical “Research report”).

WP 2, Research Think Tank on Risk management
A workshop on Risk management was held in Delft in May 2009. Main objective of the workshop was getting in depth insight in risk management methods and strategies with relevance for the Rimarocc project. Specifically the three identified methods, from UK, The Nederlands and France, was studied in order to be able to pick the best suitable method for RIMAROCC, or to gather the most appropriate aspects from different methods in order to assemble a new method. Presentation and discussion about the methods gave detailed and thorough insight in the methods.

During the workshop a set of questions was prepared and discussed:

- **Main question**: What elements of the discussed methods need to be further explored to become part of the RIMAROCC method? Is it possible to use one of the methods directly? (answer before lunch).
- What features are necessary in the method? In order to be able to:
  - Use different and differing climate scenarios in the same method
  - Use the method in different organizations
  - Fit with end user demands
- How can climate change related risks best be identified?
- How can climate change related risks best be assessed and classified? (Possibly the electronic board room can be used in order to brainstorm on this question)
  - What criteria can be used?
  - What are accompanying indicators with these criteria?
- How can measures for non acceptable climate change related risks best be identified and compared in order to be able to choose the most pertinent option?
- How can identified risks best be continuously evaluated as part of a regularly climate change adaptation check by road owners?

WP 3, Climate scenarios and consequences on risk approach
The existing view among road administrators on the critical weather conditions for roads in a future climate change has been compiled through a bibliographical review of some major references:

- UK Climate change adaptation strategy
- US report “Potential impact of climate change on US-transportation”
- France: GERICI
- Sweden facing climate change – Threats and opportunities
- Australia: Impact of Climate Change on Road Infrastructure
- Netherlands: Effects of climate change on traffic and transport

CLIMATE CHANGE ADAPTATION STRATEGY (UK, Volume 1, 31 March 2008)

**Overview**: The 3rd chapter is devoted to climate change trends. The purpose is to “identify climatic trends affecting Highways Agency”. Are distinguished primary climatic variables and secondary climatic impacts. The following listing of variables is provided in the report, without any comment.

**Climate variables**:
- Primary climatic changes
- Increase in average temperature
- Increase in maximum temperature
- Increase in winter rainfall
- Reduction in summer rainfall
- More extreme rainfall events
- Reduction in snowfall
- Increased wind speed for worst gales
- Sea level rise

Secondary climatic change impacts
- Longer growing season
- Reduction in soil moisture
- Change in groundwater level
- Flooding
- Reduction in fog days in winter
- Reduction of icy days in winter
- Frequency of extreme storm surges

**POTENTIAL IMPACT OF CLIMATE CHANGE ON U.S. TRANSPORTATION (USA, 2008)**

**Overview:** In section 2 – Understanding Climate Change, a chapter is devoted to “Climate Changes Relevant to U.S. Transportation”. Based on current knowledge, climate scientists have identified five climate changes of particular importance to transportation and estimated the probability of their occurrence during the twenty-first century.

**Climate variables:**
- Increases in very hot days and heat waves – highly likely (> 90 % probability of occurrence)
- Increases in Arctic temperatures – virtually certain (> 99 % probability of occurrence)
- Rising sea levels – virtually certain
- Increases in intense precipitation events – highly likely
- Increases in hurricane intensity – likely (> 66 % probability of occurrence)

**GERICI (France, 2007)**

**Overview:** The hazards taken into consideration in GERICI are called Unwanted Events (UE). Each UE is regarded as a long-term hazard for the infrastructure or its components, as also for continuity of service (traffic) and residents.

The motorway components are subject to detailed expertises intended to identify possible UE vulnerability. Seven main components have been analysed: major hydraulics (bridges), minor hydraulics (catchment area < 2 km²) and drainage, engineering structures, equipment, geotechnics, environment, and pavements. The components have been classified in families according to their degree of sensitivity to the same meteorological event. The variation in the intensity of the event makes it possible to establish three typical thresholds for each element: dimensioning level, critical level, breaking level.

**Climate variables**
- rain (mm/h and mm/24h), changed in flows (m³/s) when associated to a water catchment area
- flood (m³/s or clearance in m), e.g. critical level if clearance < 0.5 m under a bridge
- wind (km/h), e.g. critical levels if wind speed > 170 km/h for vertical roadsigns
- snow (snow thickness and snow weight as a combination of thickness in cm, temperature in °C, and wind speed in m/s)
- Frost (combination of number of icy days and average temperature in °C)
- Heat waves (°C), e.g. critical level if temperature > 60°C for road pavements in day time, > 50°C at night (vary according to the bituminous content).

**SWEDEN FACING CLIMATE CHANGE - THREATS AND OPPORTUNITIES (SWEDEN, SOU 2007:60). APPENDIX B1, THE ROAD NETWORK (SRA)**

**Overview:** As an input to the national Swedish Commission on Climate and Vulnerability the Swedish Road Administration has studied the impact of climate change on the Swedish road network. The
Echam4 model and A2 emission scenario was chosen as a basis and the time scale 2070-2100.

Climate variables
The specific weather conditions that were considered as most critical were defined as:
- Changes in precipitation - with a 10-40% increase in large parts of Sweden.
- High flows - increasing frequency
- Ice - more zero-crossings expected. E.g. shortening the life span of a road body.
- Sea level – rising. More erosion and flooding.
- Temperature – rising and affecting e.g. ground frost which is important for the bearing capacity of forest roads during winter.
- Wind – rising number of storm events

Comments:
The Vulnerability for different components in the system is summarised in a table:

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>Climate related vulnerability</td>
</tr>
<tr>
<td>Road</td>
<td>Landslide, Rockfall, erosion</td>
</tr>
<tr>
<td>Road</td>
<td>Flooding</td>
</tr>
<tr>
<td>Road</td>
<td>Snow and ice hindrance</td>
</tr>
<tr>
<td>Road embankment</td>
<td>Deformation and cracks</td>
</tr>
<tr>
<td>Pipe</td>
<td>Dam, erosion, flushing away of road</td>
</tr>
<tr>
<td>Bridge</td>
<td>Temperature induced tensions</td>
</tr>
<tr>
<td>Large bridges</td>
<td>Wind-swinging, wind-load</td>
</tr>
<tr>
<td>Hanging bridge</td>
<td>Ice</td>
</tr>
<tr>
<td>Concrete bridge</td>
<td>Shorter life span</td>
</tr>
<tr>
<td>Wooden bridge</td>
<td>Shorter life span</td>
</tr>
<tr>
<td>Low bridge</td>
<td>Dam, erosion, flushing away of road</td>
</tr>
<tr>
<td>Bridge-owerburdon</td>
<td>Dam, displacement</td>
</tr>
<tr>
<td>Piers</td>
<td>Erosion</td>
</tr>
<tr>
<td>Tunnels</td>
<td>Flooding</td>
</tr>
<tr>
<td>Ferry-harbour</td>
<td>High and low water level</td>
</tr>
</tbody>
</table>

IMPACT OF CLIMATE CHANGE ON ROAD INFRASTRUCTURE (Australia, 2004)

Overview: Austroads and the Department of Transport and Regional Services engaged ARRB Transport Research and CSIRO Division of Atmospheric Research to undertake a project to examine likely future climate scenarios for the whole of Australia during the 21st Century, and investigate the likely effects of this climate change on major road infrastructure, as represented by the Australian National Highway network.

The raw CSIRO Division of Atmospheric Research climate data has been transformed into parameters required by the pavement deterioration models used in the project.

Climate variables:
- Temperature (monthly averaged temperature in °C)
- Rainfall (monthly averaged rainfall in mm)
- Thornthwaite moisture index

Comments:
Climate is represented in the pavement deterioration models by the “Thornthwaite moisture index” (Thornthwaite, 1948), which is a function of precipitation, temperature and potential evapotranspiration. The latter depends on a range of factors including temperature and length of daylight hours. Roads in areas with higher value for the Thornthwaite index will deteriorate faster than those with a lower value for the same traffic loading. A warmer and wetter climate leads to a higher rate of pavement deterioration, both as function of time and as a function of the pavement load (measured in equivalent standard axles; ESAs).

Moisture and temperature are major influences on road deterioration: moisture affects pavement structural performance; and temperature affects surfacing performance (through bitumen aging effects
which include oxidation and embrittlement). Due to project constraints, it has not been possible to examine the impacts of extreme weather events such as extreme rainfall, extreme temperature or flood frequencies, but it is assumed that these events will also impact on road design, road condition and operation.

EFFECTS OF CLIMATE CHANGE ON TRAFFIC AND TRANSPORT (Netherlands, 2008)

Overview: This exploratory study is a response to the need of the Directorates-General for Passenger Transport (DGP) and Transport and Aviation (DGTL) of the Ministry of Transport, Public Works and Water Management to be able to ascertain whether any or additional policy measures are needed in order to adapt traffic and transport to climate change in time. The study was based on Royal Netherlands Meteorological Institute (KNMI) estimates regarding the way in which climate change is set to develop. The report describes observed effects of climate change on traffic and transport and the possible measures which have been and are being taken.

Climate change induced weather conditions:
- Rise of average temperature
- Rise of extreme heat (summer)
- Rise of sea level
- Rise of extreme drought (summer)
- More often low water levels
- Rise of intense rainfalls
- Rise of storms
- Rise of high water levels and flooding
- More mild winters

<table>
<thead>
<tr>
<th>Effects</th>
<th>Adaptation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutting (melting asphalt) of roads</td>
<td>Improved construction or more repair (research)</td>
</tr>
<tr>
<td>Flooding of roads by intense rain fall</td>
<td>Adaptation of design criteria (normative rainshower)</td>
</tr>
<tr>
<td>Loss of electric systems of roads</td>
<td>Improve, fall back systems, more repair</td>
</tr>
<tr>
<td>Jammed bridge openings</td>
<td>Widening of dilatations (research)</td>
</tr>
<tr>
<td>Softening of substructure of roads</td>
<td>Improved construction or more repair (research)</td>
</tr>
<tr>
<td>Consolidation of substructure of roads</td>
<td>Improved construction or more repair (research)</td>
</tr>
<tr>
<td>Flooding</td>
<td>Dike improvement or compartments, escape routes</td>
</tr>
</tbody>
</table>

Settlement of traffic and transport
- Decrease of availability and capacity of roads: Short period: none, long period: re-route
- Rise of importance of weather alarms: Further developments, improve and tune
- Rise of number of repairs: Anticipate on volume and timely help
- Rise of use of remedial tools and emergency services: Equip for more intense use
- Rise of importance of evacuation and emergency plans: Development of demands on road infrastructure
- Congestion: Variable effect, continuation of existing policy
- Rise of traffic unsafety: No substantial effect, continuation of existing policy
- Noise production: Limited effect, continuation of existing policy
- Discharge emission and photochemical smog: Variable effect, continuation of existing policy

SYNTHESIS

The critical climate conditions was elaborated in workshops in Oslo and Delft with the help of climate specialists. The results was compiled into a “state of the knowledge matrix” that is one of the cornerstones for the risk analysis and management. However the matrix is still under development: See also filled matrix in Appendix 1.
## Critical climate variables

### Major risks to road infrastructure

<table>
<thead>
<tr>
<th>Critical climate variables</th>
<th>Major risks to road infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum temperature and number of consecutive hot days (heat waves)</td>
<td>Concerns regarding pavement integrity, e.g. softening, traffic related rutting, embrittlement (cracking), migration of liquid asphalt. Thermal expansion on bridge expansion joints and paved surfaces.</td>
</tr>
<tr>
<td>Extreme rainfall events (heavy showers and long rain periods)</td>
<td>Flooding of roadways. Road erosion, landslides and mudslides that damage roads. Overloading of drainage systems, causing erosion and flooding. Traffic hindrance and safety.</td>
</tr>
<tr>
<td>Seasonal and annual average rainfall</td>
<td>Impacts on soil moisture levels, affecting structural integrity of roads, bridges, and tunnels. Adverse impacts of standing water on the road base. Risk of floods from runoff, landslides, slope failures, and damage to roads if changes in precipitation pattern (e.g.: changes from snow to rain in winter and spring thaws).</td>
</tr>
<tr>
<td>Drought (consecutive dry days)</td>
<td>Susceptibility to wildfires that threaten transportation infrastructure directly. Susceptibility to mudslides in areas deforested by wildfires. Consolidation of substructure with (unequal) settlements as a consequence. More generation of smog.</td>
</tr>
<tr>
<td>Snowfall</td>
<td>Traffic hindrance and safety. Snow removal costs.</td>
</tr>
<tr>
<td>Fog days</td>
<td>Traffic hindrance and safety. More generation of smog. Ice removal costs.</td>
</tr>
<tr>
<td>Frost (number of icy days)</td>
<td>Traffic hindrance and safety. Ice removal costs.</td>
</tr>
<tr>
<td>Thaw (number of days with temperature zero-crossings)</td>
<td>Thawing of permafrost, causing subsidence of roads and bridge supports (cave-in). Decreased utility of unimproved roads that rely on frozen ground for passage.</td>
</tr>
<tr>
<td>Extreme wind speed (worst gales)</td>
<td>Threat to stability of bridge decks. Damage to signs, lighting fixtures and supports.</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>Inundation of roads in coastal areas. Erosion of road base and bridge supports. Bridge scour. Reduced clearance under bridges. Extra demands on infrastructure when used as emergency/evacuation roads.</td>
</tr>
</tbody>
</table>

## Future Work

WP 1-3 are now elaborated and the results are taken foreword to the building of the Rimarocc method in WP 4 - 6.

**WP 4: Risk analysis based decision methods for road authorities**

A common method/procedure for risk analysis considering climate change will be developed which can be adopted by ERA-NET partners, either in complementary to existing methods or if necessary with a new proposed method. The work includes methods for calculating and comparing the costs of preventive measures and the costs of damages and methodology of cost benefit analysis. Economists from Deltares and ev. EGIS will participate.

Input is needed from WP1 and WP2. Four case studies will be used where data is collected from each country. They will be based on real climatic data events and simulations at
appropriate level. Important to have pedagogical cases. The cases can improve the methodology.

**WP 5: Risk Management options; mitigation and/or emergency plans**

Decision Support Systems, DSS, is an interaction between problem, policy and political stream. Deltares have developed the GeoQ riskmanagement methodology with six risk management steps.

WP5 is very much integrated with WP4. It is not possible to choose between measures without overview of whole risk management approach and vice versa. The needs and demands from WP1 should be part of the analyses e.g. delays, costs, value of a passable road, safety. Facts from WP2, 3 and 4 is needed.

Output of WP5 is a methodology / approach, not a calculating tool / model.

**WP 6: Dissemination**

The project has discussed examples of how to best disseminate results; reports, publications, papers, web-sites, seminars/workshops, participate at conferences.

The goal with WP6 is to present how the worked-out method can be used at different levels. A final seminar/workshop with presentation of case studies should be arranged in July 2010, and the results of the Rimarocc project will also be presented at the TRA conference in 2010 and at other conferences, e.g. ”Transportforum” Sweden 2010. There is also planned to write an scientific paper for publishing in an internationaljournal.

From discussions with ERA-NET Road it is concluded that the final report should be a short report with recommendations step by step, like for example the UK method, with references to publications.

An editorial group with one person from each partner will be established to discuss e.g. the format, editing roles, pedagogic, content.

WP6 shall make a report of the case studies. The case studies give feed back to the methodology and comparison between national methods and the one the project present. The best available climate scenarios should be used in the case studies. It is important that road owners give free information to the project.

4 Time table
Appendix 1:
## SUMMARY OF PRESENT KNOWLEDGE REGARDING CRITICAL CLIMATE PARAMETERS FOR CLIMATE CHANGE ANALYSIS IN THE TRANSPORT SECTOR

<table>
<thead>
<tr>
<th>Weight</th>
<th>Unwanted climate event</th>
<th>Critical climate parameter</th>
<th>Amount of change compared to 1961-1990 period</th>
<th>Availability of predictions: qualitative, quantitative or impossible</th>
<th>Certainty of predictions: likely, very likely, (virtually) certain</th>
<th>Geographical resolution (grid size / resolution for which it can be used)</th>
<th>Time Horizon (when will it happen?)</th>
<th>Available data / models</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Extreme rainfall events (heavy showers and long rain periods)</td>
<td>Max. intensity in [mm/h] and [mm/24h]</td>
<td>Intensity: likely (+) Frequency: North likely South ?</td>
<td>Qualitative Likely</td>
<td></td>
<td>50 km (difficult to use smaller grids)</td>
<td>No statistical evidence of trends, but happening today</td>
<td>Regional models + local expertise</td>
</tr>
<tr>
<td>4</td>
<td>Seasonal and annual average rainfall</td>
<td>Average amount [mm/3 months]</td>
<td></td>
<td>Quantitative</td>
<td></td>
<td>Main signal perceptible for 250 km grid, but can be refined locally</td>
<td>Already observed</td>
<td>Global IPCC models</td>
</tr>
<tr>
<td>4</td>
<td>Sea level rise (+ waves and storm surges)</td>
<td>Rise [m]</td>
<td>+/+- XXI Cent.: (0.2 to 0.6m) No ice cap melting (IPCC assumption)</td>
<td>Qualitative</td>
<td></td>
<td>&gt; 0.2m is virtually certain in 2100</td>
<td>Already observed (may vary according to sea basins)</td>
<td>IPCC scenarios</td>
</tr>
<tr>
<td>3</td>
<td>Maximum temperature</td>
<td>Average max. [°C]</td>
<td>+/+- XXI Cent.:</td>
<td>Qualitative</td>
<td></td>
<td>Certain</td>
<td>Already</td>
<td>Global</td>
</tr>
<tr>
<td>Weight</td>
<td>Unwanted climate event</td>
<td>Critical climate parameter</td>
<td>Amount of change compared to 1961-1990 period (++, +, +/−, −, −−)</td>
<td>Availability of predictions: qualitative, quantitative or impossible</td>
<td>Certainty of predictions: likely, very likely, (virtually) certain</td>
<td>Geographical resolution (grid size / resolution for which it can be used)</td>
<td>Time Horizon (when will it happen?)</td>
<td>Available data / models</td>
</tr>
<tr>
<td>--------</td>
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<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Drought (consecutive dry days)</td>
<td>Drought duration [number of consecutive days], [d/year]</td>
<td>++ over South. Eur.</td>
<td>Quantitative</td>
<td>Very Likely</td>
<td>South. Eur and Med.</td>
<td>Has begun</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Snowfall</td>
<td>Max. snowfall in 24h [m/day] Snow duration at the ground [nb of days]</td>
<td>Int: + Freq: - Duration: --</td>
<td>Qualitative</td>
<td>Likely</td>
<td>Extr. North Eur Whole Eur</td>
<td>Has begun</td>
<td></td>
</tr>
</tbody>
</table>

Taver. Global: 1,8 to 4,0 °C (best estim./scen.). South + Continent. > Nor. ++ Even more for extremes ++ 5 to 30 days Quantitative V. Certain Quantitative Very likely perceptible for 250 km grid, but can be refined locally, except specific case of cities (higher °C) and coastal areas (lower °C)
<table>
<thead>
<tr>
<th>#</th>
<th>Parameter Description</th>
<th>Value</th>
<th>Qualitative Description</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fog days [number of days with fog]</td>
<td>?</td>
<td>Not yet possible (local effects – vertical resolution)</td>
<td>Unknown</td>
</tr>
<tr>
<td>2</td>
<td>Thaw (number of days with temperature zero-crossings)</td>
<td></td>
<td>Qualitative</td>
<td>Certain in North. Eur. – North. and Cont. Eur. – South.</td>
</tr>
<tr>
<td></td>
<td>Thaw days [number of days with 0°C crossings]</td>
<td></td>
<td></td>
<td>Has begun</td>
</tr>
<tr>
<td>2</td>
<td>Extreme wind speed (worst gales): extra tropical or convective systems induced</td>
<td></td>
<td>Qualitative</td>
<td>Likely in North Poor (unknown) in South.</td>
</tr>
<tr>
<td></td>
<td>Max. speed [km/h]</td>
<td></td>
<td></td>
<td>Not yet recorded (Vince storm not representative)</td>
</tr>
<tr>
<td></td>
<td>? elsewhere</td>
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<td>Global IPCC models</td>
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