Mapping of climate vulnerabilities on existing national road network in Poland

General Directorate for National Roads and Motorways (GDDKiA)

JASPERS Networking Platform Seminar - 6th of December 2017
Brussels
Contents of presentation:

1. Introduction – overview of the Polish national roads network.
2. Overview of EU funded projects.
3. Project of CC adaptation on national roads in Poland.
**Network of high-class roads (motorways and expressways) current network and development**

**Introduction**

- 1660.55 out of 2027.15 km completed (81.9%)
- 56.8 km under construction
- 18.1 km in tender

- 1506.00 out of 5765.9 km completed (28.3%)
- 1091.6 km under construction
- 504.1 km in tender

**High-class roads – overall numbers:**
- Total network length: 7793.05 km
- Total length under operation: 3166.55 km
- Total percentage of completion: 40.6%

under construction

in commission

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Generalna Dyrekcja Dróg Krajowych i Autostrad
Historical data for high-class road network (since 2000)

Under construction

In commission

Estimated costs of investments foreseen for years 2017-2022 is about 16 billion Euro.
### Traffic density on state roads

**Introduction**

<table>
<thead>
<tr>
<th>Road category</th>
<th>Length - 2010</th>
<th>AADT 2010</th>
<th>Length 2015</th>
<th>AADT 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorways</td>
<td>848</td>
<td>23285</td>
<td>1556</td>
<td>26509</td>
</tr>
<tr>
<td>Expressways</td>
<td>550</td>
<td>19567</td>
<td>1484</td>
<td>21232</td>
</tr>
<tr>
<td>Main trunk roads</td>
<td>11203</td>
<td>10434</td>
<td>10536</td>
<td>9995</td>
</tr>
<tr>
<td>Trunk roads</td>
<td>4646</td>
<td>4978</td>
<td>4446</td>
<td>5260</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>17247</strong></td>
<td><strong>9888</strong></td>
<td><strong>18022</strong></td>
<td><strong>11178</strong></td>
</tr>
</tbody>
</table>
Operational Programme Infrastructure & Environment 2014-2020

Priority Axis III: Development of TEN-T road transport and multimodal transport
a) Measure 3.1 Development of TEN-T road transport and airline network

Priority Axis IV: The road infrastructure of cities
b) Measure 4.1 Increase in transport availability of the urban centres on TEN-T road network and relief for the cities from the extensive road traffic
c) Measure 4.2 Increase in transport availability of the urban centres outside the TEN-T road network and relief for the cities from the extensive road traffic

Information on OPI&E at GDDKiA (data from: 29th of September 2017)
Project applications approved by European Commission: 27
Applications for subsidy: 40
Agreements for subsidy: 36
Applications for payment: 234, for the amount of: € 3,62 billion worth of eligible expenditure
Climate change assessment is carried out for EU financed projects:

- **Mitigation** - quantification of GHG emissions and related external costs based on national values (Blue Book, 2015)
- **Adaptation** – vulnerability and risk assessment, performed at application stage considering results of KLIMADA project for the vulnerability analysis – the goal of current activities regarding adaptation at national roads level.
CC adaptation project on national roads in Poland

- In February 2016 GDDKiA started preliminary works on the CC adaptation strategy
- Climate change is understood as increase in frequency and intensity of extreme weather events
- First step – sensitivity analysis regarding disturbances in traffic flow and damages caused by extreme weather events (based on DG CLIMA model):

  \[ \text{sensitivity} \times \text{exposure} = \text{vulnerability} \]

  ...in accordance with „International Climate Change Adaptation Framework for Road Infrastructure” by PIARC

- Questionnaire was sent to all 16 regional branch offices of GDDKiA, to units responsible for road maintenance.
- Acquisition of data from period between January 2004 and March 2016.
- Feedback: information about 3300 extreme weather events, which resulted in actions of road servicing teams.

In 2017 cooperation with JASPERS was established to develop the CC adaptation project.
Questionnaire scheme:

Three main parts:

• **PART 1** - Basic data on time and location and road section of every event

• **PART 2** - Types of the event - 12 different types of events, such as intensive rainfall, lightning discharge, strong winds, flood etc.

• **PART 3** - Effects of the event - 4 main classes:
  
  • Class I – damages and defects of road or road infrastructure (no obstacles in traffic flow)
  • Class II – obstacles in traffic flow (no damages and defects of road and road infrastructure)
  • Class III – total block of traffic flow (no damages and defects of road and road infrastructure)
  • Class 0 – no damages and no obstacles, but maintenance team action needed

Acquired data adjusted for GIS analyses.
CC adaptation project on national roads in Poland

**Questionnaire - PART 2**

In the case of a single extreme weather event more than one hazard could be selected.

For all weather hazards, it was possible to select “Yes” (i.e. the hazard has occurred and caused certain negative effects) or “No” (i.e., the hazard did not occur).
CC adaptation project on national roads in Poland

Effects of the event

Class I - damages and defects of road or road infrastructure
- road body and slopes affected
- bridges and structures affected
- road signs, greenery, environmental and road safety measures affected
- other damages and defects

Class II and Class III - traffic flow affected
- Class II - obstacles in traffic flow
  - up to 1 hour
  - from 1 hour up to 12 hours
  - from 12 hours up to 3 days
  - over 3 days
- Class III – total block of traffic flow
  - up to 1 hour
  - from 1 hour up to 12 hours
  - from 12 hours up to 3 days
  - over 3 days

Class 0 – no damages and no obstacles, but maintenance team action needed

Questionnaire - PART 3

Applied approach enabled to report also events, which caused effects compartmentalized to more than one Class.

Example: A particular event brought on by intensive rainfall might cause erosion of road body slopes (Class I) and as a result of that one lane of the road must be closed for 3 days to carry out repair works (Class II).
Preliminary results – percentage distribution of weather events

Percentage of events on roads caused by particular weather events

- Fire: 0.16%
- Heat and high temperatures: 2.41%
- Frost and low temperatures: 4.12%
- Intensive rainfall: 22.30%
- Hail: 0.55%
- Intensive snowfall: 15.51%
- Ice accretion on road and road infrastructure: 2.70%
- Lightning discharge: 2.96%
- Reduced visibility (fog): 2.98%
- Strong wind: 32.61%
- Flood: 8.39%
- Other: 5.32%
Preliminary results - monthly distribution (percentage) of occurrence

Time of occurrence of weather events

<table>
<thead>
<tr>
<th>Month</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>17.86%</td>
</tr>
<tr>
<td>II</td>
<td>6.38%</td>
</tr>
<tr>
<td>III</td>
<td>4.49%</td>
</tr>
<tr>
<td>IV</td>
<td>2.79%</td>
</tr>
<tr>
<td>V</td>
<td>10.66%</td>
</tr>
<tr>
<td>VI</td>
<td>11.87%</td>
</tr>
<tr>
<td>VII</td>
<td>15.70%</td>
</tr>
<tr>
<td>VIII</td>
<td>7.26%</td>
</tr>
<tr>
<td>IX</td>
<td>3.37%</td>
</tr>
<tr>
<td>X</td>
<td>4.68%</td>
</tr>
<tr>
<td>XI</td>
<td>4.16%</td>
</tr>
<tr>
<td>XII</td>
<td>10.78%</td>
</tr>
</tbody>
</table>
Preliminary results – occurrence of events on different road classes

Average number of weather events per 100 km of road (annually)

- **Motorways**: 0.83
- **Expressways**: 0.87
- **Main trunk roads**: 1.53
Preliminary results – identification of most risk sensitive areas

The colours’ intensity represent the different frequency (absolute value) of total number of extreme weather events registered between January 2004 and March 2016.
Preliminary results – Comments

- Data from questionnaire allowed for identification of main hazards to network of national roads – intense rainfall, intense snowfall and strong winds – responsible for more than 70% of all events caused by climate factors,

- Extreme weather events on roads in Poland are most frequent during periods from December to January and from May to July, as acquired from data collected between 2004 and 2016,

- Average number of weather related events is below one per one hundred kilometres for motorways and expressways per year, but is almost twice as high for other trunk roads,

- Data was sufficient to create a spatial representation of hazard sensitive areas using GIS analyses, limiting it to boundaries of municipalities, where weather related events occurred on national roads,
Preliminary results – distribution of events caused by intense rainfall
Preliminary results – distribution of events caused by intense snowfall
Preliminary results – distribution of events caused by strong winds
## Preliminary results – table of effects of each hazard on roads

<table>
<thead>
<tr>
<th>Weather Factor</th>
<th>Road Class</th>
<th>Damages and defects of road or road infrastructure</th>
<th>Obstacles in traffic flow</th>
<th>Total block of traffic flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Damage to body and road surface</td>
<td>Damage to bridges</td>
<td>Damage to other parts of road infrastructure</td>
</tr>
<tr>
<td><strong>Strong wind</strong></td>
<td>Mtwy</td>
<td>0</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Exwy</td>
<td>0</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Tkrd</td>
<td>38</td>
<td>3</td>
<td>826</td>
</tr>
<tr>
<td><strong>Intense snowfall</strong></td>
<td>Mtwy</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Exwy</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Tkrd</td>
<td>39</td>
<td>0</td>
<td>49</td>
</tr>
<tr>
<td><strong>Intense rainfall</strong></td>
<td>Mtwy</td>
<td>22</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Exwy</td>
<td>36</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Tkrd</td>
<td>439</td>
<td>72</td>
<td>220</td>
</tr>
</tbody>
</table>
CC adaptation project on national roads in Poland

Preliminary results – table of effects of each hazard on roads

<table>
<thead>
<tr>
<th>May - July</th>
<th>flood (melting and rainfall)</th>
<th>strong wind</th>
<th>limited visibility (e.g., fog/smoke)</th>
<th>Lightning discharge</th>
<th>Iced road or road infrastructure</th>
<th>Intensive snowfall</th>
<th>heavy hail</th>
<th>heavy rainfall</th>
<th>temperatures below zero</th>
<th>waves of heat/high temperature</th>
<th>fires in the vicinity of roads</th>
<th>other factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 1 hour</td>
<td>7</td>
<td>13</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 - 12 hours</td>
<td>13</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>12 hours – 3 days</td>
<td>15</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Over 3 days</td>
<td>20</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total per factor</td>
<td>55</td>
<td>35</td>
<td>4</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>94</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>December - January</th>
<th>flood (melting and rainfall)</th>
<th>strong wind</th>
<th>limited visibility (e.g., fog/smoke)</th>
<th>Lightning discharge</th>
<th>Iced road or road infrastructure</th>
<th>Intensive snowfall</th>
<th>heavy hail</th>
<th>heavy rainfall</th>
<th>temperatures below zero</th>
<th>waves of heat/high temperature</th>
<th>fires in the vicinity of roads</th>
<th>other factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 1 hour</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>11</td>
<td>0</td>
<td>8</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>1 - 12 hours</td>
<td>0</td>
<td>19</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>13</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>12 hours – 3 days</td>
<td>0</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Over 3 days</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total per factor</td>
<td>2</td>
<td>43</td>
<td>10</td>
<td>2</td>
<td>12</td>
<td>32</td>
<td>0</td>
<td>9</td>
<td>16</td>
<td>0</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>
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Further planned steps:

1. **Validation** of the available data and statistical treatment to be used e.g. in the vulnerability and risk assessment of projects as part of the EU co-financed project applications

2. **Desk review** of available past trends of climate in Poland, description of **climate projections** based on available forecasted scenarios and trends and definition of extreme events

3. **Cost assessment** of the maintenance and related intervention of the weather-related events

4. **Workshop** involving all relevant stakeholders necessary for analysis of all possible adaptation responses

5. „Basic business case” for taking action to adapt and build resilience as a tool to convince decision-makers

6. **Action plan** on the recommended adaptation responses (using workshop results) for the existing and planned Polish national road network including methodology for the continuous data collection on extreme weather events
Conclusions

• **Acquisition of increased knowledge** on the subject and **continuous learning process** – what started solely as EU requirements is being developed into a good project practice,

• **Awareness raising** shall be continued at different levels within GDDKiA and all relevant stakeholders,

• **Need of follow-up work** on adaptation analysis and necessary actions,

• **Dissemination and extension of project** on other road managers, also at regional and international levels.
Thank you for your attention!

CC adaptation project team in GDDKiA:

Grzegorz Łutczyk – Department of Investments, Office of EU Projects
e-mail: glutczyk@gddkia.gov.pl

Jacek Wojtowicz – Department of Investments, Office of Environment
e-mail: jacwojtowicz@gddkia.gov.pl

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jaspersnetwork@eib.org

JASPERS Website:  
jaspers.eib.org

JASPERS Networking Platform:  
www.jaspersnetwork.org