

Roads and Climate Change in Poland, a case study

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1. Introduction

Since the start of the 2014-20 programming period JASPERS has advised its counterparts on the preparation of climate change assessments for numerous projects in many European countries and across all sectors, notably including roads. This case study provides a relevant example of a fruitful collaboration that JASPERS undertook with [GDDKiA](#) (the General Directorate for National Roads and Highways in Poland). More specifically, JASPERS cooperated with GDDKiA in the assessment and mapping of national road network climate vulnerabilities, and developed a proposal for an action plan to integrate climate adaptation considerations in the management and development of Polish national roads, including highlighting investments needs on climate adaptation on existing network.

2. The background

Europe's transport infrastructure and services are increasingly affected by climate hazards impacts; recurring cases of floods flushing road and rail sections away, heat waves making concrete pavement joints burst, among others, trigger a continuously growing bill of economic impacts as well as major risks for human lives. These include short- and long-term effects (including economic impacts) accounting for increased infrastructure damage and operational costs, longer user delays, disruptions, safety risks.

Polish roads are equally affected: in 2010 alone, a particularly difficult year, the national road system experienced more than 200 heavy rain incidents related to major floods. Since then, climate change continued to prove how adverse weather events, like the 2022 heatwaves, are going to be more and more common in the future and will add up to road infrastructure damages that already amount billions of euros per year.

Climate action on mitigation and adaptation is already integrated into many EU policy areas and implemented through a range of instruments. An important proportion of the current EU budget is focused on financing actions to support the reduction of GHG emissions and the decarbonisation of the EU economy, as well as to ensure overall resilience to a changing climate. Climate change considerations started to become a legal requirement for major projects in the EU co-financing for 2014-2020 programming period.

With recent events evidencing the need of a more climate resilient network system, GDDKiA was already starting to integrate climate change aspects in projects preparation for EU co-financing. In fact, a total of 78 road projects have already been approved under this last programming period 2014-2020 with those considerations included.

Traffic interruptions and high repair costs due to successive extreme weather events, together with the looming forecasts and EU requirements, have played a role in motivating the national Polish authorities to work on climate adaptation for the Polish national roads.

GDDKiA took a first step in this direction by launching an internal survey aimed at recording all road incidents related to extreme weather conditions. The survey was distributed to the 16 regional branches of the Directorate and requested data to characterise those incidents, notably in terms of their cause and impacts (i.e. road infrastructure damage; duration and type of traffic disruption, if any; or simply if intervention of road service team was required). The survey recorded more than 3,300 weather incidents for the period from 2004 to 2016. The results of the survey clearly showed that extreme weather events were already threatening the efficient and safe use of Polish national road infrastructure and operations, and that adequate and well-planned adaptation measures could translate into direct benefits for GDDKiA, road users and the overall Polish economy. On that basis, GDDKiA requested JASPERS support to work on climate change adaptation of the national road network.

3. JASPERS role

GDDKiA has a long and fruitful history of collaboration with JASPERS. Since 2006, throughout two financial perspectives, JASPERS advisory and appraisal support covered over 80 investment schemes with a total value of circa EUR 30bn and, additionally, contributed with 20 horizontal assignments. JASPERS support helped the authority to improve the quality of funding applications, with activities spanning from considerations of maturity and readiness of the projects to identification of issues and inclusion of climate considerations into project preparation. Other funding requests by the authority also benefitted from the broader JASPERS expertise through horizontal recommendations.

Over the years and across all countries of operation, JASPERS has gained considerable experience in addressing climate-related considerations both in terms of assistance for project preparation and with horizontal support, including for technical capacity-building and knowledge sharing. Among other, JASPERS published a [Guidance note on climate adaptation vulnerability and risk assessment](#) and significantly contributed to the publication of DG REGIO's [Economic Appraisal Vademecum](#). JASPERS has also strongly promoted mainstreaming climate change in transport planning and Sustainable Urban Mobility Plans, in addition to supporting the integration of climate change aspects in infrastructure projects preparation. After supporting the European Commission in the preparation of the [Technical guidance on the climate proofing of infrastructure in the period 2021-2027](#), JASPERS is currently supporting several Member States in the development of national guidelines on climate proofing of infrastructure projects in the EU Programming Period 2021-2027, as well as supporting its counterparts in strengthening their capacity to ensure these requirements are adequately addressed.

GDDKiA's fruitful collaboration with JASPERS, combined with JASPERS comprehensive experience in climate-related aspects, represented a strong basis to undertake the new joint assignment on "Adaptation to Climate Change for National Roads in Poland".

This assignment kicked-off in 2017 and the work spanned through several years. As soon as the cooperation began, three objectives were agreed upon. The first objective was to perform an analysis of the climate resilience of the national road network based on the survey data collected by GDDKiA, complemented with the most recent climate forecasts data. The second one was to develop an action plan on adaptation to climate change for existing and planned national road network. The last objective was to increase awareness on climate change considerations and the adaptation needs of the road network at the different GDDKiA levels and related stakeholders. Additionally, as an overall transversal objective, knowledge exchange and international cooperation represented a key pillar for this assignment.

These objectives were then translated into five implementation stages and are described in the following sections. Throughout the assignment, JASPERS always kept a proactive stance, advising, among other things, on the importance of considering the network criticality levels for individuating adaptation responses and on the establishment of a unified approach to collect and analyse data on weather events incidents affecting the road network and its users.

4. The project

Stage I: Climate change vulnerability assessment

During the first stage of the assignment, GDDKiA carried out an analysis of the national road network current vulnerability to climate change with JASPERS support. It was based on the results of GDDKiA internal survey on extreme weather incidents and supplemented it with climate forecasts for future vulnerability.

The assessment of the survey results provided the following relevant conclusions:

- three main climate hazards, namely heavy rain, wind and snowfalls, were responsible for more than 50% of all registered incidents¹. This contributed to validate the coherence of data gathered by the road authority.
- national roads, other than motorways and expressways, are more sensitive to those extreme weather hazards (i.e. higher number of incidents were registered on those roads resulting also in higher average of incidents every 100 km of type of road).
- about two thirds of incidents registered led to traffic disruptions.
- most of the incidents happened during the summer, and around the months of December and January.
- all data was provided in a form that would allow for GIS supported analysis.

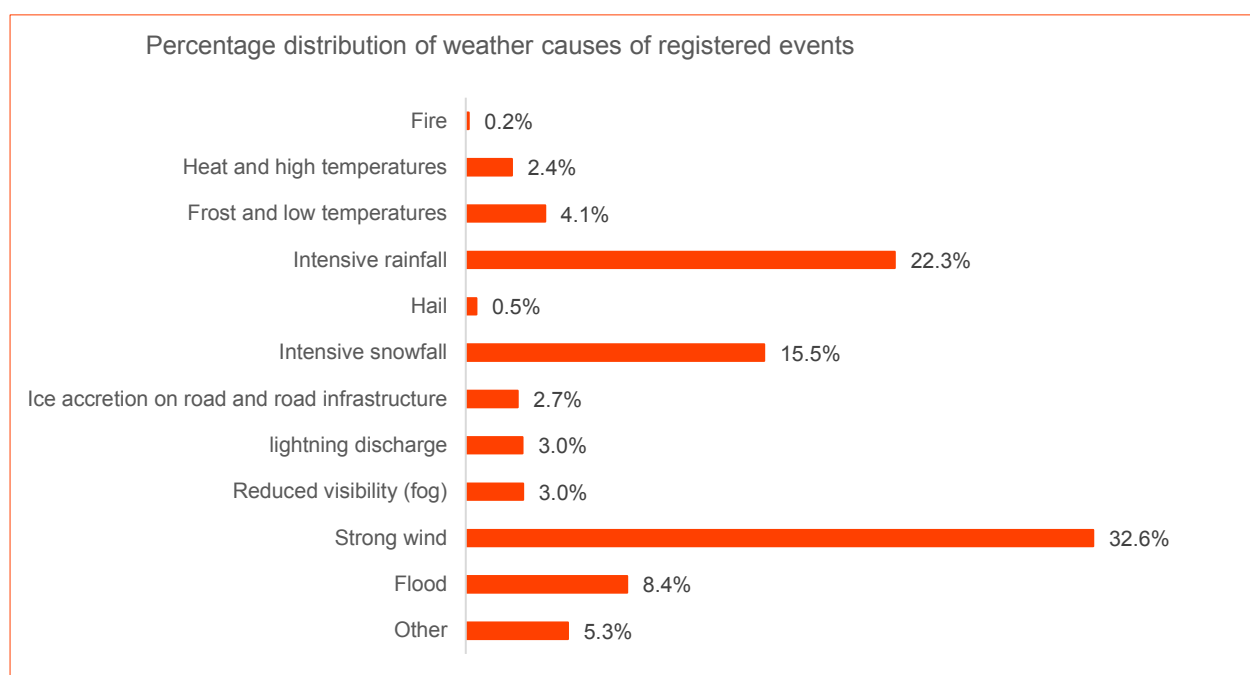


Figure 1. Cause of incident, by climate hazard, GDDKiA.

The analysis of the survey results was complemented with weather data validation undertaken by GDDKiA with JASPERS support. It was conducted for a sample of the incidents recorded in the survey using national meteorological institute data (i.e. weather characteristics on the date of incidents register). This task also provided an idea of climate factors thresholds related to incidents, e.g. cumulated precipitation or gust speed after which more incidents were recorded.

¹ This turned to be fully aligned with results from the national research project on climate change with sector specific reference available at that time (i.e. [KLIMADA](#) which has been later followed-up by [Klimada 2.0](#) as the national knowledge base platform on climate change and adapting to climate change impacts).

This climate change vulnerability assessment also looked at future exposure of the road network based on national climate forecasts:

- increases in average of annual temperature (more days with temperature above 25°C and fewer days with temperature below 0°C);
- changes in precipitation though variable in different forecasts, (overall increase, and increase of maximum precipitation in 24h as well as in the number of days with P>10 mm and P> 20 mm);
- fewer days with snow cover and reduction of its thickness;
- increase in the frequency and intensity of the wind.

A trend for a general increase of extreme weather events was identified.

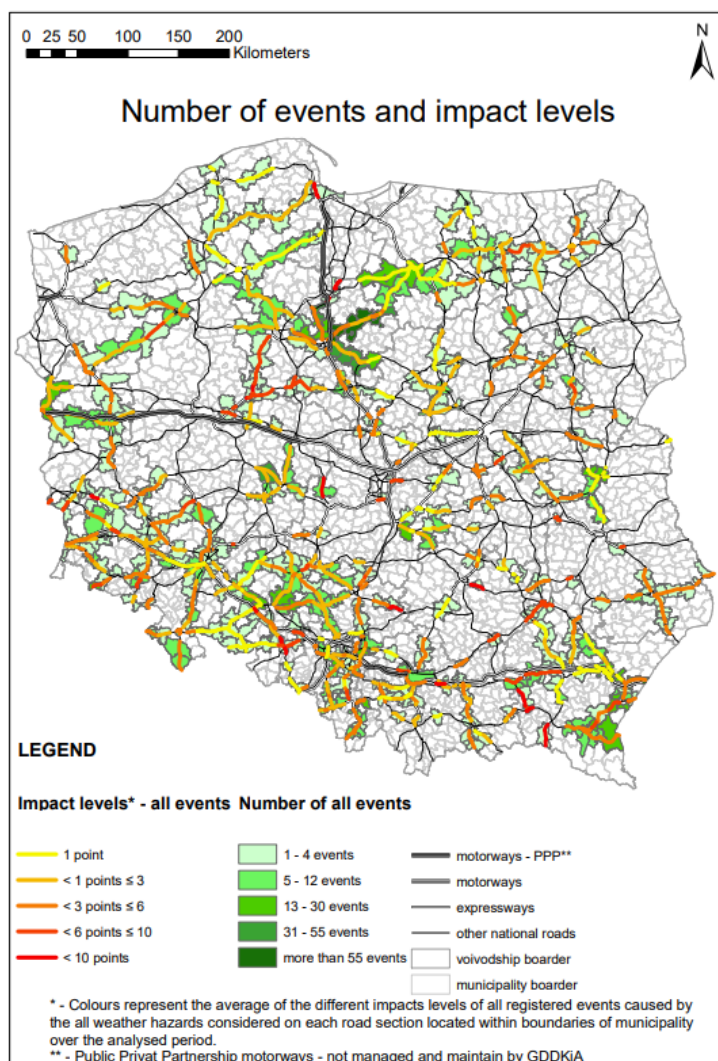


Figure 2. Current climate vulnerability map of the National road system.

According to the climate change vulnerability assessment methodological framework referred in EU² and JASPERS³ guidance, climate change vulnerability is a combination of sensitivity (how sensitive the project's components are to climate hazards in general) and exposure (the extent to which each road is subject to adverse weather events, for the present and the future, considering its location). These two aspects were assessed and mapped based on survey data results.

The current climate vulnerability map coupled with data analysis provided already a confirmation on climate adaptation needs of the existing national road network, with several road stretches along the network being subject to tens of extreme events and presenting high levels of impact, as visible from Figure 2.

The current assessment was complemented with an assessment of future climate vulnerability based on the national climate forecasts. The vulnerability assessment allowed to draw an overview and some preliminary conclusions on the exposure of the Polish road network, prior to the identification of potential

adaptation responses:

- Current medium to high vulnerability levels to heavy rains, with higher exposure risk in the future.

² <https://op.europa.eu/en/publication-detail/-/publication/23a24b21-16d0-11ec-b4fe-01aa75ed71a1/language-en>

³ <https://jaspers.eib.org/knowledge/publications/the-basics-of-climate-change-adaptation-vulnerability-and-risk-assessment>

- Low or low-medium vulnerability of strong winds and heavy snow, with higher exposure risk in the future.

Based on the assessments performed, the most vulnerable roads appeared to be those national ones other than motorways and expressways, the latter ones being designed and maintained at higher standards.

This led GDDKiA and JASPERS to confirm the need for the integration of climate change adaptation in management and development of national roads. In this respect, it was important to complement the assessment with a quantification of damage costs and overall economic impacts related to extreme events (through involvement of relevant GDDKiA divisions) as a tool for decision-making by GDDKiA management. During the first stage of its assignment, JASPERS also advised on the importance of considering the network criticality levels, with the aim of prioritising adaptation responses in the following stages.

Most importantly, this first stage confirmed the importance of properly recording and monitoring climate hazards impacts on the roads network. GDDKiA, with the support of JASPERS, proposed a structure to systematise the recording of climate incidents. This would enable a regular update of the mapping of network climate vulnerabilities.

Finally, the results of stage I represented a sound basis to inform climate change vulnerability and risk assessments in preparation of new investments, as it is the case for EU co-financing applications.

Stage II: Assessment of costs and impacts of extreme weather events

GDDKiA, with JASPERS technical advice, undertook an additional internal survey to gather data on damage costs of those incidents (on a sample basis). JASPERS supported GDDKiA on assessing overall impacts of those extreme weather events complemented with a review of relevant international literature references. This allowed a benchmarking of costs and disruption times for extreme climate events on the Polish road network, which was a key input for the cost-benefit analysis used in the business case for investments in adaptation (see Stage IV).

The data gathering performed in this phase resulted in the development of a cost database, which included damage repair costs and user costs. In parallel, the team also assessed the current frequency of occurrences of incidents based on initial survey results.

JASPERS recommendations at this stage focused on establishing a unified approach to collect and analyse data on weather events incidents affecting GDDKiA road network and its users.

Stage III: Workshops in GDDKiA regional offices

A number of workshops took place in GDDKiA regional offices organised by GDDKiA and JASPERS. They focused on:

Gathering their knowledge and experience from the ground on current climate impacts on the road network;

Assessing future climate vulnerabilities of the national road network on the basis of expected climate trends and current knowledge;

Brainstorming on possible adaptation measures at different levels.

The workshops entailed very engaging discussions including proposals on adaptation measures at different levels. The table below presents some insights from those discussions:

Event	Existing vulnerabilities	Proposed Solutions
Rain/ Flooding	Flooding of land adjacent to roads Insufficient drainage capacity Increased landslides risk on some locations Insufficient maintenance of riverbeds and structures	Reconsider the needs of further protection walls for roads along rivers (previously not needed) Adequate maintenance of drainage systems, riverbeds and embankments Increase diameters of drainage pipes for certain road (types) Analysis of wider drainage system functioning, coordinate with local water network managers or relevant entities
Wind	Old and/or bad condition of trees or not local species – Road management and nature conservation legislation weaknesses Problems with signalling/noise screen supports on animal passes	Set minimum distance between road edge and trees Regular check of trees status Revise considerations regarding (i) species planted and (ii) time of the year for plantation
Snow	Roads slopes issues on some identified hotspots Issues related to winter standards employed (i.e. high standards, less issues)	
Others	Deficiencies in tender documents (for D, D&B or B) regarding climate resilience of construction solutions considering designed solutions Problems with pavements at high temperature Monitoring and registering of events, hotspots identified by Branches Insufficient coordination of different administrative levels/ managers	Use of reinforced pavements before traffic lights Restrictions on HGV traffic circulation Guidance for tender documentation to ensure climate change resilience Monitoring and registering of climate incidents, providing timely user information and response systems Need of specific climate adaptation funding: needs cannot be covered under routine maintenance

Stage IV: “Business case” for adaptation measures on the national road network

The “business case” was developed with the view to steer and justify investments on climate adaptation of the Polish national road network. This could represent a tool for decision-making and buy-in of GDDKiA management. JASPERS advice and methodological recommendations were a key driver in this stage.

The business case was developed in two steps. The first step aimed at drawing a national wide assessment covering damages and user costs related to heavy rains in a “no-adaptation scenario”. Therefore, the assessment looked at the total economic impacts (i.e. damages and user costs) over the whole national road network and considering its increase over time according to climate forecasts.

The second step focused on deepening the analysis for a specific section of the national road network, with the appraisal of possible adaptation measures. The goal was to quantify the economic benefits (i.e. those economic impacts related to damages and user costs that would be avoided) and costs (related to the implementation of such measures) when comparing the “adaptation scenario” to the “no-adaptation scenario”.

All data gathered in previous project stages were used as inputs and assumptions for the business case, including estimated reference values for damage costs and time disruptions durations, considering the climate hazard cause and the type of road. Based on current practice for preparation of EU co-financed projects, and the national guidance on cost-benefit analysis for road projects (the so-called, Blue Books, developed with JASPERS support), a formula was proposed and used as a proxy to estimate the annual average economic user costs due to climate hazards on specific section(s) of the network. Besides damage costs, user costs were estimated on the basis of time disruption (i.e. increased user travel time costs and related vehicle operating costs and environmental impacts).

The approach from the [“Climate Adaptation Strategy”, Vejdirektoratet \(Danish roads\)](#) was used to forecast the annual economic costs related to extreme weather event(s). In this case, it considered the climate projections from *Klimada 2.0* and the scenario RCP 8.5 to assess the increase in frequency from those climate hazards in future years.

The assessment resulted in robust economic justification, with a solid ERR for the road section case study on implementation of adaption measures. Moreover, it proved that this appraisal method can be applied more widely to demonstrate the rationale of new investments on climate adaptation that could also potentially be subject of financing from EU funding sources. In conclusion, the business case represents a relevant tool in the hand of the Polish authorities to make better informed investments decisions for ensuring climate resilience for both the development and management of the national road network.

Stage V: Action Plan for the recommended adaptation measures

The previous stages of JASPERS support provided a general mapping of current climate vulnerabilities of the road network, signalled potential risks as well as defined a clear economic rationale for adaptation measures to avoid the continuously increasing damages costs and user impacts related to climate hazards on GDDKiA network. The work benefitted from exchanges and input from different GDDKiA departments, notably the ones responsible for the management of existing network. On that basis, a proposal of actions on climate adaptation were proposed by GDDKiA under JASPERS advice:

The first action concerns registering and monitoring of climate incidents on the national road network. A systematic registering method would provide a database for climate vulnerability assessments. A general structure for the register to report on potential damages and traffic disruptions details was proposed.

Integrating and updating the criticality levels of the national road network will inform prioritisation of the adaptation measures implementation.

On the basis of the vulnerability assessment results, three different climate risk levels were defined. High risks need to be tackled urgently, while medium risks require mainly monitoring actions.

Those road sections characterized by high risks, i.e. where an immediate adaptation response is required, represent immediate resilience needs of the existing network. On that basis, JASPERS advised GDDKiA to work on identifying those needs and to then translate them into investments programs for climate resilience⁴. These investments could certainly represent eligible funding for climate adaptation from both EU and EIB financing. Additionally, these programs could be an opportunity to tackle other main needs and priorities, such as road safety or deployment of electric

⁴ Sweden, for example, has already set a dedicated budget for climate change adaptation on the road network.

charging infrastructure. JASPERS could then support GDDKiA in the preparation of those investments for EU co-financing.

The project results also provide relevant information to be considered for the existing network O&M contracts. Some suggestions concern the identification of the responsibilities for the initial response in terms of traffic disruptions, user information, the definition of an extreme weather event, drainage maintenance, winter maintenance etc.

During workshop discussions, the review of design standards considerations was also referred to. The action plan proposes the creation of a working group to discuss possible proposals for design standard considerations.

The update/review of flooding maps to account for climate change forecasts, might be object of consideration by relevant authorities.

KNOWLEDGE-EXCHANGE AND INTERNATIONAL COOPERATION

The project was presented jointly by GDDKiA and JASPERS in several seminars, conferences and workshops aimed at promoting knowledge exchange and international cooperation on the area of climate adaptation in transport. At the same time, those also contributed to paving the way for the project development.

Below, references to some of those events:

Three workshops from JASPERS Networking on climate change adaptation on transport: **first workshop in December 2017** , **second one in June 2019** and **third one in April 2022**.

CEDR Climate Change Summit in November 2018.

BAST (German Transport Research Institute), Symposium on Climate Change Vulnerabilities Assessment for Roads in Europe, Berlin, December 2019

PIARC & Polish Road Congress, “Sustainable Roads and Eco-infrastructures: new challenges”, May 2021

EU-USCA Cooperation on climate resilience - Resilient Transportation Webinar: Adapting Road Networks for Climate Change, June 2021

5. The results

Benefitting from the combination of earlier GDDKiA’s work and JASPERS hands-on advice and support, this assignment allowed for a mapping of current climate vulnerabilities of the national road network in Poland, identified potential climate risks, provided a clear economic rationale for adaptation measures to avoid the continuously increasing damages costs and user impacts related to impacts of climate hazards on GDDKiA network; it concluded with a proposal of possible adaptation actions (including immediate investments needs on climate adaptation). At the end of the assignment the results were presented and endorsed by the management of GDDKiA.

This assignment represents a very sound basis to integrate climate change adaptation in the management and development of the Polish national road network. It sets the basis for further developments and confirms existing needs for investments on climate adaptation. In particular, the project concluded with the proposal of developing a pilot investment program for climate change adaptation on national roads that could also tackle other key priorities such as road safety and the deployment of electric charging infrastructure.

The results already represent a sound basis to inform preparation of climate change vulnerability assessments for new investments that are required for EU co-financing in 2021-27. In overall terms, the comprehensive assessment performed has also the potential to ensure efficiency gains for GDDKiA

future work. The results of the assignment were also presented in a number of international workshops and webinars, including on several recognised sectoral platforms (e.g. the Polish Road Congress, CEDR or PRIAC) and documents (i.e. recognised as a promising and scalable approach in the [Evaluation of EIB support to Climate Change Adaptation](#)). The international exposure and experience gathered during these events contributed to raising the visibility and recognition of the topic within GDDKiA.

The thoroughness and replicability of the assignment, ranging from a robust climate change vulnerability analysis built upon a sound register of climate incidents on the existing road network to the development of a credible business case and related action plan, represents a “good practice” approach that can be promoted among other transport authorities around Europe. Indeed, this analysis is applicable to other linear networks, such as railways, providing a comprehensive and systematic basis that would result in efficiency and cost-effectiveness of mainstreaming climate adaptation in management of transport infrastructure networks.

JASPERS is already advising other EU member states in this respect. In Portugal, *Infraestruturas de Portugal*, the manager of the rail and road infrastructure in the country, has requested JASPERS technical advice for the preparation of climate change resilience plan building upon an analogous approach.