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Session 1: Climate change: trends (and forecasts for the coming years) and assessment of climate units; consequences for the sustainability of road infrastructure;

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Title - Climate Change, how Roads4People leverage AI to plan resilient infrastructures.

ABSTRACT

Infrastructure networks, crucial for local mobility, face significant exposure to the impacts of climate change. The disruption of key links within these networks due to climate exposures has the potential to isolate entire communities, cutting off access to essential public facilities such as schools, hospitals, and markets. The use of advanced digital solutions offers a new approach to anticipate, mitigate and adapt to future constraints on the network. This paper introduces the Roads4People approach using ORIS Climate Resilience Methodology, a novel approach that leverages Artificial Intelligence and advanced digital solutions to adapt roads to climate change. Based on a multicriteria analysis and after assessing different complementary risk indicators, adaptation measures are proposed to enhance the infrastructure resilience to various climate exposures. Based on the Life Cycle Assessment approach, mitigation measures are also proposed based on the potential reductions of the Greenhouse Gases (GHG) emissions at various stages of the infrastructure service life. Lastly, all the proposed adaptation and mitigation measures are quantified, priced and compared on a digital platform. The example of application showed powerful results obtained from this methodology, as it provides an essential tool for policymakers and infrastructure planners to make informed decisions and better plan for the changing climate.

Keywords: Climate Resilience, Climate Risk Assessment, Infrastructure Network

1. INTRODUCTION

This paper introduces a novel climate resilience methodology that addresses the gap identified in the literature between conceptual frameworks for climate change assessments and digitalization for evaluating infrastructure risks. Currently, there seems to be no digital tool to allow policymakers to fully understand how infrastructures can be impacted by extreme climate events, what would be the population impacted in case of disruptions, and what would this mean in terms of adaptation and mitigation measures and financial investment. This new methodology is not only conceived to fill this

gap, but also to couple adaptation and mitigation assessments into one single digital tool. The paper begins with a review of the background literature, introduces the novel methodology, and provides a detailed real case study of a project carried out in Ivory Coast in the context of the Roads4People UNIDO program. The conclusion highlights how the ORIS Climate Resilience Methodology empowers policymakers with a comprehensive tool for assessing and enhancing infrastructure climate resilience, while acknowledging its limitations.

2. BACKGROUND AND LITERATURE REVIEW

Climate exposure evolutions can be evaluated using climate projections, which are rigorously generated through coordinated efforts by organizations like the World Climate Research Programme (WCRP) and the Intergovernmental Panel on Climate Change (IPCC). Generating these projections involves sophisticated climate models that integrate atmospheric, oceanic, and land data to simulate the Earth's system dynamics. These climate models are developed by different research institutes around the world and their outputs depend on various input parameters that can vary from model to model. An important input parameter, for example, is the Shared Socio-economic Pathway (SSP), which represents the socio-economic scenario to be expected in the future in terms of climate policies to be implemented, greenhouse gasses emissions, and land use, for instance. The various SSP scenarios are defined in the IPCC Assessment Reports, the latest being the 6th Assessment Report. Once the inputs are well defined, those climate models generate projections for any past or future periods. Projection anomalies for future periods are often applied to historical observation data to predict future climate.

Despite substantial research efforts and advancements on conceptual frameworks to evaluate climate exposures and suitable adaptation and mitigation strategies to be proposed (ITF, 2016; OECD, 2018), a critical gap remains in the development of a digital tool that seamlessly integrates climate resilience assessment with transportation infrastructure decision-making. Zhuyu Yang highlighted that the application of the concept of critical infrastructure resilience in practical disaster management is challenged by the lack of operational tools (Yang et al, 2024). Amir Esmalian also mentioned the gap between resilience research and engineering practice and highlights the need for innovative and practical methods, processes, and information for resilience integration (Amir et al, 2022). Furthermore, several studies have also been carried out to develop individual solutions for very specific needs, but no methodology combines climate science with adaptation and mitigation proposals for no matter the infrastructure location and risk.

The Climate Resilience Methodology presented in this paper, developed by ORIS Materials Intelligence, not only fills this critical gap, but has already been successfully applied in several case studies. Notably, it was used to assess the climate resilience of more than 150 km of rural roads in Jizzakh and Syrdarya, Uzbekistan, which was critical to improve the culverts sizing and to consider more heat-resistant surface layer materials and base foundations at the design stage of the project. Another impactful application, which will be the subject of a detailed chapter in this paper, is the road network assessment of an Ivorian region of interest composed by the following administrative regions: Hambol, Gbeke, Iffou, Belier, N'Zi, and the Autonomous District of Yamoussoukro.