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ORIS Materials Intelligence

Digital solution for intelligent material sourcing and infrastructure life cycle assessment – a case of German highway construction

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Materials : a major asset in road projects

Seeking excellence in sustainability, environment, and carbon reduction through material optimization

Roads are among the **most valuable assets** of our society.
However, they are still highly **CO_2 - and cost-intensive**.

We believe that roads should be built and maintained in a **sustainable** and **resilient manner** – for **our future generations**.

>25% of all materials used in road projects

Impacting **60%** of their cost

and **85%** of carbon emissions

Agenda

1. Challenges in road LCA

2. Digital solution for road LCA

1. Case study

1. Conclusion

1. Introduction to challenges in road LCA

We adresse the major challenges in LCA

Intelligent project data management is a key to sustainable roads

Contexte

Materials role in roads

Materials and pavement design choices impact up to 60% of the cost of a road project and about 85% of its overall greenhouse gas emissions. Moreover, its particularly long service life of several decades implies maintenance needs with additional materials and energy consumption to secure vehicle safety and transport comfort.

Problems

Data management

Most infrastructure projects are designed according to standardized and historical road design methods, where materials availability and adequacy are considered only later at the construction phase.

WHY? This is due to the **difficulty in data collection** and the **lack of systematic approach**, which are main challenges in life cycle assessment (LCA).

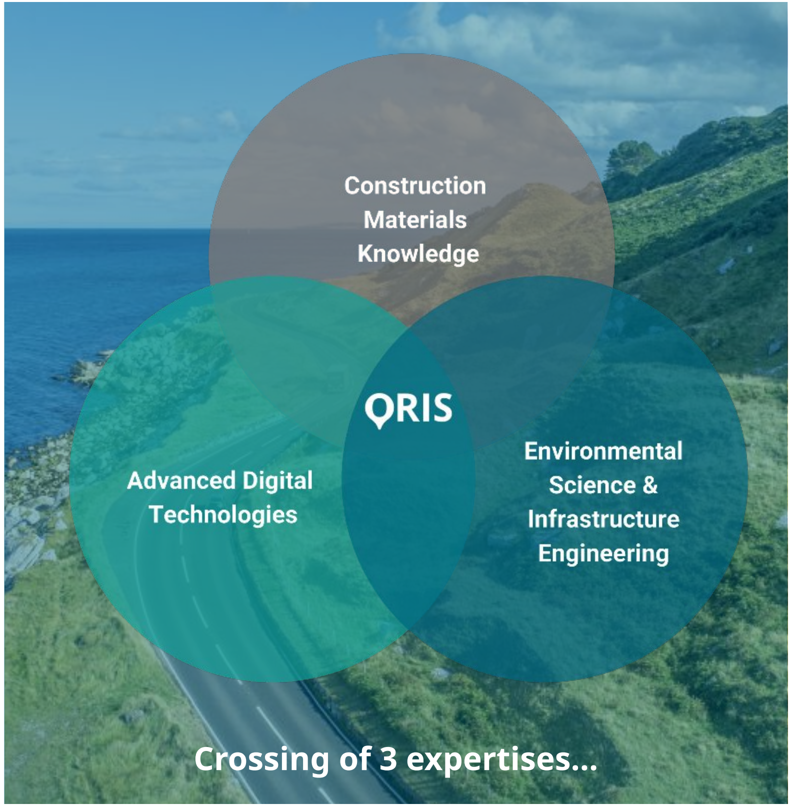
Objectives

Digital road twin

This study proposes a **digital road twin**, being a decision-making tool through a holistic approach of the construction, and demonstrate by a German case study how it can address the problematic.

Digitization, data science and cross expertises to resolve multiple challenges

Digitalisation brings more efficiency and sustainability in construction projects



… to bring a smart use of construction resources

Geolocation of local construction materials

Whole life cycle calculation of carbon impact from projects and construction materials

Early due diligence and Impact assessment of infrastructure designs with the potential to lower:

- costs **by 15%-30%**
- carbon footprint by **up to 50%**
- maintenance needs by **up to 70%**
- use of natural resources by **up to 80%**

Identification of measures to improve **resilience to climate change and road safety**

Identification of **optimal construction materials transportation routes** in real time to lower costs and carbon footprint

2. Digital solution for road LCA

Project methodology integrating a wholistic road LCA

Digital configuration to the local environment allowing an accurate assessment

1
Prepare system to project environment

- ✔ **Acquisition** of local materials data
- ✔ **Integration** of pavement designs
- ✔ **Initial setup** of a road p

2
Assess the base design performance

3
Assess alternative designs performance

- ✔ **Life cycle carbon emissions and cost assessment** on both the base and alternative designs
- ✔ Analysis of materials consumption
- ✔ The analysis is done according to the LCA standards (EN 15804 and ISO 21930) with which ORIS's approach is compliant

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Conclusions & recommendations

- ✔ **Visualization** and **reporting** of results
- ✔ **Proposal** of sustainable road strategies through a whole value chain
- ✔ **Decision making**

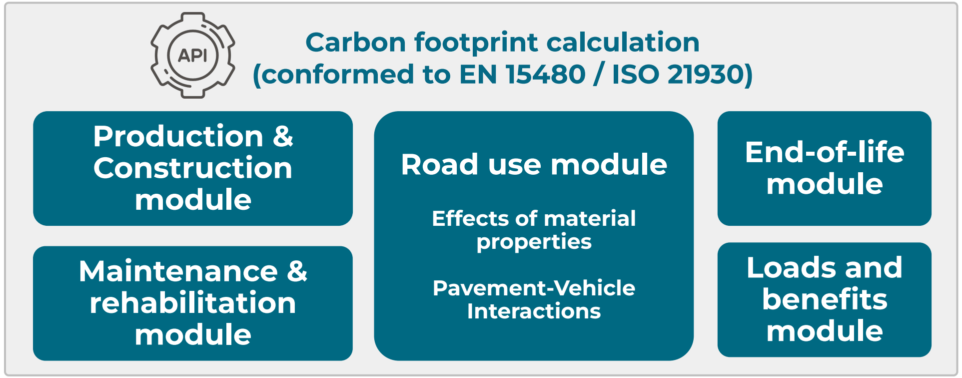
Scope of carbon footprint assessment of road LCA

✓ The methodology offers digital solution of infrastructure for **early design makings**

✓ **Carbon footprint** calculation conformed to the LCA standards that cover a full life cycle :

- Material production and Construction (A1-A5)
- Maintenance & rehabilitation (B2-B5)
- Road use (B1, B6 and B7)
- End of life (C1-C4)
- Loads and benefits from waste recovery (D)

✓ This full LCA allows **precise evaluation** and **right decision makings**

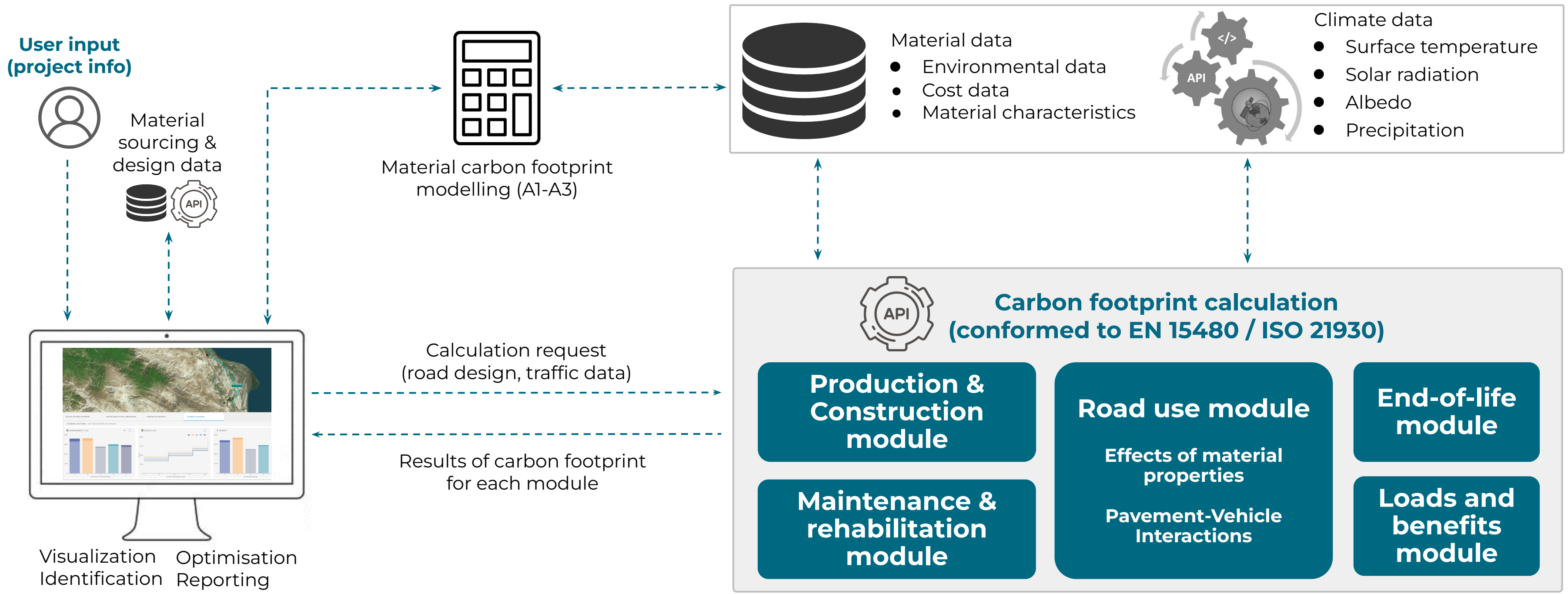


Data and digital solutions of carbon footprint calculation

Data driven approach to simplify and democratise LCA, aligned with LCA standards

✓ Extensive databases with **material data (e.g., cost, CO2,)** and **climate data from NASA** are used

✓ **Carbon footprint results** are visualized in ORIS platform to help decision makings



3. **Case study** - *German highway construction*

Case study : the section of the A94 located in Bavaria, near Munich

Impact assessment of extending from 2 to 3 lanes in each direction

Project

Renew the surface pavement and **extend** the road from two to three lanes of a **4 km** section of the highway located in Bavaria

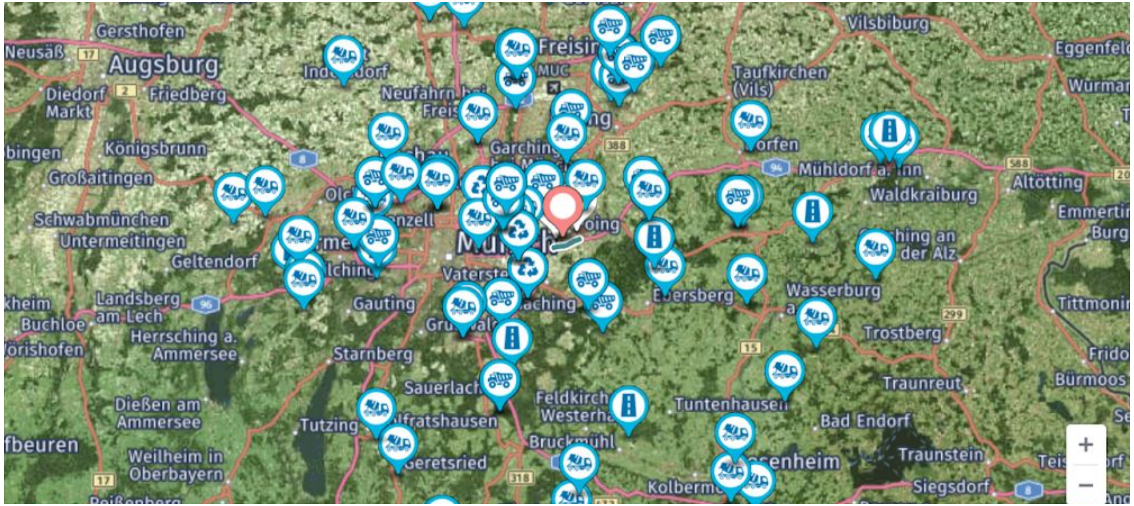
Evaluate a **Global Warming Potential** over a **30-year** analysis period including:

- **Construction (A1-A5):** Base design + 4 alternative designs (German catalogue RStO12 and ZTV Asphalt-StB 07)
- **Maintenance (B2-B5):** Program tailored to each design option
- **Use (B1, B6)**: pavement characteristics and interaction with vehicles

Data

Environmental data (GWP factor) from ecoinvent v3.8, using IPCC 2013 impact assessment method

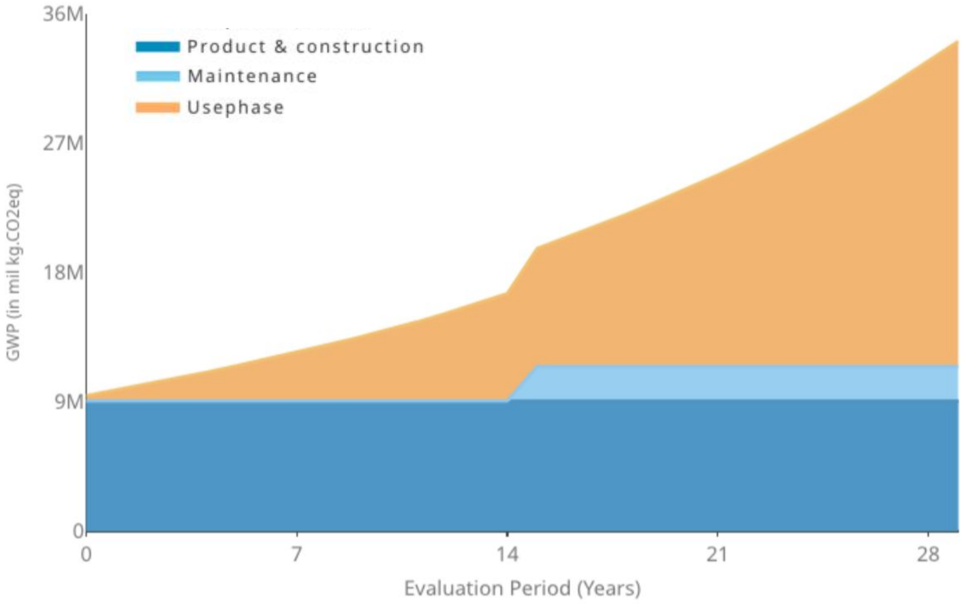
Material data (geo localisation, material properties) provided by the project local team and integrated into ORIS platform



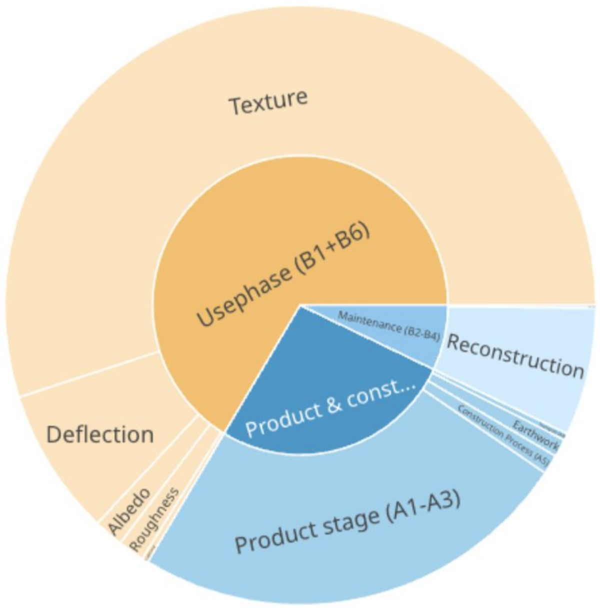
Carbon footprint results of the base design

Impact dominated by the use phase (mainly due to pavement-vehicle interactions)

Cumulative result over 30 years

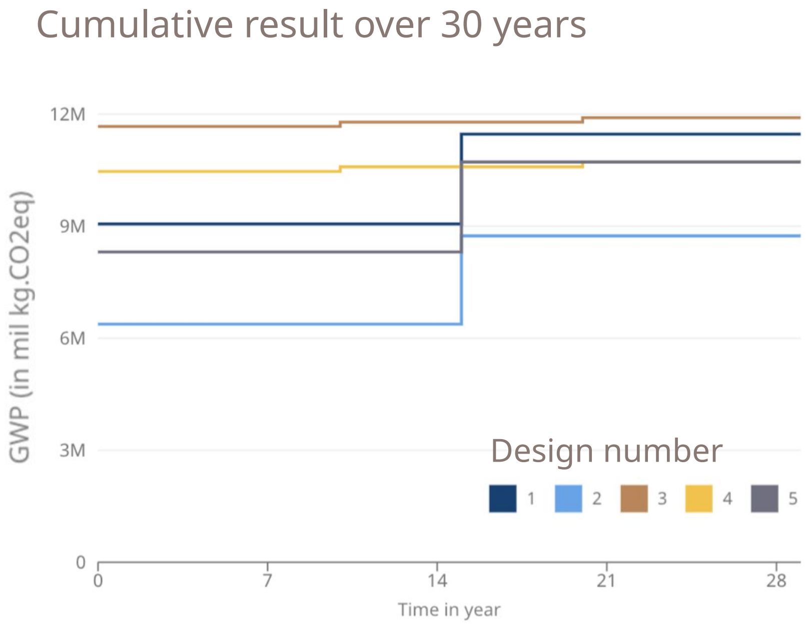


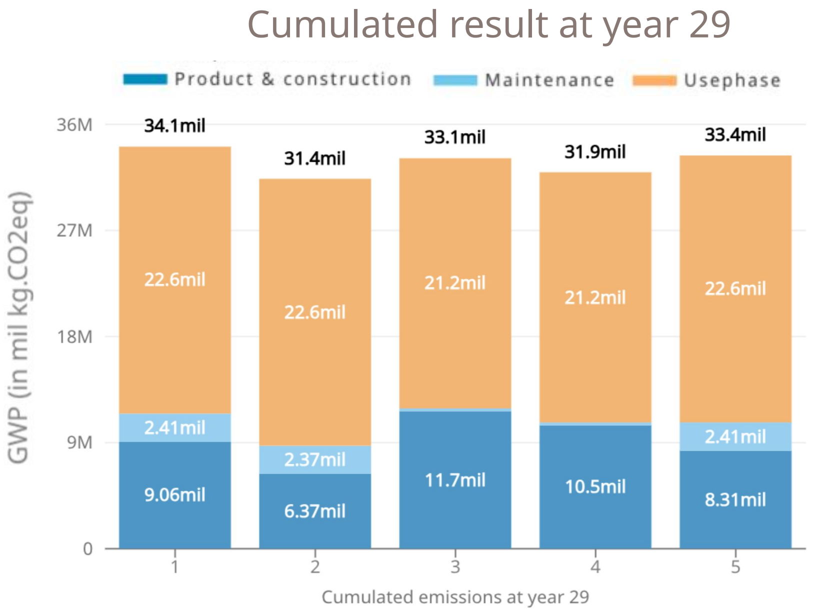
Cumulated result at year 29



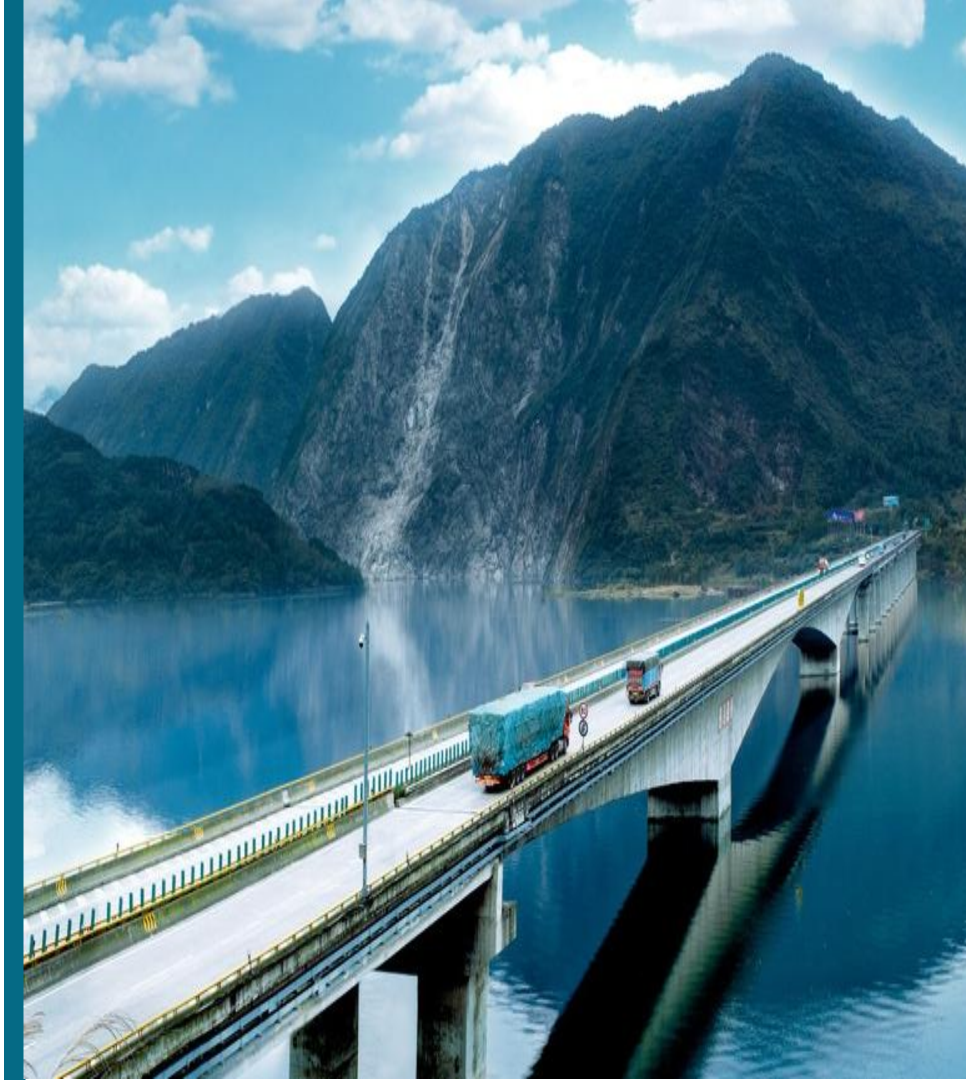
Comparison of 5 pavement designs

Cumulated GWP (A1-A5 + B) over 30 years





4. Conclusions



Conclusions

Key factors to the digital road LCA methodology

The use of **digital technologies, data analytics, and data science technics presents a promising approach for optimizing road asset management**, enabling more accurate asset tracking, maintenance planning, and operational decision-making.

Key findings from the case study

Almost 60% of the carbon footprint on the whole life cycle of a road construction project comes from the use phase, with the degradation of the road quality with time, increasing the fuel consumption of vehicles compared to an initial road quality

Design optimizations reduced up to 30% of embodied carbon

Future steps

Include new LCA insights in the platform (e.g. other LCIA indicators regarding LCA standards)

Other iterations with layer material mix design, transport and energy mix to benefit further optimization in carbon and cost

Many thanks for listening

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