A system dynamics model to predict tire wear emission and support the development of mitigation strategies

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A system dynamics model to predict tire wear emission and support the development of mitigation strategies

- **Tire microplastics** are an **important source of microplastics** in the environment.
- This raises the question **how to effectively mitigate the environmental release** of tire microplastics.
- **System Dynamics modeling** was used to capture all dimensions of the problem and potential solutions.
- **Stakeholders were involved** to ensure that all knowledge and functionalities were included to fit the model's purpose.
- Next the model will be **used in collaboration** with stakeholders to **to further evaluate mitigation options.**

Purpose

To reduce the release of tire wear particles (TWP) there is a **need** for **effective and efficient mitigation strategies**. There are many **different possible strategies imaginable** in terms of (combinations of) interventions, instruments, levels of governance and responsibilities of stakeholders. The effectiveness of a strategy not only depends on its **potential to reduce TWP emissions** and its **costs**, but also on the **acceptance by societal stakeholders**[1]. To develop a strategy with **maximum benefits**, while **minimizing undesired consequences**, one needs an approach that **captures all dimensions of the problem**.

System Dynamics Modeling[2] is a simulation-based quantitative method that facilitates mapping complex socio-ecological systems. It offers both qualitative and quantitative insights into feedback loops, delays, causal relationships and nonlinear effects[3]. System Dynamics can help identify long-term, system-wide, and sometimes counterintuitive outcomes of policy interventions[3].

The aim of this study was to create a Systems Dynamics model that predicts the environmental release of TWP emissions to analyse the impact of interventions

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Methods

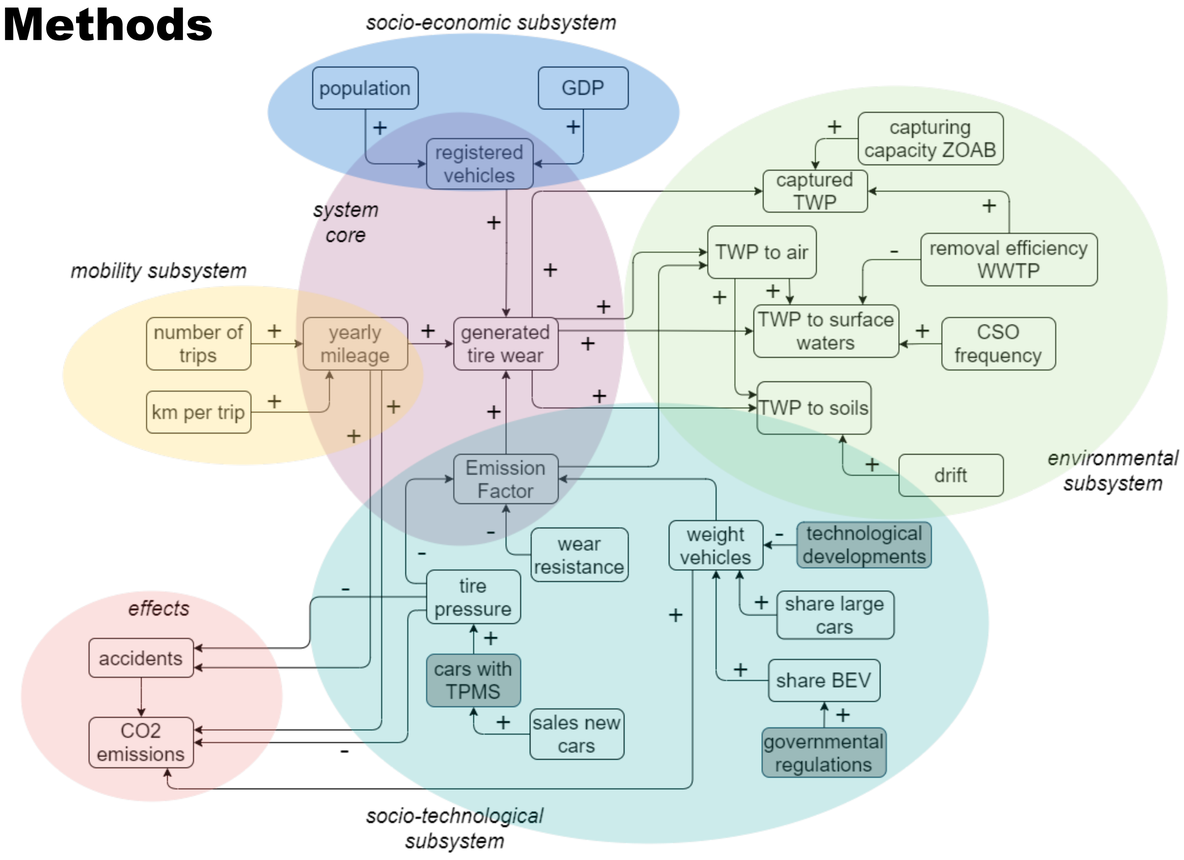


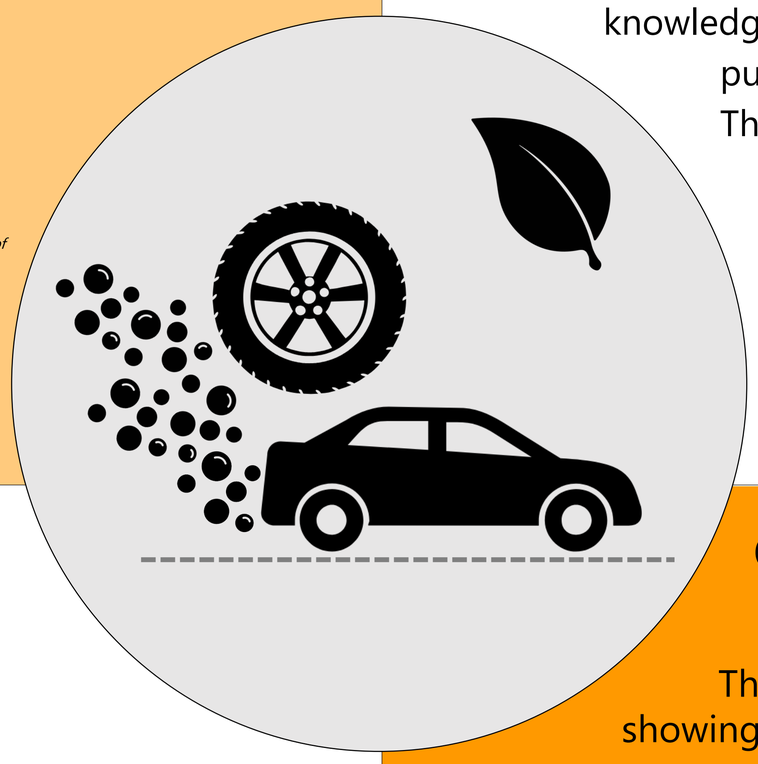
Figure 1. Causal Loop Diagram of the modelled system without interventions.

A **Causal Loop Diagram** (CLD) was developed to study the **system without interventions** (Fig.1).

- The CLD includes developments that are already in place, i.e., mandatory tire pressure monitoring system (TPMS) regulations and the growth in Battery Electric Vehicles (BEVs).
- **A stakeholder workshop** was organized to verify that all knowledge and functionalities were included to fit the model's purpose.

The CLD was translated to a **Stock and Flow Diagram**, which describes the behaviour of a system quantitatively over a period of time[4].

- Parameterization of the variables and relationships was done for **The Netherlands**.
- Backcasting was performed to ensure the models' validity.



Results

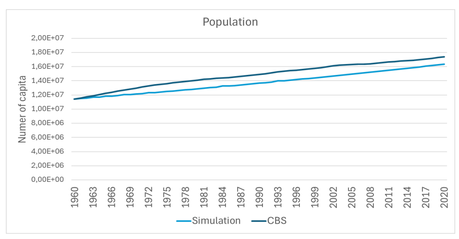


Figure 3. Simulation data on population compared with historic data

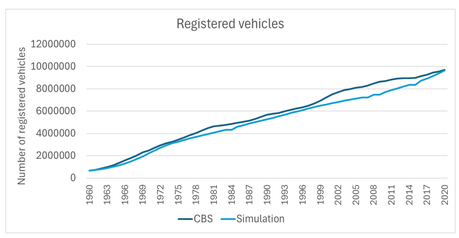


Figure 4. Simulation data on number of registered vehicles compared with historic data

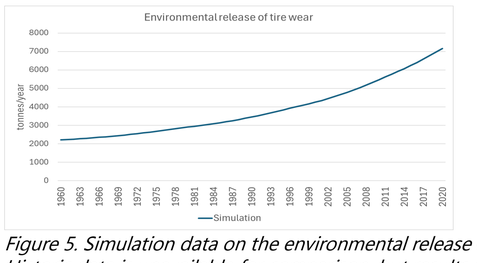


Figure 5. Simulation data on the environmental release of TWP. Historic data is unavailable for comparison, but results are in line with (5) ,(6), (7)

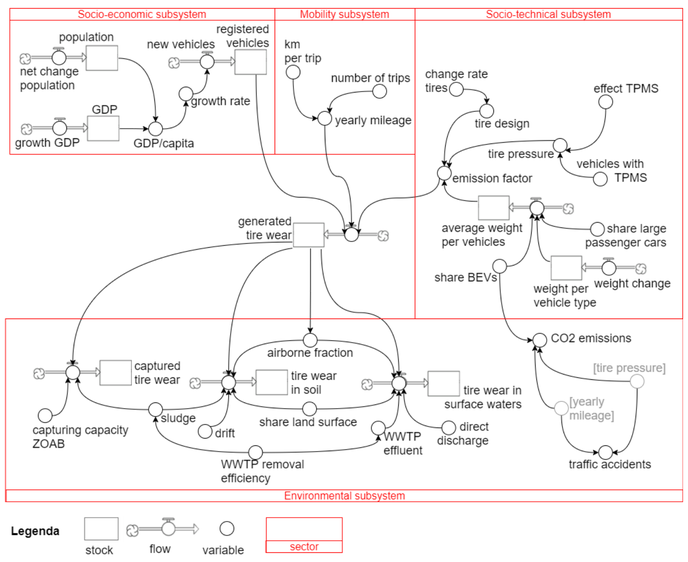


Figure 2. Stock-and-Flow diagram of the model

Conclusion

The first simulation results align with real-life data, showing promise for the model's validity.

At a later stage, the model will be used to simulate the impact of interventions on the primary endpoint (i.e., the release of TWP) and other endpoints considered relevant for the stakeholders. **In a follow-up study, the model will be used in collaboration with stakeholders to further evaluate mitigation options.**

Scan the QR code if you are interested in joining this workshop.

If you have any feedback on the model, missing variables, processes or functionalities, please reach out!

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Stay in touch!

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Join the next workshop or share feedback

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