# Data Science for Environmental Transport Systems: Data-Driven Pathways to Decarbonizing Mobility in Italy

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## Abstract

The transport sector represents one of the most complex environmental systems, characterized by strong interactions between human behavior, infrastructure, energy consumption and environmental externalities. In this context, Data Science offers a powerful framework to support evidence-based decision-making, enabling the integration of heterogeneous data sources, advanced analytics and scenario analysis to address sustainability challenges. This contribution explores the role of Data Science in environmental transport systems, with a specific focus on its application to the decarbonization of mobility. Building on recent advances in big data analytics, the paper discusses how multi-source data — including traffic sensors, GPS traces, mobility observatories, energy statistics and environmental indicators — can be combined to model transport demand, estimate emissions and assess policy impacts at national and territorial scales. The methodological framework is illustrated through an application to the Italian transport system, drawing on results developed within the Italian National Centre for Sustainable Mobility and the SUNRISE Mobility Observatory, a monitoring platform designed to periodically update mobility, energy and emissions estimates and assess progress towards decarbonization targets. A data-driven approach is adopted to estimate current and future greenhouse gas emissions from road transport, considering both Tank-to-Wheel and Well-to-Wheel perspectives and accounting for different vehicle technologies, energy carriers and mobility patterns. Scenario analysis is used to compare Business-as-Usual trajectories with alternative policy pathways aligned with the Avoid–Shift–Improve framework. Unlike conventional one-off scenario exercises, the framework is conceived as a monitoring-oriented decision-support system, enabling the periodic revision of assumptions, datasets and projections as new evidence on mobility demand, technology adoption and energy consumption becomes available. Results highlight that, without additional measures, current trends are insufficient to meet European decarbonization targets. Conversely, Data Science-based decision support tools allow policymakers to identify more effective combinations of demand management, modal shift and technological innovation, improving the transparency and robustness of climate strategies. The paper ultimately argues that Data Science should be regarded as a key enabler for governing transport systems as environmental systems, supporting not only the design of decarbonization strategies but also their continuous monitoring and adaptive revision under conditions of uncertainty.

## Keywords

Big data, decision support system (DSS), sustainable mobility, transportation planning, travel demand.