On-road freight complexities

Transforming human systems to achieve sustainability calls for holistic evidence of their multiple and interconnected facets.

Road transport is at the same time a major source of pollutant emissions, with both environmental and human health consequences, and a primary system supporting the expansion of trade and, consequently, economic activities. Therefore, transforming road transport into an environmentally and socially sustainable system is critical to improve the well-being of current and future generations. Decision-makers have long engaged with debates on the most effective interventions and innovations required to accelerate such a transformation. Significant attention has been paid so far to the environmental and health impacts of passenger vehicles, particularly in urban and peri-urban areas, and to the kind of solutions that would be required to reduce impact and make the use of such vehicles more sustainable. However, with the spatial growth of commerce, supply chains have grown into global and interconnected systems that demand, among other things, an increasing level of freight transport services. Focusing on land freight transport, a number of recent initiatives suggest that both policymakers and businesses across the globe are now increasingly concerned about the impacts of freight trucks and railways.

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In China, for example, early in 2019, the Ministry of Ecology and the Environment declared in a policy document the intention to significantly increase the number of trucks able to meet emissions standards by 2020, in combination with other interventions such as improving diesel quality and reducing pollutant emissions from fuel combustion[1]. In December 2018, a coalition of rail freight companies and federations across Europe called Rail Freight Forward committed to fight climate change by reducing up to 290 million tonnes of CO_2 transport emissions over the next decade. Their plan is to boost the share of rail in overall road transport from 18% to 30% by 2020 as part of their climate change mitigation strategy[2]. Research has recently documented the critical role of shifting freight to low-carbon-intensity modes of transport — modal shift — in the fight against climate change[3]. But in order for policies and interventions to be really effective and support the development of a truly sustainable system, a more holistic understanding of the environmental and socio-economic complexities of freight transport is needed.

Advancing this kind of knowledge is at the heart of sustainability research, as we have highlighted previously[4] in *Nature Sustainability*. Sustainability scholars fully embrace complexity, from the framing of their research questions to the methods and approaches used in their analysis of the problems. In this issue, Tamy Bond and colleagues[5] provide an example of how to design a model of complex interactions to gain a deeper understanding of the environmental and human dimensions of on-road freight transport. They develop a system-of-systems model connecting the economy, technology and infrastructure to simulate air polluting emissions, human health and climate change impacts of the US freight truck and railway system over 2010–2050. They analyse mortality caused by particulate air pollution, short-lived climate forcing due to air pollutants and long-lived climate forcing from greenhouse gas emissions. They do so under four macroeconomic scenarios — a baseline scenario (per capita US gross domestic product, GDP, doubles between 2005 and 2050), a low-growth scenario (GDP growth rate 21% lower than in the baseline), a carbon-policy scenario (GDP growth as in the baseline and a carbon tax) and a low-growth carbon policy scenario (combining the low-growth scenario with the carbon tax one). As urban development affects freight transport activity, the researchers embed three urban development scenarios within the baseline macroeconomic scenario.

They obtain a range of different results including the greatest reduction in long-term climate forcing (24%) resulting from a carbon tax that shifts freight shipment from trucks to railway, and the largest reduction in air pollution (36%) through enforcing truck fleet maintenance. They also show that increasing urban compactness reduces freight activity but increases population exposure per unit emission (as population density increases) with slight health benefits (13%) over current urban sprawl trend.

If policies and interventions have to be evidence-based to meet their goals, more of the right evidence needs to be produced, particularly when decision-makers face the challenge of transforming complex systems. And in order to move societies on a sustainable development path, dealing with complexity is inevitable. ❐

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