Carbon-aware transport and logistics

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Transport broadly, and freight transport specifically, whether by land, by water, or by air, impacts the environment. Understanding and quantifying the impacts of transport on the environment has been an ongoing pursuit for many years. For example, the report “Transport in a fast changing Europe” of the working Group “Transport 2000+” set up by the European Commission in 1990 states

“Environmental conditions are deteriorating rapidly. Polluted waters, acid rain and global heating due to the greenhouse effect take their toll of the amenity. Transport contributes to this considerably ... the transport sector should accept and understand its responsibility to society, and act accordingly”

and observes that

“There needs to be a clear, integrated and convincing policy on transport and environmental issues. ‘Integrated’ here means that the policy not only refers to technological approaches but also takes into account measures such as avoiding and influencing mobility, shifts in transport modes, etc., to countervail possible negative effects of free transport”

and that

“A balance needs to be struck between the environmental imperative and ramifications for economic growth. Any policy introducing environmental

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improvements more quickly than actually necessary, with a severely reduced GNP as a result, would be just as damaging as the too-little-too-late approach.”

Similarly, the Green Paper “The impact of transport on the environment: a community strategy for sustainable mobility” published by the European Commission in 1992 aims to

“... initiate a public debate on the issue of transport and the environment and the proposed strategy for sustainable mobility”

and its assessment

“... has shown that transport is never environmentally neutral. Thus, since existing trends indicate that transport and traffic, particularly in the road sector will continue to grow over the next decades and that the demand for transport services, all things being equal, will increase, the impact of transport on the environment will become more significant. It is, therefore, essential that the community adopt a common strategy, which aims to reduce or at least contain the overall impact of transport on the environment in a global and coherent manner.”

and that

“Such a strategy will require a global approach in order to ensure that transport continues to fulfill its economic and social functions under the most favorable environmental conditions, while safeguarding the freedom of choice for the user.”

The report “Indicators of the environmental impacts of transportation: highway, rail, aviation, and maritime transport” by the United States Environmental Protection Agency published in 1996 presents

“... quantitative national estimates of the magnitude of transportations impacts on the natural environment. It is the most comprehensive compilation of environmental and transportation data to date. This document addresses all primary modes of transportation (highway, rail, aviation, and maritime transport) and all environmental media (air, water, and land resources), and covers the full life cycle of transportation, from construction of infrastructure and manufacture of vehicles to disposal of vehicles and parts. The information presented in this report highlights that the impacts of transportation are multimedia and extend beyond the air quality impacts of vehicle travel.”

Another early study, specifically focusing on freight, is “The environmental effects of freight” published by the organisation for economic co-operations and development (OECD) in 1997, which has attempted to

“... summarise the environmental impacts of freight, in order to provide information concerning the impacts of trade liberalisation on the environment through transport of goods. The focus has been on describing the major mechanisms through which freight transportation can affect the environment, and identifying ways to quantify those links on a per-unit of good basis.”

and reports that

“Some clear conclusions can be drawn ... Data on air pollution permit the most straightforward comparison. ... despite substantial variation among the estimates within each transport mode, trucks are clearly much more polluting than trains or boats. ... The data suggest that rail may be more harmful than marine transport; however this is much less clear.”

In the announcement of the book “Globalisation, transport and the environment” published by OECD in 2010, it is noted that

“Although the specific estimates vary, transport-based CO₂ emissions are projected to grow significantly in the coming years.”

From the above, it is clear that there is urgent need to drastically reduce world greenhouse gas emissions and that the transport sector has to do its part. New transport patterns must emerge, in which larger volumes of freight and greater numbers of travellers are carried jointly to their destination by the most efficient (combination of) modes. This involves, among others, optimising the performance of multi-modal logistic chains by making greater use of inherently more resource-efficient modes, and using transport and infrastructure more efficiently through the use of improved traffic management and information systems. This special issue brings together a diverse set of papers that seek, each in their own way, to contribute to all important goals of green house gas emission reduction.

The paper “Robust design of a closed-loop supply chain network for uncertain carbon regulations and random product flows” by Nan Gao and Sarah Ryan addresses a multi-period capacitated closed-loop supply chain (CLSC) network design problem subject to uncertainties in the demands and returns as well as the potential carbon emission regulations. Two promising regulatory policy settings are considered; namely, (a) a carbon cap and trade system, or (b) a tax on the amount of carbon emissions. A traditional CLSC network design model using stochastic programming is extended to integrate robust optimization to account for regulations of the carbon emissions caused by transportation.”

The paper “Emission allocation problems in the maritime logistics chain” by Wenting Zhu focuses on emission allocation as a prerequisite for measuring and reporting the emission footprint of alternative logistics options. An analytical framework for emission allocation in a maritime logistics chain is proposed. The framework provides a mechanism for the emission allocation of logistics chains with different structures and transported cargoes.

The paper “Network equilibrium analysis of destination, route and parking choices with mixed gasoline and electric vehicular flows” by Nan Jiang, Chi Xie, Jennifer Duthie, Travis Waller explores the adoption of plug-in electric vehicles (PEVs), especially battery electric vehicles (BEVs), as a promising approach to changing the current energy consumption structure and diminishing greenhouse gas emissions and other pollutants. The authors present a fundamental analytical tool for quantifying travel choice patterns in urban transportation networks with both gasoline and electric vehicular flows.