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Inventory Analysis and Impact Assessment towards Comprehensive LCA of Automobiles

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ABSTRACT

In order to identify major issues in the LCA of automobiles, inventory analysis focusing on emissions to the atmosphere was carried out using statistical data including the I-O table, and there were several substances of which emission is dominant in exhaust gas in driving. As a preliminary trade-offs between were listed up. The spatial aspect of L a simplified exposure assessment model. A case study revealed that there were large differences in population's exposures per unit amount of emission according to source types and population density.

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OBJECTIVE

Automobiles are the largest consumer durables. Because both the magnitude of environmental burdens per product and the number of its stock are large, total scale of environmental burdens associated with automobiles is exceptionally large among industrial product. Therefore, reduction of burdens of automobiles means significant reduction of societal burdens to the environment. ……

INVENTORY ANALYSIS

System boundary and inventory items

Life stages investigated include manufacturing of an automobile, its use (driving), as well as resource extraction, transportation and raw material production associated with these stages. The main target of the inventory analysis is an average-sized, gasoline-engine generic passenger car with lifetime of 10 years, during which 10,000 km drive per year and 10km…… Inventory items and corresponding impact categories are listed in Fig. 1.

Methods and data sources

Data on the average material composition of automobiles, statistics on manufacturing industries, the Input-Output table, as well as emission factors and activity data gathered for compilation of the national GHG emission inventory are used for inventory analysis. ……

Results

Fig. 2 shows results from preliminary inventory analysis of air emissions. Emissions from operation stage are often thought to be large contributor to total life-cycle emissions as is true for CO_2 in Fig. 2, but there are exceptions. For example, it is estimated that larger amount of NMVOCs are emitted from evaporation of gasoline in refueling at service stations and painting process of vehicles manufacturing than exhaust emission. There is large emission of ution of raw materials.

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CFCs tock of vehicles as air tion is released without recovery, though their production was banned. ……

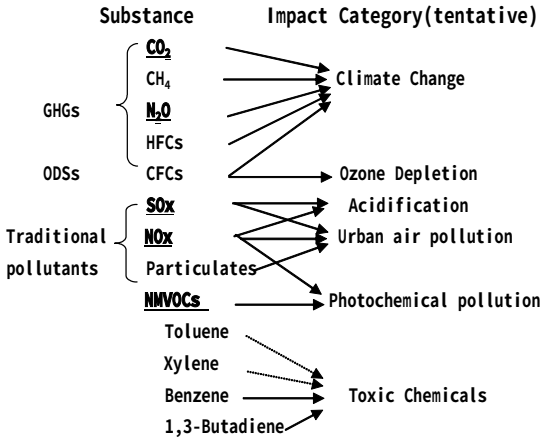

Fig. 1 Target substances of inventory analysis and corresponding impact categories

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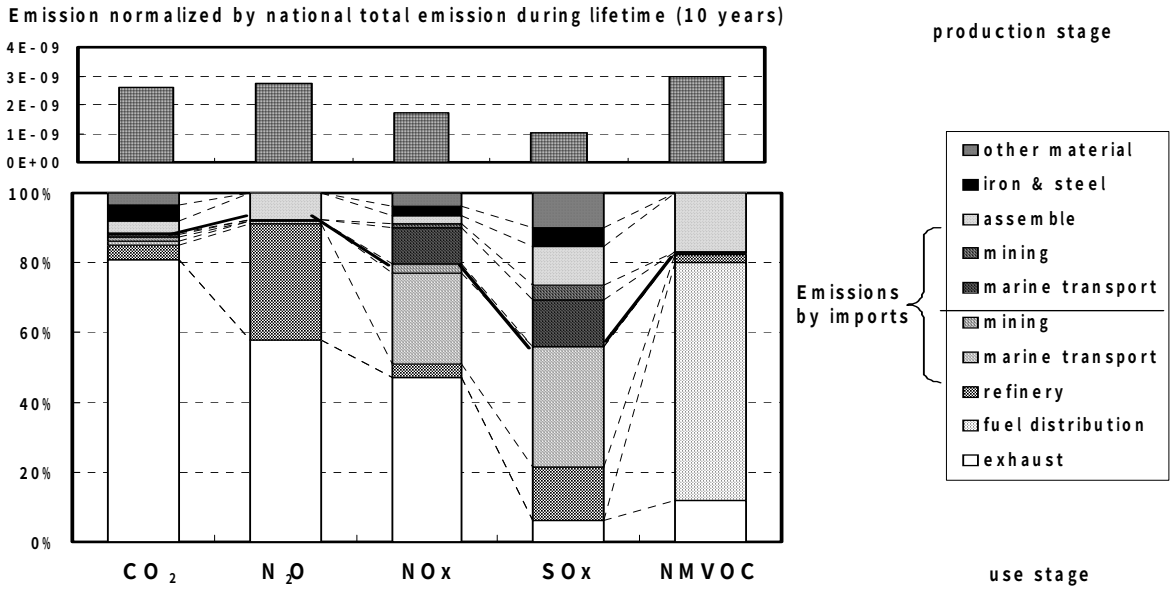

Fig. 2 Composition of life-cycle air emission from an average passenger car

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IMPACT ASSESSM

Normalization

In order to identify sig nces in terms of relative contribution to total burdens, each item of LCI was normalized by national total emission. Because the life time of automobiles is assumed to be 10 years, normalization is made by 10 times of annual national emission. Results from normalization are also shown in Fig. 2. Though much attention had been paid in Japan ⋯ ⋯⋯.

Major issues for impact assessment of automobiles

It is really difficult to establish a generic, standard methodology for Life Cycle Impact Assessment. In particular, LCIA experts are reluctant and/or deliberate in weighting among different impact categories. However, ⋯⋯

Table Ⅰ provides a preliminary qualitative assessment for comparison among gasoline-engine, diesel-engine, and electric vehicles, ⋯⋯⋯⋯⋯

Table1 Qualitative assessment of trade-offs among 3 types of vehicles

	Gasoline	Diesel	Electric
Carbon dioxide	> Diesel	< Gasoline	Depends
Nitrous Oxide	High	Depends	Low
Nitrogen Oxides	Medium	High	Depends
Sulfur Oxides	Low	Medium	Depends
Non-Methane Hydrocarbons	High	Medium	Low
Particulate Matter	Low	High	Depends
Benzene	High	Medium	Low
1,3-Butadiene	Medium	High	Low
Poly Aromatic Hydrocarbons	Low	High	Low
Non-ferrous metal resources	< Electric	< Electric	>Others

Needs to reflect locality in impact assessment of air emissions

As to some of air emissions such as GHGs that have long residence time, and of which increasing stock in the global atmosphere causes undesirable impacts, we can assume that the same amount of emission causes the same size of impacts, ⋯⋯⋯⋯⋯⋯.

$$A = (B + C) / D \qquad (1)$$

A case study by a simple exposure assessment model

This study examined two cases, dispersion from electric power plants and dispersion from roadways. This comparison is essential in order to discuss whether electric vehicles are "Elsewhere Emission Vehicle" in terms of health impacts of air emission to local population. ⋯⋯⋯.

CONCLUSION

Inventory analysis of air emissions from generic automobiles identified significant life stages for these emissions, and normalization by national total emissions suggested relative significance among different items of inventory. Spatial differentiation of impact assessment was discussed using a simplified exposure assessment model, and this revealed that the emission from automobiles give much larger impacts than the same amount of emission from power plants.

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