Economics and Ecology of Marine Transportation

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Eco-indicator, destruction index, environmental modal shift, Kyoto Protocol

ABSTRACT

Prevention of climate change and economical development are contradictory, but
important issues. Sustainable development is the word satisfying both require-
ments. However, it is not so easy to realize and evaluate. In this paper, marine
transportation is discussed from the economical and ecological view-points compared
with land transportation. For this purpose indices of life cycle assessment (LCA) are
introduced to evaluate total sustainability or survivability and an idea of destruction
index is describe.

1. Introduction

Coral bleaching is the phenomenon recently frequently reported in the world. Coral loses its
colour and looks being bleached. It was believed that the existence of oral reef is a kind
of evidence of clean ocean. However, this summer we have observed the phenomenon in
Sakishima Islands, Okinawa, Japan, even if the ocean is so clean. It is said the monthly mean
sea surface temperature (SST) excesses 1-2 deg. higher than the average value, the pheno-
menon will occur. It is also said the incom-
plete development of El Nino off Peru and Equador causes the distribution of so-called
hotspot; area with higher SST. Bleaching, by
the way, doesn't directly mean the death of
coral, but under higher temperature
environment it expels a microscopic organism
(algae) called zooxanthallae (in Japanese 蝋虫藻) with which coral maintains symbiotic
relationship. If it lasts long, coral will die and
won't recover for decades of years. It will be
spread out into various sea lives through
symbiosis and food chain. The very last end of
the chain is human beings. As Pecheux pointed out, “mass reef bleaching is unique
amongst the many alarming threats on earth
ecosystems: it is the only one where the primary level of an ecosystem may collapse all
over the world, and for reasons which are yet
unclear, but certainly global.” Who causes
only 1-2 deg. elevation of SST?

Kyoto Protocol thus adopted at United
Nations Climate Change Conference in Kyoto
on 1-11 December, 1997 is a turning point for
future economical and environmental policies
for both industrialized and developing countries. The protocol covers the reduction of three major greenhouse effect gases: carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) along with three lower-volume emissions of hydrofluorocarbons (HFCs), perfluorinated compounds (PFCs) and sulfur hexafluoride (SF₆) that have high atmospheric lifetimes.

In the area of transportation, major causes of these emissions are trucks and cars. Some efforts, of course, are taken to reduce air pollution and global warming in car industries and oil industries, but they are just within industries’ or the nation’s benefits. Global countermeasures including energy and/or modal shifts should be considered. Recently in some countries in Europe, modal shift is steadily promoted as the country’s policy.

In this paper, marine transportation will be discussed under the above background, and the necessity of proposing a new index leading to destruction is stated.

2. Modal shift and moral in Europe

As shown in Table 1⁹, the Netherlands is the unique country in Europe, where inland transportation is much than road transportation. In another resource, inland shipping shares 64.1%, while road does 30.9% and rail does 5% in tonnage base⁶. Germany is second largest country in term of inland transportation, although most other countries such as Italy, Spain and UK are almost relying on road transportation.

In Belgium, inland shipping is neither negligible, nor significant. The main difference between two neighbour countries is the elevation of the land level. Both countries has big rivers such as the Rhein and the Maas, as well as well-networked canals throughout the countries. The Netherlands is mostly flat country, while Belgium has moderate hills. Numerous locks and several hip-lifts are used for over 100 years, but they are at the same time bottlenecks for fast and mass transportation. To overcome this, the largest (in the world) slipway⁶ and ship-lift⁶ are constructed in Belgium. By these infrastructures, shortcut canal route from France to North Sea is available instead of longer trip following Maas river.

As shown in Figure 3, modal shift to inland transportation will involves economical merit to reduce fuel consumption, but also the reduction of the environmental.

However, to accelerate the modal shift we need to encourage the moral change towards ecological life. Brokk⁵, the mayor of the city of Tilburg, the Netherlands and the chairman of the Dutch Habitat Forum, for example, quotes it as “think globally, act locally” or as the campaign of “cycle to work”⁸ spread over 100 companies in the Dutch province of Zeeland. The latter movement is to encourage employees to commute in bicycle to their offices and the companies will pay certain amount of money per kilometer and they got for over four million kilometers a year, contributing the reducing of the amount of CO₂. Besides, a third of the participating companies and organizations are contributing to a newly established Climate Fund by paying in a certain sum for each kilometer cycled. The fund is used in Bhutan, Benin and Costa Rica to help their environmental investments.

3. Life Cycle Assessment (LCA) and Life Cycle Impact Assessment (LCA)

Evaluation of improving ecological aspects is still required for modal shift, as far as each company will pursue profits or for the purpose of introducing environment tax. Life cycle assessment (LCA) standardized as ISO 14040 (Environmental management and life cycle assessment)⁶ is now available for this purpose. ISO 14042 (Environmental impact assessment of products and services or rather called as Life cycle impact assessment)¹⁰ is the tool to evaluate LCA. In LCIA, each factor to influence the environment, is called impact. SEATAC-Europe¹¹ categorizes the impacts as in Table 2.

The weighting factors of individual impacts are defined such as 2.5 for greenhouse effect (0.1 rise every 10 years, 5% ecosystem degradation), 100 for ozone layer depletion (probability of 1 fatality per year per million inhabitants) etc. Total assessment can be done as shown in Figure 2.

In case of long-distance transportation, it will
be necessary to consider the local effects. Nagata et al.\textsuperscript{(12)} proposed such method applicable to restricted local area.

Eco-indicator is normally used to evaluate the alternative environmental treatment such as replacing some material of the product, but in case of environmental modal shift it might be rather replaceable with destruction index which leads to the destruction of the eco-system such as coral bleaching. In this case, destruction index is SST and the critical value is 1 deg. Authors are now considering the destruction index applicable for transportation.

4. Conclusions

Environmental modal shift is discussed through ecological consideration. Conclusions can be drawn as follows:

1) Some examples of modal shift in Europe is reviewed.
2) Ecological consideration using LCIA is introduced.
3) Environmental modal shift using destruction index is proposed.
Future works to be done should be pointed out as follows.
4) Destruction index should be carefully investigated suitable for environmental modal shift.
5) Infrastructures necessary for inland and coastal shipping in Japan should be studied.

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5. References

Table 1 Fright Transport in Western Europe\(^5\) (Unit: billions of ton-kilometers)

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**Figure 1** Comparison of Environmental Influences in Various Transportation

**Figure 2** Eco-indicator Weighting Principle