SPECIAL CONSUMPTION TAX INCENTIVE ON MARINE BUNKERS AND CARGO SHIFTING TO SHORT SEA SHIPPING IN TURKISH CABOTAGE ROUTES

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SUMMARY

Environment issue is one of the most important problems which must be solved urgently. Today, the effects of climate change linked to global warming have started to come into view. Some gases such as methane (CH_4) and carbon dioxide (CO_2) which are called as greenhouse gases (GHGs) are seen as the most important causes of global warming. Harmful exhaust gases and CO_2 emissions arise out of burning of fossil fuels on board. Maritime transportation is the most efficient mode when compared to other modes. However, Turkey's passenger and cargo transportation mainly depends on road transportation which has high fuel costs compared to sea transportation. In this study, by evaluating cabotage bunker fuels, annual CO_2 emissions from maritime ships sailing on Turkish cabotage line were investigated. Also fuel efficiency of maritime transport as well as the effects of shifting cargo between transportation modes on CO_2 emissions were analysed.

NOMENCLATURE

AE	Auxiliary engine.
CH_4	Methane.
CO	Carbon monoxide.
CO_2	Carbon dioxide.
COP	Conference of Parties.
Dwt	Deadweight tonnage.
EEA	European Environment Agency.
EEDI	Energy Efficiency Design Index.
EEOI	Energy Efficiency Operational Indicator
EF	Emission Factor.
EMRA	Energy Market Regulatory Authority.
GHGs	Greenhouse Gases.
GNP	Gross National Product.
Grt	Gross Register Tonnage.
Gt	Giga ton.
GWP	Global Warming Potential.
HFCs	Hydroflourocarbons.
HFO	Heavy Fuel Oil.
HP	Horse Power.
IMO	International Maritime Organization.
IPCC	International Panel on Climate Change.
ITF	International Transport Forum.
Kt	Kiloton.
LOA	Length Overall.
LPG	Liquefied Petroleum Gas.
μ	Mean value.
MDO	Marine Diesel Oil.
ME	Main Engine.
MGS	National Register of Ship.
Mt	Million ton.
N_2O	Dinitrogen oxide.
NO_x	Nitrous oxides.
O_2	Oxygen.
O_3	Ozone.
PFCs	Perflourocarbons.
PM	Particulate Matter.
SCT	Special Consumption Tax.
SEEMP	Ship Energy Efficiency Management Plan
SF_6	Sulphur hexafluoride.
SSS	Short Sea Shipping.
TUGS	Turkish International Register of Ships.
TUIK	Turkish Statistics Institute.
VAT	Value Added Tax.

1. INTRODUCTION

Any kind of substances spoiling the normal composition of the atmosphere are defined as air contaminants. There are many numbers and types of contaminating emissions leading to air contamination worldwide that occur from natural origins and as human-induced. Air contamination has significant detrimental effects on human health and environment.

Nowadays, studies have focused on the reduction of greenhouse gases (GHGs) causing global warming and climate change which commonly concern the world as one of the most important subjects. Fighting against climate change is a subject having utmost priority all around the world. However, negotiations are ongoing for the way to follow in this subject [1].

Greenhouse effect is the warming which occurs in the lower section of atmosphere and on the surface of the world in the result of having the absorption and dispersion of infrared beams by the gases taking place in the atmosphere of the world.

Important GHGs are water vapour, which is responsible for 36-79% of global warming, and carbon dioxide (CO_2), which is responsible for 9-26%, and these are respectively followed by methane (CH_4)(4-9%) and ozone (O_3) (3-7%) [2]. Other gases showing the greenhouse effect are dinitrogen monoxide (N_2O), hydroflourocarbons (HFCs), perflourocarbons (PFCs) and sulphur hexafluoride (SF_6).

Accumulations of GHGs in the atmosphere emitted with the burning of fossil fuels, deforestation, alterations in land usage, cement production and industry processes are rapidly increasing ever since industrial revolution. This has amplified the natural greenhouse effect and caused an increase in the surface warmth of the world with the addition of urbanization.

Warming has started to increase in global surface temperatures in the end of 19th century and it has become more evident after the 1980's and global warming records were broken almost every year by being warmer when compared with the previous year. All sensitive climate models consider the effects of GHGs and aerosols and they estimate an increase between 1-3.5 C° in global average surface temperatures until 2100 and by this, there would be a rise at the sea levels between 15 cm to 95 cm [3]. It is aimed to keep world's total CO_2 emission below 40 Gt and to maintain global warming below 2 C°.

The transportation sector is one of the important sectors which are responsible for GHG emissions. Transportation sector in The Organization for Economic Co-operation and Development (OECD) countries are responsible for 30% of total CO_2 emission [4]. According to data of Turkish Ministry of Environment and Urbanization for 2010, transportation sector in Turkey is responsible for 18% of total CO_2 emission [5].

Although ships are responsible for the carriage of 90% of world trade volume, based on Marine Environment Protection Committee (MEPC) 59/INF.10 report, they account for only 3.3% of global CO_2 emissions (international marine transportation 2.7%, cabotage marine and fishing industry activities 0.6%).

There is little known about the differences between deep sea shipping (DSS) and SSS. Short sea shipping (SSS) is defined as the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe. In the EU, SSS has begun to be seen as an alternative to highway freight traffic [6].

The shift of freight from road to SSS, is considered one of the major objectives of the common transport policy but, such a shift is far from being a reality. Road transport is regarded as the mode that fulfils to a higher degree customers' requirements in terms of transit times, flexibility, reliability, frequency and cargo safety and is often the chosen mode [7].

SSS has attracted a lot of attention in the EU in the last 15 years. It is considered as a mode favoured to alleviate road congestion. Alas, promises have not been met and cargo transfers have not reached their objectives yet, despite strong financial will and a programme for modal shift implemented by the EU [8]. However, sea–river shipping could give a new dimension and opportunities to develop intermodal transport in Europe [9].

Referring to the potential of SSS in Spain, chains including SSS-RoRo are potentially competitive when there is a high concentration of cargo and high or average opportunity costs related to the cargo. High concentration and low costs are also likely to benefit from SSS [10].

Turkey is located between Asia and Europe and attracts attention with its economic development. Turkey's land bridge position in north–south and east–west trade corridors means that ports are of vital importance to the efficiency of logistics activities in the country.

In Turkey, population and settlements are intensified especially on the coastal regions. Turkey's coastline is 8,333 km and 70% of industrial sector is located on the coastline [11]. Although Turkey has a strategic position in terms of logistics and shipping, its approximately 160 ports do not enjoy the usual benefits of ports [12]. For example, in spite of very suitable geographical, demographical and meteorological conditions, the sea is only used for the 4.4% of domestic transport in Istanbul [13].

The aim of this study, is to show the fuel efficiency of maritime transport in Turkey within the context of the country's transportation sector, as well as to examine the effects of the modal shift of freight from road to short sea shipping between domestic ports.

2. FUEL CONSUMPTION AND GHG EMISSIONS IN DIFFERENT SECTORS IN TURKEY

Turkey has become a party to United Nations Framework Convention on Climate Change (UNFCC) on May 24 2004 and to Kyoto Protocol on August 26, 2009. Turkey has not taken part in Annex B Countries List of the Protocol on the ground that it has not been the party to the Protocol in the time of its signature and has not the responsibility of emission reduction or limitation in the first (2008-2012) and second (2012-2016) of the Protocol, only to be bound to emission control thereafter.

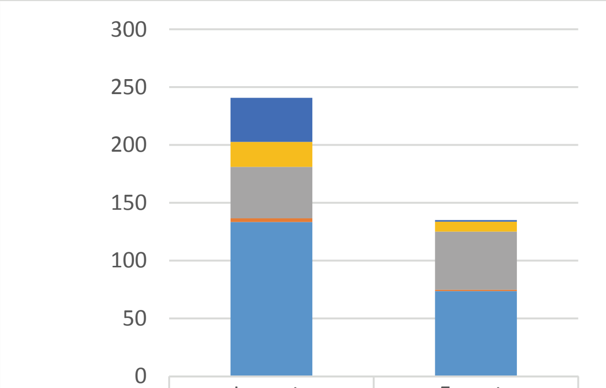
In Turkey, Energy, Science and Industry, Environment and Urbanization and Forest and Water Ministries closely monitor CO_2 emissions. Additionally, TUIK (Turkish Statistical Institute) also keep data about the emissions.

According to TUIK data, when Turkey's foreign trade distribution of 2011 is observed, it is seen that export is 135 billion USD and import is 241 billion USD. Distribution of import and export according to transportation types are shown in Figure 1.

Turkey's total petroleum quantity is 26.5 Mt for the year 2012, including production and imports, based on data of Energy Market Regulatory Authority (EMRA).

The Ministry of Environment and Urbanization reported that, in 2010, 285 Mt (71% of total GHGs) of

GHGs were emitted in the energy sector, 13% of it belonging to industrial processes, 9% to wastes and 7% to agriculture. Yet another, 39.6% of total GHGs occurs in the electricity production, 25% in the manufacturing and construction sector and 15.8% in the transportation sector.



	Imports	Exports
Others	38.2	1.3
Airway	21.5	8.6
Road	44.5	50.3
Rail	3.2	1.2
Maritime	133.4	73.6

Figure 1: The distribution of Turkey's value of trade in 2011 by transportation mode (TUIK).

According to TUIK's 2012 data, total of GHG emission was 440 Mton for 2012. While CO_2 equivalent emission amount per capita in 1990 was 3.4 ton/person, this rate increased to 5.9 ton/person by 2012. 55.7% of the other important GHG (CH_4), was generated from wastes, 34.8% was from agricultural activities, and 9.5% was from energy and industrial processes. 73.4% of the other GHG (N_2O), was generated from agricultural activities, 12.8% was from wastes, 7.1% was from industrial processes and 6.7% was from the energy sector.

Turkey's total GHG emissions have increased in 2012 to 440 Mt CO_2 and they have shown 133% increase in comparison to the year 1990. Share of transportation in energy usage was 16%, corresponding to 70 Mt. Freight transport was presumably 25%, and consequently the associated emission was 17.5 Mt. If it continues this way, figures will rise to 852 Mt in 2030; this means a twofold increase in 18 years. In this case, there may be transition from voluntary carbon market to compulsory carbon market.

Figure 2 shows freight and passenger transportation statistics by different modes in Turkey and Europe for the year 2012, with highway transport in Turkey having a clear dominance.

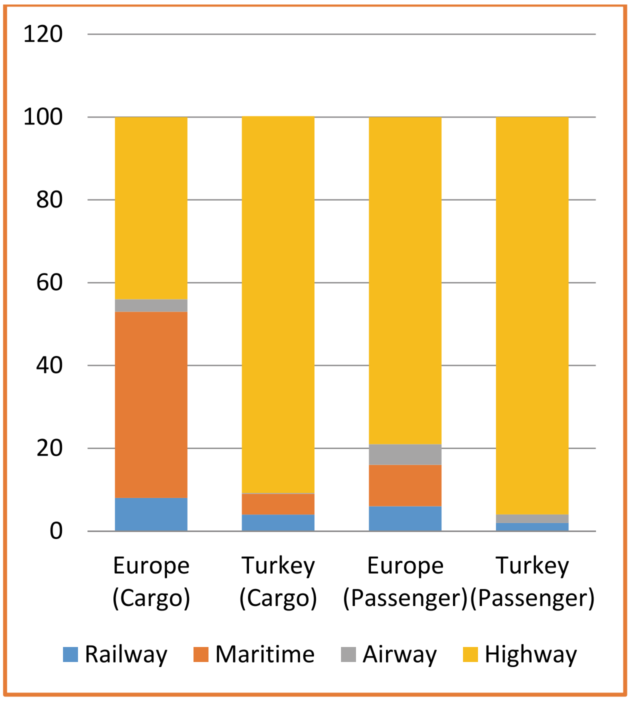


Figure 2: Comparison of transportation modes of Europe and Turkey (%).

In Turkey, road freight accounts for a quarter of the emissions from transportation sector, so it can be the primary field for targeting emission reductions. When disaggregate data exist, it is possible to detect inefficiency in freight movements and consequently to quantify emission cost of it in road freight sector [14].

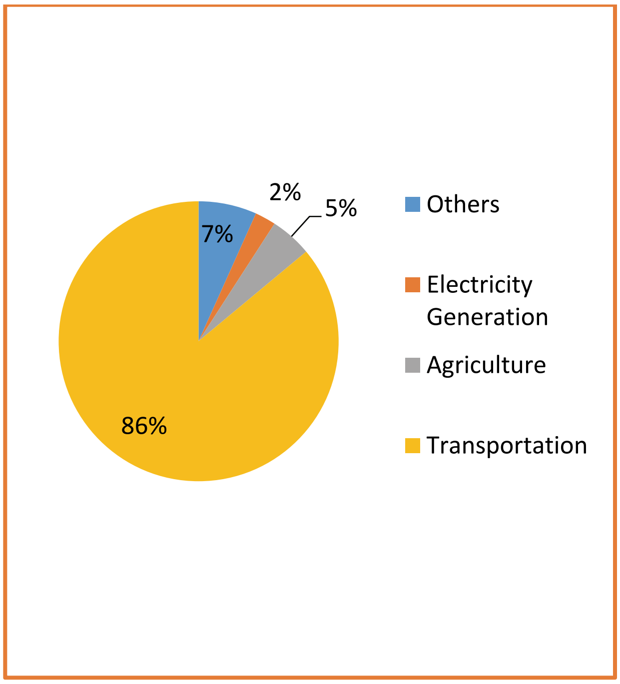


Figure 3: Sectoral distribution petroleum consumption in Turkey in 2012 (Mt).

It was revealed that in 2010, 99 Mt of CO_2 emitted from electricity production. According to EMRA data, the distribution of petroleum consumption by industrial sector in the year 2012 is shown in Figure 3.

Figure 4 shows the share of petroleum fuel consumed by different transport modes in Turkey according to the Ministry of Transportation. In total, 360 kt of fuel were associated with shipping, 330 kt were at 10 ppm sulphur rate while 10 Mt were consumed on the highways and 800 kt on the airways. However, according to EMRA data, the amount of marine fuels was 448 kt of 10 ppm and 31 kt of HFO.

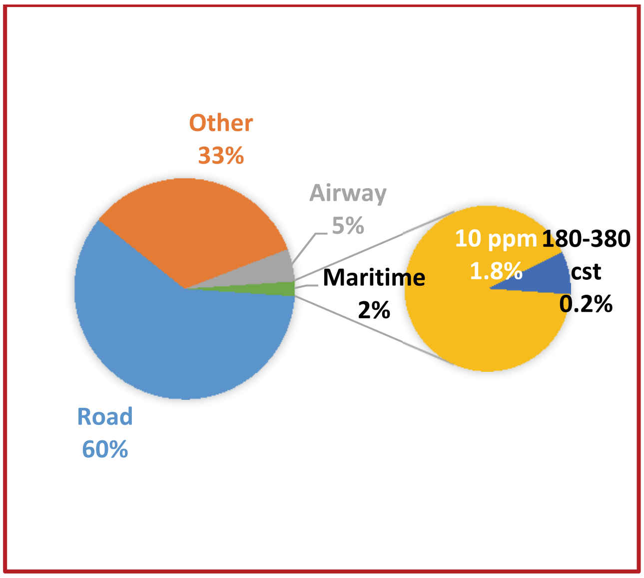


Figure 4: Petroleum fuel consumption in Turkey by transportation mode in 2012 (kt).

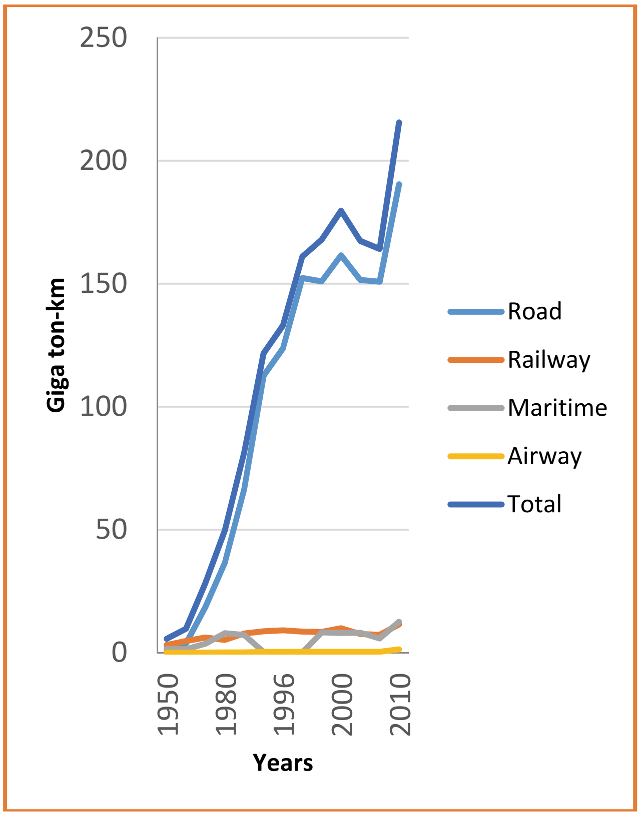


Figure 5: Performed transport work in Turkey by transportation mode.

Data from the Turkish Ministry of Transportation, Maritime Affairs and Communication for the year 2011 interprets that 88.3% of domestic cargo was carried on highways (190 billion ton-km), 5.8% was carried by sea, 5.3% by rail and 0.6% by air (Figure 5).

On the other hand, 91.8% of domestic passengers were transported through highways (227 billion passenger-km), 5.4% by air, 2.2% by rail and 0.6% by sea.

4. MARITIME SECTOR AND CO_2 EMISSIONS

The International Maritime Organization (IMO) within the framework of Annex VI of MARPOL has brought significant rules for the control of GHGs emissions from shipping and Turkey has recently (4 February 2014) ratified the relevant provisions.

IMO has identified three main types of measures for short and long term reduction of GHG emissions from ships: technical, operational and market-based instruments.

Technical measures include the optimization of the ship's hull and equipment design characteristics, the use of renewable energy and alternative (low carbon) fuels, calling for the introduction of these measures to be reflected in the gradual improvement (lowering) of the EEDI of new ships.

The operational measures such as speed optimization, optimized routing, improved fleet planning, etc. will affect the EEOI of existing ships, within the framework of SEEMP.

Market Based Measures (MBMs) are aimed at providing economic incentives for the adoption of energy saving practices by ship owners and operators. Indicative MBMs are fuel levies, emission trading schemes (ETSs), and differential port dues.

Several barriers could be discerned in short sea shipping: project management capabilities, ship-shore communication, division of responsibilities, access to performance measurements, and competence in energy efficiency. Although increased energy efficiency will be paramount in mitigating CO_2 emissions from shipping, the cost-effectiveness of many energy saving measures will have to be also demonstrated for their implementation [15].

Amongst the various MBM proposals, the fuel levy is likely to have the immediate effect of slow steaming, in response to the increased ship's fuel costs [16].

The global economic crisis and the high volatility of the fossil fuel prices are now attracting the interest of the entire maritime community, as they attempt to reconcile the environmental and economic objectives related to fuel consumption [17]. A number of events in shipping, show that a socially ''responsible'' business has positive results on stock funds and revenues [18].

Although effective in meeting environmental objectives, some of these measures may have non-trivial side effects on the economics of the logistical supply chain; for instance, reductions of speed and changes in the number of ships in the fleet and possibly on things such as in-transit inventory and other costs. There are also other important issues to be considered such as the increase of maritime costs which particularly for SSS is likely to shift freight volumes to the more environmentally damaging road alternative [19]. However, an agent-based simulation study of route choice for comparatively high-value cargo from Lithuania to United Kingdom does not provide concrete evidence of a modal shift from sea to road transport and indeed, it indicates that this shift is unlikely to occur [20].

4.1 ALTERNATIVE MARINE FUEL APPLICATIONS TO REDUCE CO_2 EMISSIONS

Fuel cells are a promising technology, and are also being considered in the maritime sector for future 'Green Ship' applications. Fuel cells meet the demands with regard to environment, comfort and signature which is essential for the naval market. However, as hydrogen is the 'natural' fuel for most types of fuel cells, there will be the need to convert the logistically favourable petroleum-based fuel of today to a hydrogen-rich gas suitable for the fuel cells of tomorrow [21].

Relatively small changes in engine performance and efficiency may result in substantial amount of emissions different from the default emissions factors. Engine operation with delayed fuel injection timing in one cylinder indicates an increase in CO_2 emission whilst NOx emission decreases. CO emission increases only at high the engine loads. Fuel leakage in the fuel pump causes changes in CO emission, the increase of CO_2 emission and the decrease of NO_x emission [22].

The use of a blend of marine fuel oil with biodiesel in marine applications is considered to be effective for reducing ship emissions and meeting the relevant international standards. Most recent life cycle assessment studies have demonstrated that biodiesels made from oil seeds, such as palm, sunflower and soybean oils, have a positive energy return or an output–input energy ratio higher than unity [23].

A preliminary analysis indicated that the liquid fuels that could be most readily manufactured from hydrogen (from electrolysis) and recycled CO_2 were: methanol, mixed alcohols and gasoline (via methanol). Three schemes for the synthesis of liquid fuels from recycled CO_2 and renewable power were presented. The methanol process had the highest efficiency, with 0.50 kWh of chemical energy stored for each kWhe used [24].

The cruising phase represents about 99% of the emissions for main engines and about 80% of the emissions for auxiliaries. Manoeuvring emissions are negligible in the total emissions picture. The main engines consume about 95% of the total fuel and more than 99% of the fuel used is heavy fuel oil. Total CO_2 emissions from ships in EU22 countries were calculated as 76894 kt based on national and international transport activities [25].

The current investigation reports on diesel particulate matter emissions, with special interest in fine particles from the combustion of two types of marine fuels. The fuels selected were diesel fuel and marine gas oil (MGO). The experiments conducted on a four-stroke, six-cylinder, direct injection diesel engine, showed that the fine particle number emissions were higher with MGO compared to diesel fuel [26].

It can be stated that the addition of up to 10% v/v biodiesel in bunker oil, considering parameters like viscosity, density and stability, is possible in terms of combustion quality [27].

Although most merchant vessels use heavy fuel oils (HFOs) for ship propulsion, these fuels are cost effective but they produce significant amounts of noxious emissions. In order to meet the IMO emission standards, the use of Liquefied Natural Gas (LNG) as a marine fuel is becoming an interesting option. LNG application on a 33,000 DWT tanker ship, LNG leads to a reduction of 35% of operational costs and 25% of CO_2 emissions [28].

Also, the use of natural gas as a 'cleaner' fuel alternative to heavy and light fuel oils for the entire domestic passenger and Ro-Pax shipping in Greece has been found to lead to an annual reduction of CO_2 emissions by 34.2% [29].

A transition to LNG or methanol would significantly improve the overall environmental performance. However, the presence of "methane slip", as unburned methane, is important to consider since it has a great impact on the global warming potential [29].

Hydrogen remains an attractive alternative fuel to petroleum and a number of investigators claim that adding hydrogen to the air intake manifold of a diesel engine will reduce emissions and diesel fuel consumption while the engine runs at idle. However, at all other loads, the influence of added hydrogen was insignificant and an analysis at 75% engine load showed that hydrogen production increased the overall equivalent fuel consumption by 2.6% at 22 standard litre per minute (SLPM) and 17.7% at 220 SLPM [30].

4.2 TURKISH MERCHANT SHIP FLEET

According to the statistics of Maritime Trade General Directorate, in 2011 the number of ships having 150 grt and above registered in Turkish International Register of Ships (TUGS) and National Register of Ships (MGS) was 1832 (987 Tugs-845 Mgs), whilst in 2012 dropped to 1148 (446 Tugs-702 Mgs). .

Although these ships represented 7.6 million dwt (68% Tugs) in 2003, it has reached to 9.8 million dwt (92% Tugs) in 2011. Furthermore, in 2003 the average age of these ships was 24 years, whilst in 2011 was lowered to 21 years. The distribution of the Turkish Marine Merchant Fleet of 150 grt and above for the year 2011 according to ship type is shown in Table 1.

Table 1: Distribution of Turkish Marine Merchant Fleet according to types of ships (150 grt and above).

Ship Type	# of ships	Σ dwt	μ dwt
Dry cargo	496	1753636	3536
Bulk cargo	115	4987983	43374
Container	70	913936	13056
Liquid/Gas carrier	221	1973704	8931
Passenger ship	237	48238	204
Service ships	80	61541	769
Tug boat	111	2711	24
Sea vessels	162	5548	34
Fishing vessels	216	8759	41
Sportive/Recreational crafts	124	2881	23
Total	1832	9758936	5327

4.3 ANNUAL EMISSIONS BASED ON MARINE BUNKER CONSUMPTIONS IN TURKISH CABOTAGE AREA

The earliest study about shipping emissions in Turkish Straits was carried out by Kesgin & Vardar [31]. They estimated CO_2 emissions from domestic passenger ships in Istanbul Strait as 171 kt for a year.

In the scope of "Special Consumption Tax General Communique Serial No 6'' published on the Official Gazette, which was dated 31 December 2003 and numbered 25333 (3rd Repeated); "Amount of Special Consumption Tax of Fuel to be given to ships exclusively transporting cargo and passenger on cabotage line by being registered in Turkish International Register of Ships and National Register of Ships, to commercial yachts, service and fishing vessels in a way to be determined according to every ship's technical characteristics and with the condition of being entered in ship's journal is reduced to zero'' expression takes place.

By the courtesy of special consumption tax (SCT) incentive, which has come into effect previously, quantity of the cargo carried on the sea increased to 5.8% from its existing rate of 2.6%.

According to the 2012 statistics of the Turkish Ministry of Transportation, Maritime Affairs and Communication, the quantity of domestic freight by sea in 2012 was 38 Mt (32% increase in the last 10 years) and the performed transport work was 8.8 billion ton-miles (150% increase in the last 10 years). These findings indicate a substantial increase in the transportation range of freight during this period. Furthermore, the number of domestic passengers has reached to 159 million through an increase of 59% in the last 10 years.

In the similar manner with IPCC (2006) Report, Trozzi (2011) has also formed a decision tree in order to be able to calculate vessel emissions and has established a system with 3 stages in order to be able to calculate emissions according to data in hand [32]. This work has examined approximately 100,000 vessels having diesel engines which consist of 99% of world's fleet in the year of 2010.

In this, since the movements of Turkish flagged vessels are not available, Tier 3 method was not used, however, since Tier 2 method is applied according to weight of the engines of the vessels as slow (<300 rpm), medium (300-900 rpm) or high speed (>900) and because of only having the engine powers of Turkish fleet in our hands, it is also impossible to use Tier 2 method. For this reason, emission values of cabotage vessels were calculated according to fuel consumption according to Tier 1 approach which uses default values.

According to Tier 1 method, amount of any emission type is calculated as stated below:

$$E_i = \sum_m (\sum FC_m \times EF_{i,m})$$

where;

Ei: Annual total emission (ton).
FCm: Quantity of fuel sold in the country in (m) type (ton).
EFi,m: average emission factor (kg/ton fuel) for the contaminating in (i) type.
i: pollutant type.
m: fuel type (fuel oil, diesel oil, gas oil, etc.).

Since CO_2 emission is the result of the full burning of fuels, factors having effect on the amount of the emission type are the quantity of burned fuel and carbon ratio taking place in such fuel. When it is accepted that 330 thousand tons of MDO fuel is consumed on the cabotage line while HFO is 30 thousand tons, emission amount generated by depending on fuel amount is shown in Table 2.

Table 2: Annual emissions in Turkish cabotage area.

Fuel type	EF (NO_x) (kg/ton fuel)	EF (SO_x)	EF (NMVOC)	EF (CO)	EF (CO_2)	EF (PM_{10})	EF ($PM_{2.5}$)
MDO	78.5	20 x S	2.8	7.4	3,206	1.5	1.4
HFO	79.3	20 x S	2.7	7.4	3,114	6.2	5.6
Fuel Consumption	NO_x (t)	SO_x (t)	NMVOC (t)	CO (t)	CO_2 (t)	PM_{10} (t)	$PM_{2.5}$ (t)
MDO (330)	25,905	6,600	924	2,442	1,057,980	495	462
HFO (30)	2,379	2,700	81	222	93,420	186	168

CO_2 emission factors have been taken from IMO's document named Guidelines on the Method of Calculation of the Attained Energy Efficiency Design Index (EEDI) Resolution MEPC.212 (63). Based on the calculations in Table 2, annual total CO_2 emission in Turkish cabotage area is about 1.15 Mt.

According to data from TUIK, 11.2% of 402 Mt CO_2 equivalent emissions have generated from the transportation sector according to Turkey's gas emission inventory of the year 2010. Same year, 88.7% of CO_2 equivalent emissions (45 Mt) originating from transportation were from highways, 6.4% from airways, 3.8% from seaways and 1.1% was from railways.

Possible reason of difference between the current calculation and the data from the Ministry may be result from inconsistency of data from Energy Market Regulatory Authority and MTMC for the fuel without private consumption tax (VAT).

The Turkish coaster fleet is 35-40 years old and the fleet is required to be renewed particularly in terms of fuel saving. In order to renew the Turkish coaster fleet, contribution shall be provided with 5 coasters having the cost of 7.5 million USD for each one to Turkish Star Project developed by ICDAS. These vessels also have the characteristic of being suitable for river transportation and they will also have tax and personnel advantages with their 5 thousand tons of transportation capacity and 3 thousand gross tons volumes. While vessels having these sizes consume 6.5-7 tons of fuel in a day, these vessels shall provide a great saving with about 5 tons of fuel consuming [33].

5. DISCUSSION AND CONCLUSION

Today, multi-mode transportation has become considerably widespread by the courtesy of global economy. When determining the routes of transportation and doing related investments, we have to find most suitable methods and solutions by considering the environment, security of life and property.

What is required to know at this stage is to determine both direct economic costs, which are generated by transportation types, and indirect costs, which concern everybody, and at the same time we must know their amounts.

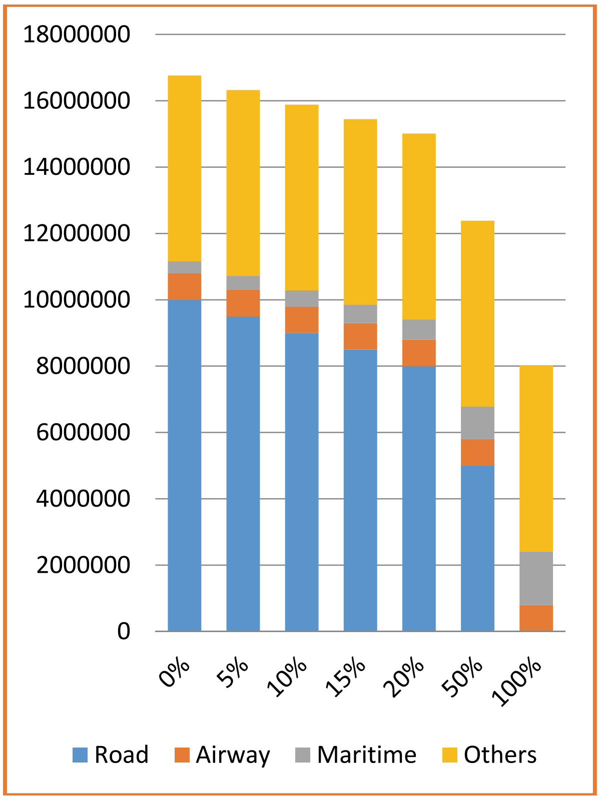


Figure 6: Effect of cargo shifting from road to marine transportation on the national fuel consumption of all transport modes.

In previous study related with the fuel consumptions in cases of carrying cargo between Istanbul-Rize through land and sea, it was calculated that waterborne freight is about eight times more efficient than land transportation in terms of fuel consumption [34]. Therefore the promotion of SSS can be an important contributor to the campaign of climate change control.

The trade-off between road and maritime transportation is indicated in Figure 6.

With today's data, existing fuel consumptions are shown with the first graphic in Figure 5 (case of 0%). On the other hand, when the amount of fuel consumed on the roads is directed to the maritime mode, new fuel consumptions are shown as 5% and 10% etc. respectively depending on the percentage of decreasing for the fuel consumed on the roads in the result of this orientation. By shifting all road transport to the sea, the overall fuel consumption of transport is reduced by 50% compared to the first case. Although this is not feasible, it indicates that a move towards sea transport shall provide significant amount of fuel savings for the country.

In this analysis, it is presumed that the fuel consumptions of air and other transport modes remain constant. However, a shift of freight transport to rail (as an alternative to road) will produce secondary reductions in fuel and emissions, as trains are more efficient than road trucks.

In respect to emissions and social costs for road versus short sea options, future research should incorporate the added variable of emissions so that willingness-to-pay for GHG mitigation is well understood [35].

In Turkey, between 1990-2005, GDP growth has been observed to be consistent with the doubling of domestic cargo and passenger transport [36].

Despite the fact that the share of CO_2 emissions from shipping is relatively low, their rate of increase is extremely high.

According to the ITF, 2005 report, within the 15 year period of 1990-2005, transport related CO_2 emissions showed a 37% increase worldwide, whilst for Turkey the relevant increase has been recorded to be equal to 56% and it has increased by 97% between the years of 1990-2007..Furthemore, during 1990-2005, the rate of increase in Western Europe and North America countries was between 20% - 30% and it was actually 30% for all OECD countries. The annual increase of CO_2 emissions in this period averaged 1.79% in OECD countries and 2.14% worldwide. On the other hand, in Turkey this increase was observed at the rate of 2.86% [4].

If the observed growth trends remain unchanged, it is clear that greenhouse gas emission in Turkey will increase substantially in the future, with the transportation sector playing a major role in this.

Taking into account that the overwhelming volumes of marine fuels (92%) are clean fuels having of 10 ppm sulphur content, there has been important improvement not only in terms of CO_2 but also for local air pollutants and the environmental damages produced by the latter.

In case of an overall freight shift from road to sea, the fuel consumption of all transport modes would decrease by 50% and despite this being unrealistic even a partial shift will provide significant amount of fuel saving in the country.

Although marine transportation is the most efficient mode, economic incentives (such as reduced VAT on fuel, favourable financing for newbuildings etc) have to be provided in order to promote a renewal of the fleet which will encompass fuel saving technologies and reduce CO_2 emissions.

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