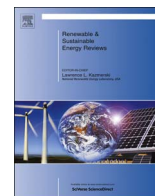




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Carbon, water and land use accounting: Consumption vs production perspectives

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ABSTRACT

The traditional approach of accounting of environmental pressure in the Kyoto Protocols follows the production-based accounting, which attributes all environmental pressures generated from production activities within a country boundary to that country total environmental pressure. However, the major flaws of this approach is that it does not take into account the environmental pressures embodied in imports and so build stimulus for shifting of environmental pressures abroad. An alternative approach to include environmental pressures associated with imports to the country and subtract export related environmental pressures is the consumption-based approach or footprint approach. This approach has been widely considered as an alternative way to more adequately allot responsibilities between the emitters and final consumers. This study compares and discusses the concepts of both approaches, showing the results of an empirical analysis and going into the application of the two different perspectives in worldwide environmental policies. This paper presents the results of an analysis of the Carbon, water and land footprints of the worldwide from 1995 to 2009, and compares the outcomes for the two approaches for four world regions (i.e. EU, OECD, BRIC and RoW). The analysis is based on a multi-region input output (MRIO) model to assess these environmental pressures. The proposed model uses the world-input-output-database (WIOD) covering 35 sectors and 41 countries. The results show that during the entire study period, the carbon emissions, land use and water use for the EU and OECD regions are higher in the consumer approach than in the producer approach. The results further indicate that, for the BRIC and rest of the world (RoW) regions, the carbon emission, land and water use are higher in the producer approach than in the consumer approach.

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1. Introduction

The rapid urbanization and globalization over the last few decades have generated a significant growth in economic activities around the world. The increasing globalization of production and consumption activities and the intensification of trade have changed our production and consumption perspectives completely and lead to a split of the locations of productions and consumptions of goods and services. A country consumption of goods and services cause various environmental pressures all over the world due to international trade. In a globalized context with increasing international trade, it is highly important to accurately determine environmental impacts resulting from various environmental pressures embodied in trade. In environmental pressures accounting, there are two approaches to measure these environmental pressures: the producer and consumer based approaches. The first approach attributes all environmental pressures generated from production activities within a country boundary to that country total environmental pressure. With related to international trade, this approach includes the environmental pressures released or used within a country for production of exports. However, the major flaws of the production based approach is that it does not take into account environmental pressures embodied in imports and so builds stimulus for shifting of environmental pressures abroad. A complementary approach is to include environmental pressures associated with imports to the country and subtract export related pressures is the consumption-based approach or footprint approach. This approach has been widely considered as an alternative way to more adequately allot responsibilities between the emitters and final consumers. The footprint approach places the responsibility for environmental pressure on consumer. In the domain of this approach all the environmental pressures related to consumption by a country's citizens, including those connected to imported goods and services for consumption, directly or indirectly are assigned to that country [27].

Recently the footprint or consumer based approach has become very popular and has been adopted for various quantitative measures of environmental stress that comply with the approach of consumer responsibility. Footprint approaches, like the carbon footprint [24], the ecological footprint [21] and the water footprint [8] are based on the basis of consumption-based approach. Furthermore, this approach can be used for assessing the impacts of production and consumption activities in both domestic and international environmental resources. For example, most of the goods and services are not produced within the boundary of a single region or country. The production and consumption activities in one country may indirectly impose pressure on environmental resources (i.e. water, Land etc) in another country through importing goods and services into that country. In addition, the production process also affirms that many businesses in developed countries are purchasing goods and services from developing countries, which may accelerate the relocation of energy use, resources use and pollution in the developing countries. Thus it is very important to calculate the footprint of these resources by taking the global supply chain effects into account.

Among the many environmental concerns today we have faced, three major challenges emerge as particularly important. First, considerable efforts are currently directed toward the task of minimizing the greenhouse gases (GHG's) emission and its effects on climate change. In recent years global warming and climate

change have received a lot of attention at national and international forums among politicians and business leaders. The variation of GHG emission in different countries is closely related to the level of economic development [3]. The transformation of CO₂ emission from developed to developing and from developing to develop countries through international trade is a substantial and growing problem. Recent research studies show that these transformation of emissions between countries and regions are so big and that up to 30% of global emissions are linked to production for export [9,19]. Another area of environmental concern is the water scarcity which has become an important subject on the environmental agendas of government and companies as well. Water is a limited natural resource and during the last decades, water use by human beings has been increased at more than twice the population growth rate [22]. Apart from being an integral source for drinking, it is also necessary for irrigation, industrial operation & production, hydropower generation and ecosystem functioning as well. Recently, due to the increasing globalization of production and consumption activities and the growth of export of water-demanding commodities to water-scarce countries make the problem even more complicated, prolonging the restraints for water scarcity large beyond the national boundaries. The third major area of environmental concern is the use of biological productive land. Today the most rapid population growth in the world belongs to BRIC and Row regions. Therefore, agricultural water and land resource management need a specific attention in these regions. Geng, et al. [7] identified a scheme of indicator system for zoning of agricultural water and land resources usage in Inner Mongolia. Valipour [1,2] conducted a comprehensive study on irrigation management in Asia and Oceania to study the land use index. Singh [16] investigated the unanimous use of water resources for sustainable irrigated agriculture. Khasraghi et al. [11] and Valipour et al. [20] evaluated the HD, ZI, and KW models for simulation of open- and closed end border irrigation system using SIRMOD. Valipour [2] estimated the ratio of area equipped for irrigation to cultivated area in Africa for the years 2035 and 2060 respectively. Fang et al. [5] determined the usefulness of irrigation management for increasing water usage efficiency in China. Khan et al. [10] inspected water management and crops production for food security.

All the above three environmental areas of concern are highly important, and though essentially different from one another but they are all interlinked and jointly influencing each other directly and indirectly. As such, it is reasonable to suggest that these environmental challenges should be assessed together when politicians and business leaders are framing policies and making investment with a sustainable future in mind. Therefore, to determine world-wide environmental pressures i.e. water use, land use or CO₂ emission related to production and consumption of a specific country or world region, it is important to take trade aspects fully into accounts. In this context, the first step is to undertake an empirical comparison of both approaches for various regions. The outcome of such analysis may support national environmental policies in upgrading their options for reducing environmental pressures, both domestically and globally.

This paper contributes to the research by presenting data on worldwide GHG emission, water use and land use for four aggregated regions (i.e. EU-27, OECD, BRIC and RoW) calculated according to both approaches. We perform detailed analysis on the emissions, land and water use embodied in exports and imports of

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