Tourism environmental responsibility: the ignored role of investment.

Cadarso Vecina, María-Ángeles; Gómez Sanz, Nuria; López Santiago, Luis-Antonio; Tobarra Gómez, María-Ángeles

Universidad de Castilla-La Mancha Facultad de Ciencias Económicas y Empresariales, Plaza de la Universidad n. 2, 02071, Albacete (Spain)
Phone +34 967 599 200 Ext. 2383
E-mail: Angeles.Cadarso@uclm.es, Luis.L.Santiago@uclm.es, Nuria.Gomez@uclm.es, Maria.Angeles.Tobarra@uclm.es

ABSTRACT

This work aims to measure and allocate emissions related to the Spanish economy touristic consumption and investment for the period 1995-2005. Our main contribution is to consider not just goods and services consumption but also investment required to produce them as responsible for tourism polluting emissions. By doing so the emissions measure is more adequate since it also accounts for the tourism sector structure. Results show that in 2005 domestic tourism consumption explains 11.2% and tourism investment 3.4% of total CO$_2$ emissions lined to productive activities. A major improvement in global environmental efficiency in the tourism sector takes place during the analysed period, since emissions linked to this sector are reduced form 0.5 CO$_2$ kilograms per euro in 1995 to 0.37 CO$_2$ in 2005.

KEYWORDS: Tourism, Investment, CO2 Emissions, Environmental Responsibility, Input-Output Analysis.

Paper presented at the *** European Trade Study Group, September 2011
1. Introduction

Following the World Tourism Organisation, tourism is one of the economic activities with a highest effect on climatic change (UNWTO, 2008). On the one hand, the intensive use of energy required for tourism activities production, especially fossil energy, leads to the emission of high amounts of greenhouse gases. Consumption of touristic goods stands between 3.9 and 6% of total CO$_2$ emissions for the world economy and between 5% and 14% if nuclear energy and other greenhouse gases are included (UNWTO 2008). On the other hand, the increasing use of natural resources required for tourism, either to build infrastructures or to make use of them, implies an important impact on use of water, land or materials.

Tourism is an important sector for Spanish economy. Spain is the second country both for foreign tourists per year (55.6 millions in 2005 and 58.5 in 2006) as for income from tourism (Spanish Tourism Department, Industry, tourism and commerce ministry, MITYC in Spanish, different years). The offered model, *sun and beach*, is still a main international touristic attraction, leading to a growing coastal erosion in the Mediterranean coast. However, urban tourism and business tourism, done mainly by residents, is also important, being the weight of resident tourism in GDP higher than the inbound one. As a result, the contribution of tourism activities to PIB is 11% and 10% to employment in 2005, according to INE (National Statistics Institute, CST, Tourism Satellite Accounts, both in Spanish). Such a main income generator must have in important impact on environment.

This paper proposes a methodology that aims to adequately quantify and allocate CO$_2$ emissions linked to tourism industry and, from that point, to apply it to the Spanish economy for the period 1995 to 2005. We focus mainly in both, emissions related to the consumption of tourism goods and services and those included in investment required to provide them. To do so we base on input-output literature to calculate direct and indirect emissions linked to touristic consumption (Jones and Munday, 2004 and 2007, Lundie *et al.*, 2007, Konan and Chan, 2010). These emissions are linked to energy directly used by tourism sectors, direct emissions, and to the energy used in the production of goods and services used by these sectors, indirect emissions. In the second classification includes, a wide range running from the emissions linked to the electric energy needed by hotel and catering for heating, air-conditioning, lighting, cooking, etc., to emissions related to agricultural products cooked. However, we consider that, in the same line that UNWTO (UNWTO, 2008), calculation of tourism emission should include, in addition to direct and indirect emissions, emissions generated by investment.

The recognition of the role of investment is an improvement for emissions calculation since it allows to work with a tourism offer model that accounts for the sector productive structure. The calculation of tourism investment necessitates an investment tourism matrix, provided by INE for the Spanish economy, that includes both investment done by tourism sectors (hotels, touristic resources, rural accommodation, restaurants, etc.) and infrastructures investment, necessary for tourism sectors to provide there services (roads, airports, museums,…). These investments are necessary

---

1 This paper analyses emission related to productive activities offered by tourism industry, however emissions directly generated for households when consuming tourism are not considered, which includes mainly gasoline and gas-oil used for travelling by car and heating in second residence.
in order to provide tourism goods and services and are themselves linked to direct and indirect emissions (as any other good) that shall be quantify for, since environmental effects of tourism are infraestimated when investment is left out.\textsuperscript{2} The proposed measure considers also emissions linked to the production of capital goods used in tourism independently of its origin, domestic or foreign, instead of adding them to the emissions of the capital goods producing sector.

Proper calculation of tourism emissions is a necessary first step to achieve a sustainable sector, and above it, a sustainable development (Becken and Patterson, 2006). However, once the total burden of emissions is measured, we consider it basic to allocate emissions responsibility to the agents that produce them, so that policy measures aimed to reduction are applied to responsible agents and can be better orientated and be more effective. In this point we connect with literature on producer and consumer environmental responsibility and, therefore, with the role of international trade on emissions (see Munksgaard and Pedersen, 2001, Ahmad and Wyckoff, 2003, Sánchez-Chóliz and Duarte, 2004, Peters and Hertwich, 2006, Su et al., 2009, o Cadarso et al., 2010). The high rates of growth of international tourism (5.5\% in 2005 and 4.5\% in 2006) leads to a responsibility transfer between countries, as is the case with international trade since the place where income is generated is different to the place where goods and services are consumed and, that means, that tourism consumption emissions are transferred between countries (Lundie \textit{et al.}, 2007), what calls for a clear definition of emissions responsibility.

The special characteristics of tourism industry and tourism product consumers require to adapt the producer and consumer responsibility criteria. The producer responsibility criterion, used among other in Kyoto Agreement to allocate emissions to countries, considers that a country is responsible for the emissions generated by goods and services productive process that take place within its frontiers. From that point, we define global tourism sector responsibility, by allocating to tourism sectors those emissions related to both, consumption goods and services produced during a period, and investment goods required for the same period (new hotels, restaurants, roads related to the industry, machinery, etc.). The measure also includes both intermediate goods imports required to provide domestic tourism consumption and tourism sector investment imported goods, since we consider that these emissions are responsibility of such industry. From that point we define a measure of environmental ecoefficiency for tourism sector, that considers total emissions related to tourism consumption and investment per million of Euros produced/consumed and invested.

Paper is organised as follows. Section 2 reviews recent literature on environmental effects of tourism. Section 3 focuses on input-output methodology required to calculate tourism industry CO\textsubscript{2} emissions responsibility and comments on the particularities of the uses statistical sources. Section 4 applies de proposed measures to the Spanish industry and comments the results. Finally, section 5 discusses conclusions.

\textsuperscript{2} Therefore it is quantify, in a similar way to the calculation of the sector weight in GDP, the weight of emissions generated by tourism industry on total human ecological footprint for a country.
2. Literature review

Local tourism environmental effects has been widely investigated while information on its aggregation to account for global effects on wider areas, countries or worldwide, is difficult to find (Gössling, 2002; Jones y Munday, 2007). It is possible to distinguish two main categories to classify models assessing environmental impact of tourism. On the one hand, models can have a bottom-up approach, also called life cycle analysis models through production process (LCA-processes). On the other hand, models can have a top-down approach, using input-output methodology to analyse life cycles (IO-LCA).

Bottom-up models are based on tourism sector samples or surveys, so that they work with detailed data on tourism industries, its types and tourists choices and preferences. This degree of detail is a main advantage, since it allows a very disaggregated analysis leading to the proposal of policies able to go down to firms and human levels. It is also a drawback, since it requires to bring together a wide number of data that require time and resources. However, its main inconvenience is its limitation to include indirect effects of tourism activities on environment. Indirect effects are usually collected in the second type. Top-down approaches are based on national statistics that itemises touristic sector that, however, is analysed as an element assembled in an economy. This is a main advantage, since it allows for inter-sectoral comparison and a more general search into the environment-economy relationship, together with the capacity to quantify indirect effects. Also, the economical-environmental accounts that result can be used as a base for different methodologies: product life cycle, input-output, ecological foot-print, tec. Even though both types of analysis are based on different data and hypothesis, they can arrive to comparable results in terms of energy consumption or CO$_2$ emissions when only direct effects are considered (Becken y Patterson, 2006).

Gössling (2002) makes a comprehensive bottom-up analysis of the environmental impact of tourism at a worldwide level, using previous analysis and national statistics. His aim is to obtain a first approximation of the effects of tourism worldwide focusing on five areas: land alterations (use and physical nature), energy, species exchange and biodiversity, illness exchange and dispersion and changes in the man-environment relationship, adding use of water as a sixth area. Focusing on energy, field close to our own paper, it is divided into transport energy (and emissions) and destination energy (accommodation, food, activities, etc., but transport). For transport energy, the paper estimates travelling per passenger and kilometre, the percentage related to tourism depending on whether the country is developed or developing$^3$ and the mean of transport and its CO$_2$ emissions, measured from the energy intensity factors per transport mean and the corresponding emissions factor. His results show that, for 2001, tourism transport generated 1.263 MtCO$_2$ equivalents. The author points to two main inconveniences: it is no possible to know whether transport in destination is included, what would involve a large distances, and it does not account for energy consumption indirect effects that are expected to reach between 25-65% of total consumed energy per passenger. With respect to the use of energy and emissions in destination, the paper calculates use of energy per accommodation and activity type. Finally, the paper concludes that transport is responsible for almost 94% of the tourism impact on global climate change.

$^3$ One half for developed and a smaller proportion for developing, leading to one third of world travelling being tourism.
warming, while energy consumption and emissions related to leisure activities have a minor role.

Gössling et al. (2005) follows Gössling (2002) methodology with a further development of the analysis of transport emissions. The main contribution is the development of a measure of eco-efficiency as environmental damage per unit of value added. The measure is calculated as the amount of CO₂ equivalent emissions on turnover and it is applied to the analysis of five different stages (a city, islands, a mountain, a country and a rural area in a developed country). The main inconveniences found in this analysis are the omission of indirect effects, together with the fact that the measure of eco-efficiency does not stress enough the relative importance of tourism income in rural areas or developing countries. Gössling et al. (2005) results show that eco-efficiency can change to a large extent depending on (in descending order): distance (main contributor), transport mean (flight is the most unfavourable to eco-efficiency), stay mean duration and daily expenditure (an increase leads to eco-efficiency improvement).

UNWTO (UNWTO, 2008) estimates worldwide CO₂ emissions linked to tourism for 2005. They work on data on the energy consumption required by the supply of tourism transport, accommodation and other touristic activities. The UNWTO calculations only include direct emissions related to fossil oils consumption for transport, and fossil oils and electricity for accommodation and other tourism activities. That is, indirect emissions are not included. Results show that emissions linked to worldwide tourism consumption are between 3.9% and 6% of total of emissions figures given by the Intergovernmental Panel on Climatic Change (IPCC). By sectors, it is Air transport (40%), Terrestrial transport (32%) and, well below, Accommodation (21%).

Jones and Munday (2007) propose the use of tourism and environmental Wales input-output satellite accounts to quantify the environmental impact of tourism turnover, following a top-down model. They take into account, direct, indirect and induced effects of tourism turnover, since they calculate a widened multiplier that considers families as an economic sector. They environmental impact measure is CO₂ emissions and waste. They found that a million pounds tourism turnover generates, as an average, 413 CO₂ tons, mainly due to the tourism requirements of Refined petroleum, over one third of total emissions, and Other terrestrial transport, Electricity and Agriculture, all adding to another third. Also, they show that tourism as a whole is, compared to other economic activities, slightly below the CO₂ emissions average.

The paper by Lundie et al. (2007) also combines input-output tables and environmental accounts. They calculate input-output multipliers for energy consumption, water use, CO₂ and other greenhouse gas emissions and land use. The direct and indirect impact of tourism in Australia are calculated from the previous multipliers, however the last set of data cannot be obtained from input-output sources, but from other statistics. Results show that 1,810 CO₂ tons are produced per tourism million dollars turnover. The main limitation of the paper is the omission of the effects of transport on environment.

Konan and Chan (2010) use an input-output model to analyse the greenhouse gasses emissions in Hawaii, distinguishing whether they were due to received tourism or households. Direct and indirect effects related to tourist’s consumption reaches to 22% of total GHG emissions in Hawaii in 1997. Air transport, Electricity and Other
transports are main responsible for the high environmental impact of tourism in Hawaii.

Our work is based in an input-output model, similar to the previous two, but adding a key element not included in any of the previous, the impact of capital goods or investment in the tourism sector on economy and environment. There are papers that analyse specifically the environmental impact of construction, none of them applied to the Spanish economy. Nässén et al. (2007) use an IO-LCA sector to calculate direct and indirect emissions related to construction sectors for six different types of buildings in Sweden for 2000 and, when compared with LCA-processes analysis these only consider 50% of total energy required according to IO-LCA studies. Sharrad et al. (2008) consists in a paper based on the use of IO-LCA models that analyses the efficiency, economic effects and environmental consequences of construction sector in the production phase. Acquaye y Duffy (2010) calculate greenhouse direct and indirect emissions for Irish construction sector in 2005, using input-output methodology and disaggregating down to 5 subsectors: ground works, structural work, services, finishes and plant operation. However, none of the mentioned works has analysed the environmental impact of investment required in infrastructures by the tourism industry, or any other industry, or even the productive sectors as a whole. Methodologically, there exists another contribution of our proposal to the previous literature on the topic, since, while previous works calculate emissions done by different building types, we proposed to allocate emissions produced by the construction sector (from buildings to infrastructures) not to the construction sector, but to the sectors that use these goods, in our case, to those that constitute the tourism sector in the proportion that corresponds to them.

3. Input-output methodology and emissions linked to tourism.

The main contribution of this paper is to propose an estimation method that allows to relate CO$_2$ emissions linked to tourism investment to each sector providing tourism goods and services. The proposed model is input-output and top-down, since it is based on national statistics to which it detaches tourism, compared to bottom-up models, that from detailed tourism statistics, infer its environmental impact on economy (Gössling, 2002 and Gössling et al., 2005).

3.1. Environmental responsibility of tourism industry

The proposed methodology focuses on the calculation of emissions associated to consumption goods that provides a country’s tourism industry and to the investment goods required for that. The domestic tourism industry environmental responsibility includes only CO$_2$ emissions linked to tourism consumption goods supplied by the tourism industry and investment domestic goods required for supplying. The calculation

---

4 None of the input-output studies applied to the Spanish economy has focus specifically on Construction. Alcántara and Padilla (2003) and Tarancón and del Río (2007b and 2007c) look for key economy sectors in order of energy use and also CO$_2$ emissions for the Tarancón and del Río cases. Other papers that focus on key CO$_2$ polluting sectors are: a) Tarancón y del Río (2007a) work on CO$_2$ emissions resulting of terrestrial transport for Spain and other four EU countries; b) Tarancón et al. (2008) and Alcántara et al., (2010) focus on the identification of those Spanish sectors that are electric energy intensive; c) Alcántara y Padilla (2008) analyse Transport within a wider subsystem formed by service sectors.
of these emissions correspond to the Kyoto Agreement producer criteria that allocates responsibility to countries. According to that criterion, a country is responsible for emissions generated in production process that take place within its frontiers and in consumption of domestic goods and services, but not in imports. The expression for the calculation of the tourism sector responsibility is as follows:

\[
TSR = \langle e \rangle (I - A^d)^{-1} < C^d > + \langle e \rangle (I - A^d)^{-1} I^d = \epsilon^d [ < C^d > + I^d ]
\]  

(1)

Where \( \langle e \rangle \) is a \( mxm \) direct emissions coefficient diagonalised matrix, measuring emissions in each sector divided by effective production. \( A^d \) is an \( mxm \) domestic and total technical coefficient matrix. \( \epsilon^d = \langle e \rangle (I - A^d)^{-1} \) is an \( mxm \) domestic multiplier matrix that quantifies domestic CO\(_2\) emissions generated directly and indirectly per unit of final demand. \( < C^d > \) is a direct tourism consumption diagonalised matrix showing tourism goods and services supplied by both proper tourism sectors and any other sector when meeting tourism demand. \( \epsilon^d = \langle e \rangle (I - A^d)^{-1} \) is an \( mxm \) matrix measuring domestic investment done by tourism sectors in \( k \) investment goods of which information is gathered.

As already mentioned, the treatment given to investment is the main contribution of our paper, both in relation to the definition of emissions responsibility and in its application to tourism. Previous literature quantifying producer responsibility by sector allocates investment emissions to the capital goods producer sector. We propose to allocate them to the sector that makes use of the capital goods to produce, in such way we calculate a more adequate measure for environmental responsibility of the Spanish tourism industry.

Climate change is a global problem far behind any country frontiers and, therefore, tourism industry must hold responsible of emissions linked to goods and services required direct and indirectly by it to generate its production. For that reason, we also calculate a country’s global tourism sector responsibility (GTSR) that includes all emissions for which a country must hold responsible, independently of whether they are produced within or outside of the national territory.\(^6\) Tourism industry requires imported intermediate goods and capital to provide present and future production, so our measure considers its responsibility of these emissions as fixed and intermediate capital importer. The expression is as follows:

\[
GTSR = \langle e \rangle (I - A^d)^{-1} < C^d > + \langle e \rangle (I - A^d)^{-1} I^d + \langle e \rangle (IA^d)^{-1} I^m
\]  

(2)

\(^5\) According to the producer criterion, final tourism goods and services imports are not responsibility of the importer country but of the country of origin where they are produced, so they are not included in expression (1).

\(^6\) The specific characteristics of the tourism sector lead to differences in the GTSR definition compared to responsibility of a country as consumer. The consumer criterion points to a country being responsible for emissions linked to the consumed goods, independently of where they are produced. In our case, since we focus on sector responsibility, we attribute it the imported investment and imported final consumption goods responsibility, while exports are not deducted.
There are two main differences between \( TSR \) (expression 1) and \( GTSR \) (expression 2). First, expression (2) considers total coefficient matrix, \( A' \), instead of the domestic one, \( A' \). From that point, the total emissions multipliers matrix, \( \varepsilon' \), that quantifies CO\(_2\) emissions within and outside a country, imported and domestic, generated directly and indirectly generated per final demand unit. The first element in the expression, 2.a, and the third one, 2.c., reflect direct and indirect emissions generated in a country and included in imported intermediate goods required to respond to domestic tourist consumption and investment respectively. Second, \( C^m \) and \( I^m \) are two imported consumption goods and investment \( mxm \) matrices. Therefore, 2.b and 2.d account for total emissions, domestic and imported, linked to imported consumption and investment goods by tourism sector. The hypothesis behind total emissions calculation is usual in uniregional models, that consider production and contamination technology is similar for the analysed country and those origin of the imports.

The \( TSR \) rows matrix gives information on direct emissions in a country generated when producing consumption and investment goods required to respond to tourists demand. By columns, \( TSR \) provides information of total emissions, direct and indirect, responsibility of the tourism sector due to the domestic intermediate goods that are required to produce consumption and investment tourism goods. In a similar way, \( GTSR \) provides information, by rows, on the direct emissions generated by an activity sector (within or outside a country) due to the consumption and investment goods that provides to the tourism sector. The columns summation of \( GTSR \) shows direct and indirect total emissions done by different sectors (domestic and from other countries) due to the intermediate goods required to provide goods and services consumed by tourist and the tourism sector investment. The columns approach allows us to reallocate direct and indirect emissions linked to tourist consumption in a national economy and to the investment goods used and bought to respond to the tourism demand within a country. Both in \( TSR \) and \( GTSR \) results by rows only include direct responsibility in investment goods production in those \( k \) sectors that produce them. However, in columns results, investment goods emissions are allocated to the sectors that use them in the tourism goods and services production.

### 3.2. Environmental ecoefficiency in tourism sector.

Once domestic and global environmental responsibility for tourism sector is defined, it is possible to build ecoefficiency measures for the sector, calculated as a ratio of total emissions per economic activity unit. Ecoefficiency related to tourism consumption includes direct and indirect emissions generated by consumption divided by million of Euros spend in tourism consumption. This is a measure similar to the ones defined by Jones and Munday (2007), since the authors use input-output multipliers and, therefore, consider direct and indirect effects. The proposed ecoefficiency measure related to tourism consumption is:

This hypothesis is the so called DTA (domestic technology assumption). See, among other, Munksgaard and Pedersen (2001), Sánchez-Chóliz and Duarte (2004) or Peters and Hertwich (2006). Andrew et al. (2009) quantifies the magnitude of the errors owing to the estimation of carbon footprints through different production and contamination technology (DTA, multiregional unidireccional y multiregional multidireccional) and finds that, for the Spanish economy in 2001, the difference between DTA and multiregional multidireccional is only 1% at a global level. However the analysis does not enter in differences per sector.
The proposed methodology is different to the one used by Gössling et al. (2007), since they estimate leisure tourism emissions (business tourism is not included) from very detailed information about tourism transport, accommodation and consumption done by tourist in other activities. This methodology does not allow the calculation of indirect impact of leisure tourism and their calculation does not account for the impact of business tourism, however, it allows to compare ecoefficiency for tourists coming from different nationalities that visit specific tourism destinations.

The main contribution of our work is to define an ecoefficiency related to the investment done by tourism sector, where direct and indirect emissions related to investment are included. So, we consider tourism sector as responsible for emissions related to infrastructures required to provide its services and to the bought of other capital goods made by the industry. This is an important element, since a great amount of the responsibilities related to tourism come from the use of vehicles, machinery or infrastructures. We define a new ratio that provides information on whether the technology incorporated to new investment goods improves, and to which extend, energy and emissions efficiency for a sector, mainly in machinery and vehicles that are the devices that can sooner incorporate technological improvements. The expression goes as follows:

\[
\varepsilon'_C = \frac{\sum <e > (I - A')^{-1} <C'>}{\sum <C'>} \]

Finally, it is possible to define an ecoefficiency global measure, including emissions related to tourism consumption and investment done by the tourism sector per million of Euros turnover. The expression goes as follows:

\[
\varepsilon'_G = \frac{\sum <e > (I - A')^{-1} (I' + C')}{\sum <C'> + I'}
\]

The three defined measures consider ecoefficiency as an adjusted measure of the weight of each of the domestic sectors supplying tourism goods and services on the total of the demand taking into account their respective emissions coefficients.

### 3.3. Data sources

To proceed with the proposed calculations for the Spanish economy we combine input-output data (IOT), Atmospheric Emissions information published in the Satellite Accounts (CSEA in Spanish) and tourism consumption, and also investment, data provided by the Tourism Satellite Accounts (CST in Spanish), all statistics published by INE. Calculations have been done for Spanish economy data disaggregated down to 46
sectors for 1995, 2000 and 2005\(^8\), where 2000 is the base year. Also all tourism consumption and investment data have been deflated at 2000 prices using products volume indices provided by INE.

CST published by INE only provide information on total tourism consumption \((C^t)\), with no distinction between domestic or imported goods and services \((C^d, C^m)\) and, therefore, do not allow to calculate tourism sector responsibility directly. Also, CST provide data on turnover in tourism consumption done by households, \((C^t_h)\), inbound tourism, \((C^t_r)\), PPAA (both individual and collective\(^9\), \((C^t_{AP})\), and intermediate tourism consumption \((C^t_{i})\), with no distinction on the origin of the goods. Therefore, the estimation of final tourism consumption (households, inbound and AAPP) has been done considering that for each type of good and services, the weight of imports is similar to the weigh for households total consumption according to input-output table.\(^10\)

Intermediate tourism consumption is distributed depending on the percentage of imported inputs demand on total input demand for each product according to information supplied by input-output table.

Intermediate tourism consumption includes business travels expenses and, according to the intermediate goods definition, correspond to turnover required to produce other goods and services. In order to include business travelling emissions with tourism emissions it is necessary to transform input-output tables by reducing intermediate consumption matrix by the business tourism amount and to increase, by the same amount, final tourism demand.\(^11\) This implies that its emissions are considered final demand, instead of intermediate goods. The considered criterion to subtract intermediate tourism demand for each product within the intermediate consumption matrix has been to reduce it in the proportion given by the total intermediate consumption for each sector. We obtain a new modified domestic technical coefficients matrix, \(A^*\), that does not consider business travels and we use it to calculate the environmental tourism impact. This matrix is the model to estimate those emissions related to the tourism industry and tourism consumer. As an example, expression (2) can be rewritten as\(^12\):

\[
RITG = \varepsilon e^t (I - A^{t'})^{-1} [C^t_{h} + C^t_{r} + C^t_{AP}] + \varepsilon e^t (I - A^{t'})^{-1} I^t' = \varepsilon e^t [C^t_{h} + C^t_{r} + C^t_{AP} + I^t']
\]  

\(^8\) 1995 has some problems due to INE methodological changes (mainly changes in the base year), both in relation with input-output data and with Tourism Satellite Account. For CSEA, there has also been a change in the base year. 2000 base series is more disaggregated but only gets to 2003, while 2010 base series get to 2008. We have worked on 2003 data because it has a high disaggregation level in transport sector, basic for tourism, while that is not the case for 2010 data.

\(^9\) For the last case, the expenditure corresponds to travel agencies and other tourism services not marketable done by PPAA.

\(^10\) This hypothesis is justified thinking that Spanish and foreign tourists find in comerces a similar percentage on imported goods than in non-tourism allocations.

\(^11\) This is the methodological alternative 2 given in CST by INE, that proposes to Guild a widened tourism demand including business travels, however affected aggregated national accounts must be modified (INE, 2002).

\(^12\) The approach for intermediate consumption tourism also modifies TSR and ecoefficiency measures, by including tourism final consumption in final demand and subtracting it from the intermediate consumption matrix.
On the other hand, it is necessary to adapt the 16 CST goods and services categories to the 46 sectors that are the minimum common divisor in IO tables and CSEA. We shall shed light on two of the categories of non-characteristic products: Goods and Other products. In relationship to the former, Goods, these are goods bought by visitors. To put it simple, we have considered that tourists distribute their consumption in a similar way than residents, so that we use information on final consumption given by IOT household sector. For the latter, Other products, includes basically services not included in previous categories: passenger means maintenance and reparation services, heterogeneous tourism services (including financial and assurance), goods rental services and other tourism services. These have been allocated homogenously in the corresponding sector, since there was no available information about the distribution.

CST provides information on Gross Fixed Capital Formation (GFCF) required to provide touristic services. This investment expenditure is not made by tourists, but by production units in order to provide tourism goods and services. Tourists pay them implicitly since its depreciation its included in the contracted services. CST considers two types of expenditures: a) Capital goods expenditures done by characteristic tourism sectors (hotels, restaurants, transports, etc.); b) Collective use infrastructures, use both by tourists and non-tourists, including all the range from roads, airports, train stations, to museums and other cultural goods. CST assigns to tourism a high proportion in some of the investments done by characteristic sectors (i.e., almost 100% in hotels). However, for infrastructures the criterion used is to consider a similar weight to that of the relationship between touristic productions to total production.

Capital goods considered by CST are: Motor vehicles, Naval construction, Railroad material; Aeronautical and special construction; Other equipment goods; Housing; Non-residential buildings; Civil engineering; Other products. All these classifications had to be gathered together because IOT and CSEA do not allow to work with such a detailed level. The final classification has been: Motor vehicles; Other transport material manufacture; Other capital goods; Edifications; Other products. Also, the distribution between domestic or imported investment goods is done for each type of good depending on the distribution between domestic or imported investment given by the input-output table.

Because of the importance of Air transport in tourism, we must also consider the international goods transport quantification and allocation particularities in CSEA. They only account for emissions done by resident firms in a country. This criterion does not consider emissions related to tourists international transport when brought by foreign companies, while it includes emissions done by resident companies over national frontiers. There is a degree of compensation in both amounts, but this is partial and it is not possible to know whether emissions related to international transport real values are undervaluated or overvaluated when using CSEA data. For the Spanish case, we

---

13 Investment in Other equipment goods corresponds to 28 different investment products given by IOT and Other products corresponds to 3 products. In both cases, the amount given by CSE has been distributed according to the weight of investment in each product for the whole of the economy on the total for the group of products (Other equipment goods and Other products).
consider that there is an underevaluation because of the high amount of foreign tourist that travelling with foreign companies.\textsuperscript{14}

4. Main results

Spanish is in 2006 the EU country that is further from the commitment signed in the Kyoto agreement for 2012. The failure to keep this compromise is explained by the growth in CO\textsubscript{2} emissions due to the high rate of economy growth and the entrance of 4 millions immigrants up to 2008. Other explanations are the high degree of specialization of the Spanish economy in fossil oils and the Construction sector extraordinary growth rates, that resulted in 20\% of GDP for 2006 when considering both households and infrastructures.\textsuperscript{15} Also, Spanish economy has a very environmentally inefficient terrestrial transport structure (Tarancón y del Río, 2007).

In this context, Spanish tourism sector environmental responsibility is 14,6\% of the total of economic activities emissions for 2005.\textsuperscript{16} Direct and indirect emissions related tourists consumption explain 11,2\% of the total, 29,636 CO\textsubscript{2} kilotons (Kt), while the investment done by tourism characteristic sectors explain the remaining 3,4\%, 9,084 CO\textsubscript{2} Kt. For 1995 to 2005 the weight of tourism emissions on total emissions goes down from the 16,2\% value in 1995. This fact is explained by the relative weigh loss of tourism sector in the period, while economic activity grows at 24,7\% the tourism consumption sector only grows by 4,6\%. The difference is also due to an improvement in tourism consumption ecoefficiency, since it moves from 0,5 CO\textsubscript{2} kilos per euro turnover in 1995 to 0,4 CO\textsubscript{2} kilos per euro turnover in 2005. (see Table 1). However, even when there is a stronger improvement in tourism investment ecoefficiency (from 0,5 to 0,31), emissions related to investment goods grow 46\%, since there is a growing provision of them, infrastructures, hotels and machinery for the tourism industry to provide its services.

\textsuperscript{14} Another possible option is to use IPCC calculated emissions for the Spanish economy, however this source does not allocate to a country emissions related to goods international transport, but it states this information separately allocated to international bunkers so that the problem remains unsolved. Also, the OPCPC lower level of disaggregation by sectors would lead to information lost.

\textsuperscript{15} According to IPCC (2001) Construction accounts for 36\% of developed countries emissions.

\textsuperscript{16} Since our measures do not include households tourism final emissions (because of the use of goods and not because of its production), the calculations related to emissions are commented on the whole of emissions related to economic activity.
Our results for tourism environmental impact are significantly higher than those given by UNWTO (2008), that consider that emissions related to tourism sector are between 3.9% and 6% for 2005. Differences can be explained both by differences in methodology, since our calculations consider direct and indirect emissions while UNWTO only considers direct and those related to energy consumption, and also because of the important weight given to the tourism sector in the Spanish economy. Also UNWTO only considers tourism consumption, while we complete this measure with emissions related to investment.

### Table 1. Tourism Consumption and investment ecoefficiency, 1995-2005

<table>
<thead>
<tr>
<th></th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourism Consumption Emissions (Kt CO₂)</td>
<td>28310</td>
<td>27771</td>
<td>29637</td>
</tr>
<tr>
<td>Tourism Consumption (millones €)</td>
<td>56636</td>
<td>69345</td>
<td>73698</td>
</tr>
<tr>
<td>Tourism Investment Emissions (Kt CO₂)</td>
<td>3464</td>
<td>7858</td>
<td>9084</td>
</tr>
<tr>
<td>Tourism Investment (millones €)</td>
<td>10645</td>
<td>21835</td>
<td>28764</td>
</tr>
<tr>
<td>Ecoefficiency Tourism Consumption</td>
<td>0,500</td>
<td>0,400</td>
<td>0,402</td>
</tr>
<tr>
<td>Ecoefficiency Investment Consumption</td>
<td>0,513</td>
<td>0,360</td>
<td>0,316</td>
</tr>
<tr>
<td>Tourism Global</td>
<td>0,502</td>
<td>0,391</td>
<td>0,378</td>
</tr>
</tbody>
</table>

Source: Own elaboration from IOT, CST and CSEA.

### 4.1 Emissions related to tourism consumption

Tourism consumption environmental impact is different to the households one, since agents consumption pattern changes when agents change their usual location (OMT, 2008). So, Konan and Chan (2010) confirm that foreign tourist have a consumption pattern much more polluting than households for the Hawaiian case, explained mainly by the former international transport. For our case, the analysis allows to distinguish for the consumption pattern for residents tourism, inbound tourism, business tourism and...
PPAA tourism expenditure, and all groups are compared to the household consumption patterns when they are not consuming tourism.

Receptor tourism is responsible for 49.4% of total emissions in 2005, followed by 35.6% of resident tourists, 12.1% of intermediate tourism consumption and the remaining 2.9% corresponds to PPAA tourism consumption (Figure 2). Intermediate or business tourism consumption emissions are the only ones that become smaller between 1995 and 2005, from 4,531 CO$_2$ Kt to 3,577, explained by the internationalization of the Spanish economy and a higher amount of business travelling goes abroad, reducing tourism domestic consumption (it goes down form 7,679.1 millions Euros in 1995 to 7,342.1 in 2005). Any other type grows for the analysed period. The highest increase occurs in tourism promotions done by PPAA, 70% increase, justified by the positive effect on production and employment in the country, but however, it highlights the need of a change in the tourism policy towards a sustainable sector.

**Figure 2. Total CO$_2$ emissions related to consumption by consumer type, CO$_2$ Kt**

Emissions linked to consumption of the 56 millions foreign tourist that visit Spain pollute 14,000 CO$_2$ kilotons in 2005. These results are much higher than those found by Konan and Chan (2010) for Hawaii, differences are explain because tourism volume is much higher for Spain and our results also include emissions related to investment goods. For the Hawaiian case, when authors calculate direct and indirect emissions related to consumption done by foreign they find that, for 1997, they get to 5,173.4 Kt of CO$_2$ equivalent (since authors calculate emissions linked to three greenhouse effect gases: carbon dioxide, methane and nitrous oxide). However, in relative terms these emissions are higher in Hawaii, since they add up to 22.1% of the total emissions in the country, compared to 16.2% of the Spanish activity in 1995.

Direct and indirect tourism CO$_2$ consumption emissions are concentrated mainly in transport emissions (see Figure 3). In 2005, Air transport represents 34% of total emissions, while Terrestrial transport only 10% and Activities related to transport 3%. Also, its weight has increased over time, from 33% in 1995 to 49% in 2005. Our results
are similar to those found by INWTO (2008), the agency finds that Air transport is responsible for 40% of worldwide tourism CO\(_2\) emissions in 2005. Even though, the weight of transport is smaller than the results obtained by previous literature that do not consider implicitly all the indirect impacts that, according to Gössling et al. (2007), get between 60% and 95% of total emissions for each touristic day.

**Figure 3. CO\(_2\) total emissions related to domestic tourism consumption by selected sectors, 2005**

Air transport weight on total tourism consumption emissions leads us to the unsolved problem of goods international trade emissions’ allocation and measurement (UNFCCC, 2005, Cadarso et al., 2010), that has lead to the exclusions of them of the Kyoto Agreement objectives. That means that a very important part of tourism generated emissions are not covered by Kyoto Agreements. For that reason we consider appropriate the inclusion of Air transport in the EU emissions allowances market from 2013, as approved by the European Parliament. Other possible measures, as the reduction in flights speed or the promotion of tourism packages based on less polluting means of transport, would also help to reduce emissions.

The following tourism activity in terms of CO\(_2\) emissions is Hotel and catering industry, with 23% of emissions in 2005, including those of bars, restaurants and hotels. Emissions are due to gas-oil and natural gas demand for heating, cooking and also electricity demand for lighting, air-conditioning and heating. Finally, we must stress the importance of Electricity production and distribution, that accounts for 9% of total Tourism emissions.
4.2 Total tourism investment emissions

In 2005, investment done by Tourism characteristic sectors accounts for 15.5% of total fixed gross capital formation in Spain. This investment is developed mainly in Construction: transport infrastructures, hotels and restaurants, thematic parks, etc. Among the characteristic tourism sectors with higher investment are, on the one hand those related to transport: Transport annexes (22%), Vehicle rental (13.2%), Road passengers transport (8.6%) and Air transport (4.7%). On the other hand, those related to leisure and culture activities as: Market cultural, recreational and sport activities (22.4%), Non-market cultural, recreational and sport activities (8.6%), including concepts such as construction of thematic parks, zoos, museums, auditoriums, opera houses, etc. In the third position we find accommodation and catering activities: Restaurants and similar (11.3%) and Hotels (7.3%).

Table 2. Tourism characteristic sectors investment, 2005, millions of Euros

|                              | Motor vehicles | Other transport | Other | Construction | Other | Total | Distribution (%) |
|------------------------------|----------------|----------------|-------|--------------|-------|-------|-----------------
| Hotels and similar           | 15.3           | 0              | 772.9 | 1351.6       | 454.8 | 2594.6| 7.3              |
| Restaurants and similar      | 175.8          | 0              | 1520.7| 1848.0       | 510.2 | 4054.7| 11.3             |
| Road passengers transport    | 2832.4         | 20.3           | 95.5  | 68.8         | 74.7  | 3091.7| 8.6              |
| Railroad transport           | 3.3            | 470.4          | 23.2  | 70.4         | 84.3  | 651.6 | 1.8              |
| Maritime passengers transport| 0.8            | 171.3          | 4.6   | 38.8         | 16.9  | 232.4 | 0.6              |
| Air transport                | 14             | 1510.2         | 26.6  | 74.8         | 68.6  | 1694.2| 4.7              |
| Travel agencies              | 8.8            | 35.6           | 67.4  | 163.6        | 78.0  | 354.0 | 1.0              |
| Transport annexes            | 95.4           | 721.1          | 519.2 | 6416.9       | 287.0 | 8040.0| 22.5             |
| Vehicles rental              | 2935           | 99.7           | 1136.2| 210.7        | 324.0 | 4706.0| 13.2             |
| Market cultural, recreational and sport activities | 17.6 | 91.8 | 1135.5 | 3639.5 | 2406.0 | 7291.0 | 20.4 |
| Non-market cultural, recreational and sport activities | 3.3 | 2.5 | 219.6 | 2678.7 | 166.4 | 3070.5 | 8.6 |
| Total tourism                | 6101.7         | 3122.9         | 5521.4| 16561.8      | 4471.7| 35779.5|                 |
| Total tourism (%)            | 17.1           | 8.7            | 15.4  | 46.3         | 12.5  | 17.1  |                 |
| Total non- tourism           | 11714.3        | 1254.1         | 37236.6| 139267.2     | 41372.3| 230844.5| 15.5             |
| TOTAL FGCF                   | 17816          | 4377           | 42758 | 155829       | 45844 | 266624|                 |

Source: Own elaboration from IOT, CST and CSEA.

Tourism characteristic sectors that are responsible for a higher pollution are also those with a higher investment expenditure.\(^{17}\) Table 3 shows direct and indirect emissions done within and outside the country and linked to the investment done by each sector.

---

\(^{17}\) Sectors are not exactly the same, since information has been aggregated to make the emissions calculations, depending on the CSEA available sectors. Also, calculations include total emissions (domestic and imported) linked to tourism sectors investment.
characteristic sector. The most polluting one is Other social activities and services (26.5%), followed by Transport annexes activities (22.5%), Hotels and accommodations (18%) and Real estate and business services (15.6%)

Table 3. Tourism characteristic sectors CO$_2$ emissions linked to investment (columns summation), CO$_2$ Kt.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2434</td>
<td>2908</td>
<td>3118</td>
<td>18,0</td>
<td>28,11</td>
</tr>
<tr>
<td>(I)- 60 Terrestrial transport</td>
<td>990</td>
<td>2478</td>
<td>2092</td>
<td>12,1</td>
<td>111,34</td>
</tr>
<tr>
<td>(I)- 61 Maritime transport</td>
<td>159</td>
<td>43</td>
<td>110</td>
<td>0,6</td>
<td>-31,12</td>
</tr>
<tr>
<td>(I)- 62 Air and especial transport</td>
<td>293</td>
<td>930</td>
<td>810</td>
<td>4,7</td>
<td>176,24</td>
</tr>
<tr>
<td>(I)- 63 Transport annexe activities</td>
<td>1793</td>
<td>2403</td>
<td>3920</td>
<td>22,6</td>
<td>118,61</td>
</tr>
<tr>
<td>(K)- 70-74 Real estate and business serv.</td>
<td>554</td>
<td>1041</td>
<td>2712</td>
<td>15,6</td>
<td>389,42</td>
</tr>
<tr>
<td>(O)- 90-93 Other social activities and serv.</td>
<td>1906</td>
<td>3665</td>
<td>4590</td>
<td>26,5</td>
<td>140,79</td>
</tr>
<tr>
<td>Total</td>
<td>8130</td>
<td>13466</td>
<td></td>
<td></td>
<td>113,44</td>
</tr>
</tbody>
</table>

Source: Own elaboration from IOT, CST and CSEA.

Table 4 provides information on emissions done by sectors when supplying the required inputs to produce investment goods demanded by tourism. Results show the importance of emissions generated by the Construction sector, that is itself a purchaser of Other non-mineral products (26.1%) and of Metallurgy (14.7%). They are followed by sectors that generate the energy required to produce those investment goods: Electricity production and distribution (24.8%) and Oil crudes, gas and uranium (10.2%).

Table 4. CO$_2$ emissions related to tourism investment, by polluting sector (rows summation), CO$_2$ Kt.

<table>
<thead>
<tr>
<th>(C)- 10 Anthracite, coal, lignite and peat</th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
<th>2005 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>48</td>
<td>90</td>
<td>137</td>
<td>0,8</td>
</tr>
<tr>
<td>(C)- 11-12 Oil crudes, gas, uranium thorium</td>
<td>211</td>
<td>1034</td>
<td>1777</td>
<td>10,2</td>
</tr>
<tr>
<td>(C)- 13 Metallic minerals extraction</td>
<td>79</td>
<td>158</td>
<td>484</td>
<td>2,8</td>
</tr>
<tr>
<td>(D)- 21 Paper</td>
<td>47</td>
<td>133</td>
<td>177</td>
<td>1,0</td>
</tr>
<tr>
<td>(D)- 23 Coker, Refining and nuclear fuels</td>
<td>411</td>
<td>646</td>
<td>732</td>
<td>4,2</td>
</tr>
<tr>
<td>(D)- 24 Chemistry</td>
<td>213</td>
<td>405</td>
<td>488</td>
<td>2,8</td>
</tr>
<tr>
<td>(D)- 26 Other non-metallic mineral products</td>
<td>2755</td>
<td>4148</td>
<td>4531</td>
<td>26,1</td>
</tr>
<tr>
<td>(D)- 27 Metallurgy</td>
<td>1253</td>
<td>1779</td>
<td>2554</td>
<td>14,7</td>
</tr>
<tr>
<td>(D)- 29 Machinery and mechanic equipment</td>
<td>43</td>
<td>45</td>
<td>105</td>
<td>0,6</td>
</tr>
<tr>
<td>(E)- 40 Elect., gas and steam product. and distribute.</td>
<td>2020</td>
<td>3397</td>
<td>4311</td>
<td>24,8</td>
</tr>
<tr>
<td>(F)- 45 Construction</td>
<td>178</td>
<td>300</td>
<td>299</td>
<td>1,7</td>
</tr>
<tr>
<td>(G)- 50-52 Vehicles and reparation</td>
<td>50</td>
<td>97</td>
<td>150</td>
<td>0.9</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>(I)- 60 Terrestrial transport</td>
<td>477</td>
<td>690</td>
<td>874</td>
<td>5.0</td>
</tr>
<tr>
<td>Selection total</td>
<td>0</td>
<td>7785</td>
<td>12924</td>
<td>74.5</td>
</tr>
<tr>
<td>Tourism total</td>
<td>8130</td>
<td>13466</td>
<td>17353</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Own elaboration from IOT, CST and CSEA.

5. Conclusions

The aim of this paper is to define an adequate and complete CO\textsubscript{2} emissions measure for tourism industry and to apply it to the Spanish case. That requires to distinguish between tourism good and services and the investment that is needed to provide these services, since the proposed measure includes emissions related to investment as part of the global tourism sector responsibility, independently of its origin, domestic or imported. Since the tourism sector makes use of these fixed and intermediate capital goods to provide goods and services, the sector must be considered responsible for its emissions.

Results found shows a reduction in the weight of tourism emissions on total emissions has been reduced in the period, from 16.2% in 1995 to 14.3% in 2005. The improvement in environmental efficiency, both for consumption and investment, has lead to a reduction in tourism emissions form 0.50 CO\textsubscript{2} kilos per expended Euro in 1995 to 0.37 CO\textsubscript{2} kilos in 2005. In relative terms, there is also a redistribution within the group, with a reduction of weight for tourism consumption and an increase for investment.

The behaviour of the ecoefficiency proposed measure sheds light on the best strategy to reduce tourism sector emissions: to work on tourism itself or to focus on sectors providing tourism with inputs and investment goods, basic information to guide the design of efficient policy measures. As a result of the implementation of both, wind energy financed by a premium system and a combined cycle energy production process, has lead to important reductions in emissions related to electric energy and, therefore, the environmental impact of tourism for Spanish economy. However, between 1995 and 2005 air transport becomes the most polluting tourism activity, with tourism destinations placed at further locations (Caribbean, China, etc.).
6. Bibliography


AENA (different years): Estadísticas de tráfico AENA, [www.aena.es](http://www.aena.es).


INE (different years): Cuentas Satélite del Turismo, [www.ine.es/inembmenu/mnu_cuentas.htm](http://www.ine.es/inembmenu/mnu_cuentas.htm)


INE (different years): Cuentas Satélite sobre Emisiones Atmosféricas, [www.ine.es/inembmenu/mnu_medioambiente.htm](http://www.ine.es/inembmenu/mnu_medioambiente.htm)

INE (different years): Encuesta de Ocupación Hotelera, [www.ine.es](http://www.ine.es)

INE (different years): Marco Input-Output, [www.ine.es/inembmenu/mnu_cuentas.htm](http://www.ine.es/inembmenu/mnu_cuentas.htm)


