Project N°: 036992

ACRONYM : **S**cience **P**olicy **I**ntegration for **Co**astal **S**ystems **A**ssessment

REPORT

INPUT-OUTPUT MULTIPLIERS
SPECIFICATION SHEET AND SUPPORTING MATERIAL

D'Hernoncourt, J., Cordier, M., and Hadley, D.

January, 2011

Université Libre de Bruxelles – CEESE, Brussels
University of East Anglia CSERGE, Norwich

How to cite: D'Hernoncourt, J., Cordier, M., and Hadley, D. (2011), Input-Output Multipliers – Specification sheet and supporting material, *Spicosa Project Report*, Université Libre de Bruxelles – CEESE, Brussels.

Integrated Project funded by The European Community
Under the Sixth Framework Programme
Priority 1.1.6.3
Global Change and Ecosystems

Note to the reader - How to use this material

This report has been designed as a hyperlinked pdf document.
The main text in the specification sheet synthesises the economic assessment method, its relation to systems approach and the appropriate use of the method. It also gives some hints on how to best present the results of your assessment to stakeholders, along with an example of the use of the method.
In the text and in the “further information” section, you will have access to links to the accompanying material available in the rest of the report (page numbers are also provided along the links in case you would like to print this report).
A back button on the bottom of each page of supporting material helps you go back to the main text.

SPECIFICATION SHEET

Input-Output multipliers

Method and assumptions

Input-Output (I/O) multipliers can be used to assess the regional (or national) economic impacts from an activity. Multipliers are derived from an I/O table or matrix (either regional or re-scaled from a national one). Learn more on how multipliers can be derived here (p. 6-17). An I/O matrix is a representation of national or regional economic accounting that records the way industries both trade with one another and produce for consumption and investments. The flows of products and services are registered, simultaneously by origin and by destination. The use of I/O multipliers for economic impact assessment rests on the fact that the direct effects of spending for a service (e.g. tourism expenditure) are followed by indirect and induced effects. These two types of effects are observed respectively because purchasing links with other industries in the region exist and employees who work in the value chain spend their incomes on regional goods and services.

Relation to systems approach

Since it is commonly assumed that the impact estimates derived from I/O analysis represent activity within a single year, economic impact assessment is mostly used as a one shot assessment. Hence, the method is not especially well adapted to systems approach.

I/O multipliers can however be assumed stable during a certain period after the initial calculation of the I/O table (typically up to 6 years), unless the region's economy has changed significantly. In a systems approach perspective, one can thus yield interesting results in terms of comparisons of scenario impacts (the different scenarios will make the components of the assessment vary), if one works with re initialization of the impact assessment each year.

When this method is especially to be used

The use of Input-Output multipliers is particularly suitable for the evaluation of regional services industries (e.g. tourism) and the impact assessment of broad policy instruments at the regional level. Economic impact analysis only helps answer the question "What is the contribution of an activity to the economy of the region?" (in terms of changes in income and employment in the region). To get a whole picture of the impacts of an economic activity, an environmental impact assessment, a cost benefit analysis or a multi-criteria analysis should be implemented as well.

How to best present results to stakeholders?

The results of an economic impact assessment should be presented and interpreted carefully. Advice should also be given to stakeholders to be cautious with respect to the use of the results.

While presenting the results to stakeholders, bear thus in mind the limitations of the method:

- Such an economic assessment only pertains to regional economic impacts and not to all the impacts of the studied activity (environmental, social or cultural).
- Income or value added are certainly the best measures of economic impact to report, compared to employment impacts. In the tourism sector, for instance, job impacts might be misleading because jobs in this sector are largely part-time and seasonal. Wages and salary rates vary as well across industries and this can make the multipliers vary accordingly.
- Working with Input-Output multipliers literally multiplies up the uncertainties regarding each step of the method: small errors in terms of estimation of the direct impact (expenses or output), of regionalization of the Input-Output matrix and of multipliers are added up and contribute to the uncertainty in the final results.

Some hints to answer those limitations:

- Even though it cannot be clearly measured, presenting the results in terms of ranges of values (rough confidence intervals) rather than a single figure can help to underline the inherent uncertainty of an economic impact analysis. A sensitivity analysis can also help.
- It might also be interesting to first present the direct effects in terms of spending or change in final demand (supposedly highlighted in the simulation model) and the multipliers; to then show the broader impact (including the indirect and induced effects) while explaining the differences and underlying uncertainties with respect to each step of the method. This will help shed light on the importance of broadening the perspective, away from considering the simple direct impacts of one measure. At the same time, it will provide a good picture of the assessment.

To conclude, bear in mind, at all times, the assumptions and limitations of Input-Output methodology while analyzing and using the results, do not oversimplify or misinterpret the results, use them with caution, since it might leave the stakeholders with a sometimes distorted or incomplete understanding of economic effects.

Example of use of the method

In the Firth of Clyde case study, the local stakeholders were interested in “the implications of increased leisure and tourist use of the Firth of Clyde”, from the perspective of combining increased tourism trends with social, economic and environmental stability. The action to be valued was thus the increase in quantity of tourist facilities due to increasing leisure and tourism use (in particular for recreational boating activities but also for mussel farming which is not the focus here).

The change in number of tourists was assessed through several scenarios. Mean spending per boat per stay was estimated along with the average length of stay. The direct effects of the increase in tourism trends were captured by these estimates of visitor spending as they represent the amount of money brought into the region by tourists. In order to get a better estimate of the economic effects of increased recreational boating in the area i.e. evaluate the secondary effects of sailing expenditure in the Firth, output multipliers were used. The multipliers were scaled from Scottish national figures to Firth of Clyde level; however, no data were available to allow the figures to be scaled down further to be appropriate for the specific area. Key economic sectors that are mainly impacted by the recreational boating activities were identified; they represent relevant categories of spending: such as Recreational, cultural and sporting activities or Tourism (hotels, catering and pubs). The direct effects were then *multiplied* up to derive the total economic effects of spending and thus capture the secondary economic effects of tourism activity.

Further information

- To know more about another type of assessment method using Input-Output methodology (green I/O tables), click here (p. 17).

Most references and further reading below focus on tourism impact assessment.

- More detail on I/O multipliers methodology in tourism impact assessment can be found from the Department of Community, Agriculture, Recreation and Resource Studies at Michigan State University: http://web4.canr.msu.edu/mgm2/econ/index.htm, accessed 01/2011
- A more in depth description of economic impacts (mainly of tourism) and of assessment using I/O multipliers methodology can be found here (p. 18-21).
- Other (tourism) economic impact assessment methodologies are shortly described here (p. 22).
- A document on forecasting tourism demand (i.e. establishing how numbers of tourists will change in the future under different scenarios) can be found here (p. 23-25).
- The method for deriving multipliers from an I/O matrix is explained here (p. 6-17).

Basic principles of Input-Output methodology and calculation of Input-Output multipliers

An Input-output matrix (I-O) is a **representation of national or regional economic accounting** that records the way industries trade with one another and produce (flows of products and services). Those flows are registered in a matrix, simultaneously by origin and by destination (OECD, 2006). The matrix illustrates the relationship between producers and consumers as well as interdependencies of industries for a given year.

Table 1 shows the basic structure of the I-O table (also called transaction matrix). Basically, the rows represent the outputs (suppliers) and the columns the destination of inputs (users).

Example[1].
If we look at the section called the domestic intermediate matrix (in red in Table 1), 6 sectors are represented: Agriculture with an annual production (or output) of 21863, Mining producing 12292, Manufactures with a total output of 210900 and Utilities; Construction and Services producing respectively 18249, 60244 and 435953. All those outputs are read on the row/column “industry inputs at basic prices” (sum of inputs and outputs are typically equal[2]) and are in million Euros 2000.

All the cells of the domestic intermediate matrix show the flows between sectors.

Example, *cont.*
If we take the *rows*, for Agriculture: of the 21863 million Euros produced, 2731 have been used inside the sector itself, whereas respectively 3, 8260, 36, 59 and 615 million Euros have been used in, Mining, Manufactures, Utilities, Construction and Services.
The *columns* describe the structure of the input of the corresponding sector. For instance, to produce 21863 million Euros, Agriculture needed 2731 of its own production, and, respectively, 4, 3322, 983, 121 and 2884 of the production in Mining, Manufactures, Utilities, Construction and Services.

It is important to note that I/O tables assume linear relations between inputs and outputs from different sectors as well as linear relations between outputs and final demand. This assumption is not always close to reality: it means that there are no economies or diseconomies of scale in production or factor substitution (double the level of production, you’ll need to double all the inputs). Moreover, all firms in a given industry are assumed to employ the same production technology.

Another section called domestic investment matrix (in blue in Table 1), accounts for the supplies of goods that are not consumed by domestic industries. The columns therefore include such categories as final consumption (both by households and general government), gross fixed capital formation (investment) and exports.

[1] The example developed throughout this second section builds on the 2000 Input-Output table for The Netherlands, available in the workbooks of Eurostat: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=2474,54156821,2474_54764840&_dad=portal&_schema=PORTAL
[2] Since the columns represent the destination of inputs and the rows sum to total output of a sector, the matrix represents a national/regional approach to double entry bookkeeping; total input and output of a sector are equal to each other.

Back to the main text, p. 3

Table1.

Domestic transactions input-output table (in million Euros 2000)

	Agriculture, forestry and fishing	Mining	Manufactures	Utilities	Construction	Services	Private final consumption	*of which*, final consumption expenditure by households	Governement final consumption	GFCF	Exports	Industry outputs *at basic prices*
Agriculture, forestry and fishing	2731	3	8260	36	59	615	962	*962*	62	567	8568	21863
Mining	4	282	2013	3979	188	60	28	*28*	0	210	5528	12292
Manufactures	3322	291	40218	480	8004	16999	16896	*16896*	2340	8573	113777	210900
Utilities	983	53	2400	4395	85	3458	6184	*6184*	14	439	238	18249
Construction	121	70	565	135	14103	9509	405	*405*	530	33974	832	60244
Services	2884	1078	28400	1404	9339	106994	126180	*123398*	87409	16752	55512	435953
Imports	1779	1029	71117	1878	7572	33964	*24189*	*24189*	*1085*	*17771*	*81863*	
Net taxes on products	129	67	497	706	249	8651	*22908*	*22954*	*-152*	*10233*	*0*	
Total Use *at purchaser's prices*	11953	2873	153470	13013	39599	180250	*197752*	*195016*	*91288*	*88519*	*266318*	
Compensation of employees	*2336*	*520*	*35083*	*1629*	*14339*	*151784*						
Value Added *at basic prices*	9910	9419	57430	5236	20645	255703						
Industry Output *at basic prices*	21863	12292	210900	18249	60244	435953						

Source: OECD (2006): OCDE aggregation of 2000 input-output table for The Netherlands and own calculations based on Eurostat

Back to the main text, p. 3

The initial monetary values in the transactions matrices can be converted into ratios called **technical coefficients** (Table 2). This is done by dividing each cell of the domestic intermediate matrix by its column total (output at basic prices).

Example, *cont.*
In the first column-third row, the technical coefficient is equal to 3322/21863 = 0.15. This coefficient shows the rate at which inputs are transformed into outputs. Here, 0.15 Euros manufactured products are purchased by Agriculture in order to produce 1 Euro of agricultural output.

These technical coefficients can be used directly to assess the added value of a given sector, calculate investments in this sector and, if the matrix is "greened" [3], determine the impact of this sector on the level of pollutant emitted.

[3] A line on pollutant production by each sector and a column on the production of goods and services resulting from the implementation of environmental measures is added to the classical I-O table.

Back to the main text, p. 3

Table2.
Technical coefficients.

	Agriculture, forestry and fishing	Mining	Manufactures	Utilities	Construction	Services	Private final consumption	*of which*, final consumption expenditure by households	Governement final consumption	GFCF	Exports	Industry outputs *at basic prices*
Agriculture, forestry and fishing	0,12	0,00	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,03	21863
Mining	0,00	0,02	0,01	0,22	0,00	0,00	0,00	0,00	0,00	0,00	0,02	12292
Manufactures	0,15	0,02	0,19	0,03	0,13	0,04	0,09	0,09	0,03	0,10	0,43	210900
Utilities	0,04	0,00	0,01	0,24	0,00	0,01	0,03	0,03	0,00	0,00	0,00	18249
Construction	0,01	0,01	0,00	0,01	0,23	0,02	0,00	0,00	0,01	0,38	0,00	60244
Services	0,13	0,09	0,13	0,08	0,16	0,25	0,64	0,63	0,96	0,19	0,21	435953
Imports	0,08	0,08	0,34	0,10	0,13	0,08	*0,12*	0,12	*0,01*	*0,20*	*0,31*	
Net taxes on products	0,01	0,01	0,00	0,04	0,00	0,02	*0,12*	0,12	*0,00*	*0,12*	*0,00*	
Total Use *at purchaser's prices*	0,55	0,23	0,73	0,71	0,66	0,41	*1,00*	1,00	*1,00*	*1,00*	*1,00*	
Compensation of employees	0,11	0,04	0,17	0,09	0,24	0,35						
Value Added *at basic prices*	0,45	0,77	0,27	0,29	0,34	0,59						
Industry Output *at basic prices*	1,00	1,00	1,00	1,00	1,00	1,00						

Back to the main text, p. 3

In order to finally calculate the **output multipliers**, one needs to derive Leontief inverse matrices.

The **type I inverse matrix** shows how much of each industry's output is needed, in terms of direct and indirect requirements to produce one unit of a given industry's output.
It is calculated using the formula:

$L = (I\text{-}A)^{-1}$

Where
L is the Leontief Inverse matrix
I is the Identity matrix
A is the Direct Requirements matrix (each cell of the domestic intermediate demand quadrant divided by its column total i.e. square matrix of technical coefficients)

Example, *cont.*
When the technical coefficients have been calculated (shaded area in Table 2), an identity matrix of the same dimensions as the so called direct requirements matrix needs to be constructed (in this case the dimension is 6*6, see Table 3). The A matrix then needs to be subtracted from identity matrix to produce the "I-A" matrix (Table 4). This "I-A" matrix must be inverted to construct the type I Leontief inverse matrix (Table 5). All these basic matrix calculations can easily be performed in spreadsheets (for instance in Excel[4]) or in other programs.

Table 3.
Identity matrix 6*6

1	0	0	0	0	0
0	1	0	0	0	0
0	0	1	0	0	0
0	0	0	1	0	0
0	0	0	0	1	0
0	0	0	0	0	1

Table 4.
"I-A" matrix

0,875	0,000	-0,039	-0,002	-0,001	-0,001
0,000	0,977	-0,010	-0,218	-0,003	0,000
-0,152	-0,024	0,809	-0,026	-0,133	-0,039
-0,045	-0,004	-0,011	0,759	-0,001	-0,008
-0,006	-0,006	-0,003	-0,007	0,766	-0,022
-0,132	-0,088	-0,135	-0,077	-0,155	0,755

[4] At least for a matrix of dimensions 52*52 in Excel.

Back to the main text, p. 3

Table 5.
Type I Leontief Inverse Matrix

	Agriculture, forestry and fishing	Mining	Manufactures	Utilities	Construction	Services
Agriculture, forestry and fishing	1,154	0,002	0,057	0,006	0,012	0,006
Mining	0,019	1,026	0,018	0,296	0,009	0,005
Manufactures	0,235	0,039	1,261	0,065	0,234	0,073
Utilities	0,075	0,008	0,025	1,322	0,010	0,016
Construction	0,017	0,012	0,012	0,021	1,316	0,039
Services	0,257	0,130	0,242	0,186	0,316	1,349

The **type II inverse matrix** also shows the induced requirements (in terms of industry's output) of a production of one unit of a given industry's output. Its purpose is to take into account, besides the direct and indirect requirements included in the type I inverse matrix, the flows of money in and out of households and the effect of these flows on industries.
The type II inverse matrix is derived in the same way as the type I inverse matrix. But since it is necessary to include households in the analysis we treat them as an additional industry by adding an extra row and column into the Direct Requirements matrix for "compensation of employees" and "final consumption expenditure by households" coefficients respectively.

The formal notation for this Direct Requirements matrix is:

$$A = \begin{bmatrix} A_{II} & A_{IH} \\ A_{HI} & A_{HH} \end{bmatrix}$$

Where

$(A_{II})_{ij}$	is the Direct Requirements matrix A, or the amount of industry i required per unit of industry j (considered above in the type I inverse matrix).
$(A_{IH})_i$	is the amount of industry i required per unit of total household income from all sources (see note below).
$(A_{HI})_j$	is the income paid to households per unit of output of industry i (compensation of employees divided by the total output of the industry).
(A_{HH})	is the household expenditure per unit of exogenous household income. (This cell is set to zero).

Total household income from all sources is used as the denominator when calculating household expenditure coefficients (A_{IH}) even though it may at first seem odd not to use the total household expenditure figure from the I-O tables (in the example below called Total use at purchasers' prices).
However, the total figure of household expenditure from the I-O tables includes household purchases that are bought with unearned income (pensions, dividends, etc).

Back to the main text, p. 3

In other words, not all household expenditure results from ‘Income from employment’ paid to households. If the Total use at purchasers’ prices figure were used as the denominator, the sum of A_{IH} would equal 1 and the resulting type II Leontief would tend to overestimate the induced effects of changes in the economy by artificially inflating the effect of earned income in generating further rounds of household spending.

Example, *cont.*
Centraal Bureau voor de Statistiek (2001) gives a figure of total household income for The Nederlands from all sources of 210485 million Euros 2000; we use this figure as the denominator when calculating household expenditure coefficients (AIH). Coefficients for the household sector can now be included in the Direct Requirements matrix (Table 6).
Following the same procedure as described above: subtracting matrix A from an identity matrix of the same dimensions (7*7) and calculating the inverse of the result (L=(I-A)-1) yields the type II Leontief inverse (Table 7).

Table 6.
Direct Requirements matrix

	Agriculture, forestry and fishing	Mining	Manufactures	Utilities	Construction	Services	Final consumption expenditure by households
Agriculture, forestry and fishing	0,12	0,00	0,04	0,00	0,00	0,00	0,00
Mining	0,00	0,02	0,01	0,22	0,00	0,00	0,00
Manufactures	0,15	0,02	0,19	0,03	0,13	0,04	0,08
Utilities	0,04	0,00	0,01	0,24	0,00	0,01	0,03
Construction	0,01	0,01	0,00	0,01	0,23	0,02	0,00
Services	0,13	0,09	0,13	0,08	0,16	0,25	0,59
Compensation of employees	0,11	0,04	0,17	0,09	0,24	0,35	0,00

Back to the main text, p. 3

Table 7.
Type II Leontief Inverse Matrix

	Agriculture, forestry and fishing	Mining	Manufactures	Utilities	Construction	Services	Final consumption expenditure by households
Agriculture, forestry and fishing	1,159	0,004	0,063	0,010	0,022	0,015	0,020
Mining	0,024	1,028	0,024	0,300	0,018	0,014	0,019
Manufactures	0,292	0,060	1,328	0,111	0,335	0,180	0,218
Utilities	0,094	0,015	0,048	1,338	0,045	0,052	0,074
Construction	0,028	0,015	0,024	0,029	1,334	0,059	0,040
Services	0,575	0,249	0,611	0,442	0,877	1,945	1,206
Compensation of employees	0,389	0,146	0,452	0,312	0,686	0,728	1,475

Once the type I (or type II) inverse matrices have been derived, the calculation of multiplier and effects is quite basic.

The multipliers allow users to **make estimates of the effects of changes in the economy**.

For instance, if there is **an increase in final demand** (defined as a change in sales to the final consumers of goods and services for a particular good), we can assume that there will be an increase in the output of that commodity, as producers react to meet the increased demand; this is the **direct impact**. As these producers increase their output, there will also be an increase in demand on their suppliers and so on down the supply chain; this is the **indirect impact**. Those two cumulated types of impacts can be calculated using the **type I** inverse matrix.

As a result of the direct and indirect impacts, the level of household income throughout the economy will increase as a result of increased employment; a proportion of this increased income will be re-spent on final goods and services: this is called the **induced effect**. This effect, along with the direct and indirect impact, is taken into account when the **type II** inverse matrix is used for the calculation of the multipliers.

Five different types of aggregate multipliers for both type I and type II effects can be calculated. (Those multipliers are derived for our example and available in table 8 and table 9).

Back to the main text, p. 3

Output multiplier $(O_{MULT})_j = \Sigma_i L_{ij}$

The Type I output multiplier for a particular industry is defined as the total of all outputs from each domestic industry required in order to produce one additional unit of output: that is, the column sums (Σ_i) from the Type I Leontief inverse matrix (L_{ij}). Similarly, the Type II output multiplier is given from the column sums of Industry rows (i.e. exclude compensation of employees) from the Type II Leontief.

Multiplying a change in final demand (direct impact) for an individual industry's output by that industry's type I (respectively type II) output multiplier will generate an estimate of direct + indirect (respectively direct + indirect + induced) impacts on output throughout the economy.

Income multiplier $(I_{MULT})_j = \Sigma_i v_i L_{ij} / v_j$

The income multipliers show the increase in income from employment (IfE) -or compensation of employees- that result from a change of €1 of income from employment in each industry. In the formula above, 'v' refers to the ratio of IfE/total output for each industry (last row in the augmented Direct Requirements matrix).

The multipliers show the ratio of direct plus indirect (plus induced if type II multipliers are used) income changes to the direct income change.

Income effects $(I_{eff})_j = \Sigma_i v_i L_{ij}$

This statistic shows the impact upon income from employment (IfE) -or compensation of employees- throughout the studied economy arising from a unit increase in final demand for industry j's output.

While direct and indirect impacts are calculated using type I multipliers, type II multipliers also include induced effects in the economy.

If data on the level of employment (in FTE, full-time equivalent) is available for each of the industry sectors[5], employment effects and multipliers can be calculated as well.

Employment multiplier $(E_{MULT})_j = \Sigma_i w_i L_{ij} / w_j$

The employment multipliers show the total increases in employment throughout the economy resulting from an increase in final demand which is enough to create one additional FTE employment in that industry. In the formula above, 'w' is equal to FTE per € of total output for each industry.

The multiplier is the ratio of direct plus indirect (plus induced if Type II multipliers are used) employment changes to the direct employment change.

Employment effects $(E_{eff})_j = \Sigma_i w_i L_{ij}$

The employment effects statistic calculates the impact upon employment throughout the economy (direct and indirect effect if type I inverse matrix is used, augmented by the induced effect if type II inverse is used) arising from a change in final demand for industry j's output of 1 unit.

[5] Which is unfortunately not the case in our example.

Back to the main text, p. 3

Table 8.
Type I, output and income multipliers

	Output multiplier	Income multiplier	Income effects
Agriculture, forestry and fishing	1,757	2,466	0,263
Mining	1,216	2,333	0,099
Manufactures	1,615	1,840	0,306
Utilities	1,896	2,372	0,212
Construction	1,898	1,953	0,465
Services	1,487	1,417	0,493

Table 9.
Type II, output and income multipliers

	Output multiplier	Income multiplier	Income effects
Agriculture, forestry and fishing	2,173	3,6377	0,3887
Mining	1,372	3,4423	0,1456
Manufactures	2,098	2,7144	0,4515
Utilities	2,230	3,4996	0,3124
Construction	2,631	2,8813	0,6858
Services	2,265	2,0907	0,7279

Back to the main text, p. 3

References

Leontief V. (1974) : *Essais d'économiques.* Ed. Calman Lévy, pp.133-157.
Available in English in :

- *Input-output Analysis*, Input-output Economics, New York Oxford University Press, 1966;

- *Environmental repercussions and the Economic Structure : An Input-Output Approach*, published in The Review of Economics and Statistics, Vol. LII, n°3, August 1970, Copyright by the President and Fellows of Harvard College; published as well in Robert and Nancy DORFMAN, Economics of the Environment, W.W. Norton & Co Inc, 1972.

OECD (Organisation for Economic Co-operation and Development) (2006): *Input-output analysis in an increasingly globalised world: applications of OECD's harmonized international tables.* STI/Working paper 2006/7. Available for download:

http://www.oecd.org/dataoecd/6/34/37349386.pdf, accessed 01/2011

The Scottish Government, Statistics (2006): *IO Methodology for Derived tables and Multipliers*. Available for download:

http://www.scotland.gov.uk/Topics/Statistics/Browse/Economy/Input-Output/MultiplierMethodology, accessed 01/2011

Back to the main text, p. 3

Green Input-Output tables to assess environmental management policy options

By converting the initial monetary values in the Input-Output (I/O) transactions matrices into ratios or technical coefficients, one is able to study the underlying system of interactions and interdependencies. These coefficients can be modeled to examine which industries are important to others. Since Leontief Input-Output tables represent a complete system of interactions for a given year, such modeling can take account of both direct and indirect flows.

For studies on environmental management, I/O tables need to be "greened" by adding a line on pollutant production by each sector and a column on the production of goods and services resulting from the implementation of environmental measures for pollution abatement (reduction of pollutants from agriculture, industry or households).

Using green I/O tables allows us to take into account the impact of environmental policy options (in terms of technical changes or changes in final demand) on the total production of each sector and on employment. Only measures with significant economic impacts (on GDP, on production, on employment… at a national or regional level) can be assessed within an I/O frame: data are too aggregated.

One can thus use I/O methodology to assess the impacts of a broad policy option for marine pollution management targeting a whole sector like, for instance, the introduction of a tax on the plastic[6] industry resulting in higher plastic prices or of subsidies for the production of substitutes for plastics. In that case, I/O analysis can help approach the following (based on and adapted from Leontief, 1974, Essais d'économiques. Ed. Calman Lévy, pp 193-209):

- the impacts of these policy options on the total level of pollution from plastic microparticles in the sea;
- the level of pollution abatement for a particular sector, resulting from the implementation of these policy options;
- the total pollution resulting from the final demand for products of each sector. I.e. taking into account the pollution from other sectors intervening in the production (agriculture for instance also needs industrial products and services to generate its production);
- the impact of policy options on production levels, total employment and prices, even in sectors not directly impacted by the policy changes.

Further reading

OECD (Organisation for Economic Co-operation and Development), 2006. Input-output analysis in an increasingly globalised world: applications of OECD's harmonized international tables. STI/Working paper 2006/7. Available for download:

http://www.oecd.org/dataoecd/6/34/37349386.pdf, accessed 01/2011

---

[6] Plastics exposed to sea water tend to concentrate toxic compounds present in the water at low concentrations. PCBs, DDT, and nonylphenols are very efficiently concentrated in the plastic material. This could harm the Antarctic krill and other zooplankton species by ingestion of small toxic plastic microparticles and cause bioaccumulation through the food chain.

Back to the main text, p. 3

Economic impact assessment of the tourism industry

When tourists visit an area the activities they undertake directly or indirectly generate an increase in economic activity within that area; mostly because they increase demand for goods and services. Economic impact studies attempt to measure the economic benefits arising from tourist activity, i.e. the net increase in the wealth of residents (of a country, region, or more specific locality) which is over the levels that would have been achieved without the tourist activity. In layman's terms this means trying to evaluate the changes in sales, income, tax revenues and jobs that come about because of tourism activities. Note that an economic impact analysis differs from a cost-benefit analysis in that the former deals solely with actual flows of money which arise from market transactions whilst the latter includes market and non-market values and tries to assess net social benefit from the perspective of economic efficiency. It is therefore important to understand that any economic impact analysis is a *partial* analysis, in the sense that it does not incorporate all economic impacts, and also since it will be area specific[7]. Note also that tourism can have negative effects which may be environmental, cultural, social, or economic. These will not be taken into account as part of this kind of analysis.

Economic impacts of tourism

Generally economic impacts are categorised into three types of effects: direct, indirect and induced (see example below).

- Direct effects only include the immediate effects of additional demand created by tourism. So, for example, this will include tourism spending on accommodation, meals, recreational activities, and so on.

- Indirect effects relate to the increased demand for goods and services by the industries which are serving tourists (that have purchasing links to other firms in the region. This would include, for example, the extra food that restaurants need to purchase; the additional inputs of supplies and labour that hotels need in order to cater for tourists, etc. These effects could also include investment in enhanced public transport infrastructure and sewerage facilities, amongst others.

- Induced effects arise when demand for goods and services from households in the region increases as a result of the direct and indirect effects of tourist activity: those employees whose jobs are supported in the value chain spend their incomes on regional goods and services thereby supporting other economic activity.

[7] This is important to remember as an increase in economic activity in one area due to tourist activity will be accompanied by a decrease in economic activity in the areas from which the tourists originate. This is worth bearing in mind for case studies where tourists are mostly domestic in origin.

Back to the main text, p. 3

Example: Stynes (1997, p 4-5)
"Let's say a region attracts an additional 100 tourists, each spending $100 per day. That's $10,000 in new spending per day in the area. If sustained over a 100 day season, the region would accumulate a million dollars in new sales. The million dollars in spending would be distributed to lodging, restaurant, amusement and retail trade sectors in proportion to how the visitor spends the $100. Perhaps 30% of the million dollars would leak out of the region immediately to cover the costs of goods purchased by tourists that are not made in the local area (only the retail margins for such items should normally be included as direct sales effects). The remaining $700,000 in direct sales might yield $350,000 in income within tourism industries and support 20 direct tourism jobs. Tourism industries are labor and income intensive, translating a high proportion of sales into income and corresponding jobs.
The tourism industry, in turn, buys goods and services from other businesses in the area, and pays out most of the $350,000 in income as wages and salaries to its employees. This creates secondary economic effects in the region. The study might use a sales multiplier of 2.0 to indicate that each dollar of direct sales generates another dollar in secondary sales in this region. Through multiplier effects, the $700,000 in direct sales produces $1.4 million in total sales. These secondary sales create additional income and employment, resulting in a total impact on the region of $1.4 million in sales, $650,000 in income and 35 jobs. While hypothetical, the numbers used here are fairly typical of what one might find in a tourism economic impact study."

To sum up, this means that initial rounds of tourism expenditure will have a series of direct, indirect and induced economic effects and that the total economic impact is the sum of these effects within a region.
Put another way, the direct effects are *multiplied up* to derive the total economic effects of spending because of value chain (indirect) and induced income effects.
This can be taken into account while using the Input-Output (I/O) framework and I/O multipliers that capture the secondary economic effects of tourism activity.

Measuring the economic impacts of tourism[8]
Basically, the economic impacts of tourism are estimated using the simple formula:

Economic impact of tourism =
Number of tourists * Average spending by visitor * Multiplier

This formula suggests 3 steps for estimation:

1. **Estimation of the change in the number (and perhaps type) of tourists to the region**

Estimates or projections for the number of tourists in an area are not always available. Some local reports on the levels of tourism activity might solve this data need (this corresponds to primary data).
Demand models might also be used, provided they are enough disaggregated (this might be considered as secondary data in a more or less disaggregated form).
Good judgment can also help. In the absence of any real data, you would have to rely on subjective estimates.

Within the SAF methodology, scenarios on the increase of the number of local tourists can be explored and different trends of tourist flows assessed, relative to their economic as well as to their environmental impact. However, the "baseline trend" with respect to the number tourists would also be useful to consider and estimate, in order to be used as comparison.

[8] The structure and contents of this section mainly builds on Stynes (1997).

Back to the main text, p. 3

2. Estimation of the average levels of spending of tourists in the area

The I/O approach enables the assessment of the effects of individual developments, provided that they can be linked with a change in tourism consumption spending. **The final demand change** (change in sales to the final consumers of goods and services) **needs to be estimated**.

One thus needs to estimate the **mean expenditure** of a tourist at local businesses. When no visitor spending survey exists for the area you are studying, such a survey might need to be implemented (this means acquiring primary data). Those estimates should be based on a representative sample, taking into account variations across seasons, types of tourists and locations within the studied area.
Spending averages might also be borrowed or adapted from other studies: it is possible to rely on secondary data, adjusting it over time using consumer price indices.
As for the estimation of the number of tourists, expert judgment or guesstimates might also be used.
Segments of the total tourism industry can also be explored and assessed. However, estimation of the average level of spending should, as much as possible, take into account the differences existing within the tourist segment studied: i.e., local residents vs. tourists, day users vs. overnight visitors, etc. and consider different spending patterns.
When the number of tourists is multiplied by the average spend per visitor, one gets an estimate of the total tourism spending in the area or **direct effect**, which represents the amount of money brought into the region by tourists.

3. Estimation of the local I/O multipliers to determine secondary effects of tourism

To estimate the **secondary effects** of tourism spending, the I/O multipliers can be used. Multipliers can come from a regional I/O table or be re-scaled from a national I/O table (this can be considered as secondary data). It might be more effective if sector-specific multipliers are used, rather than aggregate tourism spending multipliers.
Care should be taken if you wish to transfer multipliers from existing studies (secondary data), in other contexts: one should not take a multiplier adjusted for one region and apply it in a region of quite a different economic structure.

Stynes (1997, p. 7) notes that" to properly apply tourist purchases of goods to an I/O model (or corresponding multipliers) various margins (retail, wholesale and transportation) must be deducted from the "purchaser price" of the good to separate out the "producer price". Indeed, in an I/O framework, retail margins accrue to the retail trade sector, wholesale margins to wholesale trade, transportation margins to transportation sectors (trucking, rail, air etc.) and the producer prices of goods are assigned to the sector that produces the good".
Moreover, he states (p. 7) that "in most cases the factory that produces the good bought by a tourist lies outside of the local region, creating an immediate "leakage" in the first round of spending and therefore no local impact from production of the good. Before applying a multiplier to tourist spending, one must first deduct the producer prices of all imported goods that tourists buy (i.e. only include the local retail margins and possibly wholesale and transportation margins if these firms lie within the region). Generally, only 60 to 70% of tourist spending appears as final demand in a local region".

If uncorrected or rough tourism spending is used, the calculations are thus bound to generate an inflated estimate of tourism impacts. However, such a corrected value for tourism spending is difficult to properly estimate.

Back to the main text, p. 3

Data availability: Input-Output tables

Input-Output tables are available for most of the European countries (except Romania and Cyprus) and for Norway and Turkey.
To access the workbooks by country you can go to.
http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks [9].
It might also be useful to investigate if regional authorities provide regional tables, more suited to the studied area.

When you have the data, the I/O multipliers can be calculated. Note that for the calculation of the I/O multipliers, all the information available (all the industries covered in the table) will be needed. However, if relevant for the issue you wish to study, some categories of expenditure might be aggregated by sectors.

Disaggregation and rescaling of the multipliers

To use the multipliers to assess the economic impact of the chosen tourism issue, you will first need to identify the most relevant categories for the studied issue (select the categories of expenditure in the I/O tables). This part of the assessment can be problematic since tourism employment and activities are difficult to precisely define: visitors often use other services than restaurants and hotels such as postal or health services and tourism is rarely a homogeneous activity (Jones and Munday, 2004).

In order to disaggregate the multipliers to refine the analysis, the national or regional multipliers often need to be re-scaled to a local level.
It would be an error to apply a statewide multiplier to a local region, since multipliers tend to be higher for larger regions with more diversified economies and hence their use would yield estimates of local multipliers effects which would be biased upwards.

The use of an I/O framework to assess tourism activity is not always clear-cut. Data on the tourism industry at a regional level is often scarce. You can rely on rough estimates of the scale of tourism to disaggregate the multipliers. However, if you wish to refine the regional Input-Output table, it might be necessary to collect statistical information on the size and transactions of industries with a significant degree of tourism dependence. A regional survey on tourism activities (business activities, employment, purchasing, etc.) is thus sometimes needed (Jones and Munday, 2004).

References

Stynes, D.J. (1997) Economic impacts of Tourism: A handbook for tourism professionals, Urbana, IL: University of Illinois, Tourism Research Laboratory. https://www.msu.edu/course/prr/840/econimpact/pdf/ecimpvol1.pdf, accessed 01/2011

Jones, C. and M. Munday (2004) Evaluating the Economic Benefits from Tourism Spending through Input-Output Frameworks: Issues and Cases, Local Economy, 19:2, 117-133.

____

[9] If you want some precise data on a particular industry or product, click on “Database functions” and Select in the folders “Economy and finance”, “National accounts (including GDP)”, “Supply, use and Input-Output tables”, “Tables at current prices”, “Input-output table-current prices”. The table can then be downloaded once you have made your selection regarding the sector, country and year you want to study.

Back to the main text, p. 3

Tourism economic impact methodologies

Most commonly three methods are used to evaluate the economic impact of tourism (or other economic sectors): computable general equilibrium models, Input-Output (I/O) analysis and tourism satellite accounts.

Computable general equilibrium analysis

Computable general equilibrium models are complex, data intensive models of national or regional economies. They consist of equations describing model variables and a database consistent with the model equations. They can be used to explore the impacts upon an economy of changes in policy, technology or other external factors (e.g. tourism demand). Their complexity and data requirements mean that their use is not appropriate within the SAF.

I/O Analysis

I/O models describe the flows of money that occur between the different sectors of a region's economy. From these models multipliers can be estimated which measure how much of direct spending is recirculated within the regional economy in terms of indirect and induced effects, thus allowing the overall economic impact of tourist activity to be evaluated.

Many countries produce I/O tables at a national (and some at a regional) level and multipliers derived from these can be adapted for a more local use.

Much more detail can be found on this methodology (and other tourism economic impact methodologies) from the Department of Community, Agriculture, Recreation and Resource Studies at Michigan State University which has a website devoted to the economic impacts of recreation and tourism:
http://web4.canr.msu.edu/mgm2/econ/index.htm, accessed 01/2011

Tourism Satellite Accounts

Some organisations and countries have developed national and/or regional sets of tourism satellite accounts. These accounts extract information from national economic accounts to try and identify the extent to which tourism contributes to these. They are generally only calculated at a national scale (if they are calculated at all) and it seems difficult to scale them down to more localised areas. Furthermore, tourism satellite accounts only account for the direct economic impacts of tourism and do not include indirect or induced effects.

Further information on tourism satellite accounts can be found on the World Travel & Tourism Council's website at:
http://www.wttc.org/eng/Tourism_Research/Tourism_Satellite_Accounting/ where there are also a number of downloadable tourism satellite accounts country reports.

Back to the main text, p. 3

Forecasting tourism demand

There is a large and growing literature on forecasting tourism demand. Increasingly sophisticated time-series and other econometric models are being employed by researchers, predominately to forecast international tourism demand, i.e. tourist arrivals/departures at/from a particular region or country.

The typical form of model that is estimated is[10]:

$$DT_{ij} = f(Y_j, TC_{ij}, RP_{ij}, ER_{ij}, QF_i)$$

Where

DT_{ij}	=	demand for international travel services by origin *j* for destination *i*;
Y_j	=	income of origin *j*;
TC_{ij}	=	transportation cost between destination *i* and origin *j*;
RP_{ij}	=	relative prices (i.e. the ratio of prices in destination *i* to prices in origin *j* and in alternative destinations);
ER_{ij}	=	currency exchange rate between destination *i* and origin *j*;
QF_i	=	qualitative factors in destination *i*. A large number of qualitative factors can effect demand for tourism travel and can include; gender, age, education level, household size, destination attractiveness, political, social and sporting events in the destination, etc.

Economists have certain expectations of how some of these variables might be related to demand for travel to a particular destination. For example, a positive relation is expected between demand and income in the origin country and a negative relationship is expected between relative tourism prices and transportation costs.

There are two ultimate aims of these models:

1. to estimate trends in demand and extrapolate these into the future;
2. to estimate parameters for each of the variables included the model which will allow calculation of elasticities.

An elasticity is economic jargon for a simple concept. For our example the income elasticity of tourism demand for travel to destination *i* refers to the ratio of the percentage change in tourism demand for travel to destination *i* to the percentage change in income in origin *j*. So if demand changes at the same rate as does income then the elasticity estimate will have a value of 1 (unitary elasticity). Different types of goods have different elasticities. Demand for necessities, such as staple food items (e.g. bread, rice), are usually inelastic with respect to their own price (e.g. a 1% rise in price will cause a less than 1% fall in demand). Luxury goods, such as tourism, are generally elastic with respect to their own price (e.g. a 1% rise in the price of travel to destination *i* will cause a greater than 1% fall in demand). Although a simple concept, these elasticity estimates can provide very useful information to policymakers and researchers who are interested in how tourism demand changes in response to income or prices or other variables.

[10] Lim, C. (2006): A survey of tourism demand modelling practice: issues and implications, in, Larry Dwyer and Peter Forsyth (Eds.) International Handbook on The Economics of Tourism, Edward Elgar, Cheltenham)

Back to the main text, p. 3

Practical implementation of tourism forecasting methods

As previously mentioned these kinds of models are estimated using a variety of times-series and econometric techniques of varying degrees of sophistication. Since all estimations are made using statistical techniques, the statistical significance of the estimates obtained from the model increases as the number of observations increases. Hence most research in this area has used data sets based on national data which has been collected according to consistent data definitions and which is (generally) available over a number of years. For this reason it is unlikely that demand for tourism in a localized area can be estimated since there might not be enough good quality data available that is specific to the geographical area the SAF implementation is dealing with. The most practical course of action open to the researchers will be to use estimates of overall trends or elasticities for specific variables from existing studies.

Tourism demand forecasting studies

There are a large number of studies that have been done related to estimation of tourist demand to or from certain areas. The majority of these use data on movements of tourists between countries and there are few that model demand for domestic tourists. The listing of publications that follows only includes general papers which are either meta-analyses or reviews of tourism demand studies. These papers give further details of the approaches used. It is recommended to carry out a country specific literature search in order to find literature that would be relevant before using parameters estimated from such models.

Crouch, G. I. (1995) A meta-analysis of tourism demand. Annals of Tourism Research 22, 103-118

Eilat, Y. and Einav, L. (2004) Determinants of international tourism: a three-dimensional panel data analysis. Applied Economics 36, 1315 – 1327

Lim, C. (1997) Review of international tourism demand models. Annals of Tourism Research 24, 835-849

Smeral, E. and Weber, A. (2000) Forecasting international tourism trends to 2010. Annals of Tourism Research 27, 982-1006

Song, H. and Li, G. (2008) Tourism demand modelling and forecasting - A review of Recent research. Tourism Management 29, 203-220

Witt, S. F. and Witt, C. A. (1995) Forecasting tourism demand: A review of empirical research. International Journal of Forecasting 11, 447-475

The World Tourism Organization (UNWTO) has also published more general forecasts for tourism demand for Europe in its 2001 publication Tourism 2020 Vision Vol. 4 Europe, although the accuracy of these forecasts is likely to have been adversely affected by the recent economic downturn. The UNWTO website also has a variety of other information and publications available that may be of some use: http://www.e-unwto.org.

Tourism demand and climate change

Climate change is very likely to have a significant impact on patterns of tourism demand in Europe over the long-term and this should be acknowledged in all coastal areas where tourism is of importance. Possible effects of climate on tourism have been explored in the following recent journal articles:

Back to the main text, p. 3

Bigano, A., Bosello, F., Roson, R. and Tol, R. (2008) Economy-wide impacts of climate change: a joint analysis for sea level rise and tourism. Mitigation and Adaptation Strategies for Global Change 13, 765-791

Bigano, A., Hamilton, J. M. and Tol, R. S. J. (2006) The impact of climate on holiday destination choice. Climatic Change 76, 389-406

Hamilton, J. M., Maddison, D. J. and Tol, R. S. J. (2005) Effects of climate change on international tourism. Climate Research 29, 245-254

Hamilton, J. M. and Tol, R. S. J. (2007) The impact of climate change on tourism in Germany, the UK and Ireland: a simulation study. Regional Environmental Change 7, 161-172

See also, for a comprehensive bibliography on climate change and tourism and recreation:

Scott D., Jones B. and McBoyle G. (2006) Climate, Tourism and Recreation: A Bibliography - 1936 to 2006.

Information can also be found on the eCLAT (Experts in Climate Change and Tourism) website at: http://www.e-clat.org/.

Back to the main text, p. 3