INPUT-OUTPUT MODELS FOR ECONOMY-ENERGY-ENVIRONMENT ANALYSIS OF TOURISM-RELATED BUSINESSES IN A NATURAL PARK

V. ALBINO – S. KÜHTZ[1]

Politecnico di Bari, Italy – Universita della Basilicata, Potenza, Italy

The analysis of relationships among socio-economic activities and the environment is fundamental to plan a sustainable development. In the present work an Input-Output (I-O) analysis based upon production processes is used to estimate energy and material flows (including pollutants/waste) in the supply chain of tourism-related activities based in a recently established Italian natural park (Pollino natural park). Tourism is a sector of utmost importance for present and future development policies of the park, therefore monitoring energy use and pollution levels in this sector can be useful for the sustainable development of the area. In particular, flows of energy necessary to lodging activities (hotel supply chain) are investigated and consequent production of pollutants evaluated. An increased need of energy due to the growth of tourism demand may cause an increment of pollution. The I-O model formulated herein enables to examine the local supply chains of the main lodging companies already existing in the park, and allows to balance positive and negative impacts caused by future tourism development and economy-energy-environment interactions.

1 Introduction

The economic impact of tourism-related businesses is remarkable. The World Travel and Tourism Council (The Economist, 1998) estimates that the total 1996 economic value of goods and services attributable to tourism was 10.6% of the gross global product. In 2000 Europe holds still the 50% of the whole market (Il Sole 24 Ore, 2000). In Italy the economy linked to tourism represents the 5.7% of the added value, the 11% of total consumption and counts above 1 million and 600 thousand employees (Beato, 1999). The importance of tourism as an area of academic investigation (see for example, Gonzales and Moral 1996; Borooah, 1999) stems in fact from the large contribution that it makes to the national income of several countries and the potential that it offers for generating output and employment growth. Generally, these studies deal with two main aspects: demand growth and infrastructure growth. In fact, the development of tourism-related activities may push local development and in particular that of rural areas with employment rates

[1]Corresponding author. Address: DIFA, Universita della Basilicata, Cda Macchia Romana, Potenza, Italy. e-mail: kuhtz@unibas.it

much lower than the national averages, i.e. almost all the Mediterranean area. But unplanned development of tourism may spoil the nature, so the question about environmental aspects (e.g., increased pollution and waste materials) arises.

Sustainability has gained considerable momentum as the main basic ground for development programs (Kyoto Protocol, 1997) and recently within this framework new forms of tourism-related activities have started to grow, i.e. sustainable tourism.

The problem deepens when these activities are based in natural parks where it is necessary to protect the environment, to favour local socio-economic development and to keep traditions alive. It is then strategic to plan the development of tourism-related businesses in a natural park in the more general and cogent framework of a sustainable development that complies with certain constraints (Migliorini et al., 1999). Besides, parks themselves should be considered as models and laboratories of a global sustainable development. They prove that it is possible to develop profitable activities (also based upon naturalistic values) and at the same time to protect the environment (Giuntarelli, 1998). To put sustainable development into practice it is necessary to explore how economic and social activities interact with the environment and influence each other. In particular, relationships among economy, energy and environment (Uno, 1998) and the policies for local development should be analysed although their investigation may be very complex. In the face of such complexity, models based upon input-output approach may provide tools that allow to deepen the understanding of flows relationships both in micro-scale and macro-scale regions (Ayres, 1978).

In this paper, the I-O approach as proposed by Albino et al. (2000), is applied to the supply chain of tourism-related activities to analyse the impact on the environment of material and energy flows entailed by tourism-related processes located in a natural park and to plan in advance which tourism-related activities and which type and intensity of such activities may be allowed.

2 Input-output models for supply chains

Input-output technique has been typically used to analyse the economic structure of regions in terms of economic flows between sectors (Leontief, 1951). Herfindhal and Kneese (1965) approached the resource/environment interface from an economic perspective. Later Cumberland (1966) suggested the extension of conventional I-O models to incorporate environmental factors in analysing regional development strategies. Leontief (1970) published a formulation of the extended I-O model to include both residuals generation and abatement activities.

Input-output can also be used for enterprises (termed Enterprise Input-Output (EIO)). In Italy, for example, a project was developed to forecast at a sectoral level the macroeconomic effects of the Italian conglomerate IRI, on the Italian economy and especially on southern Italy regions. Through I-O techniques IRI's internal structure and its influence on the outside was studied (La Noce et al., 1993).

Recently, Lin and Polenske (1998) used an input-output approach for enterprises based on production processes, where the production system of a company is composed of interrelated production processes that combine factor inputs to produce outputs, and developed a specific I-O process model.

Using a similar approach Albino et al. (2000) have formulated input-output models to map production activities, to interrelate and estimate flows of energy and materials, including use and consumption of fuels and production of pollutants within supply chains. Defined a *production process* as the transformation of input flows in output flows, both global and local supply chains have been modelled therein. In particular, a *global supply chain* was considered as the network of processes that procure raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system. For a given supply chain the relationships among all processes (global) as well as among processes located inside (local) and outside a given area can be analysed and modelled.

Consider a given geographic area and the supply chain related to a final product. The input-output approach can be used to analyse the flows (of raw materials, energy, products, pollution, imports and exports) relative to the chosen supply chain that take place inside the region, or which, at the most, cross its borders. This is the case of a *local supply chain*.

In this case, the model permits to investigate local processes interdependencies as well as the relationships among local processes and processes of the supply chain directly connected to them through the border line.

The input-output approach based on production processes, as described in details in Albino et al. (2000) can be used: i) to recognise functional relationships among flows of processes in a local supply chain, ii) to determine the processes that contribute more to environmental pollution, and, iii) to evaluate how one can change the input mix or the imports rate (for instance of energy sources) in order to respect environmental constraints (e.g., to reduce pollution, keeping other output flows constant).

3 Input-output model for tourism-related businesses

Any tourism-related business can be described as a supply chain. It can be composed of a variety of processes which can be treated as the production processes described in the previous section and represented via physical flows as in *Figure 1* where a simplified two processes supply chain is presented; boxes represent processes and arrows represent flows.

For example, to give accommodation (and other services for tourism) is herein considered a process that produces outputs (e.g. tourists accommodated per year) due to various inputs (e.g. energy inputs to run the activity, tourists that look for accommodation, food, etc.). All the typical hotel processes which range from accommodation to catering, all the processes needed to produce food (e.g., bakeries, dairy farms), guides, banking services and other activities are systems that produce main product outputs due to various inputs. In order to have a tool simple to use a main hypothesis is set: only one main product (X_i) per process is allowed.

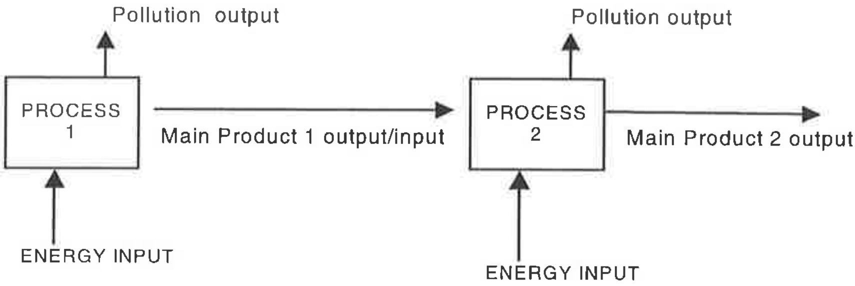

Figure 1. Simple scheme of a two-process supply chain

In particular, the supply chain of a hotel which provides accommodation in a natural park can be effectively analysed using a specific input-output process model.

The following notation is used in order to write balance equations for the different flows. Z_{ii} indicates the main product output of the i-th process, Z_{ij} $i \neq j$ is the fraction of the i-th process output to the j-th process, Y_i is the fraction of the i-th process output which may be sold outside the local supply chain (final output), P_{kj} is the purchased input (e.g., raw materials) of type k to the j-th process, M_{ij}, is the import of the same main product produced by the i-th process to the j-th process, W_{kj} is the output of by-products and unwanted materials (i.e. waste, pollution, by-products or energy and materials residuals generated in production processes) of type k to the j-th process.

In matrix notation:

$Z = [Z_{ij}]$ = Production and intermediate consumption of main products;

$A = [A_{ij}]$ = Direct input-output coefficients for main product outputs;

$P = [P_{kj}]$ = Purchased inputs;

$W = [W_{kj}]$ = Output of by-products and unwanted materials;

$X = [X_i] = Z_{ii}$ = Gross output of main products;

$Y = [Y_i] = \sum_j Z_{ij}$ = Final output of main products;

$\mathbf{M} = [M_i] = \sum_j M_{ij}$ = Total imports;

$\mathbf{P} = [P_k] = \sum_j P_{kj}$ = Total consumption of purchased inputs;

$\mathbf{W} = [W_k] = \sum_j W_{kj}$ = Total output of by-products/waste;

$V = [V_{kj}]$ = Primary inputs (in this work k = labour employment);

$\mathbf{V} = [V_k] = \sum_j V_{kj}$ = Total labour employment required.

It is possible to estimate direct input-output coefficients A_{ij}, referred to all the input main products of type i. For $i \neq j$ the direct input-output coefficient A_{ij} can be defined as the ratio of the total input, sum $Z_{ij} + M_{ij}$ (if there are imports) to the total output of the j-th process. A_{ij} can be estimated using actual data related to a given supply chain; in the model it is assumed constant over time (i.e., the input requirements for each process are assumed to be an unchanging characteristic of the production technology). So, if the gross output of the j-th process X_j is considered, the direct coefficient can be expressed as:

$$Z_{ij} + M_{ij} = A_{ij} X_j \tag{1}$$

and in matrix notation:

$$Y + \mathbf{M} = A \cdot X$$

let A_{ii} equal to one. Also purchased inputs (e.g. energy inputs, raw materials), pollution outputs and primary inputs (i.e., labour employment) can be expressed in terms of direct input-output coefficients, B_{kj}, as the ratio of input P_{kj} to the total output of the j-th process, C_{kj}, as the ratio of output W_{kj} to the total output of the j-th process, D_{kj} as the ratio of input V_{kj} to the total output of the j-th process, respectively:

$$\forall k, \forall j \qquad P_{kj} = B_{kj} X_j; \quad W_{kj} = C_{kj} X_j \quad \text{and} \quad V_{kj} = D_{kj} X_j \; . \tag{2}$$

In matrix notation they become, respectively:

$$\mathbf{P} = B \cdot X \qquad \mathbf{W} = C \cdot X \qquad \mathbf{V} = D \cdot X \; ,$$

where:

$B = [B_{kj}]$ = Direct input-output coefficients for purchased inputs;

$C = [C_{kj}]$ = Direct input-output coefficients for by-product and waste outputs;

$D = [D_{kj}]$ = Direct input-output coefficients for labour employment.

As described in the next section, the model is applied to study functional relationships among flows and then in particular to evaluate the new amount of energy inputs needed when the final demand is changed. Also, how to satisfy the demand of final product with a different mix of energy sources in the respect of given waste/pollution constraints can be analysed.

4 Case examples

The case examples deal with tourism-related businesses located in an Italian natural park, the Pollino Natural park, situated between Basilicata and Calabria, regions in the South of Italy. The park extension is of about 1930 km^2 and it is the largest natural park in Europe. Large forests characterise the Park whose average height is about 1000 m. The area has suffered from the increased urbanisation in the seventies, before the natural park was established (November 1993).

From the economic point of view, tourism-related businesses are considered essential for the local development. Hence, in the economic plan of the park (in the development phase) supply chains related to tourism activities are taken into consideration to enhance their efficiency and effectiveness. However, the planners have to take care of the environmental impact of such businesses. In particular, energy sources and pollution seem to constrain size and location of hotels, restaurants, laundries, etc. The model is applied in the following sections to support both accounting and planning activity.

4.1 Accounting

A simplified supply chain whose final product is the lodge service is modelled as a network of processes. In *Figure 2*, the scheme of materials and energy flows is drawn. The input-output technique described in the previous section, used herein as an accounting tool, is applied to processes 1 to 3, all located in the park area and described in *Table 1*. They compose a supply chain related to basic accommodation activities.

Process	Main product output in a year
1 – Laundry located in the park area	Number of cleaned linen modules
2 – Lodge Hotel (it provides accommodation)	Number of beds let
3 – Transport service	Number of linen modules transported
1^0 – Laundry not located in the park area	Number of cleaned linen modules

Table 1. Processes and relative main products for the case example in Figure 2

The following hypotheses are set:

i) Only flows represented in Figure 2 are accounted for (e.g., transport service needed for the outside Laundry is not considered);

ii) The model parameters are estimated on the basis of a specific supply chain. Data are collected through interviews with the process owners. Each process is assumed to be statistically representative of processes embedded in similar lodge hotel and laundry supply chains located in the park. In case the processes performed by other lodge-hotels, laundries, and transport services are equal to those analysed herein increasing the number of beds let per year means increasing the number of hotels, laundries and lorries actually used;

iii) Linear proportionality between the number of beds let (i.e., tourists who spend the night in the area) and the quantity of inputs and outputs of the processes is assumed;

iv) Imports of cleaned linen from the laundry process located outside the park, process 1^0, are considered. Because they are imported products equal to the main products produced by the internal Laundry, the flow M_{1^02} is termed M_{12} and it contributes to the direct coefficient A_{12} (as explained also hereafter).

Based on Figure 2, and upon the notation given in section 3, *Table 2* presents balance equations of material/energy flows written for process outputs, purchased inputs, pollution outputs, imports and labour employment.

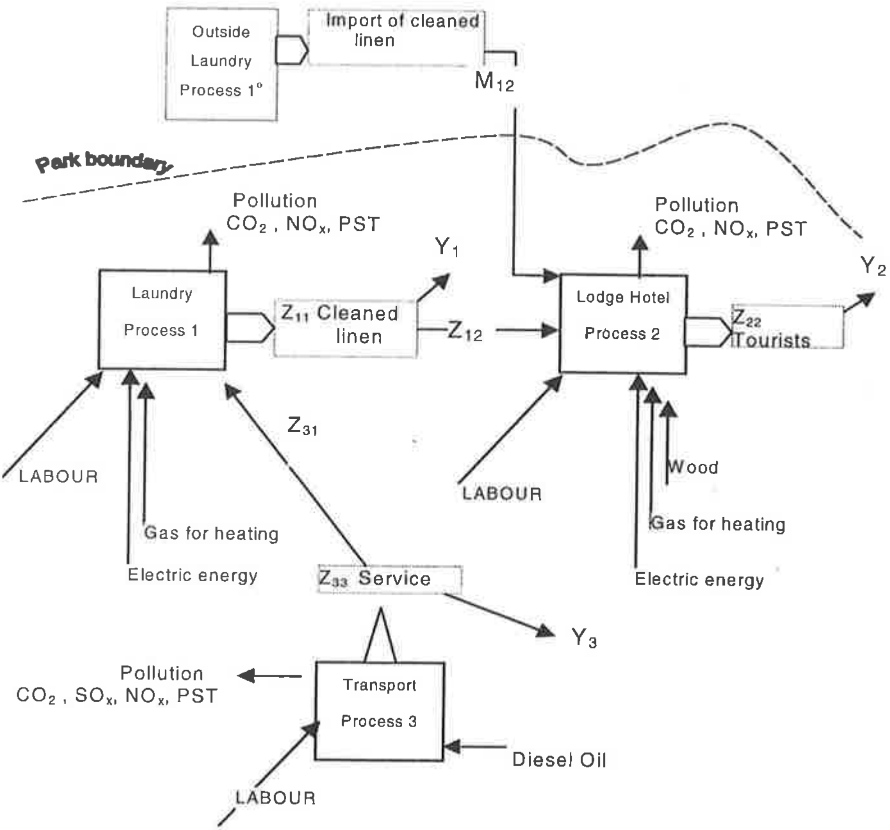

Figure 2. Simplified supply chain in the present situation

Process outputs	$Z_{11} + Z_{12} + 0 = Y_1$ $0 + Z_{22} + 0 = Y_2$ $Z_{31} + 0 + Z_{33} = Y_3$
Purchased inputs	$P_{e1} + P_{e2} + 0 = P_e$ $P_{w1} + P_{w2} + 0 = P_w$ $P_{g1} + P_{g2} + 0 = P_g$ $0 + 0 + P_{D3} = P_D$
Pollution outputs	$W_{CO21} + W_{CO22} + W_{CO23} = W_{CO2}$ $0 + 0 + W_{Sox3} = W_{Sox}$ $W_{NOx1} + W_{Nox2} + W_{Nox3} = W_{NOx}$ $W_{PST1} + W_{PST2} + W_{PST3} = W_{PST}$
Imports of main product	$M_{102} = M_{12} = M_1$
Labour employment	$V_{L1} + V_{L2} + V_{L3} = V_L$

Table 2. Balance equations based on flows in Figure 2

$A_{11} = Z_{11}/Z_{11}$	$A_{12} = (Z_{12} + M_{12})/Z_{22}$	$A_{13} = Z_{13}/Z_{33}$
$A_{21} = Z_{21}/Z_{11}$	$A_{22} = Z_{22}/Z_{22}$	$A_{23} = Z_{23}/Z_{33}$
$A_{31} = Z_{31}/Z_{11}$	$A_{32} = Z_{32}/Z_{22}$	$A_{33} = Z_{33}/Z_{33}$

Table 3. Direct input-output coefficients A_{ij}

In particular, the direct coefficients are presented in Table 3. It should be noticed that when imports of main products occur they contribute to the direct coefficients referred to main products (and not to each input flow). Note in particular coefficient A_{12} where both Z_{12} and M_{12} appear.

In *Table 4* are shown the present data (in physical units) for the three process hotel supply chain illustrated in Figure 2. They are distributed in five sections: main products, main product imports, purchased inputs, pollution and labour employment. Main Products of Process 1 are measured in cleaned linen modules, as they are generally called. The last line of the table is a recall of the main products of each process and is comprised of the diagonal elements of the matrix of the first section.

Each row in Table 4 describes production (positive number, i.e., production of pollution, or of main products) and consumption (negative number, i.e., use of energy) of main products, purchased inputs, pollutants. For example, the third row in the main products section describes the use of the transport service: 1800 modules transported are the service offered (produced) and −1800 modules are transported to and from (i.e., consumed by) the laundry in the park.

Each column provides information on inputs and outputs for each production process. For example, to transport 1800 modules per year the transport process (process 3) consumes 925 litres of diesel oil, produces 2430 kg of CO_2, 3.41 kg of SO_x, 10.08 kg of NO_x and 1.94 kg of solid particles (PST) and needs 5 employees.

In this way, a complete accounting of the local supply chain model considered in this section is given in Table 4.

	Process 1 Laundry	Process 2 Lodge Hotel	Process 3 Transport service	Final Output / Total Demand
Main Products Z_{ij}				Y_i
Laundry: 1 cleaned linen module per bed	900	-900	0	$Y_1 = 0$
Lodge Hotel: beds let	0	1200	0	$Y_2 = 1200$
Transport service: transported modules	-1800	0	1800	$Y_3 = 0$
Main Product Import M_{ij}				$\mathcal{M}_i$
External Laundry, 1°, cleaned modules	0	-300	0	$M_1 = -300$
Purchased Inputs P_{kj}				$\mathcal{P}_k$
Electric energy [kWh]	- 3600	- 5770	0	$P_e = -9370$
Wood [kg]	0	- 20000	0	$P_w = -20000$
Heating gas [Nmc]	- 231	- 1385	0	$P_g = -1616$
Diesel oil [l]	0	0	- 925	$P_D = -925$
Pollution* [kg] W_{kj}				$\mathcal{W}_k$
CO_2 (wood)	0	19000	0	$W_{w,CO_2} = 19000$
CO_2 (heating gas)	444	2659	0	$W_{g,CO_2} = 3103$
CO_2 (diesel oil)	0	0	2430	$W_{D,CO_2} = 2430$
CO_2 (total)	–	–	–	$W_{CO_2} = 24533$
SO_x (wood)	0	4	0	$W_{w,SO_x} = 4$
SO_x (heating gas)	0	0	0	$W_{g,SO_x} = 0$
SO_x (diesel oil)	0	0	3.41	$W_{D,SO_x} = 3.41$
SO_x (total)	–	–	–	$W_{SO_x} = 7.41$
NO_x (wood)	0	26	0	$W_{w,NO_x} = 26$
NO_x (heating gas)	0.578	3.46	0	$W_{g,NO_x} = 4.04$
NO_x (diesel oil)	0	0	10.08	$W_{D,NO_x} = 10.08$
NO_x (total)	–	–	–	$W_{NO_x} = 40.12$
PST (wood)	0	346	0	$W_{w,PST} = 346$
PST (heating gas)	0.028	0.169	0	$W_{g,PST} = 0.197$
PST (diesel oil)	0	0	1.94	$W_{D,PST} = 1.94$
PST (total)	–	–	–	$W_{PST} = 348.1$
Labour employment V_{Lj}				
Number of employees	-3	-5	-3	$V_L = -11$
Process Main products	900 modules	1200 beds let	1800 transp. linen	

* **Emission Factor** values sources: US-EPA & OAQPS (1998)

Table 4. Flows balance table, accounting of the present situation

4.2 Planning

In this section the model is used as a planning tool for the same supply chain of Figure 2, in two limit cases:

1. Case B: no imports of cleaned linen, M, allowed, i.e., process 1 produces all the needed linen (see *Table 5*);

2. Case C: cleaned linen only imported from a laundry external to the park area, (see *Table 6*).

As expected, comparing with the present situation (Table 4), in case B pollution emissions in the area increase, but also labour employment (by two units); in case C pollution emissions decrease because are only those due to process 1, therefore this alternative may comply better with sustainability issues, but labour employment decreases by more than half when compared to the present situation.

For the assumed proportionality, these values double if an increment by two of the final demand is considered.

Because as stated previously both environmental and economic impact are equally essential for the park development, a case example that allows to plan a pollution decrease and an employment increase (when comparing with the present situation described in section 4.1) represents the ideal scenario to be pursued, this is called Case D.

	Process 1 Laundry	Process 2 Lodge Hotel	Process 3 Transport service	Final Output / Total Demand
Main Products Z_{ij}				
Laundry: 1 cleaned linen module per bed	1200	−1200	0	$Y_1 = 0$
Lodge Hotel: beds let	0	1200	0	$Y_2 = 1200$
Transport service: transported modules	−2400	0	2400	$Y_3 = 0$
Main Product Imports M_{ij}				
External Laundry, 1°, cleaned modules	0	0	0	0
Purchased Inputs P_{kj}				
Electric energy [kWh]				$P_e = -10570$
Wood [kg]				$P_w = -20000$
Heating gas [Nmc]				$P_g = -1693$
Diesel oil [l]				$P_D = -1233$
Pollution* [kg] W_{kj}				
CO_2				$W_{CO_2} = 25488$
SO_x				$W_{SO_x} = 8.55$
NO_x				$W_{NO_x} = 43.67$
PST				$W_{PST} = 348.8$
Labour employment V_{Lj}				
Number of employees	−4	−5	−4	$V_L = -13$
Process Main products	1200 modules	1200 beds let	2400 transp. linen	

* Emission Factor values sources: US-EPA & OAQPS (1998)

Table 5. Case study B, with same supply of lodge service as in Table 4, and no Imports

	Process 1 Laundry	Process 2 Lodge Hotel	Process 3 Transport service	Final Output / Total Demand
Main Products Z_{ij}				
Laundry: 1 cleaned linen module per bed	0	0	0	$Y_1 = 0$
Lodge Hotel: beds let	0	1200	0	$Y_2 = 1200$
Transport service: transported modules	0	0	0	$Y_3 = 0$
Main Product Imports M_{ij}				
External Laundry, 1°, cleaned modules	0	−1200	0	$M_{12} = -1200$
Purchased Inputs P_{kj}				
Electric energy [kWh]				$P_e = -5770$
Wood [kg]				$P_w = -20000$
Heating gas [Nmc]				$P_g = -1385$
Diesel oil [l]				$P_D = 0$
Pollution* [kg] W_{kj}				
CO_2				$W_{CO_2} = 21659.2$
SO_x				$W_{SO_x} = 4$
NO_x				$W_{NO_x} = 29.46$
PST				$W_{PST} = 346.17$
Labour employment V_{Lj}				
Number of employees	0	−5	0	$V_L = -5$
Process Main products	0 modules	1200 beds let	0 transp. linen	

* Emission Factor values sources: US-EPA & OAQPS (1998)

Table 6. Case study C, with same supply of lodge service and only Imports M.

The strength of the model is in fact that it may also help examine alternative options to produce energy in a cleaner way. For example, substituting the natural gas boiler and the wood fireplace used in case B, with solar panels, case D, results in emissions reductions. This is evident when comparing the results presented in Table 5 with those in Table 7.

Moreover, comparing the present situation, Table 4, with Table 7 again, which corresponds to no imports and solar thermal panels, shows that an increment in the production of the laundry process requires two additional labour units, and decreases emissions. See *Table 8* for the comparisons.

Further development of the model takes account of another primary input in Table 3, indicating capital costs. So, accounting for financial costs, the model serves as a tool to support investment decisions when substituting traditional energy technologies in favour of sustainable ones. In fact, it is often difficult to examine alternative pollution control measures and evaluate costs and returns of environmental quality improvements.

Furthermore, because conventional enterprise accounting systems record little (or none) information on environmental performance it is difficult to control and to incentive the minimisation of environmental pollution. These models based on input-output techniques can help. In fact they allow to take account of the non-used or non-desired energy outputs, and to decide how to reduce or reuse some portions.

	Process 1 Laundry	Process 2 Lodge Hotel	Process 3 Transport service	Final Output / Total Demand
Main Products Z_{ij}				
Laundry: 1 cleaned linen module per bed	1200	−1200	0	$Y_1 = Z_{11} + Z_{12} = 0$
Lodge Hotel: beds let	0	1200	0	$Y_2 = 1200$
Transport service: transported modules	−2400	0	2400	$Y_3 = 0$
Main Product Imports M_{ij}				
External Laundry, 1°, cleaned modules	0	0	0	0
Purchased Inputs P_{ij}				
Electric energy [kWh]				$P_e = -10570$
Wood [kg]				$P_w = 0$
Heating gas [Nmc]				$P_g = -1462$
Diesel oil [l]				$P_D = -1233$
Pollution* [kg] W_{ij}				
CO_2				$W_{CO_2} = 6045$
SO_x				$W_{SO_x} = 4.55$
NO_x				$W_{NO_x} = 17.08$
PST				$W_{PST} = 2.77$
Labour employment V_{Lj}				
Number of employees	−4	−5	−4	$V_L = -13$
Process Main products	1200 modules	1200 beds let	2400 transp. linen	

* Emission Factor values sources: US-EPA & OAQPS (1998)

Table 7. Case study D, no Imports M and solar panels

	Case studies			
	Accounting, present situation	B no Imports M	C only Imports M	D no Imports M, solar panels
Pollution produced [kg]				
Total CO2	24533	25488	21659.2	6045
Total SOx	7.41	8.55	4	4.55
Total NOx	40.12	43.67	29.46	17.08
Total PST	348.1	348.80	346.17	2.77
Labour				
Total number of employees	11	13	5	13

Table 8. Summary and direct comparison of the four cases considered

5 Conclusions

The input-output approach described herein is based upon processes and their input-output relationships. This is used to develop a specific model for the hotel supply chain located in a natural park area recently established in South Italy whose economic development plan accounts for tourism as the main economic activity to be expanded for future development of the area, as long as it complies with sustainable development issues. Tourism increased demand may present some drawbacks because the new need of energy may increase pollution. The input-output model presented in this work is very easy to implement and flexible and allows to evaluate the environmental impact of the main lodging companies already existing in the park. Also, as a planning tool it allows to estimate the effects of environmental and energy constraints on production processes and to examine alternative energy sources use. Many environmental problems may in fact be solved with a higher degree of self-sufficiency at local level, and higher use of renewable energy sources.

References

1. Albino, V., Izzo, C. and Kühtz, S. (2000) Input-Output Models for the Analysis of a Local/Global Supply Chain, submitted for publication on *International Journal of Production Economics*.
2. Ayres, R. U. (1978) *Resources, Environment, and Economics — Applications of the Materials/Energy balance principle*, John Wiley & Sons, Inc. pub.
3. Beato, F. (1999) *Parchi e società*, Liguori editore – Srl.
4. Borooah, V. K. (1999) The supply of hotel rooms in Queensland, Australia. *Annals of Tourism Research*, Vol. 26, n.4, pp 985–1003.
5. Cumberland, J. H. (1966) A regional inter-industry model for analysis of development objectives. *Reg. Sci. Assoc. Papers*, 16.
6. Fehr, M. (1998) An integrated environmental matrix for a social unit. *Resources, Conservation and Recycling*, Vol. 22, pp. 193–202.
7. Filipic, P. (1985) *Implementation of Input-Output (Structure) models in Planning of Organisations of Associated Labor*, Split, Yugoslavia, LOGOS.
8. Filipic, P. (1986) Input-Output model as the quantitative basis of self-management techniques. *8th International Conference on Input-Output Techniques*, Sapporo, Japan, July 28 - August 2.
9. Giuntarelli, P. (1998) Il Parco come metafora dello sviluppo sostenibile. *Parchi*, n. 24.
10. Gonzales, P. and Moral, P. (1996) Analysis of Tourism trends in Spain. *Annals of Tourism Research*, Vol. 23, pp. 739–754.
11. Herfindhal, O. and Kneese, A. V. (1965) *The Quality of the Environment*, John Hopkins University Press Baltimore.
12. Il Sole 24 Ore (2000) Rapporti: Turismo, 15 maggio.
13. Kyoto Protocol to the United Nations Framework Convention on Climate Change. (1997) Conference of the Parties – Third session, 1-10 December.

14. La Noce, M., Latorre, M., Schachter, G., (1993) Structural and Integration Analysis of an Italian Public conglomerate. *Journal of Policy Modelling*, Vol. 15, n. 3, pp. 235–250.

15. Leontief, W. W. (1951) *The structure of the American economy*, New York, Oxford University Press.

16. Leontief, W. W. (1970) Environmental Implications and the Economic Structure: An Input-Output Approach. In *A challenge to social Scientists* edited by S. Tsuru. Asahi, Tokyo, reprinted in Rev. Econ. Stat., LII.

17. Li Bingquan (1991) Applications of the Input-Output Technique in Chinese Enterprises. In *Chinese economic Planning and Input-Output applications* edited by Karen R. Polenske and Chen Xikang. Hong Kong, Oxford University Press, pp. 257–272.

18. Lin, X. and Polenske, K. R., (1998) Input-Output Modelling of production Processes for Business Management. *Structural Change and Economic Dynamics*, vol. 9, pp. 205-226.

19. Migliorini, F., Moriani, G., Vallerini, L. (1999) *Parchi naturali*, Franco Muzzio editore.

20. Odum, H. T. (1996) *Environmental Accounting*, John Wiley & Sons, Inc., New York, USA.

21. Sundkvist, A., Jansson, A. M., Enefalk, A., Larsson, P. (1999) Energy flow analysis as a tool for developing a sustainable society — a case study of a Swedish island. *Resources, Conservation and Recycling*, Vol. 25, pp. 289–299.

22. The Economist, (1998) 1998 Survey: Tourism and Demand. *The Economist* 346, January, S1 - 15.

23. Uno, K. (1998) Policy application of Global Economy-Energy-Environment (3E) accounting and modelling: an overview. *International Input-Output Association Meeting*, New York, USA, May 18-22.

24. US – EPA (Environmental Protection Agency) and OAQPS (Office of Air Quality Planning and Standards) (1998) *Compilation of Air Pollutant Emission Factors AP-42*, Fifth Edition (also available at www.epa.gov/ttnchie1/index.html).

25. Zhang, R, Gao, N., Wu, H. (1991) Input-Output method to Anshan Iron and Steel Corporation. In *Chinese economic Planning and Input-Output applications* edited by Karen R. Polenske and Chen Xikang. Hong Kong, Oxford University Press, pp. 257-272.