



<http://www.sciforum.net/conference/wsf3>

*Article*

## **Life Cycle Approach: A Critical Review in the Tourism Sector**

**Gabriella Arcese<sup>1\*</sup>, Roberto Merli<sup>1</sup> and Maria Claudia Lucchetti<sup>1</sup>**

Department of Business Studies, Roma Tre University, Via Silvio D'Amico, 77- 00145 Rome, Italy. E-Mails: [mariaclaudia.lucchetti@uniroma3.it](mailto:mariaclaudia.lucchetti@uniroma3.it) (M.C.L.) ; [roberto.merli@uniroma3.it](mailto:roberto.merli@uniroma3.it) (R.M)

\* Author to whom correspondence should be addressed; E-Mail: [gabriella.arcese@uniroma3.it](mailto:gabriella.arcese@uniroma3.it); Tel.: +39-0657335713; Fax: +39-06 57335797

*Received: 16 September 2013 / Accepted: 11 November 2013 / Published: 11 November 2013*

---

### **1. Introduction**

The concept of sustainability comes from the scientific literature that defines sustainable the management of a resource if, being known his ability to play, is not exceeded in its exploitation beyond a certain threshold defined critical natural capital [1].

In the past, economic growth has been achieved at the expense of natural resource depletion, without stocks being allowed to regenerate. Ecosystems have been widely degraded and biodiversity has been lost at an unprecedented pace [2,3].

In this sense, the concept of sustainability and development are not compatible with the degradation of heritage and natural resources (non-renewable and potentially exhaustible), but also with concepts mostly related to ethical and social values such as the violation of the human dignity and freedom, with poverty and economic decline and the lack of recognition of the rights and equal opportunities [4,5].

The three basic components of sustainability are therefore:

- the ability to generate income and employment for the people's livelihood (economic sustainability)
- the ability to generate conditions of human well-being, understood as the territory security, an equal distribution of health and civil rights (social sustainability);
- the ability to maintain the same level of quality and reproducibility of natural resources (environmental sustainability)

The research on sustainability valorization led to the creation of models capable of evaluating, represent and monitor sustainability. In this research model, economic, environmental and social variables can be included, comparable in time and space [4,1].

The most important paradigm that includes all the three kind of sustainability variables is the life cycle sustainability assessment, based on Life cycle approach.

The life cycle thinking considers every action of the process and reflects the acceptance that the main social actors should not possibly limit their liability to those phases of the life cycle of a product, process or activity in which they are directly involved. It expands the scope of their responsibility to include environmental implications throughout the entire life cycle of the product, process or activity.

The Life Cycle Sustainability Assessment (LCSA) can be used for product/process or service sustainability evaluation. The goal is to create a comprehensive tool to measure all dimensions of sustainability whose output can be presented and understandable to non-experts in the field and methodology [6].

In the economic life cycle based approach, a company designing a new product has to analyze the consequences of his proposal in a wide range of issues, including the environment, business costs, the benefits to the local economy in which the production will take place, the social rights of workers, and so on. A multidisciplinary study is needed to follow this approach, falling within the broad discipline of industrial ecology, which studies the links between natural systems and economic and industrial activities [7].

Today, sustainability is, therefore, accepted by all the players in the market both as a guiding principle for the development of public policies and business strategies. However, the biggest challenge for most organizations remains the choice of the correct tools for its implementation, and above all, the problem remains substantially its measurement and quantification in performance.

## **2. Methods: literature review**

This paper identifies issues on environmental consideration of tourism performance. The tools for sustainability assessment based on life cycle approach are argue with the aim to improve some current methodologies application for environmental analysis, socio and economic evaluation of impact in the cycle of the tourism activities. The literature quality of existing environmental appraisals in tourism has often inadequately or not specified and has predominantly aimed to merely identify and list the diversity of tourism environmental impacts with no in-depth evaluation of their consequences [8,9], or to study tourist perceptions of tourism environmental impacts [10,11,12] or to examine the attitudes of tourism businesses towards complex “tourism–environment” interactions [13,14]. Attempts to systematically evaluate the environmental impacts of tourism, and its contribution to climate change, are limited to a small number of sustainability assessment tools [15]. In the interesting critical review of method for climate change appraisal based on life cycle approach for tourism of Filimonau et al. (2011) a classification of instrument for environmental evaluation of impacts has been presented.

## **3. Tourism sector sustainability: the scenario**

Tourism is a very particular sector, characterized by the combination of actions and behaviors around several areas: energy, agriculture, transport, services etc. This is the reason for the high sector’s relationship with sustainability has gradually consolidated, given the increasing importance of

consumption and its environmental impacts [16,17]. Tourism has been defined as "... the sum of the phenomena and relationships resulting from travel and stay of non-residents..." [18].

In 2011, tourism contribution to worldwide Gross Domestic Product (GDP) is around 5%, whilst in Italy the total contribution amounted to 10,3%. At the same time in 2005 the tourism sector was significantly responsible for the human-induced climate change, accounting between 3,9 and 6% of global CO<sub>2</sub> emissions. Due to its economic and environmental relevance is emerging worldwide the necessity to develop strategies for the sustainability of the sector, focused on the reduction of emissions from transportation and accommodation [19].

In many countries, tourism is a strategic national key sector. One of the consequences of its size is the significant impact on the deterioration of environmental conditions. This can determine an hardship of the same natural resources that determine tourist inflow. For countries like Italy, with a typical tourist vocation, the challenge to build a sustainable tourism sector is essential to protect and preserve one of the strategic variables of the economy. In this sense, many efforts have been made in order to identify common tools to reduce the impact of tourist reception structures. This necessity is due to both the requirements of preserving natural resources, often the center of touristic interest, and the general increase in the demand for sustainability by the various categories of stakeholders. In fact, the interest in sustainability is growing both at institutional and consumers level, whose choices to preserve the environment are becoming critical variables [20].

Even if mass consumption is endangering the future of our world in many different ways - and tourism has significantly contributed to this situation - tourism development can also bring extensive benefits to society. In an attempt to promote sustainable practices, different kinds of eco-labelling have been developed in this sector [21]. Sustainability appears to be a key business variable for tourism and for this reason, it is a integrated part of business strategy of this market's actors [22]. As evidence of this, data on the European Regional Policy for tourism shows that, from 2007 to 2013, EU support for tourism under Cohesion Policy amounting to more than EUR 6 billion is planned, (1,8% of the total). EUR 3,8 billion is allocated for the improvement of tourist services, EUR 1,4 for the protection and development of natural heritage, and EUR 1,1 billion for the promotion of natural assets. In addition, support for tourism-related infrastructure and services can be provided under other headings, such as innovation, promotion of small and medium-sized enterprises, information technology applications and human capital [23]. An important number of sustainable transnational thematic tourism products and services has being developed and has a great potential to contribute to tourism growth. Large number of projects was funded to stimulate competitiveness in the European tourism sector and the European Commission encourages diversification of the supply of tourist services and products. By supporting projects promoting sustainable thematic tourism products, EU aims at trans-national cooperation with regard to sustainable tourism, cheering an elevated involvement of small and micro enterprises and local authorities and motivating competitiveness of the tourism industry by funds of an enhanced focus on the diversification of sustainable thematic tourism products [24].

#### **4. The sustainability Indicators**

The sustainability indicators consider areas where economy-environment and society are weak. The indicator is then, a parameter or a value that is derived from other parameters expressed by an absolute index or aggregate. A good sustainability indicator must meet the following requirements for effectiveness [4]:

1. Relevance: that show an aspect of the system that you need to know
2. Comprehensibility, even by non-experts
3. Verifiability, otherwise it cannot be credible
4. Representativeness: that is likely to prove difficult measures directly executable.

International Organizations, such as the UN or the OECD, have been working on sustainability since a long time, but also the European Environment Agency that deal with the monitoring of environmental phenomena and to design strategies for mitigation of impacts worked on the creation of indicators such as HDI (Human Development Index) or the ones presented in the local Agenda 21, or the international sustainability indexes, such as indices related to financial performance of sustainable businesses.

Both in management and environmental literature, three principles were however defined, related to the sustainable management of resources [25]:

1. renewable resources utilization rates must not exceed their rates of regeneration;
2. emissions of pollutants shall not exceed the assimilative capacity of ecosystems;
3. non-renewable resources should be used in a "nearly sustainable" way, limiting the rate of their use at the rate of creation of renewable substitutes.

The basic rules for the construction of good indicators have been defined by Opschoor and Reijnders [26] according to which we must identify the main elements of natural capital and the corresponding economic function. Selected elements that are important with respect to the possibility that threatened the integrity of the resources themselves, determine the "threshold" values, based on the sustainable management of resources, and contribute to the construction of indicators that reflect the actual conditions of the environment, compared with the standards of sustainability.

At the moment the sustainability indicators that have been developed can be grouped into three categories:

1. indicators of critical load and critical level;
2. socio-ecological indicators;
3. indicators for measuring sustainable development (SDR, Sustainable Development Records).

The use of sustainability indicators is affirmed at the international level (UN, OECD, EU) as a means of reporting on the state of the economy or the environment, to clarify objectives and set priorities, evaluate the performance of policies and monitoring progress towards sustainable development.

Among the sustainability indicators, a selection of "key indicators" should be identified to measure the results achieved in terms of outputs.

These indicators are useful to represent, through the use of integrated evaluation tools sphere environmental, economic and social order to measure the performance results. they are a tool for decision support that facilitates the exchange of information and communicates the status of implementation of the objectives and sustainable development strategies. The set of shared indicators facilitates benchmarking between institutions and the spread of best practices.

Application to corporate management strategies for sustainability arise the phenomena of industrial ecology (IE) and industrial symbiosis. The IE Concept refers to the metaphorical relation between the natural and industrial ecosystem as a model for transforming unsustainable industrial systems [2]. The IE aims to analyze systematic interactions between economic and environmental needs for structured settlement and collective environmental problems. Industrial symbiosis refers to the network of product, by-product and waste exchanges that reduce the ecological footprint of industrial areas.

The impact's assessment approach based on the life cycle thinking (LCT) tries to identify the improvements that could be made to goods and services, in the form of lower environmental impacts and reduction of resources between all stages of the life cycle, analyzing the complex relations between the technological system and the environment from cradle to grave. The "From Cradle to

"Grave" slogan summarizes the philosophy of the approach. Before being known and applied by the methodological tool of Life Cycle Assessment (LCA), the methodology has taken several names including "Cradle to Grave analysis", "Life Cycle Analysis", "Eco-balance", "Energy and Environmental Analysis" etc. [27].

From the life-cycle approach birth, the paradigm of sustainability has evolved, contributing to what is the current paradigm of global sustainability today. Rubik, in 2002 [28] theorized the transition from a traditional paradigm of sustainability to what is now the modern paradigm, then recalled by Finkbeiner et al. for carrying out the evolution of the life cycle [6].

The Life Cycle Sustainability Assessment (LCSA) is a framework of interdisciplinary integration of different models rather than a model in itself: in fact, attempts of implementation actually concern the selection of different models available, which usually occurs in the lens function of sustainability that you want to achieve with a bottom-up approach [29].

Although this is fully compatible with the ISO assumed that "there is no single method for conducting LCA" [30], it represents significant deviation from the classical LCA practiced until now, for the extension to the economic and social impacts. Moreover, the same ISO 14040:2006 standard proposed a new approach directed towards a three dimensional complementary model through the integration of tools and techniques individually designed for the three spheres of sustainability.

The definition of LCSA is stated in the last report of the Life Cycle Initiative of 2011, "Towards a Life Cycle Sustainability Approach", in which it is defined as the approach to evaluation of all relevant environmental, economic and social impacts and benefits in decision making the improvement of the sustainability of a product through the entire lifecycle [31].

This idea is conceptualized through the general formula suggested by Walter Klöpffer that correlates the three techniques through the following relation:

$$LCSA = E-LCA + LCC + S-LCA$$

where E-LCA refers to the environmental life cycle assessment, LCC is the life cycle costing methodology and S-LCA is social life cycle assessment. [32,6].

In the specific application of the methodology, which is still under development, some aspects seem to be key points of departure for a correct analysis.

First of all, the need for a multi-criteria assessment regime. This scheme of analysis, in fact, allows the evaluation of parameters through scales of values and indicators comparable between them. For an analysis of this type, there is a level of global weighting, but rather there are at least two different levels of weighing: between indicators of the same nature (e.g. environmental + economic) and between the three different dimensions (environmental, economic, social) [6].

The trade-off between the three dimensions of sustainability must be approached with the utmost care, in order to maintain a sustainable balance, and just that, turns out to be the main problem still not resolved. The strands of thought are essentially two: the first part of experts who want to "weigh" the three dimensions of sustainability in a single-score, and a part of scholars who are deeply opposed [32].

In the first case, you are facing a new construction of the framework of the LCA which includes LCC and SLCA in a single analysis, including additional impact categories in the inventory. The advantage, in this case, is to have a single inventory of data and consequently of impact categories and a single analysis model with objective and common purpose.

In the second case, the LCSA is based on three distinct assessments of the life cycle consistent with the boundaries of the system, ideally identical, as in the general formulation, and composed of the three

tools that reflect the three branches of sustainability. In the future, the three methods should be standardized (as for LCA) or at least harmonized, performing a formal weighting between the three pillars. The main advantage of this approach is its transparency and the reduction of subjective assessments and even more advantageous is the absence of the possibility of compensation between the pillars.

For the standardization purposes, the ISO seems to preponderate the latter case, leaving the three analysis to be conducted separately even if a revision of the standard should not be excluded [32].

On the other hand, models of different nature for the resolution of the problem have already been proposed. A model is suggested by the Research Group of The University of Stuttgart which adds to the variables of life cycle engineering (environmental, economic and technological) the variable "capital" or adding it as a fourth variable. Another understandable communication tool, even for non-experts, is represented by the revision of "The Mixing Triangle" proposed by Hofstetter [33], through the Life Cycle Sustainability Triangle or model of communication of the results proposed by Finkbeiner et al. [6], and finally the model suggested by Calcas international project, coordinated by ENEA with the aim of connecting the instruments of Life Cycle Thinking and make them more consistent with the wider concept of sustainable development to define a "new LCA" that included all variables [34].

## **5. Life Cycle Approach and Tourism: our model**

The purpose of the application of LCT to tourist services can be: motivations of cultural, natural, relaxation, sports and health, etc., push potential users to move towards a variety of locations that meet their expectations [35].

LCSA application to services in general is more difficult than the one to products, by reason of the lack of indicators.

Shared in fact is the integration of the standard model for the analysis of the life cycle with typical indicators of the sector, such as for example, the evaluation of the load capacity, the time-space concentration, the seasonal variability of the data, the risk that the attractiveness of a territory, directly dependent on the quality of the environment, decrease gradually with the increasing of the influx of tourists. Among the variables directly related to the life cycle instead, the integrated water cycle, water supply, solid waste management, conservation of habitats and biodiversity are generally monitored[1]. However, the cases of LCA implementations are not so many in literature, and they are widely variable in terms of the object of study, methodological choices and results. In particular, the objects studied could be classified in a different manner, from a simple analysis concentrated on the service, to one that takes into consideration mainly the buildings, up to one that have as an object of study the entire tourism industry [35]

In literature, the low number of analysis may lead to different interpretations of the motivation of the phenomenon; the main thing that stands out is the considerable difficulty in applying the Life Cycle Thinking and the limited awareness of the potential of application of the methodology in the field. In addition, the lack of data banks leads to a lack of consideration of the environmental impact of the sector or under estimate the results of the application of the instrument to the sector [35,36,37].

The first applications of the methodology in the tourism sector dates back to the '90s, with the implementation of LCA methodology to the Tour Operator by the UK CEED, who conducted the analysis for British Airways Holidays (BAH). At a first step only the environmental impacts of major destinations were detected, and only in a second phase the impact of the management of tourist facilities was carried out [38,39,40].

De Camillis et al. (2010) highlights the main differences between the analysis and consideration concerning all questions relating to the application of the methodology in the field. In particular, it is detected whether or not the conventionality of the analysis conducted in each study (based on compliance with the standard ISO 14040), the different object of study and the objective of the analysis, the clear definition of the functional unit [41].

Special relevant features assume the LCA conducted on hotels, in which the phases of the life cycle have been defined basing on the life cycle of the building, and lead mainly to an environmental assessment of the performance characteristics of the building and related services, or to support an eco-design of processes with the aim of comparing the various construction projects.

Several approaches have been taken on the detection and evaluation of the environmental performance of the services provided. In these cases, the method is generally applied door to door.

According to this approach are included in the processes of departure and return of tourists, adopted in many cases, but limited to a few important steps in the life cycle. If we consider the overall tourist experience, considering it as a "product" of the real sector, this experience it is the result of the sum of the various processes connected with each other, and therefore includes a package of services [42].

This is, in general, the most complete approach but, at the same time, the most complicated in the evaluation phase of the service. The door-to-door scheme becomes easier to apply in the analysis generalized to entire regional systems [43].

The missing data can be found through the integration of models such as input-output analysis [36,37,41].

The approach used for our analysis of an accommodation facility is the modular approach, based on the door to door approach. It allows the assessment of individual processes and impacts of the service through the total sum of it.

This mainly happens for methodological reasons, since, for product analysis is easier to outline the flows and exchanges between processes as flows of matter, because in the case of services, the connection between them is not so obvious and intuitive. In the following table, we have summarized the setting of the analysis based on the ISO 14040-14044.

**Table 1.** Setting up of the analysis according to ISO 14040-14044 for tourism sector applications

<b>The objective of the study</b>
Quantify the environmental impact of the activities carried out by the customer during the time of full use of its tourist services of a holiday in a specific structure, in this case, the accommodation taken into analysis.
<b>The aim of the study</b>
Identification of the critical points and design of appropriate strategies to reduce the impacts.
<b>Functional Unit</b>
The functional unit is a temporal unit. The service is considered as a stay of 10 days, chosen on the basis of mean residence time in the structure during the high season. Analyzing the locally obtained data in fact, it was verified that the largest number of customers stay on average from 7 to 14 days. Customers of the structure, moreover, tend to be loyal to the site and to repeat the same holiday for several consecutive years. This helps to detect the profile.
<b>System Boundaries</b>
In the definition of system, boundaries have been outlined, taking into account the

period of stay of tourists in the structure. For each phase, the processes usually considered are: arrival in the structure, permanence, the end of the stay and departure of the visitor [44].
<b>Cuts off:</b>
It is excluded the environmental impact of the construction of the building. They are not charged with the cost of production and maintenance of household appliances.
<b>Quality of data: Source</b>
<ul style="list-style-type: none"> <li>• Primary data coming directly from the bills of water, electricity and gas use, waste through questionnaires and direct interviews to facility staff and customers;</li> <li>• Secondary data analysis from interacting with local companies operating in connected services (transport, tourism, catering and laundry services) specific databases for LCA, including Ecoinvent, database software used for modelling inventory, and other external documents.</li> </ul>

Source: Our elaboration, based on Arcese, (2013).

## 6. Discussion and Conclusions

In conclusion, it is possible to observe that there are many studies and applications of the methodology in the field of tourism services. Part of these studies are based on LCA framework, whereas in part represent a hybrid economic-environmental input-output LCA or simplified analysis. More frequent in tourism LCA application is the adoption of a hybrid model [36]. In particular De Camillis, Petti and Raggi [45] applied LCA in Hotels but they not include buildings operations impact in the analysis [15]. Many studies analyzed in this paper have been conducted on Italian tourism system and it is important to note that the geographical characterization of the studies makes the more subjective analysis of the traditional subjectivity of the tool generally.

In the end, according to the general report on the environmental impacts, literature review and bibliography of LCA for the functional unit so specific impact indicators most affected concur with the findings in other studies, confirming that the analysis model seems to be correct [36,40,45].

In particular, in the analyzed papers the most affected indicators of impact categories are the GWP for all reservation services and, based on the Eco Indicator, especially for the quality of transport eco-points Human Health and the indicator of the end point. In many cases of LCA applied in tourism, high value had occurred in water depletion and acidification potential, in particular for the services of guest rooms and laundry services. The CML indicator had a minimum amount in the reference and are not to be considered in major part of calculation as the ADP (Abiotic Depletion) according the CML2001. For the same CML instead, but also EDIP2003 and Eco-indicator 99 emissions are relevant and the index Recipe Midpoint Water Depletion [1].

For this reason, it is important to identify a pattern of application of LCA methodology for the tourism sector in macro scale and for companies in the sector, such as accommodation, in micro scale.

## Conflict of Interest

"The authors declare no conflict of interest".



## References and Notes

1. Arcese G., Il Life Cycle Sustainability Assessment per la valutazione della sostenibilità aziendale, PhD Thesis, **2013**, Padis Sapienza, <http://hdl.handle.net/10805/2044>
2. Lucchetti M.C., Papetti P., Arcese G., Eco -innovation and green economy: the role of sustainability life cycle assessment, Planet Under Pressure, 25–29/03, **2012**, publication in Abstract, Elsevier conference, P2.221
3. Azapagic A., Clift R., Life cycle assessment and multiobjective optimisation. Journal of Cleaner Production, **1999**. Vol. 7, No. 2, pp. 135-143.
4. Tenuta P. Indici e modelli di sostenibilità. Franco Angeli Editore, Milano, **2009**
5. Merli R. La responsabilità sociale di impresa: aspetti teorici e strumenti operativi, Cedam, **2012**
6. Finkbeiner M., Schau E.M., Lehmann A., Traverso M. Towards Life Cycle Sustainability Assessment, Sustainability **2010**, 2, 3309-3322; doi:10.3390/su2103309
7. Allenby B., Industrial Ecology: Policy Framework and Implementation, Prentice Hall, **1999**.
8. Holden, 2008; THE ENVIRONMENT-TOURISM NEXUS Influence of Market Ethics, Annals of Tourism Research, **2009**, Vol. 36, No. 3, pp. 373–389,
9. Mieczkowski, Environmental issues of tourism and recreation, University press of America, Maryland, **1995**
10. Becken S. & Hay J.E., Tourism and Climate Change: Risks and Opportunities, Channel View Publications, Clevedon, UK, **2007**
11. Dickinson, Robbins, & Fletcher, Representation of transport: A Rural Destination Analysis, Annals of Tourism Research, **2009**, Volume 36, Issue 1, Pages 103–123, <http://dx.doi.org/10.1016/j.annals.2008.10.005>
12. McKercher, Prideaux, Cheung, & Law, Achieving voluntary reductions in the carbon footprint of tourism and climate change Special Issue: Tourism: Adapting to Climate Change and Climate Policy, **2010** Journal of Sustainable Tourism, Volume 18, Issue 3
13. Becken S., Harmonising climate change adaptation and mitigation: The case of tourist resorts in Fiji, Global Environmental Change [0959-3780] Becken yr:**2005** vol:15 iss:4 pg:381 -393
14. Bohdanowicz P., European Hoteliers' Environmental Attitudes, Greening the Business, Hospitality, Leisure, Sport & Tourism doi: 10.1177/0010880404273891 Cornell Hospitality Quarterly May **2005** vol. 46 no. 2 188-204
15. Filimonau V., Dickinson J.E., Robbins D.K., Reddy M.V. A critical review of methods for tourism climate change appraisal: Life cycle assessment as a new approach, Journal of Sustainable Tourism, **2011**, Volume: 19, Pages: 301-324, ISSN: 0966-9582, DOI: 10.1080/09669582.2010.527345
16. Lepp A., Harris J., “Tourism and national identity in Uganda”, Int. J. Tour. Res., vol. 10, pp. 525–536, **2008**
17. Burkart A.J., Medlik S., “Tourism: Past, Present and Future”, Heinemann Educational Books: London, United Kingdom, Vol. 2, **1972**
18. Gossling S., “Global environmental consequences of tourism”. Global Environmental Change , **2002**, vol.12, pp. 283–302,
19. UNWTO Tourism Highlights, **2012** Edition
20. IPCC (**2007b**), ‘Summary for Policymakers’, in M. L. Parry et al. (eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability – Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, University Press Cambridge, Cambridge and New York
21. Font X., “Environmental certification in tourism and hospitality: Progress, process and prospects”, Tour. Manag., **2002**, vol. 23, pp. 197–205
22. Arcese G., Lucchetti M.C., Merli R., “Social Life Cycle Assessment as a Management Tool: Methodology for Application in Tourism”, Sustainability, **2013**, 5:8, pp. 3275-3287
23. European Union, European Regional Policy for tourism, **2013**

24. EIO, The eco-innovation challenge: Pathways to a resource-efficient Europe. Brussels, Belgium: European Commission, Directorate-General for the Environment, **2011**
25. Turner R.K., Pearce D., Bateman, I., Environmental Economics: An Elementary Introduction, John Hopkins University Press, Baltimore, **1993**
26. Opschoor, H. and Reijnders, L., Towards sustainable development indicators, In: O. Kuik and H. Verbruggen (Editors), In Search of Indicators of Sustainable Development. Kluwer Academic Publishers, Dordrecht, **1991**
27. Baldo G.L., Marino M., Rossi S., Analisi del ciclo di vita, Franco Angeli Ed, Roma, **2008**
28. Rubik, F. Integrierte Produktpolitik; Metropolis: Marburg, Germany, **2002**
29. UNEP/SETAC, Guidelines for social life cycle assessment of products, UNEP/SETAC Life Cycle Initiative, UNEP, Paris, France, **2012**
30. International Organization for Standardization - ISO, ISO 14040: Environmental management - life cycle assessment - principles and framework, ISO copyright office, **2006**
31. UNEP/SETAC, Guidelines and principles for social impact assessment, Environmental Impact Assessment Review, 15, 11-43, **2011**
32. Kloepffer W., Life cycle sustainability assessment of products, The International Journal of Life Cycle Assessment, **2008**. Vol. 13, n.2, pp. 89-95
33. Hofstetter P., Braunschweig A., Mettier T., Müller-Wenk R., Tietje O., The Mixing Triangle: Correlation and Graphical Decision Support for LCA-based Comparisons. Journal of Industrial Ecology, **1999**, 3, pp. 97–115. doi: 10.1162/108819899569584
34. Zamagni, A., P. Buttol, P. L. Porta, R. Buonamici, P. Masoni, J. B. Guinee, R. Heijungs, T. Ekvall, R. Bersani, A. Bienkowska, U. Pretato. **2008**. Critical review of the current research needs and limitations related to ISO-LCA practice. Technical Report of the CALCAS project
35. De Camillis C, Raggi A, Petti L Ecodesign for services: an innovative comprehensive method. **2010**, International Journal of sustainable Economy Vol.2, No3, pp. 277-292
36. Patterson M. and McDonald G. How Clean and Green is New Zealand Tourism? Lifecycle and Future Environmental Impacts, Manaaki Whenua Press, Landcare Research, Lincoln, Canterbury, New Zealand, **2004**
37. Rosenblum J., Horvat A. and Hendrickson C. Environmental Implications of Service Industries, Environmental Science & Technology, **2000**, Vol. 34, No 22, pp. 4669-4676
38. Sisman A life-cycle analysis of a holiday destination: Seychelles, British Airways Environment Report 41/94, UK CEED, Cambridge, UK, 1994
39. UK CEED An Assessment of the Environmental Impacts of Tourism in St. Lucia, British Airways Environment Report 5/98, Cambridge, UK **1998**
40. Petti L. and Tontodonati S. The Use of LCA as a Tool to Implement EPDs: An Application to Hotel Services, Proceedings of the Fifth International Conference on Ecobalance, **2002**, “Tsukuba, Japan, pp. 329-332
41. De Camillis C., Raggi A, Petti L., Tourism LCA: state-of-the-art and perspectives, International Journal of Life Cycle Assessment, **2010**, n. 15, pp.148–155, DOI 10.1007/s11367-009-0139-8
42. Judd D.R. Commentary: Tracing the Commodity Chain of Global Tourism, in Tourism Geographies: An International Journal of Tourism Space, Place and Environment Volume 8, Issue 4, **2006**, DOI:10.1080/14616680600921932
43. Kuo N.W., Chen P.H., Quantifying energy use, carbon dioxide emission, and other environmental loads from island tourism based on a life cycle assessment approach, Journal of Cleaner Production **2009**, 17 (15):1324–1330
44. Castellani V., Sala S., Ecological Footprint and Life Cycle Assessment in the sustainability assessment of tourism activities. Ecological Indicator, **2012** n.16, pp.135–147. DOI: 10.1016/j.ecolind.2011.08.002
45. De Camillis C, Petti L, Raggi A. LCA: a key-tool for sustainable tourism? Proceedings of the 8th international conference on EcoBalance, Tokyo, Japan, 10–12 December 2008, pp 485–488, **2008**