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The Environmental Effects of Tourism Architecture on Island Ecosystem in Cayo Guillermo, Cuba

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Abstract

The objective of this study is to determine the main adverse impacts that may be caused by tourism architecture upon island ecosystems consisting of small islands or islets and to propose an architectural and landscape design with a focus on the environmental sustainability of the same. A study of projects was undertaken in Cayo Guillermo, located to the north of Ciego de Avila in Cuba using methods of life-cycle assessment of buildings, matrix methods of the activities that caused severe environmental impact and statistical processing through multivariate analysis. Conclusions were reached on the need for designs that did not harm the ecosystems of islands with high ecological fragility. It has been determined that suitable construction intervention would decrease the negative impact and would allow the natural resources of these valuable ecosystems that are the basis for responsible sun and sand tourism to be preserved.

Keywords

Environmental Effects, Architecture, Tourism, Island Ecosystem

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1. Introduction

Tourism architecture on island coastal ecosystems on the whole provokes undesirable environmental effects, also called negative environmental impact and these have severely affected the vegetation, wildlife habitats, landscapes, soils and wetlands, as a result of the construction activities taken.

The rise of new innovative construction technologies and the high complexity of current tourism projects impose special attention on the problem of prediction and estimation of potential failures, which can through their adverse impact determine unimagined scenarios exceeding the limits for acceptable change of the vulnerable

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coastal ecosystems because they jeopardize the development of sustainable tourism for society and the environment [1].

Tourism to the islands is the second most important holiday destination, just behind historic cities. Ecotourism in Dominica and the Seychelles, diving in Malta and the Maldives, music tourism of Cape Verde, cultural tourism in the Marshall Islands, the tourism festival in the Bahamas, tourism meetings and conventions in Trinidad and Tobago, and medical tourism in Barbados, are just some of the strategies that small island states resort to [2].

Thus, among the reasons why tourists choose the islands is, firstly, climate and, secondly, the existence of a physical separation from the continents, which makes the islands a special and attractive place for travelers AND the attraction posed by natural and cultural resources that exist in these geographic areas should also be added as a reason [3].

Tourism in the islands raises concerns for safety and excessive growth with an unsustainable focus on the interests of a model of economic development [4]. Moreover, the small islands are considered to be among the most vulnerable ecosystems in the world, due to the reduced size of their territory and their physical conditions of insularity, which increase the susceptibility and exposure of their natural or social systems to the impact of threats of a natural character or from mankind. They are fragile ecosystems, with highly physical and socio cultural complexity in those inhabited islands. The mere description of island takes for granted that it is fragile, small, peripheral, and vulnerable [5].

Besides the natural factors that have led to the deterioration of the beaches, man has increased erosion with inadequate management of coastal vegetation and incorrect location of tourist facilities in areas of sunshine. In general these islands have high biodiversity and unique landscapes, they have a high dependence on imported products and an ever increasing pressure exerted on them by the development of tourism. They have a high vulnerability because they are subject to risks and natural disasters such as rising sea levels, increasing temperatures and the frequency of hurricanes and tsunamis. In addition they have few reserves of fresh water and sandy beaches with high ecological fragility eroded by different natural and anthropogenic causes [6].

In the Balearic Islands of Spain, urbanization, the construction of the road infrastructure, the opening of quarries and the construction of golf courses are the main tracks of artificial territory which in the Balearic Islands is closely linked to tourism [7]. Also in reference to the example mentioned [7], it is proposed that the flows of imported materials to the Balearic Islands—in the main fuel and construction materials—amount to 9.8 tons/capita (1997-2008 average), well above the Spanish average (5.5 t/capita) and that of the EU-15 (3.76 t/capita, both figures from 2000).

Tourism activities in island ecosystems, although a source of income for them can affect the natural and cultural heritage of these if appropriate measures for the management of tourism projects are not applied. A lot of them are located in coastal ecosystems with very fragile beaches and cause high negative effects on the environment due to the lack of ecological education of the designers, builders, investors and tour operators.

In order to prevent ecological damage on small islands, one of the environmental management tools most commonly used is the integrated management of the coastal area which attempts to coordinate planning and action, involving local communities and institutions so as to design new strategies in the hope of achieving equitable and sustainable solutions. Among the main topics covered are the management of fresh water; the maintenance of coastal communities and the biodiversity that underpins them; migration and the quality of life of coastal human settlements; the impact of climate change; coastal erosion and rising sea level [6].

2. Research Methodology

Case studies are analyzed on the projects of Cayo Guillermo a small island, recognized as part of the northern keys located in the Sabana Camagüey Archipelago, in the province of Ciego Avila in Cuba are analyzed. The physical and socio-economic environment of the site [8] chosen for the case study was examined and was complemented with the scenario method compared to similar coastal ecosystems [9]. The compared scenarios method which is one of the most optimal qualitative observation methods to compare projects in different biogeographic regions, in addition to diagnosis and monitoring of environmental changes, for a fixed period of time can incorporate other complementary analysis such as the aforementioned matrix methods [9].

The analysis was based on information from qualitative and quantitative research methods. The analysis and discussion of international and national experiences concerning architectural projects of tourism in island ecosystems was conducted.

The method of consulting selected experts was used in the issue of the management of fragile ecosystems [6]. Within this method, the qualitative selection of 34 experts with the Delphi Method [10], was conducted with the use of the process of quantifying 0 - 1 range [8], by the Kendall Coefficient for Competence (W Kendall) [8], and a final panel of 15 experts was formed with a high degree of competition (H), which was calculated in accordance with the opinion of each candidate on their level of knowledge about the problem to be solved and with the sources that will allow the criteria to be argued. The values of the degree of influence [8] [10], of each of the sources in the criteria are given, (**Table 1**).

Information from non-parametric statistics was processed because non-parametric statistics make no assumptions about the probability distributions of variables being assessed whose interpretation does not depend on the population fitting any parameterized distributions, such as activities constructions.

The analysis of the main components was used, a method which is feasible to use due to the characteristics of the selected variables: discrete, qualitative and measures on an ordinal scale Although there are several types of correlation coefficients, it was decided to use the Spearman's rank correlation coefficient order coefficient for allowing a greater number of variables correlated with matrices identifying environmental impacts [9].

Spearman range coefficients with values between 0.700 and 1 were grouped in a first range or level of importance and coefficients with values 0.600 and 0.699 were included in a second range or level of importance. Spearman range coefficients with values below these ranges were not considered due to the low relevance of the figures, although they are also present to a lesser degree in construction activities that cause environmental impacts. The results were classified according to the mathematical magnitude of the coefficients closest to 1. Only the values of a first range or level of importance were considered and coefficients with values between 0.700 and 1 [9] were brought together. The coefficients with values lower than these ranges mentioned were not considered on account of the little relevance produced by the figures, although they are present to a lesser extent, within the construction activities that cause environmental negative impact.

The life-cycle assessment (LCA being the acronym in English) was performed, by way of identification matrices of impacting activities contained in the architectural projects. Finally the information was processed using non-parametric statistical analysis of main components and the results and conclusions of the research were obtained.

The lifecycle analysis which is one of the most accurate methods of environmental assessment focused on the sustainability of products, processes and services and saving materials and energy from various aspects identified in diagnostics or inventories and assessment of the potential impact of actions or activities that cause such impact. It is raised by several authors [11] [12] that there are many methodologies proposed in articles that aim to overcome the existing prejudices of architects and engineers on the complexity of the LCA [13].

However, the assessment of the environmental impact of the construction technologies is a complex process given that there are many elements involved, combined in different operations and stages throughout its life. Although the analysis of the life cycles can be broken down into many more [11] for the purposes of evaluating the negative effects of architectural projects or impacting activities in this work it is sufficient to use the following four cycles:

Table 1. Values of expert's competence.

Sources of argument on the issue: architecture, tourism, island ecosystems	Degree of influence of each experts criteria (0 - 1 range)		
	High (H)	Medium (M)	Low (L)
1. Research related to tourism architecture, sustainability, and island ecosystems	0.4	0.39	0.2
2. Experience gained in working on the issue (undergraduate and graduate received and/or given, scientific degrees, participation in scientific projects)	0.4	0.33	0.2
3. Participation in international and national workshops on the subject	0.3	0.12	0.08
4. Analysis and knowledge of foreign specialized literature and publications by national and foreign authors	0.15	0.09	0.05
5. Scientific and/or teaching expert category	0.2	0.06	0.04
Total of experts criteria	15	9	10

- Cycle 1 Projects: includes all the indicators and activities involved in planning where conceptual designs with the loads of tourists and employees are planned, the urbanizations and the infrastructure, the geological investigations and others, as well as all activities of the architectural project up to the final stage. This cycle is the most important in the evaluation of a project.
- Cycle 2 Construction: includes all activities carried out in a work from the preparation of temporary facilities for workers, earthworks, foundations, structures and finishes, exterior areas and ground and gardening, to the point of delivery to the tour operator.
- Cycle 3 Operation: an increased load of tourists and workers occurs, temporary facilities are located in the beach area, solid waste and higher consumption of fresh water and energy, among others are generated.
- Cycle 4 Closure or Abandonment: linked to the closure of the temporary facilities for the builder, degradation of landscapes and impact to the coastal zone and the beach as well as the closure of mines and quarries extracting building materials.

3. Case Study of Projects in Cayo Guillermo

Cayo Guillermo is located in the Sabana-Camagüey Archipelago; a chain of islands stretching 465 km along the north coast of Ciego Avila province, in north central of Cuba The sampling site on the northern shore of the cay includes reefs, seagrass beds, and a permanently flooded red mangrove forest [6].

Historically, Cayo Guillermo has been virtually devoid of human population. The social and economic assimilation of Cayo Guillermo and Cayo Coco, and adjacent cays of the archipelago took place at the beginning of the 20th century, characterized mainly by forest exploitation and charcoal production [6].

Human influence on marine, coastal, and terrestrial environments is limited that are analyzed are located within of the beaches Punta Rasa and Pilar in the Cayo Guillermo projects which have an area of only 13.2 km^2. There are three beaches with calm waters with an approximate length of 4 km [6].

The analyzed architectural projects were designed in the early 2000s and located in the Punta Rasa and Pilar beaches with the distances established within the legal framework known as the Decree Coastal Zone Law.

Nevertheless these pristine beaches contain unique landscapes, exclusive coral ecosystems and high endemic biodiversity so architectural intervention in them must contain a focus on sustainability in the long term.

The project is located in an area of 46 hectares and there is expected to be the planning for over 1700 tourist rooms; with a density of 50 inhabitants per hectare (in Hab./Ha) in Pilar, which is excessive considering the high natural values and fragility of this area. It has tectonic hills—abrasive; chains of sandy dunes measuring 12 - 15 meters in height, on the beaches The proposed project of Punta Rasa—Pilar, the subject of this study comprises several beaches of high quality such as El Paso beach measuring 3300 meters in length; El Medio beach 700 meters long and Pilar beach, on the western tip of the islet [6].

At Playa Pilar, a comprehensive management plan for this scenic unit should be prepared. However, it is required that the following activities be immediately undertaken: remove inappropriate and illegal facilities, ban vehicle access to beach areas, prohibit anchoring boats on the beach, Caesarians' trees and remove stumps. The establishment of the western boundary of the plot should be conditioned to a conciliation process between the relevant agencies in order to achieve the lowest possible impact of future investment on starting chains fossil dunes. In the Punta Morro plot maintaining the rock as an important landscape element should be considered; use a low-density ecotourism mode for high (soft) income instead of the 700 rooms proposed with very high densities of 50 rooms per hectare, respecting the protection zone limit proposed for this type of coast in the Decree Coastal Zone Management Law in Cuba [14].

4. Results and Discussion

The planning and the environmentally responsible architectural and landscape design in coastal ecosystems comprising small islands or islets, would avoid most of the impatient activities that are produced in the life cycle of the tourism architecture. It is estimated that the potential impact would diminish or be mitigated by almost half. Whilst conceptual ideas do not change, the focus on sustainability cannot effectively be introduced.

For planning and forecasting in these small island ecosystems more detailed studies are required of the base line of the physical environment, the high fragility, sensitivity and ecological significance for the entire regional ecosystem of the Caribbean, where the Cuban archipelago belongs.

Appropriate technologies (intermediate) should be introduced on small islands or keys. Technological changes have to be produced and the inefficient energy and high environmental impact traditional building techniques replaced. Prefabricated is an option, because it saves labor and time of execution; the elements and parts can be produced off site, particularly in very fragile areas and the consumption of building materials rationalized. However, the assortment of prefabricated systems to be introduced in the keys should be carefully studied, and the systems subjected to a process of technological and environmental assessment before making decisions.

Another reason why the application is recommended in hotel construction of prefabricated building systems is because of the lack of sand, stone, and aggregates in general, in the keys and the critical impact arising from their extraction. The increased initial cost of transportation of light prefabricated elements can be offset by the head start of the operation and the lack of effect on the ecosystems which are irrecoverable, being affected and sometimes destroyed by improper tourism architecture in island ecosystems [14].

The criteria for assessing the impact and determining its significance were applied to the case study in Cayo Guillermo; as was the identification matrix method of evaluating only the negative effects of architectural projects or impacting activities (0 - 1 range) [14] in this work that were assessed in the tourism architecture projects taking into account the four construction stages into which said such activities were pooled according to the LCA (**Table 2**).

During the first stage or cycle 1 Projects the effects occur in the air and soils because the geological research impacts the environment and the natural landscape. During the second stage of construction, primary and secondary effects occur in the climate and environmental well-being; in geomorphology and geology of the cumulative plain and marine; in the complexes of sandy shoreline vegetation, xeromorphic scrub and ever green microphyll forest; wildlife habitats, mainly in the floristic plateau, mangroves and lagoon systems in the southern border; in the structure, and uniqueness of the natural landscape, which becomes more critical with the proximity of areas of technical services (elevated tank, power plant, etc.); and the drainage and surface water runoff area.

The adverse environmental impact of building life cycles on the impacted environmental factors (F) are grouped into the environment in accordance with the components either the abiotic, biotic or socioeconomic environment, and are expressed in the summary tables (**Tables 3-6**) which are shown below.

Table 2. Negative effects of the projects in the punta Rasa-Pilar, Cayo Guillermo.

Activities (A)	Cycle 1. Projects	Cycle 2. Construction	Cycle 3. Operation	Cycle 4. Closure
A1. Geological research	1	0	0	0
A2. Urbanization overload	1	0	0	0
A3. Recreational beach facilities	0.73	0	0	0
A4. Overload of people	0.73	0.92	0	0
A5. Air pollution	0	1	0	0
A6. Liquid waste pollution	0	1	0	0
A7. Solid waste pollution	0	1	0	0
A8. Earthworks	0	1	0	0
A9. Transportation of materials	0	1	0	0
A10. Prefabricated assembly	0	1	0	0
A11. Natural landscape construction	0	1	0	0
A12. Exoticgreen area	0	1	0	0
A13. Paving of roads	0	0.76	0	0
A14. Dumping of waste	0	1	1	0
A15. Excessive vehicle traffic	0	0.73	0.71	0
A16. Beach facilities	0	0	0.75	0
A17. Power plant	0	0	1	0
A18. Temporary facilities	0	0	0.78	0.73
A19. Degradation of landscapes	0	0	1	1
A20. Dumping sand beach	0	0	0.72	0.71
A21. Abandoned quarry	0	0	0	1

Table 3. Impact identification matrix (I) by activities (A) in cycle 1 projects.

Environmental impact factor (F)	Activity A1	Activity A2	Activity A3	Activity A4
F1 Temperature	0	1	0	0.73
F2 Air	1	1	0.73	0.73
F3 Noise	1	1	0.73	0.73
F4 Geology	1	1	0	0.73
F5 Sandstones	1	1	0.73	0.73
F6 Rocks	0	1	0	0
F7 Lagoons	0	0	0	0.73
F8 Cumulative coastal plain	1	0	0.73	0.73
F9 Surface water	0	1	0.73	0.73
F10 Groundwater	1	1	0.73	0.73
F11 Surface drainage	1	1	0.73	0.73
F12 Landscape structure	1	1	0.73	0.73
F13 Coastalvegetation	1	1	0.73	0.73
F14 Xeromorphic scrub	1	1	0.73	0.73
F15 Forestmicrophyll	1	1	0	0.73
F16 Endemic fauna	1	1	0.73	0.73
F17 Population dynamics	0	1	0.73	0.73
F18 Temporary workforce	1	1	0.73	0.73
F19 Urban infrastructure	1	1	0.73	0.73
Total	14	17	10.22	13.14

Table 4. Impact identification matrix (I) by activities (A) in cycle 2 construction.

F	A4	A5	A6	A7	A8	A9	A10	A11	A12	A3	A14	A15
F1	0.92	1	0	0	1	1	0	1	0	0.76	1	0.73
F2	0.92	1	1	1	1	1	1	1	0	0.76	1	0.73
F3	0.92	1	0	0	1	1	1	1	0	0.76		0.73
F4	0	0	0	0	1	0	1	1	0	0.76	0	0
F5	0.92	1	0	1	1	0	1	1	0	0.76	0	0
F6	0	0	0	1	1	0	1	0	0	0.76	1	0
F7	0	0	1	1	1	0	0	0	0	0	1	0
F8	0.92	0	1	0	1	0	1	1	0	0.76	0	0
F9	0.92	0	1	1	1	0	1	0	1	0.76	1	0
F10	0.92	0	1	1	1	0	1	0	1	0.76	1	0
F11	0.92	0	1	1	1	0	1	1	1	0.76	1	0.73
F12	0.92	0	1	1	1	1	0	1	1	0.76	1	0.73
F13	0.92	1	1	1	1	0	1	1	1	0.76	0	0.73
F14	0.92	1	1	1	1	0	1	1	1	0.76	0	0.73
F15	0.92	1	1	1	1	0	1	1	1	0.76	0	0.73
F16	0.92	1	1	1	1	0	1	1	1	0.76	1	0.73
F17	0.92	1	0	0	0	1	0	0	0	0.76	0	0.73
F18	0	1	1	1	1	1	1	0	1	0.76	1	0.73
F19	0	0	1	1	1	1	1	0	1	0.76	1	0.73
Total	12.88	10	13	12	17	7	15	12	10	13.68	12	8.76

Table 5. Impact identification matrix (I) by activities (A) in cycle 3 operation.

F	A14	A15	A16	A17	A18	A19	A20
F1	0	0.71	0	1	0	0	0
F2	1	0.71	0.75	1	0.78	1	0.72
F3	1	0.71	0.75	1	0.78	0	0.72
F4	0	0	0	0	0.78	1	0.72
F5	0	0	0.75	0	0	1	0.72
F6	1	0	0	0	0.78	0	0.72
F7	0	0	0	0	0.78	1	0
F8	0	0	0.75	0	0	1	0.72
F9	1	0.71	0	1	0.78	1	0.72
F10	1	0	0	1	0.78	0	0
F11	1	0.71	0.75	1	0.78	1	0.72
F12	1	0.71	0.75	1	0.78	1	0.72
F13	0	0.71	0.75	1	0	1	0.72
F14	0	0.71	0	1	0.78	1	0
F15	0	0.71	0	1	0.78	1	0
F16	1	0	0.75	1	0.78	1	0.72
F17	0	0.71	0.75	1	0.78	0	0.72
F18	1	0.71	0	1	0.78	0	0.72
F19	1	0.71	0.75	1	0.78	1	0.72
Total	10	8.52	7.50	14	11.7	13	10.08

Table 6. Impact identification matrix (I) by activities (A) in cycle 4 closure.

F	A18	A19	**A20**	A21
F2	0	0	0.71	1
F3	0.73	1	0.71	1
F4	0	0	0.71	1
F5	0	0	0.71	1
F6	0	1	0.71	1
F7	0	1	0	0
F8	0	0	0.71	0
F9	0.73	1	0.71	1
F10	0	0	0.71	1
F11	0	0	0.71	1
F12	0.73	1	0.71	1
F16	0	0	0.71	1
F17	0.73	1	0.71	0
F18	0.73	1	0.71	1
F19	0.73	1	0.71	0
Total	4.38	8	10.65	11

In the third cycle of operation, the impact will be caused by the disruption caused by the excessive number of people in the area and high degree of urbanization, an effect that begins at the planning and design stage. Another impact is the increase in noise, temperature and air pollution by paving and designs for hotels that do not promote the use of passive solar and bioclimatic design, as well as the power plant fuel oil. They produce more positive impact on social structures, through increased employment and the labor force of higher qualifications, than that of the construction cycle.

In the last cycle of closure, abandonment and recycling the landscape, fauna, geomorphology, and surface and groundwater is affected. On a positive note, the possible restoration of an abandoned quarry on the edge of the tourist road of Punta Rasa, and the dismantling of some of the temporary facilities is appreciated.

The most severe impact is caused by the contamination of soils and the lagoon fills with foreign material in several areas; as with the loss of quality of seawater and the beach through the dragging of sediment and dust, which added to the excessive load, the remaining caesarians' trees, and the very beach erosion, can degrade this valuable unit within a few years

5. Conclusions

- The life-cycle assessment methodology can analyze the overall environmental impact during the life of a building. In the cycle of projects environmental factors suffer changes related to the protected area proposed as a national park; the beach and the chains of fossil dunes; as well as the vegetation complexes of a sandy coast, xeromorphic scrub, ever green microphyll forest, the habitats of endemic wildlife such as birds, fish, mollusks, amongst others. The greatest impact of traditional technologies used in the islets and other coastal areas is mainly produced in the proceedings on the ground level (level 0.00 above the sea) and below it. It requires minimizing clearings, excavations and earthworks, as well as lightening foundations and loads and high load-bearing structures and reducing their heights. It imposes removing the fill, mainly in lagoons systems connected to the sea.
- The need for changes in the technologies used to build small islands, before it happens in other ecosystems, is demonstrated, because of the high environmental impact generated; the high energy consumption; excess workforce in work which reinforces the aggression to the environment; changes in heavy construction equipment and lifting means for smaller and lighter equipment; and especially changes in the materials used and traditional building techniques, which extend the deadlines. The same response to building and designing nature tourism on an islet cannot be the same as the one given for tourism on the mainland.
- It is necessary to study new forms of tourism that are being imposed on the world. A good option is a healthy real estate construction for family tourism, as a second home, which in turn reduces the seasonality; high densities of tourists simultaneously; creates a greater sense for visitors of identity and belonging to the region; and it offers the variant to also build in the second coast lines, leaving strips of beach free, with a new morphology that may be small developments with common service centers, and keeping the humid tropics architectural typology, the scale of island ecosystems, and the historical and cultural legacy of traditional beachside towns of Cuba.

References

[1] Gutiérrez, L.R. and Céspedes, D.G. (2014) Environmental Failure Analysis for Tourism Constructions on Coastal Ecosystems. *Revista Electrónica de la Agencia de Medio Ambiente*, **14**, 26. http://ama.redciencia.cu/articulos.php

[2] Roberts, S. and Lewis-Cameron, A. (2010) Small Island Developing Status: Signs and Prospects. In: Lewis-Cameron, A., Ed., *Marketing Island Destinations*: *Concepts and Cases*, Elsevier, Oxford, 1-10. http://dx.doi.org/10.1016/B978-0-12-384909-0.00001-5

[3] López-Guzmán, T., Borges, O. and Cerezo López, J.M. (2012) Analysis of the Tourism Supply and Demand on the Isla de Sal, Cabo Verde. *Rosa dos Ventos—Turismo e Hospitalidade*, **4**, 4. http://www.ucs.br/etc/revistas/index.php/rosadosventos/article/view/1458

[4] Baldacchino, G. (2014) Small Island States: Vulnerable, Resilient, Doggedly Perseverant or Cleverly Opportunistic? https://etudescaribeennes.revues.org/6984

[5] Amoamo, M. (2011) The Mitigation of Vulnerability: Mutiny, Resilience and Reconstitution. A Case Study of Pitcairn Island. *Shima*: *The International Journal of Research into Island Cultures*, **5**, 69-93.

[6] Alcolado, P.M., Garcia, E.E. and Arellano-Acosta, M. (2011) Sabana-Camagüey Ecosystem: State, Progress and Chal-

lenges in the Protection and Sustainable Use of Biodiversity. *Transactions on Automatic Control Editorial Academia*, Habana.

[7] Murray, I. (2010) Indicators of Socio-Ecological Sustainability of the Balearic Islands (2003-2008). Grupd' Investigació Sostenibilitat i Territori, Universitat de les Illes Balears. http://www.uib.es/ost/estudi/

[8] García Céspedes, D., *et al*. (2014) Proposed Methodology of Environmental Management for Agroecosystems with Health Risks by Chemical Contamination. *Revista Habanera de Ciencias Médicas*, **13**, 4. http://new.medigraphic.com/cgi-bin/resumen.cgi?IDREVISTA=260&IDARTICULO=52088&IDPUBLICACION=5298

[9] Gutiérrez, L.R. (2015) Impact Assessment of Tourism Construction in Cuba. *Journal of Building Construction and Planning Research*, **3**, 1. http://www.scirp.org/Journal/PaperInformation.aspx?PaperID=54460 http://dx.doi.org/10.4236/jbcpr.2015.31002

[10] García, D., *et al*. (2013) Environmental Management Model for Agro Ecosystems with Possible Health Risks Due to the Presence of Chemical Contamination. *Proceedings IX Convención Internacional Sobre Medio Ambiente y Desarrollo*, Habana.

[11] O'Reilly, V., Bancrofft, R. and Ruiz, L. (2010) Concrete Technologies in Their Life Cycle. Concreto y Cemento: Investigación y Desarrollo. *Revista CONPAT*, **1**, 42-47. http://www.redalyc.org/pdf/3612/361233546004.pdf

[12] Cárdenas, J.P., Muñoz, E., Riquelme, C. and Hidalgo, F. (2015) Life-Cycle Assessment Applied to Housing Simplified Panels SIP (Structural Insulated Panels). *Revista Ingeniería de Construcción*, **30**, 1. http://www.ricuc.cl/index.php/ric/article/view/555/pdf http://dx.doi.org/10.4067/S0718-50732015000100003

[13] Zabalza Bribián, I., Aranda Usón, A. and Scarpellini, S. (2009) Life Cycle Assessment in Buildings: State-of-the-Art and Simplified LCA Methodology as a Complement for Building Certification. *Building and Environment*, **44**, 2510-2520. https://www.researchgate.net/publication/223242372 http://dx.doi.org/10.1016/j.buildenv.2009.05.001

[14] Ruiz, L. (1999) The Environmental Impact Assessment of Tourist Constructions in the Northern Keys and Other Coastal Areas of Cuba. Ph.D. Thesis, Higher Polytechnic Institute. https://www.academia.edu/10509977/