

## **Linking EIA to CIAM**

### **Juan Carlos Páez Zamora**

Since the early 70's and despite all their limitations, the Leopold cause-effect matrix methodology has been widely used to display the Environmental Impact Assessment (EIA) processes' results. For a long period these analyses were more than adequate to determine the future environmental effects of a specific project. However, time showed they were not sufficient and that a new approach that factored in individual impacts generated by other projects sharing parts of the same areas of influence was needed.

The Cumulative Impact Analysis and Management –CIAM was born to respond to this need. Several methodologies were soon developed for that purpose (checklists, network diagrams, matrices, etc.), most of them resulting on a variation of those previously conceived for the EIA process, and therefore, carrying to the CIAM their same limitations (e.g. subjectivity, time and spatial frameworks, etc., depending on the method). Still, a great number of cumulative impact analyses use matrices to display their results.

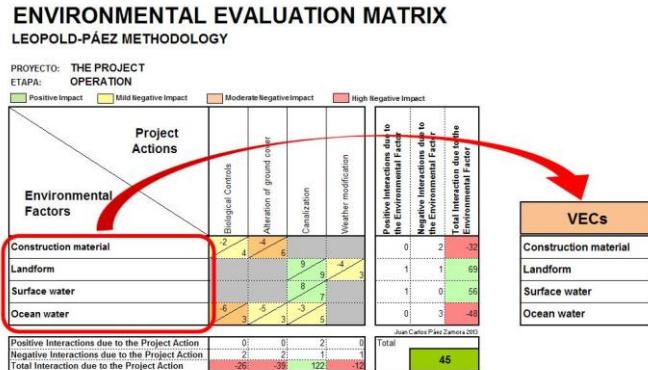
The proposed methodology links the EIA to the CIAM process in a simple approach, using a user friendly Excel application, that allows: i) perform de usual EIA analysis; ii) transform the results of the EIA to figures that can be used in the CIAM; and iii) perform the CIAM from the stand point of a specific project and display its results in a matrix and graphic forms.

### **Assumptions to begin with**

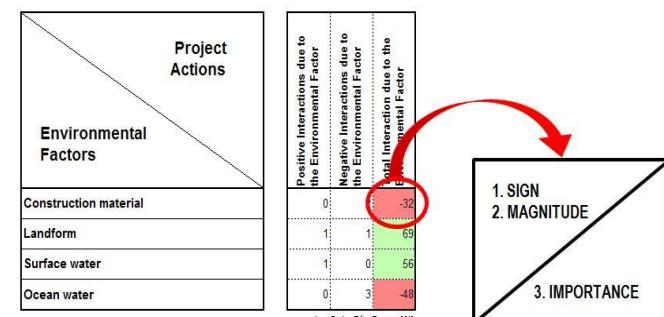
- i) The CIAM is to be carried out from the perspective of a particular project (The Project). Therefore, its main objective is to determine the overall environmental conditions of The Project's area of influence (resulting of the union of its direct and indirect influence areas) after having considered, besides The Project's individual incremental impact, those generated by other past, present and reasonable foreseeable future projects (RFFP). Note that this approach is different from the traditional one –often called the planner's perspective- where the main purpose is to determine the variations of a Valued Ecosystem Component (VEC) as a result of the effects of past, present and future projects.
- ii) A sound EIA is available for The Project. This means that: i) a good baseline has been prepared; ii) the analysis identified the most relevant Project actions as well as the most important environmental components (ENC's) prone to be affected by the selected actions; and iii) the environmental evaluation is solid.
- iii) The EIA results have either been displayed using the Leopold methodology or can easily be translated in to it.
- iv) The criteria to assign the values of magnitude, sign and importance of the action- ENC's interactions are explicitly explained and respond to a sound analysis.
- v) The CIAM will use a matrix to display its results. This means that the project-VEC interactions will also be qualified with values of magnitude, sign and importance, using the same criteria that were employed while performing the EIA.

These assumptions have the following implications:

- i) Given that the starting point for the CIAM is a sound EIA, the sensitive ENC's of The Project's area influence are those -and only those- identified in the EIA. Therefore, these components are adopted as VECs for the CIAM (see Figure 1).



- ii) Given that the CIAM results will be displayed in a matrix, the aggregate impact for each ENC obtained in the EIA has to be translated into figures of magnitude, sign and importance when transforming them into VECs, and the project-VEC interactions will have to be qualified with the latter three values following the same criteria that were used in the EIA (see Figure 2).



- iii) Since The Project's EIA relied on a solid baseline, the impacts generated by past and present projects located near or within The Project's area of influence, must have already been factored in when performing the EIA. This means that the cumulative analysis should only consider new ongoing projects –not taken under consideration in the EIA- and all RFFP.

## How to proceed

With the results of the EIA displayed in a matrix having The Project's actions as columns and the ENC's as rows, each cell where an action-ENC interaction is verified receives three values that respond to previously defined criteria: magnitude, from 1 to 10 that represents how much of the component will be modified by the action; importance, also from 1 to 10 that denotes how much that change is to be cared for; and sign either positive or negative depending if the interaction will improve or deteriorate the given environmental condition.

To determine the overall project incremental impact (which will be used as starting point for the CIAM), three columns are added to the EIA matrix: the first one represents the positive interactions along each of the rows (resulting by counting the number cells with a positive sign); the second, the negative interactions (number of cells with a negative

## ENVIRONMENTAL EVALUATION MATRIX LEOPOLD-PÁEZ METHODOLOGY

		Project Actions						
		Environmental Factors						
		Biological Controls	Alteration of ground cover	Canalization	Weather modification			
Environmental Factors	Construction material	-2	1	6	2	Positive Interactions due to the Environmental Factor	Negative Interactions due to the Environmental Factor	Total Interaction due to the Environmental Factor
	Landform	4	2	1	3	0	2	-32
	Surface water	6	8	9	4	1	1	69
	Ocean water	-6	-5	-3	5	1	0	56
		3	3	7		0	3	-48

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Figure 3: EIA Matrix with results columns

sign); and the third, the total interactions, that is the result of summing along the rows the individual products of the magnitude with its sign times its importance (see Figure 3).

The total interactions column provides very useful information related to each ENC: if value is positive, this means that the component will be benefited by The Project's actions; if it's negative, its overall conditions will deteriorate. The more positive, the better future conditions; the more negative, the stronger deterioration will surely be obtained.

To proceed with the CIAM, the total interaction value for each ENC has to be translated into equivalent values of magnitude, sign and importance when transforming it to a VEC. The *equivalent importance* of the VEC calculated as the average of the values of importance of the corresponding ENC. The *sign* (of the equivalent magnitude) is that of the total interactions of the ENC. The *equivalent magnitude* is calculated as it follows:

- i) Determine the maximum absolute value of the total interactions of the EIA's result column, divide it by its corresponding number of positive or negative interactions (depending respectively if its sign is positive or negative) and then by its equivalent importance (already calculated). The obtained number (rounded to the nearest integer, keeping in mind that if it is greater than 10, the value to be adopted is 10, and if it's lesser than -10, value to be adopted is -10) is the calculated equivalent importance for the VEC that corresponds to the most impacted (either positively or negatively) ENC of the EIA.
- ii) Multiply the calculated equivalent magnitude for the VEC of maximum impact in the EIA by its calculated importance and divide it by its total interactions value to obtain the so called *distribution factor*.
- iii) The equivalent magnitude for each VEC is obtained by multiplying its total interactions value by the *distribution factor*, then dividing it by its calculated importance and finally by rounding the found value to its nearest integer.

Once the ENC's have been converted into VECs and their equivalent values of magnitude, sign and importance have been calculated from the results of the EIA, the next step is to determine which additional projects, other than The Project, have to be considered for the CIAM.

As a rule of thumb, all the projects that are o will be located within The Project's area of influence or whose areas of influence intersect latter's one should be the first to be considered. Then, all other projects located upstream any flow that intersects The Project's area of influence (rivers, underground streams, air flows, etc.), are ought to be included. Finally, all other projects that could modify any of the selected VECs should also be considered.

This preliminary list has to be screened to be sure that: i) all of the listed projects can indeed produce an alteration on the selected VECs; ii) none of the projects have already been considered when preparing the baseline for The Project's EIA; iii) if there is a gap between the cutoff date of the EIA and the date when the CIAM is performed, all the projects whose execution began during that period or that are in an imminent stage of execution should be also considered; and iv) all the projects that will not be executed in reasonable foreseeable future are eliminated.

Past and present projects are relatively easy to identify. RFFP are a little more difficult to spot. A good starting point is to consider all projects that: i) their sponsor has requested a green light to proceed with the environmental licensing process: ii) are included in the pipeline that the authorities are planning to

undertake in the following years; iii) form part of the political speech of the authorities; iv) have the needed financing for their execution; v) a request has been submitted to a financer; vi) a procurement schedule has already been prepared; and/or vii) have a clear people's support, among others. The more these requisites are verified, the more confidence that that project will probably be executed.

With the VECs transported from the EIA and the list of projects that can potentially generate material modifications in them, a CIAM matrix is prepared placing the VECs in the rows and the projects in the columns, where the first one corresponds to The Project and the equivalent values for magnitude, sign and importance are those directly calculated from results of the EIA (and are therefore fixed). Just like the EIA matrix, each project-VEC interaction cell has to be qualified with values of magnitude, sign and importance keeping the same criteria that was used when assigning those values during the EIA. Once all the interactions have been qualified, three additional rows have to be added to the matrix to register the positive, the negative and the total interactions for each project (see Figure 4).

Besides helping in the prioritization of the actions to be included in the CIAM's mitigation plan, the total results for each project can be normalized by dividing the obtained values by the total interaction value of The Project; so that the incremental and total cumulative impact can be expressed in a number of times of The Project's the incremental impact. These results can be graphed in order to provide the decision makers with solid arguments to decide which projects (including The Project) should be undertaken in the future (see Figure 5).

## Final Remarks

The proposed methodology relies on the preexistence a sound EIA for The Project, built upon a good baseline and a solid impact analysis. It also needs its results to be presented in a matrix and that each interaction cell contains values of magnitude, sign and importance that describe the way a proposed action will affect a selected ENC. Therefore, if the EIA did not use a matrix to show its results, transforming them into it usually needs additional time and resources which may not be always available.

## CUMULATIVE IMPACT ANALYSIS MATRIX PÁEZ ZAMORA METHODOLOGY

		Projects				
		THE PROJECT				
		Project 1	Project 2	Project 3	Project 4	
Environmental Factors (VECs)	Construction material	-6 5	-5 7	-3 9	-10 6	
	Landform	10 6	9 5	-10 6		
	Surface water	7 7	2 4	-8 6	-7 2	4 8
	Ocean water	-10 4	-6 6	-4 8	2 6	6
		Positive interactions due to the Project	1	1	0	2
		Negative interactions due to the Project	2	1	2	1
		Total interaction due to the Project	39	-27	-39	-16

Figure 4: CIAM Matrix

## CUMULATIVE IMPACT ANALYSIS PÁEZ ZAMORA METHODOLOGY

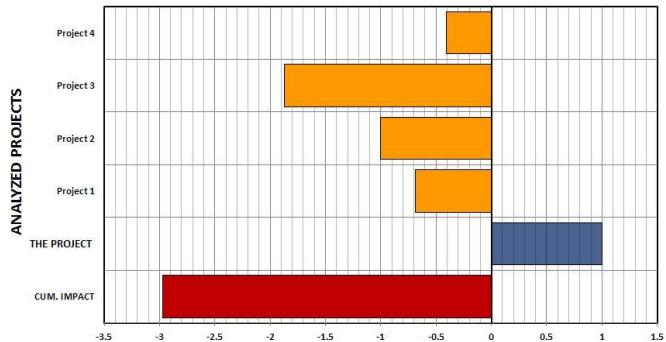


Figure 5: Graph of the CIAM results

A key ingredient to assure the compatibility between an EIA and a CIAM is that the evaluation criteria used to qualify the cause-effects interactions in EIA has to be kept during the CIAM when evaluating the project-VEC interactions. This means, for example, that a given value of magnitude or importance used in the EIA has to signify exactly the same kind of interaction in the CIAM. Therefore, the best scenario to use this methodology is when preparing the EIA and the CIAM one after the other and -preferable- by the same team of experts.

This methodology allows presenting the EIA and CIAM results in graphs and can also provide a time graphic evolution of the impacts, both direct and cumulative. It has been conceived to perform a CIAM from the perspective of a particular project and cannot be used as presented when undertaking a cumulative analysis from a planner's stand point. However, its matrix arrangements and the graphing procedures can easily be adapted to display the CIAM results from a planner's perspective.

As any other type of matrix-based methodology, this one shares all their advantages and shortcomings (linear additivity effects, analysis of only first order cause-effect interactions, being punctual in space and time, etc.). Notwithstanding it has a great advantage: it can be easily programmed in an Excel workbook to effortlessly produce results that can help the decision making process.

This methodology it is only a tool and does not replace the CIAM process. Therefore it has to be carefully used to avoid the trash in - trash out principle.

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