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Municipal sustainable development possibilities along the US-Mexico border: an interdisciplinary evaluation effort

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Abstract

After 15 years of created, the Border Environmental Cooperation Commission (BECC, in Spanish COCEF, *Comisión de Cooperación Ecológica Fronteriza*) is interested in measuring sustainability in the Mexican municipalities along the US-Mexico border. BECC is a bi-national organization created by the Governments of United States and Mexico to help conserve, protect and enhance the environment in the region. This assessment of municipal sustainability helps understand the impact of the BECC actions and guide plans and projects on the region. Sustainability is evaluated through a series of indices. Each one is the result of comparative interpretation of indicators based on a graphic display of weighted interactions of environmental, social, and economic nature. The assessment is conducted through workshops with a group of experts in BECC and Utah State University. Scores, percentages, and rankings are produced by an interactive computer application allowing a stronger and detailed diagnosis for each municipal unit.

Keywords: Sustainability, sustainable development valuation, US-Mexico Border.

1 Introduction

As part of the side agreements of the North America Trade Agreement (NAFTA) between Canada, United States and Mexico, the Border Environmental Cooperation Commission (BECC, in Spanish COCEF, *Comisión de Cooperación Ecológica Fronteriza*) was created in 1993 by US and Mexico. According to their mission, the purpose of BECC is to help conserve, protect and enhance the environment in the US-Mexico border region, through the development and certification of environmental infrastructure projects that incorporate innovative sustainability and public participation concepts (BECC, 2009). After fifteen years of activities, the BECC is interested in measuring their contribution to the sustainability of the Mexican municipalities along the US-Mexico border. This assessment of municipal sustainability can help understand the impact of the Commission actions and guide regional plans and projects on the region.

The assessment uses a model to evaluate sustainable development possibilities based on a graphic interpretation of indicators, expressed as limitations to development (Licon, 2003), (Licon, 2006). A team of experts in the BECC and a team in the Swaner Green Space Institute at Utah State University created this assessment. The results of this study will help guide future planning decisions along the 224 municipalities in the Mexican side of the border.

1.1 The US-Mexico Border

A two thousand-mile line separates Mexico from United States moving through large urban centers, small rural communities, a wide variety of landscapes, environments and cultures. However, mainly, this line defines a region, where both countries have things in common, together with a wide array of contrasts, differences and issues. The BECC area of action is within a region defined 100 kilometers north of the border and 300 kilometers south. The Mexican border is divided in 224 municipalities with a total population if sixteen million. A municipality is the smallest unit of government in Mexico. Each *municipio* has a defined territory, an *alcalde* or mayor a *cabildo* or council and normally includes more than one city or town. The 300-kilometer "buffer" defining the Mexican border includes all the capital cities of the six Border States. The intense activities that take place along the border, including growth of cities and towns, commerce and the establishment of industry has not only created a powerful economic driving force, but also immigration to the border in search for employment opportunities. All these movement of investment and people have affected the environment with demands for resources, generation of waste and needs of infrastructure and energy.

Figure 1: The US-Mexico Border Region

1.2 BECC/COCEF

The Border Environmental Cooperation Commission, created together with the North American Development Bank, certifies and finances environmental facilities along the US-Mexico border region. In their fifteen years of operations, the BECC has certified more than 140 projects with a total cost of more than three billion dollars (BECC 2009). Throughout these years, the BECC has played a key role to protect the environmental health and to improve the quality of life of the border residents. The BECC has a solid group of experts with deep knowledge of the border, together with access to information and indicators on the region. Recently, the Commission has extended its mandate and is more involved in regional planning efforts on the area. Together with this new role, the agency needs to explain the contribution to the sustainable development of the region in order to provide guidance, leadership, and knowledge, to communities and often, to local, state and federal levels of government.

2 Sustainable development possibilities

Sustainability is understood as a process, directed to promote activities that take in consideration the distribution of benefits and responsibilities of development actions. It is effectively an anthropocentric position since human actions and conditions are the focus of sustainability studies, and by implying that the understanding and conservation of the non-human environmental assets is the path to sustain human life and to pursue higher states of well being. However, it also an environmentally strong position, since the major threat to the quality and quantity of the components of the natural world (non-human) is mainly threatened, from global

to local scales, by human development, therefore there is a moral responsibility requiring our species to take responsibility in its overuse of the other species life resources. Sustainability, is also a social convention (Roe, 1998), acting as a driving, force even under the possibility of not achieving a sustainable goal in the future.

The issue of complexity appears in all these recent theoretical approaches to sustainable development. Roe (1998) argues that complexity is a shared characteristic of the different conceptualizations of sustainability and proposes a multi-referential mode of studying sustainability. This interdisciplinary approach when complexity and uncertainty is high does not eliminate complexity but helps to devise a "compass" or a "map" to "chart out the terrain" on the assumption that there cannot be a single sustainability view. Therefore, in his view, the epistemology of sustainability will be an interactive process between different theoretical approaches. Roe (1998) and Byrne (1999) suggest the initial works into complex systems and complex interactions of the reality of sustainability need a benchmark and an initial approach to help organize information and to establish foundations for future more elaborated and complex works.

Sustainable development is a condition of development that needs to consider multiple and inseparable relationships between humans and the environment in their production and process interactions. It is the understanding that the connection between these "worlds" necessarily implies a positive relationship where ecosystem well-being is linked to human well-being. Sustainable development is a human process, or at least is human driven, therefore implies resolving not only humans-nature discrepancies, but also humans-humans development differences, spatial and temporal. These equity issues, consequently, have implications for the rest of the environmental resources and living species.

The degree and characteristics of human intervention and the extent of human actions endangers both the humans and the non-human components of the planet. Sustainability is an appropriate paradigm to focus development efforts aware of its distributional implications and the effects of that development on the environmental and the human context. Sustainability also implies developing ways of dealing with human exposure to environmental forces and with human development impacts on the natural world. Human and natural dynamics, together with the long-term view, call for understanding sustainability as a process, rather than a final state. One of the main goals of planning for sustainable development needs to be, engaging a community, state, country, etc. in a process that addresses issues of human and natural wellbeing, with focus and careful understanding of the long-term impacts.

Ideally, we should implement and measure sustainability with the holistic, interdisciplinary, and long-term effect demanded by the multiple definitions available. We should also be able to identify with clarity when development is sustainable, and establish a mean to make certain development actions effectively promote a "sustainable" contribution in long and short terms. After assessment, effective implementation and adequate monitoring will guide future development. In summary sustainable development requires identifying, promoting, and

implementing actions that can improve or maintain environmental conditions. At the same time these action should produce and increase human wellbeing in short and long terms. Some initial steps include:

- Implement measuring and evaluation strategies that help to establish benchmarks for future more comprehensive research.
- Focus on linking measurements to understandings of sustainability.
- Identify to what degree actions do in fact promote sustainable development.
- Demystify the concept and uncover development actions that seem or are claimed to be "sustainable" when they are not.
- Work towards comprehensible means to assess sustainability.
- Search for ways of promoting discussion and consensus on what sustainability should be.
- Learn from other examples and promote exchange of experiences.

3 Methodological framework

Soft systems theory provides a methodological framework to "operationalize" a definition and perform an assessment of sustainable development. Soft systems admit there are multiple perceptions of reality, a more subjective approach to systems thinking and practice (Checkland and Scholes, 1990), (Jackson, 1991). Being interpretive in character, soft systems do not seek to study objective facts or to search for regularities and causal relationships in social reality. The social world is seen as the creative construction of social beings. Approaches towards a soft systems methodology are based on interpretive assumptions. Within the soft systems view, there are several methodologies for problem management.

Soft systems understand methodology as a dialectical process, focused in finding assumptions and relationships among participants, and in dealing with individual subjectivities through open debate. The general procedure in soft systems involves four main steps (with variations depending on the particular method):

- Identification of assumptions of decision makers or stakeholders. Some methods call this "worldviews" and other method describe this step as establishing a "reference scenario"
- Representation of the problem, either by creating an "ideal" scenario, by conceiving an opposite view of the perceived situation, or by explicitly stating assumptions adopted.
- The third step involves some sort of debate to sort out differences between the perceived, ideal, or expected scenario and the existing or reference situation. The comparison takes place in an open debate in which some degree of objectivity is expected to emerge through the debate of subjectivities.
- A synthesis process of the debated issues. This synthesis is accompanied by an

evaluation of resources and an in some cases an implementation plan.

Sustainability assessment is often performed based on hard systems views and a functionalist paradigm (Jackson, 1991). Conceptualization and definitions of sustainability are based on increasingly subjective assumptions of complex interactions and conflicting goals. These two "ends" need to need to be tied for implementation purposes. Soft systems can help to bridge this need of connection between measurement and definition. In the process of relating definitions with assessments of sustainability, multiple discussions among decision makers need to take place, as suggested by soft system methodology (Checkland and Scholes, 1990). The key in the implementation success of actions promoting a sustainable development will be in the discussion and debates of the models built by stakeholders and decision-makers. This will not only link quantitative assessments to conceptual definitions, but will also create new definitions to review and will create demands for new indicators (See Figure 2)

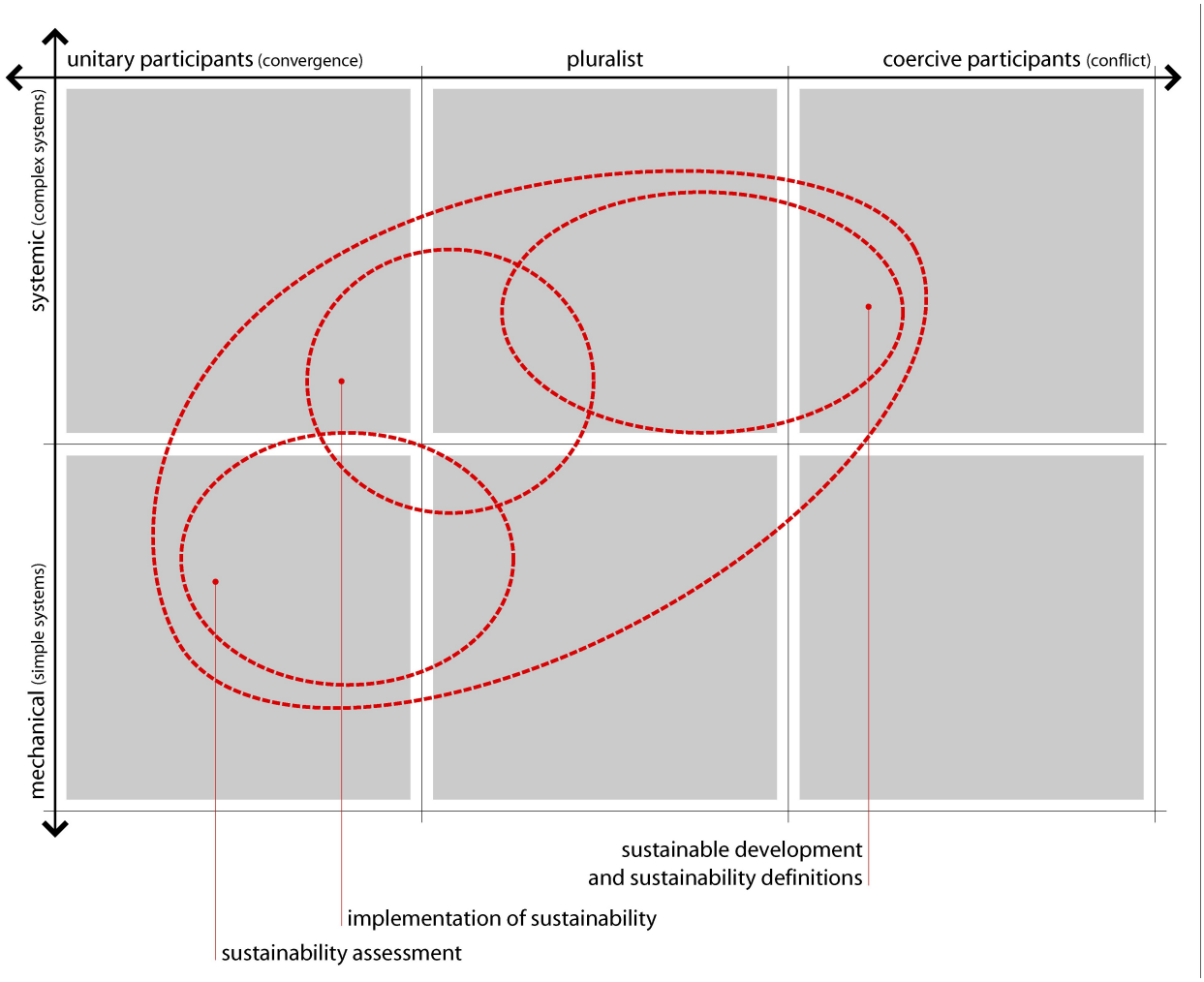

Figure 2: Sustainable development within systems approaches context (Licon, 2003), (Jackson, 1991).

3.1 Graphic Assessment Models

The graphic models can help planners and decision-makers to communicate more effectively existing conditions as well as planning goals and strategies toward sustainability. It allows a transparent manipulation of indicators defining sustainability by including indicators in the assessment. This feature helps to monitor the degree of effect each indicator has in the overall index and hence guide planning strategies. The model is flexible ad it allows possibility of testing different scenarios by selecting different indicators. The index is constructed through an interdisciplinary approach assuming there is a relationship between each indicator and the three basic dimensions of sustainability.

Some of the models published in the literature deal with conceptual and evaluation issues for sustainability with variations in approaches, data, and methods. Among them are the Campbell´s triangle of conflicting goals in planning (Campbell 1996), the barometer of sustainability (Prescott-Allen, 1997), (Prescott-Allen, 2001), the triple bottom line (Elkington, 2000), the amoeba model (Bell and Morse, 2008), the sustainability assessment maps, SAM (Clayton and Radcliffe, 1996), and the dashboard of sustainability (Hardy and AtKisson 1999). Some indicator frameworks used include Donella Meadows' flower (Meadows, 1998) and the United Nations' pressure-state-response framework (UN, 1996), together with aggregated-indices like the ecological footprint (Wackernagel and Rees, 1996) or the pilot environmental sustainability index (WEF 2000).

3.2 Towards an interdisciplinary model

This assessment is based on the assumption that sustainable development can be defined by the combined attention to issues and concerns about the environment, the economy, and society (WCED, 1987). Graphically, this conceptual model incorporates Campbell's issues of conflict among pairs of domains, defining three types of possible conflicts when development is not sustainable (1996). These two aspects constitute the starting point to the graphic model operationalized in this work.

It starts with a simple idea; an activity can be a restriction for other activities even of a different nature. For example, a decision to use a piece of land for economic production reduces or eliminates its possible use for recreation or for wildlife habitat purposes. If these levels of restrictions can be measured, a graphic representation can be made using a rectangle describing the universe of action and a line dividing this area as the level of restriction defined by the new activity over the original one. This same idea is applied for each of the three elements of sustainability, and then the three rectangles are combined leaving only the overlapping area. The resulting overlap is a triangle where each side represents the base (zero restrictions) for each of the elements considered. The any possible development action (sustainable or not), is found inside this triangle.

We will apply this idea to relate activities from each domain of sustainability, and interpret this

relationship as restrictions to activities of the other two. This implies constructing relationships between domains and defining each term using the other two. In this sense, a sustainable economy necessarily means an economic activity that is environmentally friendly and socially responsible. A sustainable society would be a productive and environmentally responsible one, and a sustainable environment will be capable to provide resources and healthy opportunities for its residents.

Three kind of restrictions (of social, economic, and environmental nature), each one affecting the other two, result in six clusters of indicators defining the following types of development constraints:

- Environmental limitations to economic development refer to the availability or scarcity of resources, land productivity, and in general the environment's carrying capacity for intended or existing economic productive activities.
- Environmental limitations to social action are related to environmental conditions and their effect on population's health. These restrictions represent the impact of the relationship humans-environment, and are related to the capacity to support a given population.
- Social limitations of economic activities. The contribution or restrictions the social conditions impose on the productive sector have to do with population skills and education, the availability of labor, the demand for jobs. Also has to do with the demand for products and the potential consumer market the population represents together with their purchasing power.
- Socio-cultural constraints to environmental activities include the impacts of population on the environment, such as waste generation, pollution, and land uses. Also included in this category are people’s preferences for environmental appropriation such as settlement patterns, densities, outdoor activities, etc.
- Economic restrictions of environmental action address how the productive sector is affecting the environment. Pollution, waste generation, energy consumption patterns are part of this set of indicators.
- Economic limitations to social action include the supply of jobs, the income distribution, and the diversity of productive activities among others.

The area of intersection of the resulting triangles defines the area of possible sustainable development. Sustainable development is possible when development activities occur within the limits (or restrictions) imposed to each other by the three dimensions of sustainability (the economy, the environment and the society). The areas where only a pair of domains intersect, describe different kinds of relationships. Issues of justice are related to combinations of social and economic matters; issues of health are discussed in the relationship between the environment and society; and environment-economic relationships are described in terms of efficiency.

Considering the condition for sustainability requires meeting all the limitations identified, we can say that in order to have a sustainable activity these three conditions of justice, health and efficiency need to be accomplished. The areas outside the limits represent the conflict between pairs of domains as described in Campbell's diagram (1996).

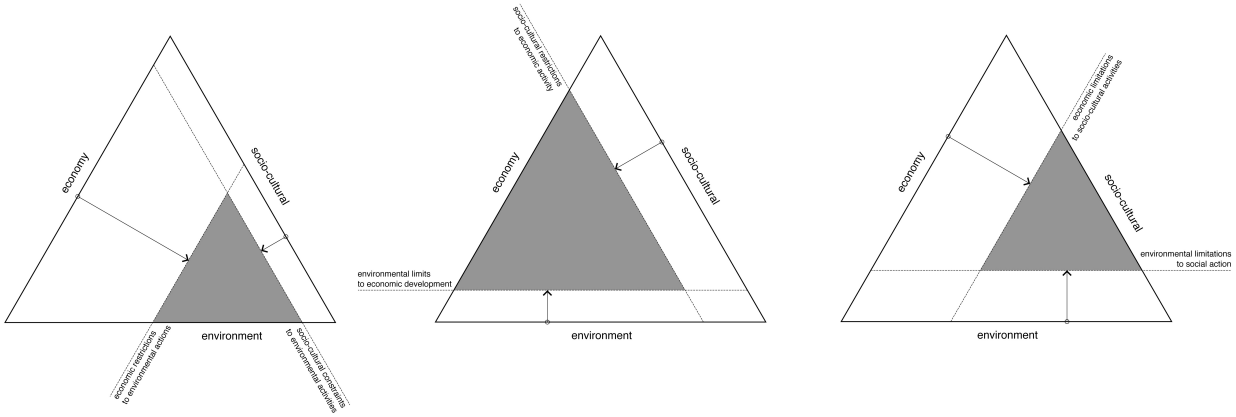

Figure 3: Triangles formed by limitations established among social,environmental and economic domains.

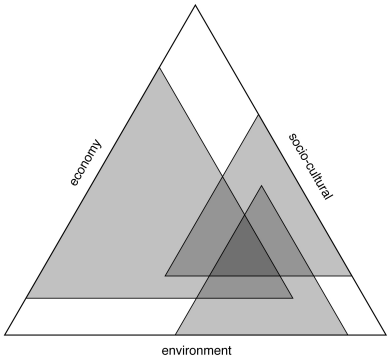

Figure 4: Area of possibilities of sustainable development, located at the intersection of the triangles.

4 Operationalization process

A computer based template allows to create a workable template for the construction of the graphic assessment of sustainable development possibilities. There were several purposes for this template: First, to develop a general template that would allow the input of existing databases with indicators describing a group of places in the three main domains of sustainability. This means having indicators of the economy, the environment and the social aspects of an array of comparable places. A second purpose was to create a template usable by decision makers and other stakeholders to provide them with means of manipulating data and visualizing the effects of their considerations. A third goal was to make this tool easy to install distribute and use. It is expected this template can generate guidelines to action and make a direct contribution on the implementation of sustainable development efforts directly associated to what is measured. Figure 5 shows the general organization of interconnected worksheets making the assessment flexible, visual, and easy to use. The first sequence of worksheets allows inputting data (a matrix with columns listing indicators and rows geographic units). Additional worksheets in this group help visualize and manipulate values distribution and ranges. A second series of inter-related worksheets help build the evaluation by selecting through a series of options and questions described later in this document. A third part allows to visualize results and to generate different reports. Throughout the workbook, changes made in one worksheet are automatically adjusted in the rest allowing a great degree of interaction and scenario-testing situations.

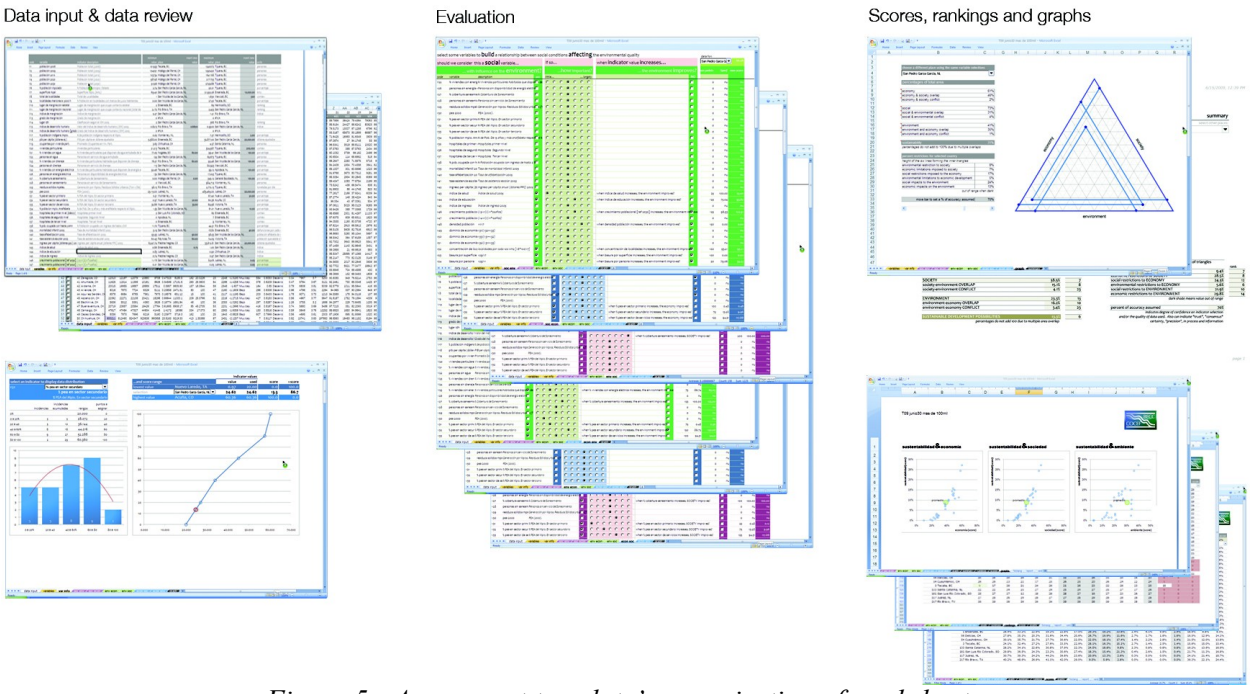

Figure 5: Assessment template's organization of worksheets.

4.1 Data

To develop the assessment, a technical team in the BECC created a data set with 45 indicators describing the environmental conditions, the economic characteristics and the demographics for 224 municipalities in the Mexican Border Region. To be able to use the indicators in this model, the initial set of indicators grew to 65 from the combination of original measurements to create comparable values. Some examples include population divided by the municipality area to create density, and population projections used to determine growth rate used.

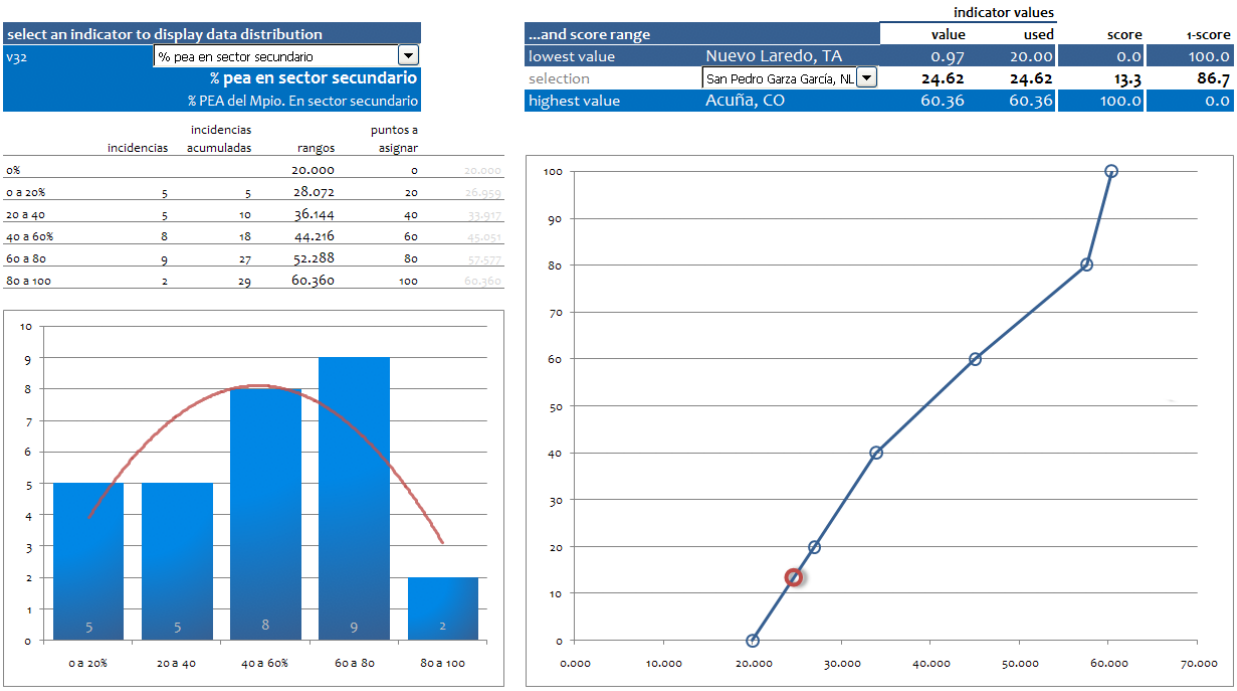

Figure 6: Indicator and performance score value distributions worksheet

The performance score is normalized through the range of values for each indicator category. Figure 6 shows a worksheet used to data distribution for each indicator and its associated performance score distribution. This graph is helpful to identify problems with data and to make adjustments before going through the evaluation process.

4.2 Evaluation Process

To create the assessment, the Border Environmental Commission assessment team established regular meetings to work with the template. To build the graphic, the indicators were selected by the team establishing connections between each indicator and the restriction they impose to the other two sectors. This was done on six worksheets corresponding to the six clusters of indicators performances described before. The evaluating team needed to answer three questions to decide whether or not to include an indicator on each of the six worksheets (example of template screen shown in Figure 7):

- Should the indicator be considered a descriptor of a particular sector (environmental , social or economic) with influence on another sector?
- How important? This option weights the selection
- When the indicator value increases, the sector condition improves? This check defines direct or inverse relationship, i.e. when inflation rates increase, social condition decreases.

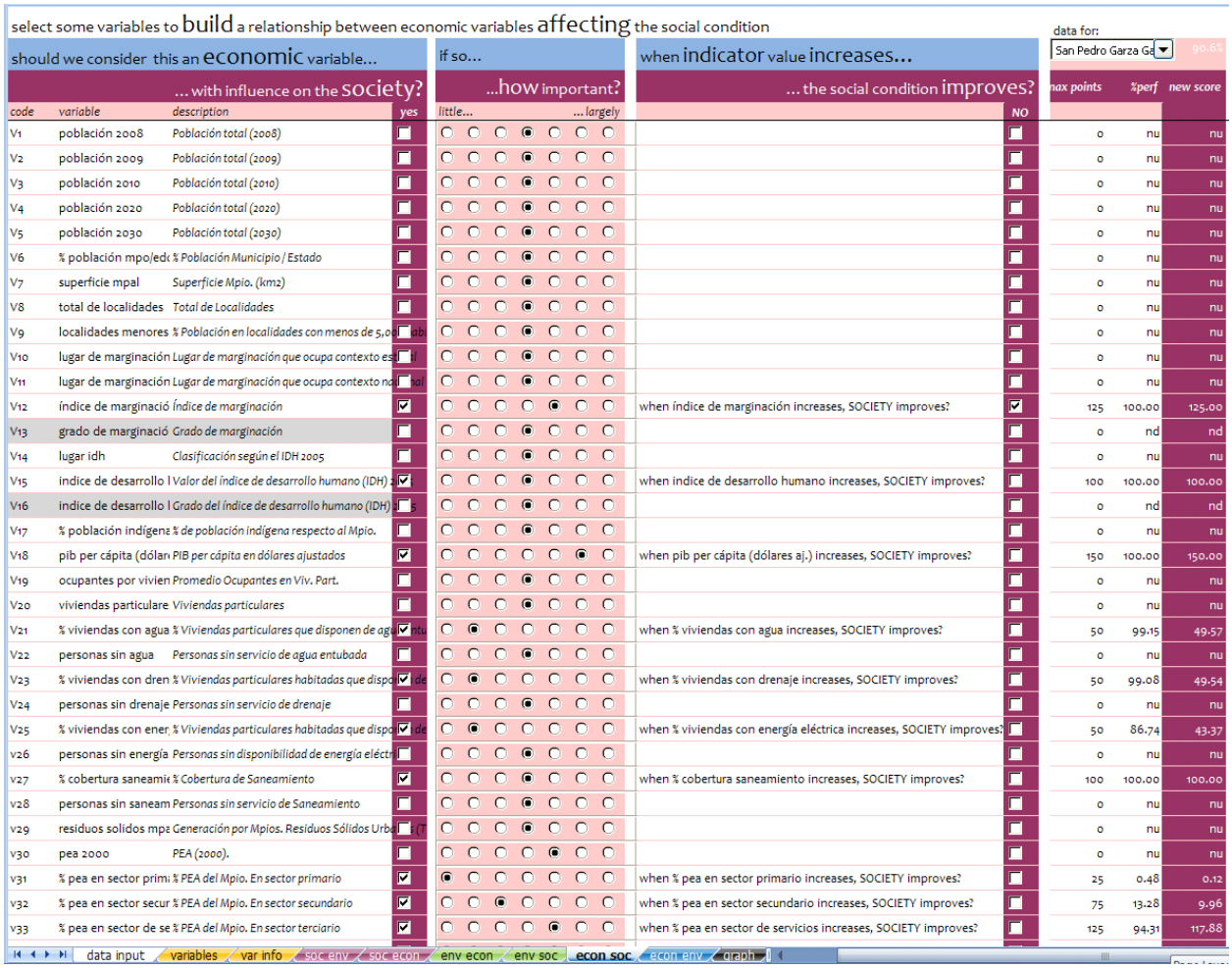

Figure 7: One of the six evaluation worksheets

5 Results

After indicators are selected, the template provides individual scores for each municipality. Individual graphic results are displayed by selecting the unit from a list (example in Figure 8). Group information is also available through rankings of results (Figure 9). The template allows sorting the places by: rankings of sustainable development possibilities, by sector value, by overlap values, or by conflict value. All the values are expressed as percentage of the total possible area of development.

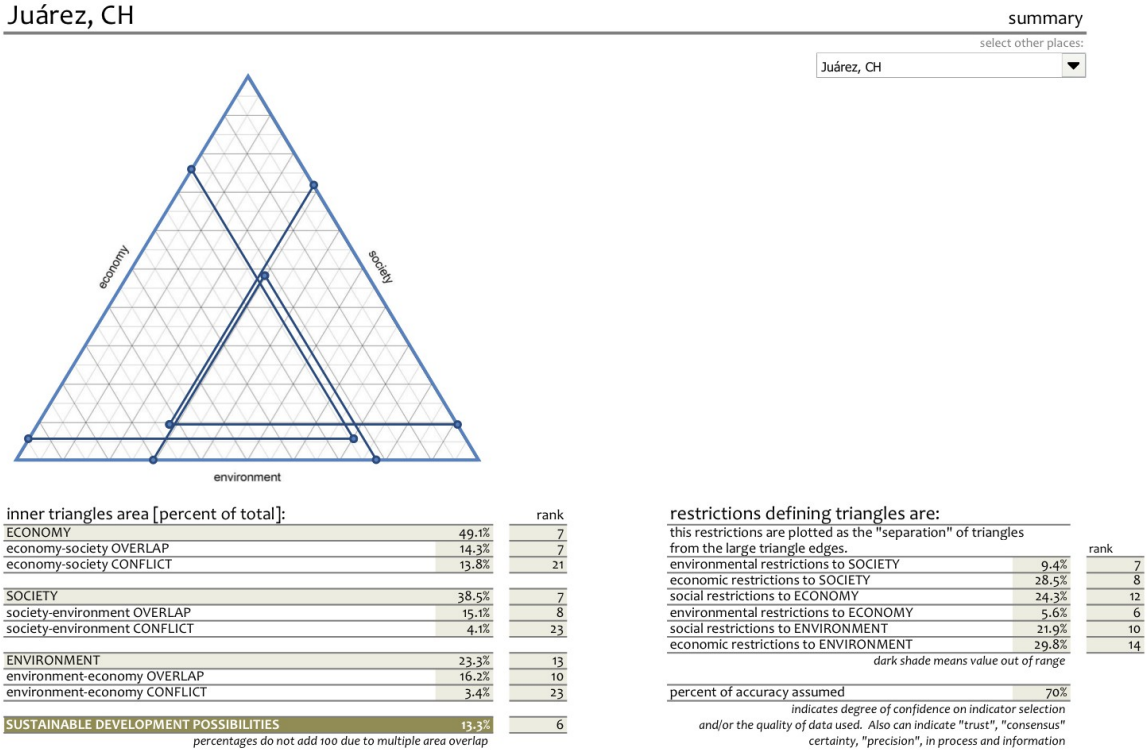

Figure 8: Individual sustainability scores report

Observation of individual graphic patterns helped identify and group municipalities by relevant issues. This part of the project grouped municipalities with common challenges towards sustainability even though they were not necessarily close to each other geographically, or apparently with not many things in common. From the 224 municipality a small group was clearly dominant with higher sustainability scores. This group was followed by *municipios* with relatively good scores in sustainability but facing important conflicts between social and economic conditions. Another group showed very tight scores requiring comprehensive strategies to address simultaneous issues. In these cases, sustainable development strategies necessarily needed, from the start, combined efforts to resolve environmental, social, and economic challenges. An interesting observation was to discover *municipios* where the capital

of the state was located not always ranked in the highest positions with respect to sustainable development possibilities scores, but more in the middle ranks.

Municipios Fronterizos con más de 100 mil habitantes

code	country	rankings higher to lower restrictions						areas			overlaps			SUST	conflicts		
		soc econ	econ soc	env soc	soc env	econ env	env econ	econo	soc	amb	econ soc	soc env	env econ		econ soc	soc env	env econ
132	San Pedro Garza García, NL	1	1	3	13	1	2	1	1	1	1	1	1	1	29	24	29
131	San Nicolás de los Garza, N	2	2	4	2	4	1	2	2	2	2	2	2	2	28	27	28
50	Chihuahua, CH	3	3	2	3	7	3	3	3	3	3	3	3	3	27	28	27
111	Guadalupe, NL	7	5	12	7	10	10	10	5	9	5	6	8	4	23	22	19
22	Monclova, CO	8	10	5	4	9	5	6	6	8	7	5	4	5	21	26	24
124	Monterrey, NL	15	4	9	20	5	7	12	4	11	6	9	5	6	22	16	26
67	Juárez, CH	12	9	7	10	15	6	7	8	14	8	8	11	7	20	23	22
29	Piedras Negras, CO	14	12	6	6	14	8	11	9	12	10	7	12	8	16	25	20
106	General Escobedo, NL	10	13	11	14	13	9	9	11	13	12	10	10	9	19	20	21
92	Apodaca, NL	5	8	8	24	11	4	4	7	19	4	13	13	10	24	18	25
2	Mexicali, BC	6	7	17	15	8	12	5	13	10	9	14	7	11	25	13	18
223	Victoria, TA	11	14	15	9	3	17	13	14	5	14	11	6	12	17	17	17
172	Nogales, SO	13	11	13	8	21	15	14	12	15	13	12	14	13	18	19	14
7	Acuña, CO	24	15	1	1	23	14	18	10	6	15	4	18	14	12	29	15
209	Matamoros, TA	18	16	16	19	22	18	15	16	22	16	16	17	15	13	14	12
216	Reynosa, TA	21	19	14	18	20	16	17	18	21	17	17	16	16	10	15	13
214	Nuevo Laredo, TA	28	24	10	11	2	11	16	17	4	18	15	9	17	4	21	23
4	Tijuana, BC	4	6	18	27	12	13	8	15	24	11	21	19	18	26	6	16
161	Hermosillo, SO	17	21	21	17	16	22	23	20	17	20	19	20	19	11	10	10
63	Hidalgo del Parral, CH	19	23	22	16	19	23	24	22	18	23	20	21	20	7	11	9
34	Saltillo, CO	16	18	19	23	26	20	20	19	25	19	22	24	21	14	9	6
1	Ensenada, BC	23	20	25	5	6	19	19	23	7	24	18	15	22	9	12	11
56	Delicias, CH	20	25	20	26	25	21	22	21	26	21	25	25	23	6	5	7
54	Cuauhtémoc, CH	26	26	23	22	17	25	26	25	20	26	24	22	24	5	7	8
3	Tecate, BC	9	17	29	21	24	26	21	26	23	22	26	23	25	15	3	5
133	Santa Catarina, NL	22	22	24	25	27	24	25	24	27	25	27	27	26	8	4	3
181	San Luis Río Colorado, SO	25	27	27	12	18	28	28	27	16	27	23	26	27	3	8	4
117	Juárez, NL	27	28	26	29	28	27	27	28	29	28	28	28	28	2	2	2
217	Río Bravo, TA	29	29	28	28	29	29	29	29	28	29	28	28	28	1	1	1

Figure 9: Rankings

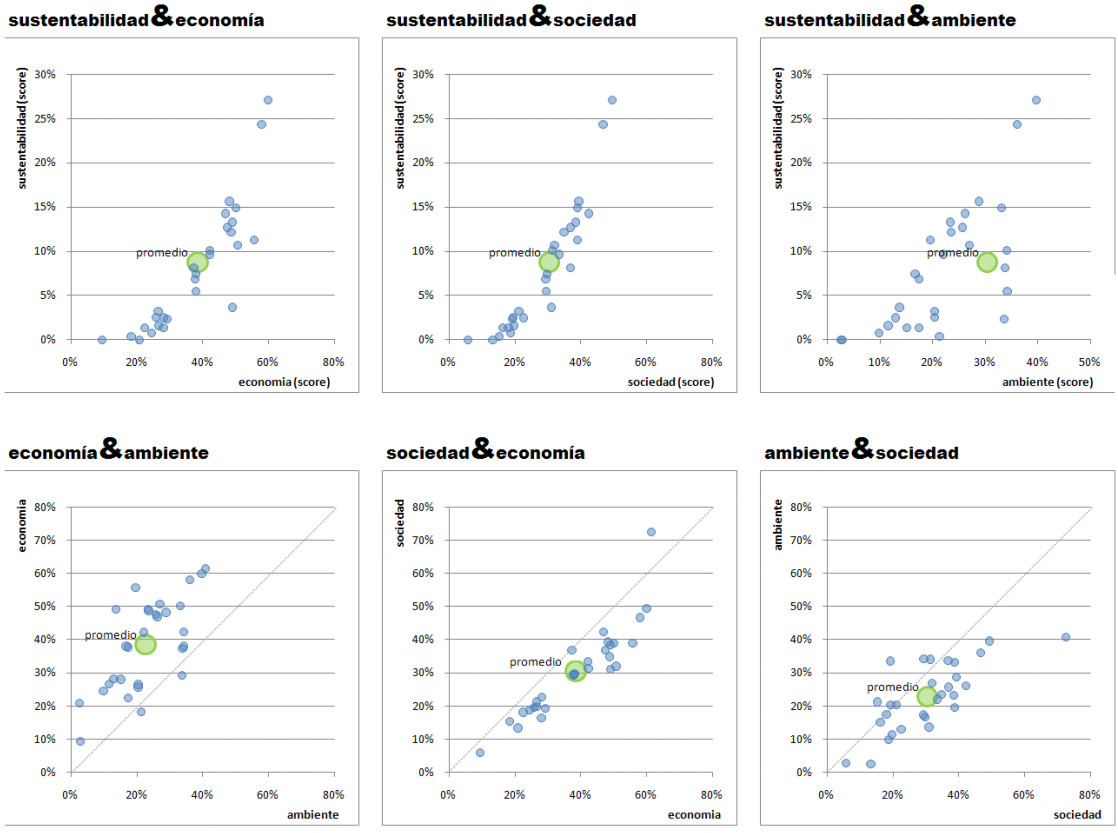

Figure 10: Scores scatter plots

The template also provided graphic displays of paired scores. This allows identifying trends, associations of results and compactness of scores relationship. The scatter plots made evident one of the first observations during the evaluation work: the need for more environmental information with connection to social and economic characteristics. Building strong assessments of sustainability in the future will require more information about the environmental condition of the places analyzed. This information need is already being addressed by the BECC.This papers covers phase one of the project, working with the existing data available to the BECC. A second phase will examine the geographic distribution of the sustainability scores. Later, phase three will identify data needed to build a stronger and more comprehensive data set, especially with environmental information. There are factors not currently included in the model, and future assessments will need to address the implications for sustainability of important border issues such as shared air and water quality, security, employment opportunities and migration, and other critical aspects of the border life.

In summary, some of the findings are:

- *Municipios* can be grouped by relevant issues. There are patterns that help build a better understanding of the border. Next step will be to map these results to review new patterns.
- Dominant *municipios* with perceived high quality of life were on top of the list, but other traditionally leading cities and *municipios* were not ranked among the more sustainable. Large cities like Tijuana, or Hermosillo, state capitals with concentration of industrial activities, political control, were often not in the upper places
- With the information available, it can be said there are appropriate conditions to engage in sustainable actions in many places along the border
- Environmental quality is a main issue as economic activities and social characteristics have strong impacts on the physical world.
- There is good documentation of social or economic conditions, but more indicators for the environment is needed, especially in small rural municipalities.
- A constant in the assessment was the conflict between the economy and the social dimensions along the border. Economic distributional effects and social productivity are important challenges to increase the sustainability of the border
- The BECC is comparing results with their knowledge of the place to identify opportunities for action and develop future intervention strategies.

5.1 Model sensitivity

Being an assessment based in comparative performance scores, the evaluation became very sensitive to changes, especially when sites were added or removed from the analyzed dataset.

Even though many of the scores of sustainability changed by small amounts, the changes did have an effect on rankings, in some cases making *municipios* climb or fall several places. This made the evaluation team very aware how the results could have influence in planning decisions by local authorities as local authorities react when they see their community ranked together with other communities they were not considering part of or comparable to.

5.2 Planning Implications

The assessment process provided opportunities to discuss how different evaluators interpret indicators and what each measurement means when it considered as an operational argument. The same could be expected when planning and policy decisions are made. The relevance of issues and the number of issues involved to inform the planning process require discussion, and means to understand how these views are turned into implementation actions. The assessment generated through this project attempts to advance in this line. It provides communities (*municipios* in this case) with clear and understandable connections between what is measured (isolated indicators) and how this is expressed as possibilities or limitations to development (opportunities and conflicts). This knowledge will help stakeholders and decision-makers to take steps in the right direction towards achieving consistent and coherent progress towards sustainability, meaning healthy, fair, and efficient development actions.

The BECC implements many of their projects through local agencies, governments, and community organizations. Having a border-wide assessment of sustainable possibilities, together with other associated evaluations, is a powerful tool to focus efforts and resources, and to target the right communities. More than anything else, this initial stage of evaluation should create a lot of discussion among interested parties. Offering an assessment of sustainability together with specific operational indicators of progress and their scores should facilitate the *municipios* understanding of what it takes to achieve sustainability. This project should also serve to challenge the indicators used to evaluate sustainability. This first phase utilized existing indicators available to all the municipios, but future and more thorough assessments will benefit from improved information in quantity and quality.

5.3 Future Work

The results of this first phase will be distributed among involved *municipios* and other agencies. This should create discussions about indicators used, modes of understanding development, and hopefully a series of observations and suggestions helpful to improve future evaluations. New indicators, especially describing the environment need to be identified and generated for the next phases of this project. New applications of the evaluation model are also explored.

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