CLIMATE CHANGE IN THE MEXICAN REGIONS:

INTEGRATION OF THE DIRECT, INDIRECT AND DYNAMIC EFFECTS IN A SIMULATION MODEL INPUT OUTPUT

I. INTRODUCTION

In Mexico, State Programs of Action on Climate Change (PEACC by its Spanish acronym) arise from the National Development Plan: 2007-2013 and is the mechanism that links both the international view on this phenomenon, with the national commitments assumed on National Strategy on Climate Change; as well as regional objectives to develop local scenarios on Climate Change (CC by his Spanish acronym) for the XXI century, to assess the impacts and vulnerability of different socio-economic sectors and regional ecosystems to possible environmental changes; besides defining the actions for mitigation and adaptation.[1]

The fundamental questions that the PEACC tries to answer, while alterations of biogeochemical cycles (i.e., carbon, heat and water) will impose an increasingly higher cost to ecosystems and society, are: what is the economic cost for each of the various socio-economic sectors and ecosystems attributable to the effects of CC? And how much will it cost society as a whole, if it does not implement mitigation measures on facing CC?

The answers to these questions were found in the PEACC through studies that were carried out that considered the potential impact of environmental degradation of various "key" sectors with available explicit prices; such as agriculture (crop and livestock subsectors), tourism, transport, health, energy, among others. Similarly, other studies were conducted for certain ecosystems, with available implicit prices such as the marine ecosystem.

In PEACC sectorial impacts of climate studies are biased and fail to include indirect (interdependencies) and dynamic effects (feedback). This is important, since it is recognized that the direct effect generated by CC in any sector and the global economy underestimates the total effect, since the direct effects end up generating indirect effects, and in turn, this will generate induced or dynamic effects, generating new cycle effects (Jemio and Andersen, 2013).[2]

The purpose of this document is to integrate all the effects on "key" economic sectors and on the global economy associated with CC in a Regional Multisectorial Dynamic Simulation Model (MRMSD by his Spanish acronym) using the state of Baja California as case of study . This modeling approach allows quantification of the total effects attributable to CC.

---

[1] Currently, 11 of 32 Mexican states have completed their PEACC (PEACC-BCS, 2012, p. 9).

[2] According to the input-output approach, the direct effect of an exogenous decline in final demand (DF) in any sector of the economy undervalues the total effect, since the effects of DF are not exhausted by the intermediate demand but generating spillovers end a drop in corporate income households and residents could translate into a decrease in investment and less consumption; which in turn generate a new cycle induced effects (Fuentes et al 2013;. p.3).

The MRMSD is conceptually based on the *Systemic Approach* that attempts to capture the interdependencies and feedbacks underlying in the sustainability of socio-economic-ecological system. Thus, according toshe socio-economic-ecological (land use, economic sector, social group, etc.), some of its generic systemic features that are universally required for the sustainability of the system will be collected.

The behavior of MRMSD is based on *System Dynamics*, containing eight subsystems. Climate changes, land use, agriculture, regional economy, gross capital formation, population, tourism and quality of life[3]. In the MRMSD three models are embedded: an agricultural land use model (agriculture and livestock) employing a *Markov Transition Matrix*, a regional intersectorial and intertemporal model that uses a *Leontief Input-Output Matrix;* and a demographic model by age cohort using a *Leslie Transition Matrix*. The general model has supply and demand controllers. CC and agricultural (agriculture and livestock) land use are key engines of the model. The change in the land distribution among the various agricultural subsystems determines the agricultural and non-agricultural output. The dynamics of the population is affected by the agricultural and non-agricultural sectors via labor demand. In turn, the population is linked to tourism due to water quality being affected by residents and tourists. Finally, the quality of life incorporates social value between physical (per capita income) and natural (land and water) capital in the migration behavior.[4]

The MRMSD, simulated in *Stella* (ISEE Systems; 2005) software, allows greater accuracy in the real impact that the phenomenon of CC would have on the state. In particular, estimates show that the economic loss to the state's economy is two to three times greater than that reported in the State Program of Action on Climate Change in Baja California (PEACC-BC by its Spanish acronym). Additionally, the model structure could be adapted to other Mexican states for allowing the possibility of an interregional comparison of sectorial and regional macroeconomic impacts of CC.

The document is divided into six sections. Section II shows the projections of climate variables (temperature and precipitation) linked to the scenarios of the accumulation of greenhouse gases in the state. Section III highlights the direct or expected outcomes of sectorial and global studies in the state due to CC as recorded in the PEACC-BC. Section IV develops conceptually MRMSD in eight subsystems following the systemic approach. Section V shows diagrammatically the dynamic behavior of MRMSD and its key variables. and quantifies sectorial and global economic impacts of CC in the state. Finally, Section VI presents the document's concluding remarks.

---

[3] The RMSD but uses the concept of balance and considers the entire regional economy is dynamic-recursive as TOPMARD (Bryden, 2009) model; i.e. resolves period by period without any real maximization of utility functions or production across the horizon.

[4] The general welfare of individuals and society in the region is evaluated by the concept "quality of life". This concept should not be confused with the standard of living (or physical capital) based solely on income, wealth or employment (Tenorio, 2013).

II. CLIMATE CHANGE SCENARIOS UNDER PEACC-BC

The state of Baja California is located in the northwestern region of Mexico and the northern part of the Baja California Peninsula, the state is limits on the north with the border of the United States of America (USA), on the east by the Colorado River and the Sea of Cortez, on the south by the state of Baja California Sur and on the west by the Pacific Ocean. The total state territory is 71,446 km^2 which represents 3.7% of Mexico's land area (INEGI, 2010).

In 2012, the first stage of PEACC-BC was performed to analyze the state's vulnerability to climatic variables. Highlighting the changes in temperature and rainfall in the current century, under two accumulation scenarios of anthropogenic greenhouse gases (GHG): B1 (low emissions up to 550 ppm) and A2 (high emissions up to 859 ppm).

Related to annual variations in the average temperature projections for Baja California -whose average annual temperature is set to 20° C [5]- in the climate scenario B1, an approximate increase of 1° C for the next 50 years is expected, and up to 2.5° C by the end of this century; while the forecast for the A2 climate scenario considers an increase of 2° C in the first half of the century and foresees a change of up to 5° C in the second half of it.[6]

Regarding the change in the pattern of gross precipitation which's annual average is less than 250 mm-[7], scenario B1 noted a fall in a range from 12% to 15%; while the A2 scenario foresees a loss ranging between 18% and 20%.[8]

Additionally, large inter-annual variability in gross precipitation implying the occurrence of very rainy years, followed by years with droughts that will affect water availability, stand out in climate projections. High vulnerability scenarios in precipitation project increases of up to 20% in rainy years (El Niño effects), and drops to 40% in dry years (La Niña effects).[9]
Finally the report, anticipates effects in the state's coastal area. The projections expect a rise in the average sea level of about 2 ± 0.1 mm/year. Understanding that this rise in sea level is not uniform along the coastal areas of the Baja California.

[5] The annual average air temperature does not exceed 20 ° C in most of the state except in the coastal Gulf of California and Mexicali area where the average temperature can be higher than 30 ° C (PEACC-BC, 2012; p 15).

[6] The projected climate change scenario B1 is about 0.5 ° C higher than projected by the National Institute of Ecology and Climate Change (INE-CC), while for the A2 scenario is almost 1 ° C. That is, the PEACC-BC projects a change of up to 5 ° C for climate scenario A2, while the INE-CC projected 4 ° C rise in temperature for the state (PEACC-BC, 2012, p.25)

[7] State precipitation is 3.8 times lower than the national average (773.8 m) (PEACC-BC, 2012; p. 10).

[8] The difference between the PEACC-BC and INE-CC in projecting precipitation is also important. The first few years projected to be decreases in rainfall of up to 30% for climate scenario B1 and 40% for climate scenario A2, while for the second projected reductions are 10% and 20% respectively (PEACC-BC , 2012, p 25)

[9] El Niño and La Niña are opposite sides of a weather phenomenon formally known as Southern Oscillation (PEACC-BC, 2012; p. 10).

III. Sectorial socio-economic impacts of PEACC-BC

An effort in the PEACC-BC has been made to determine the negative effects on key socio-economic sectors attributable to environmental changes in Baja California.

In particular, the report states that there will be adverse consequences for the population of the area of the coast and border with the United States due to the reduced availability and quality of water resources. Highlighting the heavy reliance on water sources originating outside the state (Colorado River) and local aquifers that are mostly considered over-exploited. Pointing out that the Colorado River supplies 51% of total water consumption, while local aquifers provide around 30% of it.[10] Moreover, of the total water available, agriculture consumes almost 87.1%, followed by the -urban public with 7.8%, and the industrial sector which consumes the remaining 5.1%

The report notes that agriculture is one of the most damaged by the CC due to irrigation requirements, increases in evapotranspiration, and reduced phenological cycle sectors.[11] It specifically notes that in the climate scenarios B1 and A2, have differential impacts on the area of land devoted to each of the (perennial and seasonal) agricultural production subsystems. Noting that according to the crop plan of 470,150 planted hectares 23% of the area is devoted to perennial crops, and 77% to seasonal crops; of the latter 70% are autumn-winter cycle (OI by his Spanish acronym), and 20% of second spring-summer crops (PV by his Spanish acronym) cycle. The percentage of the area planted with seasonal crops in OI is 70% wheat, 15% cotton, 6.7%, onions, tomatoes 4.1%, 3.1% strawberries, and the rest is fodder oats in OI. In the PV cycle crops planted there seconds; 30% wheat, 25% cotton, 9.7% onion, tomatoes 7.1% and 4.1% strawberries. Meanwhile, rates for perennial crops are: 80% green alfalfa, grapes 8.5%, 8.1% asparagus, and the rest for fruit (orange, lemon, and dates). The report estimates that the CC will induce a greater reduction in perennial crops in relation to seasonal ones and OI harvests will be reduced cycle twice that of PV Cycle.[12]

The document also states that livestock is another of the hardest hit with a drop of 12% in scenario B1 sectors.[13] Crops like green alfalfa, which is considered the most important feed ingredient for livestock for its high nutritional value, will be affected for its high water consumption. This may worsen if the lack of irrigation water covers other crops with less water requirements but that are part of livestock's diets such as wheat, oats, forage sorghum and rye-grass. The report also considers the area for the establishment of meadows and pastures in both the OI cycle and PV will be diminished by the effects of climate change.

The PEACC-BC also states that, although the importance of climate on agricultural subsectors' activities is very evident, it also represents an important asset for the tourism sector. The climate

[10] The binational Colorado River basin is the only source of water and is shared with 7 states in the United States of America (PEACC-BC, 2012; p.48)

[11] Three agricultural regions are distinguished: the Mexicali Valley, which basically practiced agriculture irrigation; and Costa and San Quintin area, including irrigated agriculture and temporal (PEACC-BC, 2012, p126).

[12] Reducing the phenological cycle of wheat (seasonal) and alfalfa (perennial) by the CC shows an earlier initiation of growth and delayed latency, resulting in a greater number of cuts, higher growth rate and increased water consumption (PEACC-BC, 2012; p.127).

[13] In the Valley of Mexicali problems are expected in livestock adaptation to heat stress (Rivers, 2003).

allows the existence of some basic natural resources for the development of the sector, since activities under the sun and beach destinations are tourist attractions in the state.[14]

According to the document: 472 hotels that together offer 20,661 rooms that satisfy the demand of abroad visitors and local residents. Statewide, about 16% of Gross Domestic Product (GDP) is generated by tourism; but by action of CC its contribution to GDP could be affected in a range between -0.3% to -0.5% in scenario B1. This loss that could be magnified in the order of -0.7% to -1.0% of GDP in the A2 climate scenario. Tourism affects the construction of hotels and complementary services in a wide range of branches of trade, industry and services sector.

In the report the adverse impact of CC in agriculture, manufacturing and tourism sectors could change the superiority of the state's GDP and employment growth compared to national figures. Since in the last three decades state GDP and employment growth figures (10.1% and 3.0%, respectively) are greater than the national rates (3.2% and 1.5%, respectively), this may change.[15] According to the report, the increase of 2° C in the average temperature and the reduction of rainfall of 15% could represent an annual average loss in a range between -1.0% and -3.0% of state GDP in the low emission scenario.[16]

The report foresees that CC induces changes in the size and structure of the population of the region.[17] Namely, less job options, lower wages, and lower quality of life could alienate the population to other regions. The population structure may change due mainly to the change in demand of jobs causing the migration of youth. Additionally, it can induce quantitative changes in the population by qualitative factors such as the perception of the quality of the environment, which will cause migrants to reevaluate their movement towards the urban areas of the state, according to their needs and aspirations.[18]

In short, the PEACC-BC represents an effort to determine local negative effects of CC based on separate and starting to consider the direct or expected impacts in various socio-economic key sectors in the global economy. In other words, studies of sectorial impacts exclude both the indirect effects (interdependencies) and the dynamic effects (feedback).

IV. STRUCTURE OF REGIONAL MULTISECTORIAL DYNAMIC SIMULATION MODEL

Some Latin American institutions (ECLAC, 1999; Table 1) and authors (Jemio and Andersen, 2013; p.2) state that ignoring the sectorial indirect and dynamic effects, causes the significant underestimation the effects of CC on the economy of the continent. Therefore, the modeling

[14] The tourism sector is also very sensitive to water availability and the average sea level. The latter will encourage the erosion of beaches and tourist facilities on the same (PEACC-BC, 2012; p.134)

[15] The different sectoral productive structures between the region and the country are basically due to the existence of export sectors: agricultural, industrial or manufacturing, and tourism (PEACC-BC, 2012; p. 15).

[16] The economic losses estimated in most models of the impact of CC range between 3.0% and 7.0% of GDP in developing countries (IPCC, 2012; p.13) countries.

[17] The migration phenomenon in the state is characterized by welcoming more than 170,000 people annually, representing each month the state has more than 14,000 new residents (PEACC-BC, 2012; p. 99).

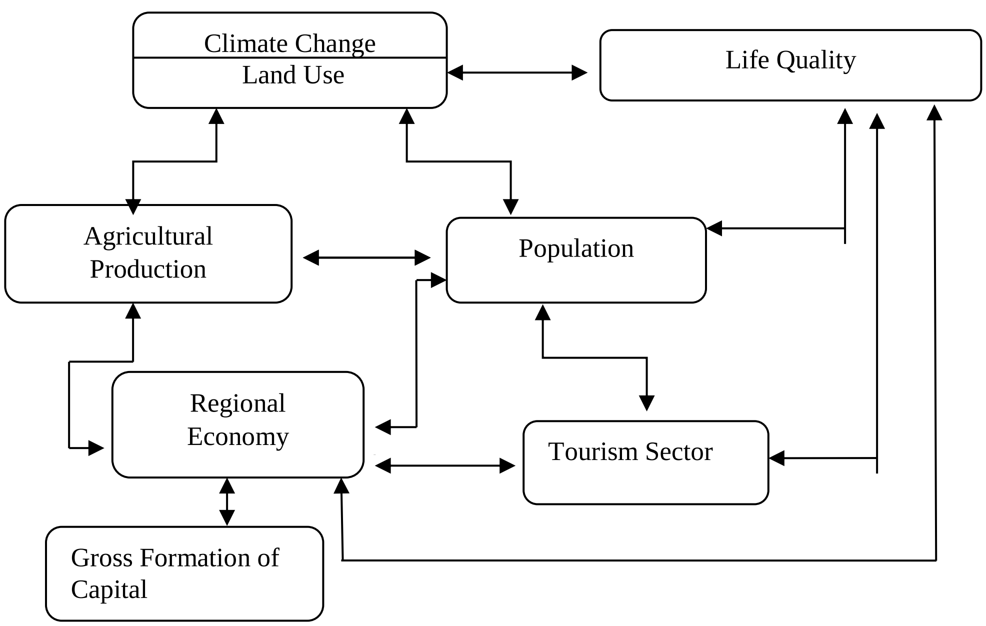
[18] The population is considered urban because it is based in districts with more than 15,000 inhabitants. This is independent of the sector where the workforce plays (PEACC-BC, 2012, p.99).

carried out in the PEACC-BC must be expanded to determine the economic cost on the condition linked to the phenomenon of CC identifying the interdependent behavior and sectorial feedbacks.

As previously stated, the MRMSD is conceptually based on the *Systemic Approach* and tries to collect fundamental linkages and feedbacks underlying the sustainability of social-economic-ecological systems. Thus, according to the subsystem in concern (land, industry, social group, etc.) some generic systemic features are universally required for the sustainability of social-economic-ecological system is collected.

The conceptual structure of MRMSD is displayed in Figure 1. It is built on three basic dimensions: environment, economy, and population; and consists of eight blocks with indirect and linkages between them; for example, between the CC and agricultural production via land use; between agricultural production and productive capacity (capital) via the regional economy; between the economy and quality of life via the population; and, between tourism, economy and quality of life via the population.[19]

Figure 1. General structure of MRMSD



Source: Author.

[19] The MRMSD is conceived as a representation of the regional economy at a given moment, where an income / expenditure of the main economic interrelations between productive agents and markets, which are adjusted for changes in quantities of factors balance shown, with the exogenous prices

Model behavior MRMSD is based on *System Dynamics* a methodology for building simulation models for complex systems, such as those that are studied in ecology, economics, and demography.[20] System dynamics applies basically interdependence ideas and feedback, along with the theory of models in state space and numerical analysis procedures. Therefore, it is a methodology categorized as a "soft system".[21]

The aim of MRMSD, as in system dynamics and all soft systems methodologies, is to understand how the structure of the modeled system is responsible for its behavior. This understanding should normally generate a favorable environment for the determination of actions that can improve the functioning of the modeled system or solve the problem's observed frame. The main advantage of this technique is that these actions can be simulated at low cost, making it possible to assess the results without putting them into practice in the real world.

MRMSD simulation is performed by *Stella* (ISEE Systems; 2005) which is a software modeling tool that integrates interdependence and feedback. Thus, *Stella* is a dynamic simulation program with extensive interactive capability that allows model display using graphical procedures with icons.

In particular, *Stella* employs four elements of Forrester symbology:[22]

1. The "rectangle" representing a state variable or acquis, which is a variable that accumulates in time. It is important to note that the shaded rectangles represent matrix variables.
2. The "Valve" represents a flow variable, which is a variable that affects the behavior of state or stock variables. Again, a shaded valve represents matrix variables.
3. A "circle" representing an auxiliary variable, which affect the flow values. The shaded circles represent matrix variables, circles without shadow are scalar variables, and dashed circles (~) represent a graphic function of the variable.
4. An "arrow" represents a material or information channel.

MRMSD in the *Stella* programming is presented in Figure 2.

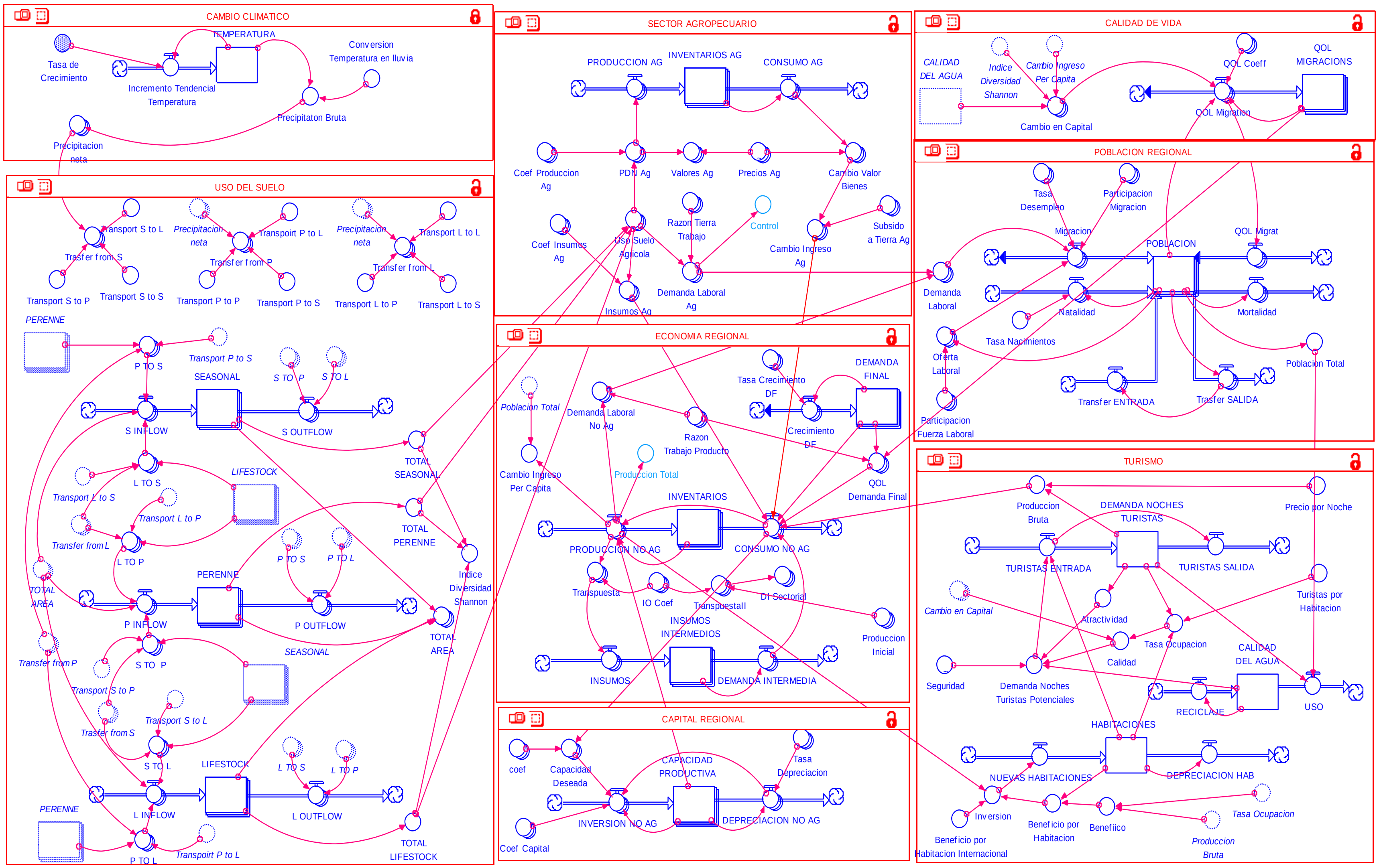
---

[20]A complex system is composed of several interconnected or interwoven parts whose links contain additional information and hidden from the observer. As a result of interactions between elements, new properties that cannot be explained by the properties of the individual elements (; 2013; p 2. De Wit and Crookes) arise

[21]A soft system is a system purpose that is not only able to choose means to achieve certain ends, but is also able to select and change these purposes. In these systems the clear determination is difficult and precise purpose in contrast to the hard systems (as in physical sciences). Soft systems are not easily identifiable structures (Osorio, 2010, p. 45)

[22] Diagram of Forrester, is the characteristic diagram of system dynamics. It is a translation of causal diagram terminology that makes writing equations on the computer (Tenorio, 2013).

Figure 2. Conceptual Design and Programming MRMSD



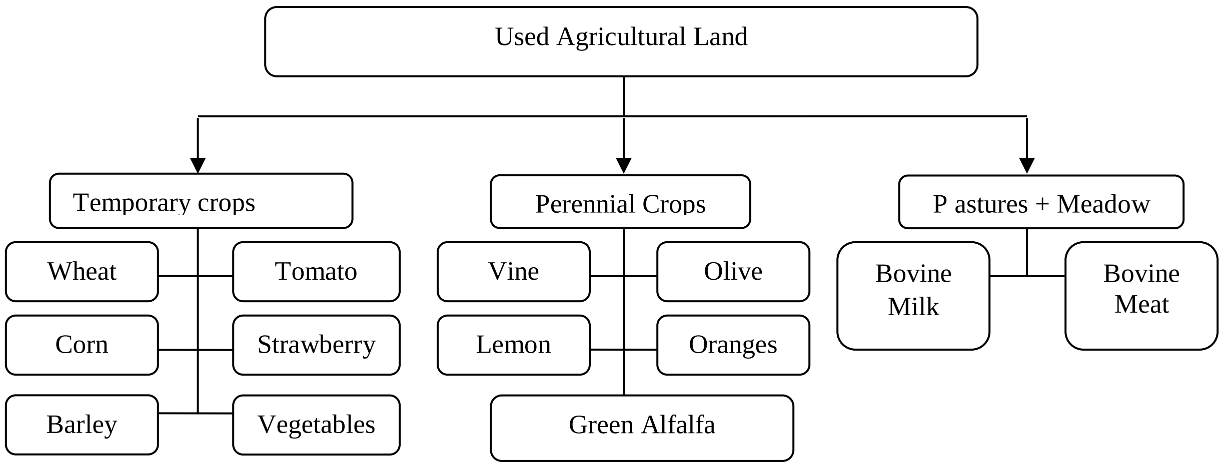
The blocks of the model were programmed using matrix calculus, which provides an inestimable help to easily address the problem of dynamic short (growth) and long term (development).
The precise way in which the temporal change of the environment is modeled are inside the "climate change" block. The module, determines the rising time path of the air temperature and the inverse relationship between gross rainfall and temperature -this last relationship indicates that the rise in temperature is associated with a drop in gross precipitation. It also determines the net or effective precipitation conceived as the fraction of gross precipitation that directly impacts the different agricultural production systems. Changes in these two climatic variables are the central source of setting land use of state agricultural production systems.

The "climate change" block is interconnected with "land use", comprising land areas of each agricultural production system. Its controller is a Markov Transition Matrix. Thus, the change in land use can be represented by a time probabilistic progression of land status changes, as follows: land areas devoted to agricultural activities are divided into three segments H1 (seasonal crops), H2 (perennials) and H3 (pasture for cattle). Each surface can change from one category of land use to another, depending on climatic variables -through the transition matrix that determines the probability of moving from state *i* to state *j* at time (*i, j* are land use) -. Then, from the coefficients of this matrix and given the distribution of initial proportions of the surface in agricultural subsectors, the description of the dynamics of the acquis land use is possible (Clark and Mangel, 2000). The change in the distribution of agricultural land among the various subsystems is the main source of variation in the regional agricultural supply.

The "land use" block is linked to "farming", organized in alternative production systems that jointly determine the agricultural supply in the region (supply-driven agriculture). The allocation of land area among different agricultural production systems determines the primary production sector. This is due to the limited capacity of substitution of productive systems of the various subsectors of agriculture -the module breaks down the surface of agricultural production systems used according to the hierarchical tree depicted in graph 1.[23] Thus, it is assumed that soil surfaces of agricultural activities are determined exogenously by the CC. However, producers adjusted purchases of primary inputs including labor and raw materials according to the change of use of agricultural land and agricultural inputs coefficients of each production system. In turn, these purchases of intermediate inputs increase the demand of the sectorial production of the rest of the regional economy. Moreover, the categories of use of agricultural land and the land-labor ratio determine the demand of labor that affects the "population" block. The dynamics of agricultural stocks is determined by inventories generated by the agricultural supply (production) and agricultural demand (consumption or usage).

[23] The approach, therefore, attempt identifies the surface distribution of agricultural production systems, by the separation of the agricultural surface allocation and their relative returns.

Figure 3. Predominant Uses of Agricultural Area in Baja California



Source: Direct Information.

The "farming" block is connected to "regional economy" due the demand impact for agricultural inputs in the state's gross domestic production dynamics and its sectorial distribution. The block is composed by the regional dynamic input-output model adapted by Johnson (1986) and used by Bryden (2009). This model is similar to an ecological system where the adjustment in sectorial output is a function of demand excess. That is, the economy responds to changes in the demand excess (imbalance) adjusting the gross domestic production sector in the opposite direction. The adjustment mechanisms are the "unplanned inventories".[24]

The sectorial gross domestic production is the sum of intermediate demand –fraction of sectorial output that is used as industry input-[25] and final demand. The latter is broken down into the following components: home consumption, government consumption, exports, gross capital formation (production capacity), and unplanned inventory adjustment.[26]

It is observed that because the sectorial production is itself a fee, the block represents a system of second order differential equations -the Inventories are stocks that are flow determined called "adjustment rate of production", but the level change in inventories (excess demand) determines the exchange rate adjustment by production sectors. Then a second order differential equation system is required to solve the model. This is solved by trying to adjust the rate of production as a collection (annual production) associated with a flow: the change in the rate of production adjustment. This block is linked to the "population" via the demand for labor (through work-product and sectorial output ratio).

---

[24] When production (supply) and consumption (final demand) are equal, unplanned inventories are in balance. Otherwise, the system is unbalanced (Bryden, 2009).

[25] The intermediate demand is technically defined with input coefficients product multiplied by the level of sectoral output (Bryden, 2009).

[26] The main link between agriculture, tourism and regional economy, final demand for regionally produced goods (Bryden, 2009).

Also, the "regional economy" block is connected with "regional capital" that endogenously determines the level of investment and sectorial production capacity (capital).[27] Here it is assumed that economy sectors are adjusted adaptively to the difference between its ideal and installed production capacity.[28] The ideal capacity is proportional to the expected level of consumption, which in turn is related to final demand. The dynamics of the stock of productive capacity (capital) is determined by the investment positively and negatively by the depreciation.[29]

The "population" block is interfaced with "regional economy" and "farming" due to the set of labor demands. The block consists of a population in which the birth rate, mortality, aging, and migration are structured by age cohort and its controller is the *Leslie Transition Matrix* (Hannon and Ruth, 2001; p.67). The module includes seven age cohorts (0-9, 10-19, 20-29, 30-39, 40-49, 50-59 and 60-plus). Births in the region are determined by the birth rate in families age cohorted 20-29 and 30-39 years. Aging is regulated by a series of flows denominated input and output transfers as age cohort. The output transfer estimates individuals that due to age leave the group and join the next age group. The input transfer adds these individuals to the new age group. The participation of migration by age group controls the overall migration (inputs and outputs) of working age in response to changes in labor demand in the regional economy and changes in quality of life. Consequently, population dynamics acquis depends in part on the distribution of birth and death rates at different ages, which are specific to the state, and part of the current distribution of the number of individuals in each age class; reflecting economic conditions and recent environmental atmosphere to which the population has been exposed. The "population" block is linked in turn to "tourism" and "quality of life".

The "Tourism" block is interfaced with "population". The dynamic behavior of tourism is determined by the demand for tourism services. The system basically consists of the number of tourists, the number of hotel rooms, number of nights stay and the room price per night. The rate of profit depends of sector spending over total income and occupancy rate of hotel rooms. Rooms depend on investments in the sector and the depreciation rate of the rooms. The rooms are the capital stock of the tourism sector. Total revenues from tourism, in turn, influence the size of the "regional economy" (income, shopping, and employment) and part inventories sectorial output. Demand for hotel nights stays depend on indicators of environmental quality (water, beaches and tourist areas) linking to the levels of natural capital in the region. In addition, water quality affects the demand of tourists.

Water quality depends on the amount used for state residents and tourists and also the recycling rate thereof; the quality of the beaches is determined by the rate of hotel occupancy that is, the number of tourists divided by the total rooms-; and the attractiveness of the tourist areas depends on the amount of tourists who visit. When a new hotel is being built, a new beach area is

[27] The Gross capital formation is determined by multiplying capital ratios (demand per unit of sectoral capacity) and desired levels of sectorial investment (Johnson, 1986).

[28] To allow sectoral productive capacity restrictions (capital), the sectoral output is defined as the minimum required consumption (including inventories), plus the sectoral production capacity.

[29] The rate of sectoral gross output is limited by its capacity. Relationships in this block create a series of lags between changes in final demand, changes in capacity and sectoral growth limits.

developed and then offered to tourists. In this sense it is assumed that tourists do not like completely empty or crowded beaches.

Finally, the general welfare of individuals and society is evaluated by the concept "quality of life". This concept should not be confused with the standard of living or physical capital based on income, wealth or employment. Quality of life also includes indicators of natural capital (water quality, land use, etc.), and other indicators of cultural capital (identity and recreation, etc.), historical equity (belonging or social cohesion) and social (for example, physical health and education). Therefore, the "quality of life" block induces an endogenous supply-driven migration (each immigrant creates its own work post from the quality of life) that is added to the demand-driven migration (labor migration).

To determine the temporal behavior of "quality of life", the estimation of a set of "quality of life" elasticities is needed, defined as the ratio of net migration (migrants input - output migrants) for age groups (20- 59 and 60-plus) due to changes in two types of capital equipment and natural. As an alternative to direct elasticity's estimation of the "quality of life", having no official or published, we were forced to use a set of "borrowed elasticity's" of the TOPMARD study.[30]

The block also requires that exchange rates for each type of capital are estimated. For the coefficient of physical capital, the change in per capita income was divided by its regression coefficient. While in the case of natural capital, the percentage change in water quality variables and land is used.

With the above calculations of capital levels induced migration for two age categories (20-59 and 60-plus) is estimated. The first age category includes individuals active in the labor market (20-59) but migrating (inputs or outputs) not directly related to labor market opportunities. The second category includes old retired individuals (60-plus) but who migrate for better quality of life. The latter category does not affect labor supply, but the population and income of the regional economy. Both age groups contribute to the final demand (consumption) due to change in personal income.

To accommodate this new migration living conditions or guided by supply in the economy, an increase in exports is needed to use them and this must be added to the final demand (consumption). Thus it is assumed that the new final demand and employment keep the same regional structure.

[30] This practice has been used, for example, sectoral models used to assess the impact of alternative measures of Common Agricultural Policy (CAP) in the negotiations of the European Union (Garcia and Rivera, 1995; Casado and García, 2006, p. 941).

V. CLIMATE CHANGE SCENARIOS AND EMPIRICAL RESULTS

With the model MRMSD you can respond to the central questions raised in the PEACC-BC, but considering the interactions and feedbacks of the system. To do this, you must establish a climate baseline. This scenario serves as a reference for the evaluation of the CC in the global economy and to see how this translates into sectorial impacts.[31] The baseline scenario should not be seen as the best forecast or as the most likely outcome, but should be viewed as indicative and reference.

The climate scenario is based on a path of sustainable economic growth with socio-economic-ecological based on the trend of the last 30 years in the state. In this scenario no CC mitigation policy is enforced. This baseline scenario will be compared with the climate scenarios of low (B1) and high (A2) emissions consisting of raising the temperature and decrease in the rain 2° C and 15% ± 5° C and ± 20% respectively.

In each block of MRMSD variables or indicators give an overview of the results of environmental and territorial situation. However, only certain selected variables (marked with an asterisk *) are systematically presented and explained.

Climate Change: temperature*, gross precipitation*, and net precipitation*.
Land Use: seasonal crops land*, perennial crops land*, pastures and rangeland for cattle land* and total land*.
Agricultural Sector: agricultural production by subsector*, labor demand*, intermediate inputs demand*, subsidies, and agricultural prices.
Regional Economy: non-agricultural production by sector*, employment by sector*, non-agricultural consumption, labor demand*, inventories, intermediate and final demand.[32]
Capital Regional: current production capacity*, desired investment, and depreciation.
Population: population*, economically active population*, age, jobs, births and deaths distribution, and migration*.
Tourism: total income*, tourists*, rooms*, price per night, profits rate*, employment rate*, water quality*, recycling and use of water*.
Quality of Life: income per capita, water quality*, and land use percent*.

The MRMSD uses 2008 as a base, and makes the system simulation calculations until 2040. The initial conditions and relationships of the variables are based on data from several sources (MIPBC-COLEF, 2008; Economic Census -INEGI, 2009); agricultural subsectors (Statistical Yearbook-INEGI, 2009), the tourism sector (SECTUR, 2008; National Accounts System-INEGI, 2008); agricultural land use, climate projections and water availability (PEACC-BC, 2010); and demographics (CONAPO, 2008; General Census of Population and Housing-INEGI, 2010).

---

[31] Also serves to analyze policies and sensitivity analysis. These two analyzes are illustrative of possible exercises that can be performed with Dynamic Simulation Model (Hannon and Ruth, 2001).

[32] To simplify the calculations, the State input-output matrix has three sectors structure. I. Primary Sector (Agriculture, Forestry, Fishing, and Mining), II. Secondary sector (manufacturing industry) and III. Tertiary Sector (trade and services). The MIP original have 72 sectors.

Table No.1 shows the initial values and units of the endogenous variables key climate scenario based on a regional scale.

Table 1 Initial Value of Endogenous Variables

Parameters	Value	Units
Average temperature 1_ /	20	° C
Gross precipitation 2_ /	250	Mm
Seasonal Crop Land	11,223,520	Has
Perennial Crops Land	3941188	Has
Area Grazing + Meadows	786.874	Has
Total Land	15,951,583	Has
Value Prod. Growing Seasonal	$ 65.988	thousands
Perennial Value Prod	$ 22.031	thousands
Value Prod. Livestock	$ 4.737	thousands
Value Prod. Primary Sector 3_ /	$ 92.757	thousands
Value Prod. Secondary Sector 3_ /	$ 329.506	thousands
Value Prod. Tertiary Sector 3_ /	$ 220.005	thousands

Value of GDP	$ 1,189,732	thousands
Primary Sector Jobs	5,670	thousands
Secondary Sector Jobs	4,662	thousands
Tertiary Sector Jobs	9,950	thousands
Total Jobs	20.282	thousands
Migration		thousands
Population	66.847	thousands
Economically Active Population	22.066	thousands
Number of Hotel Rooms	210.465	Rooms
Foreign visitors (tourists)	63.085	thousands
Revenue of Tourism	70.655	thousands

1_ / $temperature_t = 17.1 + 0.015 * Time$ (increase of 0.06% pa)
2_ / $Prec^b_t = 250.3 - 1.217 * temperature_t$
3_ / See footnote 30.

Source: Official statistics, several sources.

The climatic variables PEACC-BC indicate an increase in the average temperature of 0.06 ° C per year for Baja California on a climate baseline scenario.[33] The average temperature will rise by the end of the century by 2 ° C (0.06 ° C) and 5.0 ° C (0.10 ° C) in scenarios with low emissions and high emissions or B1 or A2, respectively. Annual rainfall will decrease on average 30.2 mm and 45.5 mm in scenarios B1 (15%) and A2 (20%). Moreover, the value of annual or actual net precipitation is measured as a fraction of the water requirements of the two major crops, wheat (seasonal crop) and alfalfa (perennial crop) normalized to the base period (Ojeda-Bustamante, et al , 2011), is estimated as rainfall of 50.2 mm and 75.0 mm in scenarios B1 (25%) and A2 (50%).[34] The variation in climate variables is presented in Table 2.

[33] The temperature change on average *every year from 1903* to 2003 in the B1 scenario (PEACC-BC, 2010; p. 10).
[34] The water requirements of crops depend mainly on the species, variety, phenological cycle, crop cycle and environmental conditions. In particular, the need for water is in a range from 1000 mm to 1550 mm for wheat and from 1234 mm to 1350 mm for green alfalfa.

Table 2. Variation of Climate Variables in Scenarios B1 and A2, 2008-2040.									
	Base Scenario			Scenario B1			Scenario A1		
Weather Vars	**2008**	**2023**	**2040**	**2008**	**2023**	**2040**	**2008**	**2023**	**2040**
Temperature	20	20	20	20	20.9	21.9	20	22.5	23.2
Gross precipitation	250	250	250	250	230	211	250	205	192
Net precipitation	200	200	200	200	150	136	200	125	104

Source: MRMSD

Table 3shows the changes in the pattern of land use from agricultural production subsystems generated by water deficit and by the increased heat in the state. In the scenarios B1 and A2, with the climate becoming more seasonal effects on agricultural production management subsystems in the state are more significant, reducing the area of land for perennial crops and pastures greater extent than the land area of seasonal crops.

Table 3. Distribution of Land Occupied by Category Production System in Scenarios Base, B1 and A2, 2008-2040.									
	Base Scenario			Scenario B1			Scenario A2		
Land Use	**2008**	**2023**	**2040**	**2008**	**2023**	**2040**	**2008**	**2023**	**2040**
Seasonal	11,223,521	10,696,708	10,227,351	11,223,521	10,728,947	10,256,167	11,223,521	10,891,503	10,569,308
Perennial	3,941,188	3,617,292	3,339,046	3,941,188	3,353,836	2,854,011	3,941,188	2,767,190	1,942,890
Pasturage	786.874	747.685	712.871	786.874	710.323	641.219	786.874	539.897	370.439
Total	15,951,583	15,061,685	14,279,268	15,951,583	14,793,106	13,751,398	15,951,583	14,198,590	12,882,636

Source: Information MRMSD.

Identifying interdependent and sectorial feedbacks behaviors when emissions are low, a reduction of land areas for seasonal crops, perennial and pastures for cattle is estimated in 8%, 27% and 18%, respectively. Whereas when there are high emissions cultivable land will fall 5%, 50% and 52% respectively, compared with the baseline scenario of 8%, 15%, 10%, respectively.

Table No. 4, shows the variation in the volume of output, employment, and demand for agricultural inputs induced by changes in the pattern of crops and herds of cattle, in turn, generated by the increase of greenhouse gases (scenarios B1 or A2) in the state.

Table 4. Effect on the Agricultural Sector in Scenarios Base, B1 and A2, 2008-2040									
	Base Scenario			Scenario B1			Scenario A2		
Year 2008	**Production**	**Employment**	**RawMat**	**Production**	**Employment**	**RawMat**	**Production**	**Employment**	**RawMat**
Seasonal	65,994	4,153	43,772	65,994	4,153	43,772	65,994	4,153	43,772
Perennial	22,071	1,301	6,700	22,071	1,301	6,700	22,071	1,301	6,700
Pasturage	4,721	220	5,902	4,721	220	5,902	4,721	220	5,902
Total	92,786	5,674	56,373	92,786	5,674	56,373	92,786	5,674	56,373
Year 2023	**Production**	**Employment**	**RawMat**	**Production**	**Employment**	**RawMat**	**Production**	**Employment**	**RawMat**
Seasonal	62,897	3,958	41,717	63,086	3,970	41,843	64,042	4,030	42,477
Perennial	20,257	1,194	6,149	18,781	1,107	5,702	15,496	913	4,704
Pasturage	4,486	209	5,608	4,262	199	5,327	3,239	151	4,049
Total	87,640	5,361	53,474	86,130	5,275	52,872	82,778	5,094	51,230
Year 2040	**Production**	**Employment**	**RawMat**	**Production**	**Employment**	**RawMat**	**Production**	**Employment**	**RawMat**
Seasonal	59.944	3,772	39,759	60,306	3,795	39,999	62,148	3,911	41,220
Perennial	18.592	1,096	5,644	15,982	942	4,852	10,880	641	3,303
Pasturage	4,263	199	5,328	3,847	180	4,809	2,223	104	2,778
Total	82.799	5,067	50,731	80,136	4,916	49,660	75,250	4,656	47,302

Source: Information MRMSD.

As assumed in the model, the amount of land devoted to agricultural activities is exogenously determined by the CC. Then the agricultural producers adjust the purchase of primary inputs downward -workers and raw materials in either scenario-. In scenario B1, the average fall of the three variables (output, employment and raw materials) of the three agricultural production subsystems (with variations including ± 2%) would be 9%, 28% and 18% respectively. While in the A2 scenario it would be 6%, 51% and 53%, respectively. Compared to the 9%, 16%, 10% baseline scenario respectively.

Table 5, shows the economic and social losses measured by declines in production, sector productivity capacity (capital) and in the agricultural, the manufacturing and the commerce and services as well as macroeconomics caused in the State by the CC.

Table 5. Effect on Regional Economy in the Base Scenario, B1 and A2, 2008-2040									
	Base Scenario			Scenario B1			Scenario A2		
Year 2008	**Production**	**Employment**	**Capital**	**Production**	**Employment**	**Capital**	**Production**	**Employment**	**Capital**
Agricultural	92.757	5,674	1,277	92.757	5,674	1,277	92.757	5,674	1,277
Manufacture	322.903	4,569	64.228	322.903	4,569	64.228	322.903	4,569	64.228
Trade and Services	288.502	9,874	13,576	288.502	9,874	13,576	288.502	9,874	13,576
Production (PIBE)	704.161	20.116	79.082	704.161	20.116	79.082	704.161	20.116	79.082
Year 2023	**Production**	**Employment**	**Capital**	**Production**	**Employment**	**Capital**	**Production**	**Employment**	**Capital**
Agricultural	54.554	3,958	55,000	52,180	3,456	53.330	50.312	5,094	51,840
Manufacture	515.091	7,355	305.874	471.447	6,671	284.992	469.467	6,643	282.924
Trade and Services	482.734	16,521	325.582	467.251	15,991	315.408	465.698	15,938	314.320
Production (PIBE)	1,052,379	27.834	686.456	990.878	22.662	653.730	985.477	27.675	649.083

Source: Information MRMSD.

According to the model, the CC has an adverse effect on growth in key sectors of the regional economy through various mechanisms: provision of primary inputs, changes in final demand, changes in productive capacity (capital), changes in demand per hotel night, recycling of water by changes in tourism and population, and lower demand by falling revenues, among others. In the climate scenario of low emissions or B1, the average decrease of the three variables (output, employment and capital) agriculture, manufacturing, and trade and services (including variations of ± 0.5%) is 4%, 7 % and 4% respectively. Meanwhile, the negative effect on the state GDP would be 5%, the fall of regional employment and 10% lower capital loss of 5% over a period of 15 years.

In the high emissions scenario the effects of CC in key sectors and the regional economy tend to accumulate over time and can reach considerable magnitudes. The adverse effects of the scenario in the production end up generating a drop in the local corporate and households' income are resulting in a decrease in investment and less consumption; which could generate a new cycle of induced effects, hampering the economy to return to production levels were achieved in the scenario with no CC. The scenario indicates the biggest average drop of the three variables (output, employment and capital) the agricultural, manufacturing and trade and services sectors (including variations of ± 0.8% to 6%, 9% and 6%, respectively. While the negative effect on the state's GDP of6.5%, the fall of regional employment of 14% and capital loss of less than 5.4% within 15 years.

Extending the modeling of PEACC-BC shows that the total negative effects by sector and general level in the regional economy would be two to three times greater than the direct effects in the reference report, which points to the importance of not excluding both indirect effects (interdependencies) and the dynamic effects (feedback) in the assessment of environmental degradation at the regional level.

Table No. 6, shows the interdependence and dynamics of some demographic variables (population, economically active population and migration) linked to the level of economic activity of the state, in turn, determined by effects of CC on a regional scale.

In the analysis of the climate scenarios B1 and A2 it's important to note that, although admittedly a logical relationship cannot be determine between anthropogenic CC and labor migration, for various economic and social factors in migration flows involved, if it has been shown that environmental degradation acts as an accelerator of the migration process, forcing people to look for places that can offer more stable and secure livelihoods.

Table 6. Population Dynamics in Scenarios Base, B1 and A2, 2008-2040									
	Base Scenario			Scenario B1			Scenario A2		
Year 2008	**Population**	**PEA**	**Migration**	**Population**	**PEA**	**Migration**	**Population**	**PEA**	**Migration**
0-9	19,632	982	579	19,632	982	579	19,632	982	579
10-19	16.751	3,953	127	16.751	3,953	127	16.751	3,953	127
20-29	10,959	6,718	179	10,959	6,718	179	10,959	6,718	179
30-39	7,245	4,593	29	7,245	4,593	29	7,245	4,593	29
40-49	5,058	3,146	14	5,058	3,146	14	5,058	3,146	14
50-59	3,330	1,978	7	3,330	1,978	7	3,330	1,978	7
60 and over	3,649	1,682	4	3,649	1,682	4	3,649	1,682	4
Total	66.624	23,052	939	66.624	23,052	939	66.624	23,052	939
Year 2023	**Population**	**PEA**	**Migration**	**Population**	**PEA**	**Migration**	**Population**	**PEA**	**Migration**
0-9	14,942	747	441	14,949	747	441	14,815	741	437
10-19	22,119	5,220	-1.511	22.092	5,214	-1.514	21.785	5,141	-1.612
20-29	16,086	9,861	-298	16,107	9,874	-313	16,185	9,922	-465
30-39	10,887	6,902	-80	10,887	6,903	178	10,810	6,853	128
40-49	7,540	4,690	129	7,529	4,683	129	7,381	4,591	107
50-59	5,002	2,971	81	4,990	2,964	82	4,853	2,883	73
60 and over	2,896	1,335	-372	2,881	1,328	-368	2,756	1,271	-349
Total	79.472	31.726	-1.350	79.435	31.713	-1.365	78.585	31.401	-1.680

Source: Information MRMSD

In general, as the model set the population dynamics is related to economic growth and quality of life due to changes in the two types of capital considered (material and natural) which in turn are affected by the CC. Thus, the table shows processes of change naturally, i.e., shows a decrease of population size, accompanied by change in structure due to migratory outflows in the age group of working and retired seeking a better quality of life.

Climate change in the geographical environment has clear effects on the age structure of the population in the climate scenario B1. It is estimated that the level of induced migration for two working age categories (10-19 and 20-29) is -1,524 and -313 individuals, i.e., a migration outflow of working age people due to economic contraction. Moreover, the age group that includes retired individuals (60 and over) exhibits an output of -372 individuals leaving because of perception of environmental quality. The net outflow of population would -1,350 people at the regional level.

The climate scenario A2 suggests a major change in the structure of the population due to changes in the demand for jobs in the category of youth (10-19 and 20-29) to -1,621 and -465 and retired (65 and more) -349 individuals. The net population loss would be -1,680 individuals of the regional economy. Table 7, shows a detailed interaction between tourism, regional economy, environment and CC. The table highlights variables: gross production by sector, demand for hotel nights by tourists, rooms, hotel occupancy rate, monetary benefit per room, water quality, water recycling, and investment amount in the sector and service quality perception in the tourism sector. It is important to note, before analyzing that the variables subject to study do not include the seasonal period (winter, summer and fall) and the relations between these variables theoretically show positive and negative effects.

Table 7. Impact on Tourism Sector in Scenarios Base, B1 and A2, 2008-2040

Years old	**Production**	**Tourists**	**Rooms**	**Occupation**	**Benefit**	**Water Quality**	**Recycling**	**Investment**	**Quality**
2008	70.655	63.085	210.465	0.60	42.375	99	0.01	4,638	1.00
2023	74.018	66.087	272.850	0.54	40,133	92	0.08	2,728	0.73
2040	73.018	65.195	274.011	0.54	39.278	84	0.14	2,736	-0.91
	Scenario B1								
Years old	**Production**	**Tourists**	**Rooms**	**Occupation**	**Benefit**	**Water Quality**	**Recycling**	**Investment**	**Quality**
2008	70.655	63.085	210.465	0.60	42.375	99	0.01	4,638	1.00
2023	73.092	65.260	269.344	0.54	39.637	92	0.08	2,609	-0.87
2040	72.196	64.460	261.041	0.55	39.486	84	0.14	2,462	-2.29
	Scenario A2								
Years old	**Production**	**Tourists**	**Rooms**	**Occupation**	**Benefit**	**Water Quality**	**Recycling**	**Investment**	**Quality**
2008	70.655	63.085	210.465	0.60	42.375	99	0.01	4,638	1.00
2023	71.751	64.063	265.782	0.54	38.820	92	0.08	2,516	-2.43
2040	69.442	62.002	253.619	0.54	37.809	84	0.15	2,340	-5.39

Source: Information MRMSD

The model assumes that the importance of tourism is, in general, the number of visitors and the economic benefit they generate in the state. This importance or impact can be translated directly into construction of new hotels, government revenues and the creation of new jobs; and indirectly in the generation of additional services in a wide range of branches of manufacturing, agriculture and trade and services sector.

As for border travelers in the state they can be visitors and tourists. That is, only a proportion of foreign tourists remain in the state from the total demand of border travelers (the range between 35% and 45%). Thus, the number of tourists who require accommodations at the low emissions scenario B1 or show a drop of -1%, number of rooms -5% hotel occupancy rate -2% currency benefit per room -1% quality -7% water, the amount of investment in the sector -10% and a decline in the perception of the quality of the environment of -219%. Also an increase in the amount of recycled water 8%. The gross product generated by the tourism sector would decrease by -1%.

In the climate high emissions scenario or A2 the number of tourists who demand hosting shows a reduction of -5%, number of rooms at -7% hotel occupancy rate -2% currency benefit per room -4% quality -12% water, the amount of investment in the sector -14% and a decline in the perception of the quality of the environment of -539%. Also an increase in the amount of 15% recycled water. Meanwhile, the sectorial gross domestic product would fall by 5%.

VI. CONCLUSIONS

In this document the modeling performed in the PEACC-BC by abandoning the simple explanation of the direct impacts of CC from partial studies, to a dynamic systemic and relational approach was extended.

For this, a MRMSD was proposed, that parts from idea of conceiving Baja California as an economic-social ecological sustainable system that allows us to interpret it as a set of subsystems (land, sectors, social groups) interrelated and interacting among which matter moves, in the following flow paths interconnected. Subsystems are related such that a change in one of them has the ability to produce changes in all others. From this viewpoint, we assume that the entity is a soft system and system behavior leads to the idea of a feedback cycle - defined as the number of phases and changes made as an orderly succession, by which the system evolves over time, eventually returning to the initial conditions that happened at an earlier stage. In this sense, the *Systems Approach* and *System Dynamics* methodology provides a more detailed and richer view of the magnitude and how the impacts of CC circulate in the different key sectors and the regional economy in the long term.

The MRMSD calculations show that the CC has an adverse effect on the industrial structure and regional economy, not only by direct, but also indirect and dynamic effects on other sectors of the regional economy, which is transmitted through various mechanisms: land use, provision of primary inputs, changes in final demand, demand for hotel nights, recycling water for tourism and population changes, loss of productive capacity (capital), lower demand due to falling revenues, etc. Then, global economic losses for the entity fluctuate within a range of -5 and -

6.5% of the state GDP that are two to three times higher than the direct effects reported in the reference report unless we take measures to mitigate and adapt the CC.

Also the importance of effects on key sectors before the CC is displayed. In any climate scenarios there is a reduction in the areas of land for seasonal, perennial crops and pastures for cattle of -8% / - 5% -27% / - 50% and -18% / - 52%; in the agriculture sector an average fall of the three variables (output, employment and raw materials) of the three agricultural production subsystems (with variations among them) is -9 / -6% -28% / - 51% and -18 % / - 53%; in the regional economy an average drop of the three variables (output, employment and capital) in the agricultural, manufacturing and trade and services sector (with variations among them) -6% -9% and -6% in the size and population structure and migration induced for two categories of working age (10-19 and 20-29) is -1.524 / -1.621 and -313 / -465 and retired individuals (65 and older) with -372 / -349 individuals. It also shows serious negative impacts on the tourism sector.

Finally, for the PEACC-BC does not become only a catalog of good intentions or in a regulatory framework without enforcement capacity in the state, it is important to define more accurately the magnitude of the consequences caused by the CC level regional and use MRMSD for evaluating environmental policies.

BIBLIOGRAPHY

Bryden, John (2009), " Towards a New Analysis of CAP Policy Options: Using System Dynamics to Model the Relationships Between Agricultural Functions, Territorial Rural Development, and Policies " ESEE Congress, Lubljiana, Slovenia. June 2009.

Clark, Colin W. and Marc Mangel (2000), **Dynamic State Variables in Ecology: Methodsand Applications** . New York, Oxford: Oxford University Press, 289 pp.

Married, José M. and Azusena García (2006), "Spanish Econometric Simulation Model Agricultural Policy (SEPA) "Study of Applied Economics. 24-3: 1, pp. 941-978.

De Wit, J. Douglas Martin and Crookes (2013), "Improved decision-making on irrigation farming in arid zones using a system dynamics model. " *South African Journal of Science* 109: 11/12, pp.1-8.

Fuentes, Noé Aron, Alejandro Brugués and Gabriel Gonzalez-König (2013), "Modelo de Insumo-Producto Dinámico", Journal of Economics, University of Yucatan. 21 pp.

García Álvarez-Coque, José Maria and Luis Miguel Rivera (1995), "A model for the economic diagnosis and simulation of agricultural policies. " *National Congress of Agricultural Economics and Sociology* . Madrid, Spain.

Hannon, Matthias Ruth and Bruce (2001), **Modeling Dynamic Systems** . Springer Press, 2000, 409 pp.

National Institute of Statistics and Geography (INEGI), 2010. E-mail to http://www.economia.gob.mx/delegaciones-de-la-se/estatales/baja-california.

Jemio, Luis C. and C. Lykke Andersen (2013), "Climate Change in Bolivia until 2100: Integration of Direct Effects, Indirect, and Dynamic using a Computable General Equilibrium Model. " *Available on the Internet* , La Paz, Bolivia. 29 pp.

Johnson, Thomas G. (1986), "A Dynamic Input Output Model for Small Regions." *Review for Regional Studies* 16: 1 (Spring) pp. 14-23.

Johnson, Thomas G., John Bryden and Karen Refsgaard (2008), "A system Dynamics Model of Agriculture and Rural Development: The TOPMARD core model " *107 th EAAE Seminar* , Sevilla, Spain, from January to February.

Ojeda-Bustamante, Waldo, Ernesto Sifuentes, Maura Iñiguez and Martin J. Montero (2011) "Impact of Climate Change on Water Requirements Development and the Crops " *Agrociencia,* 45: 1, January-February, pp. 1-11.

Osorio, Paul H. (2010), Proposal of a Simulation Model as a Tool in the Rationale and Understanding Decision Making in Public Investment. A Systems Approach. Doctoral Thesis, Industrial University of Santander, Bucaramanga, Colombia.

PEACC-BC (2012) **.** Baja California State Program of Action on Climate Change. SEMARNAT, Government of Baja California and National Institute of Ecology.

PEACC-BCS (2012) **.** Baja California Sur State Program of Action on Climate Change. SEMARNAT, Government of Baja California Sur and National Institute of Ecology.

Tenorio, Luis (2013), System Dynamics: Systemic Real World Vision, Teaching Organizational systemic. Weblink https: //www.google.com.mx/tenorio