Development of Simulation Model of the Canary Islands for Strategic Decision Making

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Razvoj simulacijskega modela Kanarskih otokov za strateško odločanje

Prispevek obravnava razvoj modela sistemske dinamike za podporo odločanju na strateškem nivoju pri razvoju Kanarskih otokov. Kvantitativno modeliranje zajema relevantne spremenljivke, ki vplivajo na trajnostni razvoj in kvaliteto življenja na Kanarskih otokih. Relacije med ključnimi spremenljivkami so bile formalno opredeljene s pomočjo matrike vpliva. Opredeljen je bil vzročno posledični diagram, ki določa povezavo med elementi matrike. Analizirani so bili pod-modeli populacije, turističnega trga, kmetijstva, okolja ter BDP. Programsko orodje Powersim je bilo uporabljeno pri simulaciji modela. Analiziranih ter opisanih je več simulacijskih scenarijev z odzivi. Trenutno je model v fazi validacije. Začetni rezultati obetajo pozitivne validacijski izid.

Ključne besede: sistemska dinamika, simulacija, model, sistem za podporo odločanju, trajnostni razvoj, turizem

1 Introduction

In our previous work (Kljajić et al, 2002) we have described the model of the Canary Islands for development and decision support. Initially, the model consisted of 52 variables defined by the influence matrix **M** representing the size of 52x52 (Legna & Riveros, 2001). Each value of the interaction was scored between zero and five according to its impact on regional development. On the basis of the graph theory, the matrix was reduced and decomposed to sub-models (Kljajić et al, 2002). In this paper the integral simulation model of the Canary Islands for public decision support will be described. Several scenarios of future developments will be studied which consider strategic public decisions. The developed model should be viewed as decision support on the strategic level. The systematic solution, which incorporates the developed model, tends to diminish the uncertainty that affects the decision processes in the region. Such an approach is not new; Forrester's World model č Forrester (1971); Meadows et al. (1991); Mesarovic & Pastel (1984), but is seldom applied in regional planning. The starting point of our work was a thorough examination of the problem stated through the means of the influence matrix, which is described in our previous work (Legna % Ceballos, 2001; Kljajić et al.; 2002, Kljajić et al, 2000). The influence matrix was the source of information in the model building process. It contained the most important variables and the information regarding interactions between them as noted by the decision makers. The applied methodology of decomposition enabled us to divide the model to sub-models in order to assure the transparency of model validation. Simulation scenarios were prepared to study the possible strategic development of the region. The key variables that strongly influence the economic system development are considered as: Population, education level of the population, agriculture and industry production, tourism market, infrastructure and the environment. Scenarios that describe possible future development of the region are analyzed in order to achieve proper policy change, which should result in the improvement of the economic system. At present preliminary results for three basic scenarios were obtained in order to model validation. It must be stressed that the main effort in model building and evaluation were performed through e-mail communications therefore some achievements will be revised and improved.

2 The model of the Canary Islands

Figure 1 shows the CLD with the main variables for the Canary Islands case. There are five main feedback loops marked in the diagram, three reinforcing and two balancing. The positive loop, which interconnects GDP, Development Policy and the Tourism Market, represents the development cycle of the economy, which tends to grow. The second positive feedback loop from GDP, Development Policy, Agriculture and Industry Production also has positive characteristics, which lead to enhanced industrial and agriculture production. There is also the positive feedback loop, which includes the Tourism Market, Employment Opportunities and Quality of Life, Immigration, Population, Human resources, Agriculture and Industry. This reinforcing loop represents development, which incorporates population, employment opportunities and immigration. The model is balanced by the negative feedback loop, which considers the Tourism Market, Preservation of Natural Resources and Regional Attractiveness. Although the system tends to increase the Tourism Market on the Islands, the process is moderated by the environmental attractiveness, which is diminished by the overcrowding of the region. Similar negative effects are represented by the loop, which interconnects Agriculture Production and Preservation of Natural Resources. An important negative feedback loop is also present between the GDP, Population and the Preservation of Natural Resources. Therefore the CLD model highlights the main variables, which determine the development of the Canary Islands region. On one side, there are three positive loops, which represent the technological development in the field of Tourism and Agriculture and on the other side, two negative loops that consider environmental preservation. The proper balance between the loops should result in sustainable development of the region. More detailed examination of the variables was presented in our previous work (Kljajić et al., 2002).

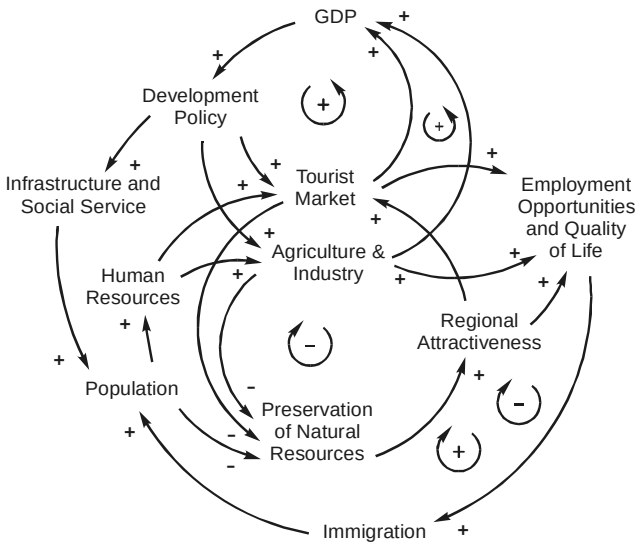

Figure 1: Causal Loop Diagram of the Canary Islands

Tourism as the main economic entity determines the activity of the production sector and increases employment. However the development of tourism increases the negative environmental impacts such as infrastructure building and increased agricultural production. Natural resources are the main factor in the development model of the Canary Islands. These resources are under certain stress and should be preserved in order to formulate a sustainable development policy. The negative impact is identified by two processes:

- increased tourism and infrastructure building diminish the quality of agricultural and urban land
- agricultural technology and industry have a great negative impact on the environment and water resources

Consequently, the system considered reduces its own economic resources and the quality of life. Therefore, the developmental model of the region should be changed.

This model takes into consideration the following main sub models, which are described as: Population, Tourism, Agriculture, Environment and GDP. The complete model consists of 171 variables and parameters, realized in the Powersim™.

2.1 Population sub-model

Figure 3 represents the population sub-model where the population is divided into three categories: the population under the age of 16 (minors), the active population between 16 and 65 and the elderly, over 65. The total number of residents on the Islands is approximately 1.8 million. The main variables that characterize the dynamics of the population are the birth rate coefficient, mortality coefficient and immigration. The Canary Islands acreage is 7447 km^2. The demographic density is 240 people/ km^2. The demographic density of Spain, for example, is 80 people/ km^2. If we include the "dynamic" population of about 10 million tourists that visit the Canary Islands every year we can see, that the area demographic density is relatively high. Besides the high demographic density it should be mentioned, that the population is relatively young in comparison to other regions of Spain. The population is rapidly increasing due to the high birth ratio. In Spain, 44 % of the population is younger than 30, while on the Canary Islands, this ratio is 51%. The mortality is lower than the Spanish average therefore the parameters for population growth is certainly met.

2.2 Tourism sub-model

Tourism is the main economic activity of the region. Figure 5 represents the Tourism sub-model, which incorporates the number of tourists that are residing in the Canary Islands. The tourist population is influenced by their arrivals and departures. The income from tourism is determined by the number of tourists, the service price and the GDP of the tourists' country of origin. The number of tourists that arrive to the Canary Islands in one year is de-

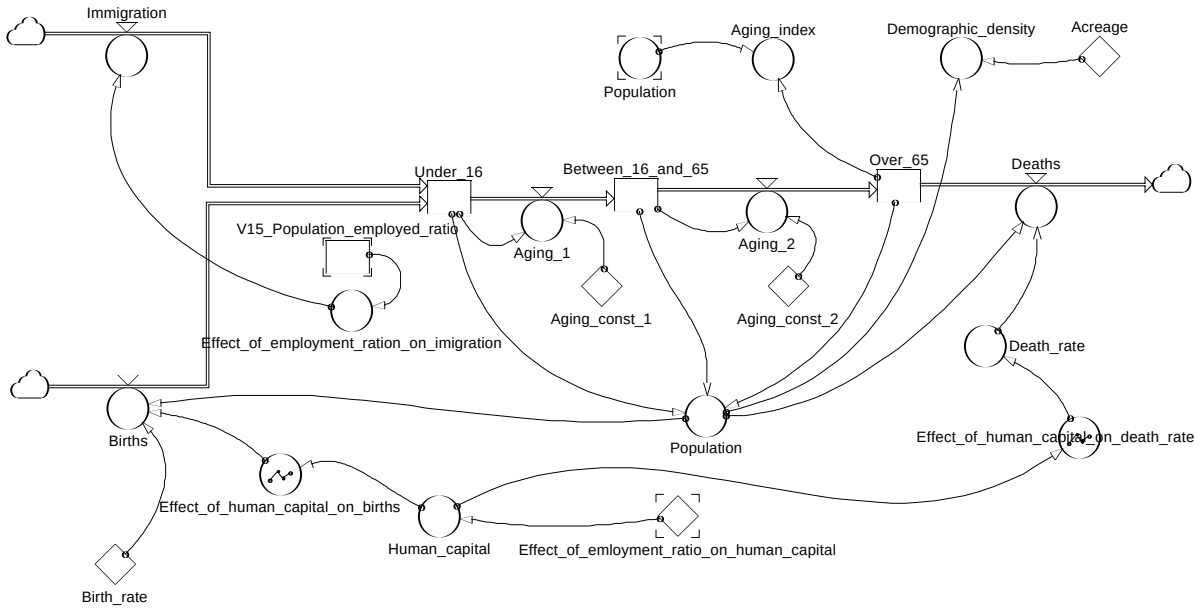

Figure 2: Population sub-model

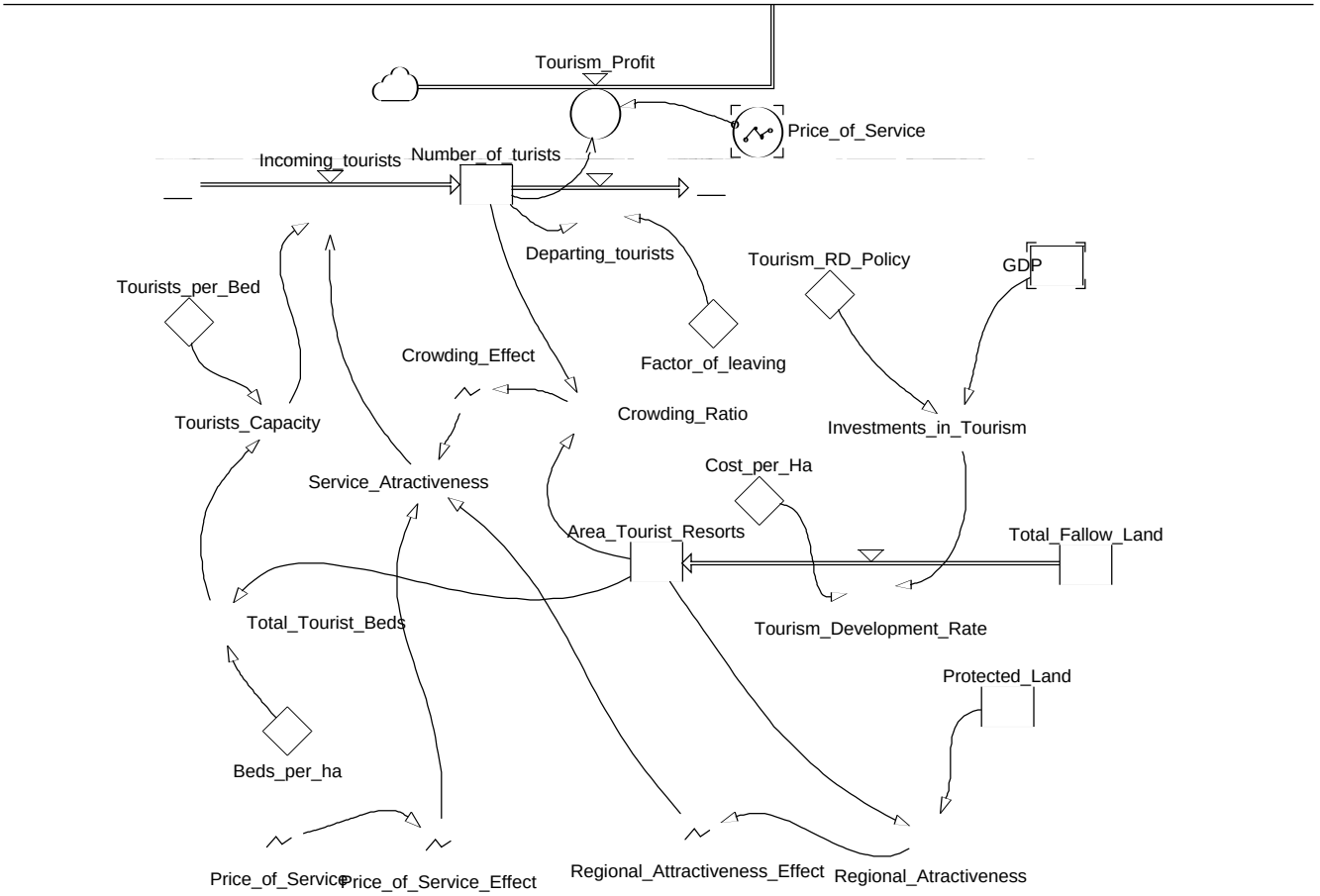

Figure 3: Tourism sub-model

pendant on the tourist capacities and the attractiveness of the service. The capacity to house the tourists determines the number of arrivals. There are approximately 350,000 beds available. Service attractiveness depends on the service price, environmental attractiveness and demographic density of tourist resorts. The GDP is mainly dependant on the number of tourists that arrive to the islands each year. Increased income causes additional investments in the tourism infrastructure. This negatively affects the environmental attractiveness, which negatively influences the number of tourists. There is also the negative effect of crowding by the increasing number of residing tourists.

The important factor is the ratio of the GDP that is relative to the R&D in the field of tourism. It is anticipated, that the price of service would remain the same with reduced costs and environmental pollution. This should increase the funding of further research, which is indicated as the positive feedback loop. The improved preservation of the environment results in the increase of environmental attractiveness and consequently in growing interest from potential tourists.

Regional Attractiveness depends on the acreage of Tourist Resorts and Protected Land. This is transformed by the arbitrary function to the Regional Attractiveness Effect, which determines the Service attractiveness. The Regional Attractiveness Effect is normalized and the output value of the function is transformed to the interval Š0, 1Ć. This is one of the possibilities to formulate the Attractiveness factor in the model. In our case there should be equilibrium between the Protected Land by which the tourists are mostly attracted and the Tourist Resorts, which have to be provided in order to accommodate the tourists.

2.3 Agriculture sub model

Agriculture is the traditional economic branch in the Canary Islands. The crops are produced for domestic as well as for the export market. The land is fertile but the region is exposed to aridness. The main crops are bananas, tomatoes, sugar cane and tobacco. Fishing is also an important activity. Agriculture in general offers a small contribution to the GDP however the impact of agriculture on the environment and natural resources is rather significant. Agricultural production is dependant on the price of crops. Production is relative to the high cost of watering the fields. The cost for the water is dependant on the demand. The model also considers the application of the techniques used in agriculture. The greater proportion of the GDP intended for R&D should positively impact land exploitation, which influences the income and GDP. Here we can indicate the positive feedback loop, which leads to better agricultural land exploitation.

The following tendency of development can be estimated for agricultural production:

i. The stagnation of agricultural production combined with the continuous use of techniques degrades the environment and cause low productivity. A significant number of non-competitive productions require subsidization.
ii. The increase in agricultural production market value due to the augmentation of productivity and the appropriate selection of products to be produced by this sector (eliminating low productivity branches). This increase is combined with the reduction of the damaging effects of some agricultural products on the environment and water consumption.

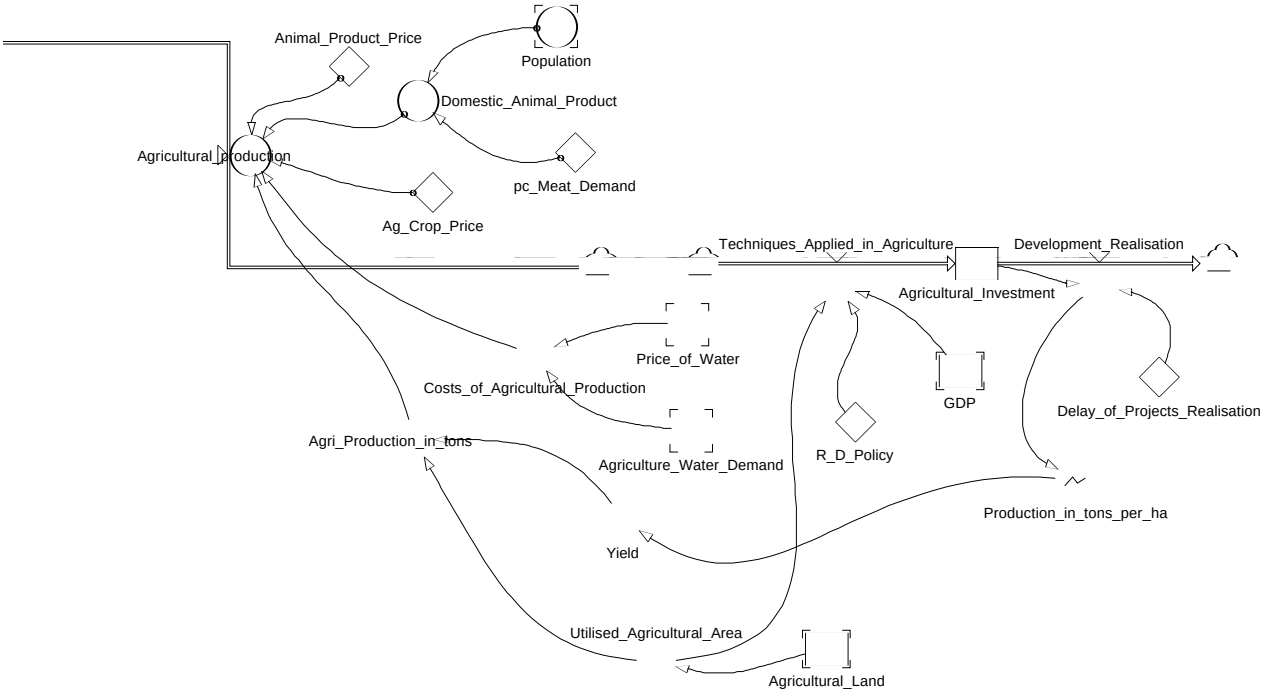

Figure 4: Agriculture sub model

2.4 Ecology sub model

Figure 8 shows the environment sub-model, which incorporates the following levels: Tourist Resorts, Fallow Land, Agricultural Land, Urban Land and Protected Land. Fallow land is estimated at 338,000 ha and decreases yearly. 12, 000 ha are exploited as tourist resorts. The proportion of land that is devoted to tourism increases each year. This is mainly influenced by the GDP, which determines the investments in tourism infrastructure building. In future

years, ¾ of the total investments in Spain will be designated for the Canary Islands. The agricultural land is estimated to be 100,000 ha, however only ½ of the land has been efficiently exploited. Agricultural land is diminishing on account of the population growth. The size of the agricultural land is dependant on the GDP that is dedicated to the development of the rural area and the costs that are related to those improvements. 40% of the total acreage has the status of protected territory. The laws of natural areas, which were set in 1992, govern the protection. A large portion of the land which was initially intended for tourism infrastructure is now under protection (Cipriano, 2000). The size of urban land is 100,000 ha. Due to the increasing population, the size of urban land is increasing. This portion is also dependant on the GDP, which influences the development of the urban infrastructure. The variable Environmental Attractiveness has a significant impact on service attractiveness and the number of tourists. The factor is dependant on the size of the natural environment, agricultural land, urban land and tourist resorts. Due to the shrinking natural environment this factor is slowly decreasing. From a strategic point of view, the conclusions are quite interesting:

i. The increase of revenue and the services generated by the tourist sector are crucial, because they are important factors in determining the rates of increase in employment, the GDP and the revenue of the Canarian population.
ii. This increase in tourism and the related activities will have a "ceiling" in the future, due to the degradation of the environment and the crowding effect.
iii. Consequently, in order to achieve sustainable economic development and development in the quality of life of the Canarian society, protecting environmental quality and reducing the Crowding effect of tourists that arrive to the Islands are necessary.
iv. In particular, the protection and improvement of the environment require urban and agricultural land planning (including the control of land degradation and using appropriate agricultural techniques).

2.5 GDP sub model

There are several measurements that are applied to determine economic activity. One of the most common is Gross Domestic Product (GDP) which measures the value of all produced goods and services in a certain economic system for the given period; usually for the period of one year. GDP is represented as the level in Figure 10, which is dependant on Industrial Production, Construction Sector Production, Tourism Income, and Agricultural Production. The GDP is also dependant on Government Expenditures, Investments and Trade, which are determined as the difference between exports and imports. In our case, the trade balance is negative i.e. imports are greater than exports. The main trading partners are France, Germany and Italy. The economic growth of the Canary Islands (3.5%) is higher than the Spanish average and has consistently increased over the last 15 years. GDP per capita is 14,000.00 USD and above 75% of the European average. Economic growth is shadowed by the population growth due to immigration (Consejeria de Economia 2003). The economic growth of the region is greater than other regions of the European Community, which can be observed in Table 1 where the main macro-economic parameters for the year 1999 are shown.

The services and construction sectors are the main cause of economic growth, which can be seen in Table 2.

The tourism sector is the most important economic activity on the Canary Islands as the income from tourism represents 80% of the GDP. Due to the importance of tourism income this sector is studied in detail and mode-

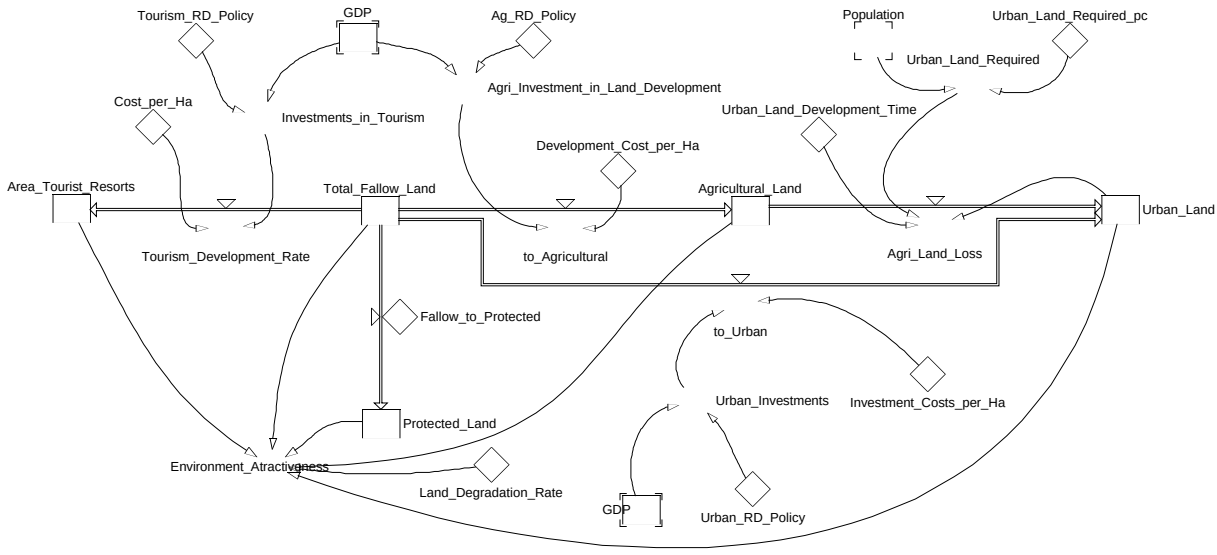

Figure 5: Environment sub model

Table 1: Main Macro-Economic Parameters for 1999

% ->	GDP	Import	Price index	Unemployment
EC	2.30	3.00	1.30	9.20
Canary	4.58	7.10	2.40	14.53
Spain	4.24	8.50	2.90	15.85

Table 2: Sector growth for the Canary Islands for 1999

	% real growth
Primary sector	-5.10
Industry	3.60
Construction sector	13.20
Services sector	4.30

led as described in section 2.2. The Construction sector has been significantly developed in the past few years mainly on account of infrastructure investments. Income from the production sector represents 8% of the GDP. Similarly, the industrial sector also represents 8% of the GDP, however it is decreasing. Canary Islands industry consists of enterprise branches that manage the two important strategic resources on the islands: water and energy. Production for the domestic market is very important. The development of the industry has certain constraints such as the limitation of natural resources, remoteness of the region, and high transportation costs between the islands. There is also a problem with human resources, which are needed for the innovative development of the sector. Agricultural production is estimated at 4% of the GDP.

3 Test simulation – initial model validation

There is no general theory of model validation or the model building of a complex open system. Based on the problem being studied, we can usually deduce: the definition of the task, the criteria, the model in relation to the system's variables and its environments etc. However, the essence of each complex simulation model can be found in its validation. There are several heuristic approaches in model validation derived from model philosophy of model building: structural, functional, replicate, predictive etc. Data such as the initial condition of variables, parameter values, and functional dependence among variables are usually very difficult conditions that have to be met

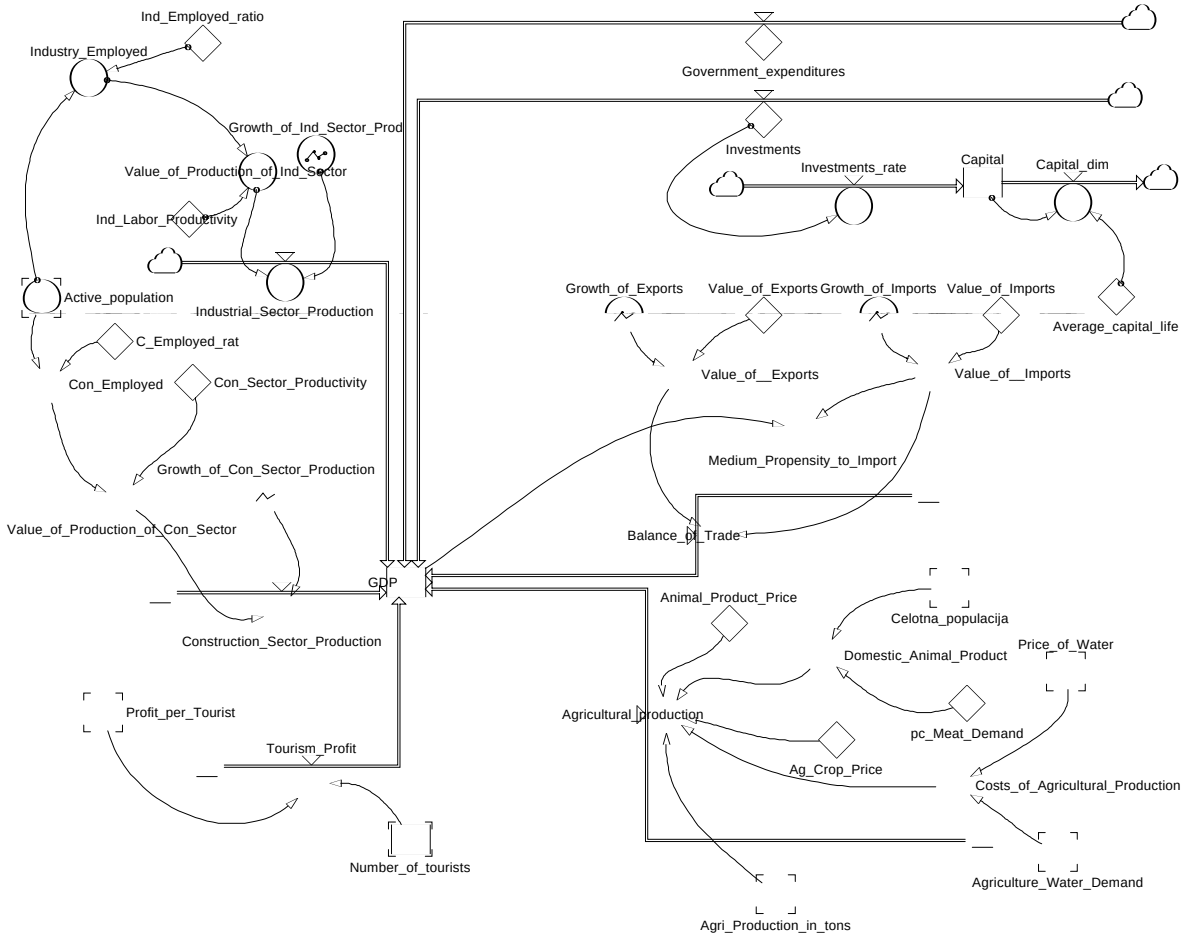

Figure 6: Sub-model of GDP – economic view

for good simulation. Usually each phase of model validation is interactive and interdependent (Forrester, 1973). In our case, structural and logical validation was described in our previous work in Palermo (Kljajić et al., 2002). For further validation and confidence in the implemented model in Powersim™ we tested its behavior in relation to the behavior we expected in the near future on the basis of the what-if philosophy. Therefore, we developed two simple scenarios regarding possible population trends. In the first part of this section we will describe some basic scenarios which represent the starting point of the proper policy design which would lead us to a goal: better quality of life and sustainable development of the region. Sustainable development fulfills the needs of the present, which do not threaten the ability of future generations to fulfill their needs. Sustainable development should be based on:

- social development which incorporates the needs of each individual
- effective environment preservation
- reasonable exploitation of the natural resources
- preserving high and stable economic growth.

The following two scenarios considering population dynamics were tested:

1. The growth of the population remains consistent for the following 25 years. This is likely to occur if there are no other external forces to influence the birth coefficient. The expected exponential growth should result in the higher number of inhabitants causing overcrowding and negative impact to the environment.
2. The growth of the population is controlled and moderately reduced in order to achieve the stable population numbers. This should contribute to the preservation of the Islands from population overcrowding, which negatively impacts the environment and further development, which is interconnected through the tourism market.

Figure 7 represents these two possible scenarios of population growth. The curve labeled 1 represents the scenario where the birth coefficient remains the same for the next 25 years. As we can see, this causes exponential growth. With the increasing number of inhabitants, sustainable development is much harder to provide. The quality of life under this scenario will also decrease. In our second scenario, labeled 2, the birth rate is considered to be moderately decreasing over the next 25 years. By decreasing the birth rate coefficient the rate of births and deaths should be equal at the end of the 25 year period. This is the condition where the population is stabilizing. Growth in the second scenario is more moderate.

Therefore, the following trajectories depict the possible population:

i). Population permanently (and population density) increases, with a low birth rate and a high immigration rate. In this case, the main cause of population augmentation is immigration. In turn, this immigration may be classified in two categories: a) older people who are on retreat and come to the Canary Islands to profit from its climate and environment (generally Europeans); or b) people classified in the working age (between 16 and 65). This trajectory refers to situations where the aging of the population pyramid is very strong.

ii). The zero or negative increase of the total population, due to the combination of a low birth rate with low immigration.

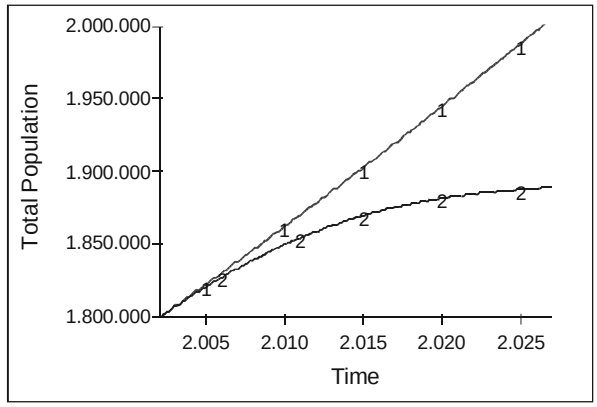

Figure 7: Total Population 1 ~ Constant Birth Coefficient, 2 ~ Decreasing Birth Coefficient

Population pyramid dynamics can be observed in Figure 14. The diagram on the left shows the result when the birth coefficient is constant and the diagram on the right represents the dynamics where the coefficient is decreasing. This is another key theme, from the perspective of strategic decision making for the Canarian future. According to the projections of the first scenario, the population in the "working age" (16-65 years old) will be stable during the following 20-25 years; the population of older people will increase. At the same time, the population of youth will decrease. An important conclusion is made: the increase of the total population is not due to the increase in the working age population. On the contrary, the factor of its augment is the growth of the older population. If this is so, the offer of quality labor is not substantially affected by the increase in population. This conclusion is stronger in other scenarios. In any case, if these projections are correct, the increase of the GDP will need, as a necessary condition, an augment in labor productivity. This need will be accentuated more in the case of the second scenario. The change of the population pyramid structure, toward an older one, affects the demand of public and private services. The quality and the quantity of public services such as education, health and urban services need to be adapted to the new structure of population. That is to say, the public sector ought to design and implement strategic plans in these sectors, taking into account the new conditions. The same points apply to some private sectors such as tourism, personal services (paramedical, cultural services, house keeping, and so on). Interestingly, at the same time, these new conditions present a possibility, an opportunity, and an open "window" for the development of different and more qualified jobs in the work market.

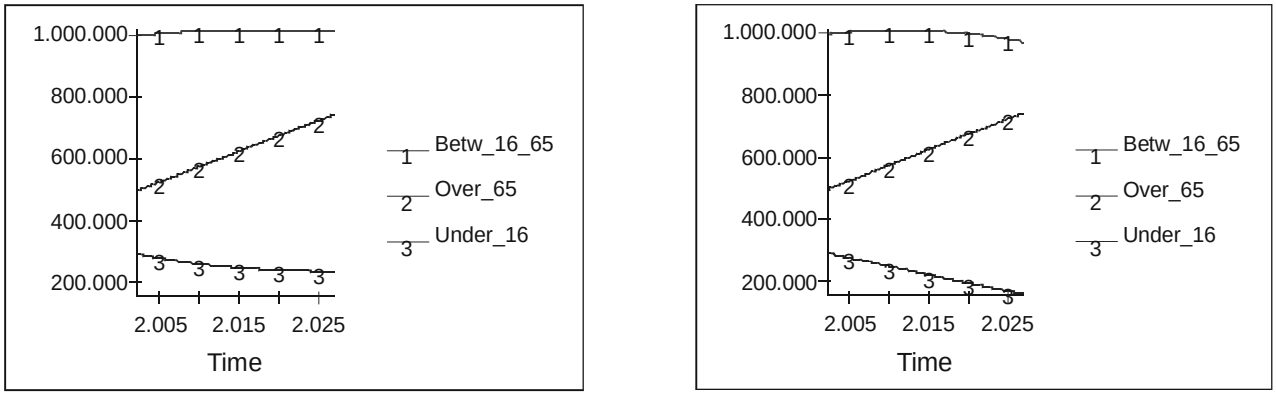

Figure 8: Population pyramid dynamics; left ~ Constant Birth Coefficient, right ~ Decreasing Birth Coefficient

By changing the birth ratio the demographic density has also changed which is represented in Figure 9. In the year 2025 the demographic density of the Canary Islands would be 398.25 per square km.

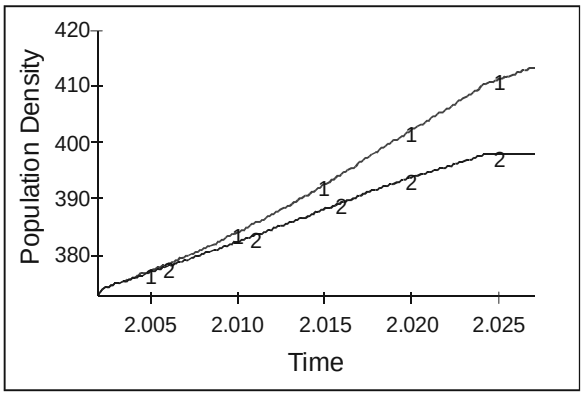

Figure 9: Population density; 1 ~ Constant Birth Coefficient, 2 ~ Decreasing Birth Coefficient

Changing the birth ratio coefficient in the model is something completely different from changing the coefficient in the real case. One of the more applicable solutions would be to limit immigration, which would also raise the population.

Figure 10 represents the effect of a decreased birth coefficient on the cost of water. The demand in scenario 2, where the population is sustained, would result in a lower cost of water due to lower demand. It is reasonable to suppose that water demand will increase in the future, due to augmentation of the population and economic activities. Thus, the strategic variables for the Canarian sustainable development are the following: "waste water reuse", efficient use of "ground water", "desalination" and reduction of water waste.

In the seventies there was a growth in infrastructure development of tourism objects . Today, the construction of the tourist infrastructure is still the leading force of the growth in tourism with its negative impact on the environment. To achieve sustainable development the balance between different economic, environmental and social goals have to be met. The alternative for mass tourism should not be eko-tourism or rural tourism. We have to

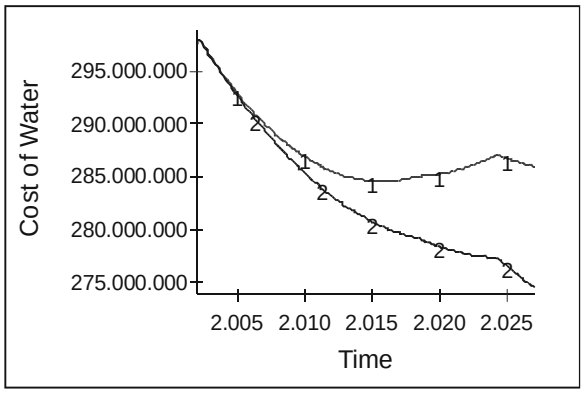

Figure 10: Cost of Water; 1 ~ Constant Birth Coefficient, 2 ~ Decreasing Birth Coefficient

consider that 11 million tourists visit the Islands each year. Eko-tourism in such numbers would mean an additional threat to the environment. Such tourism would need a new infrastructure, which would negatively impact the preserved environment. One of the possible scenarios would be the moderation of investments in the tourist infrastructure. In the original scenario the 0.001 % of the GDP was invested in infrastructure construction. If this investment would be moderated or stopped, the response of the number of tourists would be as seen in Figure 20. If the construction of infrastructure will stop, then the number of tourists would fall under 11 million (curve 1). That is 10% less than in the basic scenario, where the number of tourists rises well above 12 million.

The following trajectories regarding tourism could be identified:

i. A decline in total tourism near 2020-25 due to the degradation of the environment, the crowding effect, the augmentation of the price of water and the reduction of regional attractiveness. These declines will lead to the reduction of activity in the services, construction and industrial sectors and the GDP rate and consequently, an augmentation of the unemployment rate.

ii. A constant increase in massive tourism combined with the degradation of the environment, the crowding effect, augmentation of the price of water and the reduction of regional attractiveness.

iii. The maintenance of total tourism combined with: an improvement in the environment and quality of life; and a type of tourism more interested in qualified services that produce multiplying effects on other sectors such as education, health, environment, etc. In this case, population density problems are lower than in the precedent case.

iv. A slow reduction of total tourism (particularly mass tourism) combined with: an improvement in the environment and the quality of life; and a type of tourism more interested in qualified services that produce multiplying effects on other sectors such as education, health, environment, etc. In this case, population density problems are lower than in the precedent case.

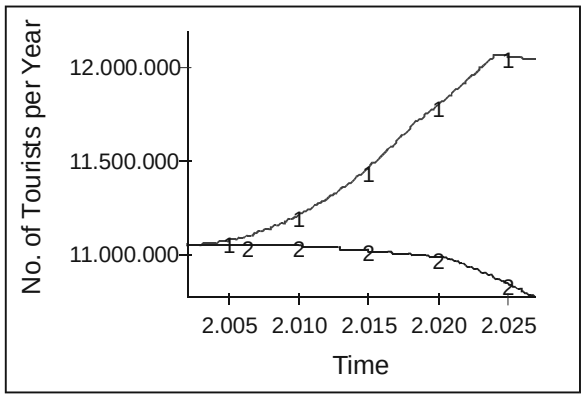

Figure 11: Number of Tourists per Year; 1 ~ investments continue, 2 ~ moderated investments

Figure 12 shows the demographic density in the case where investments in infrastructure are moderated (curve 3). We can observe that on account of the lower number of tourists residing in the region, the demographic density has fallen which contributes to the higher quality of the environment.

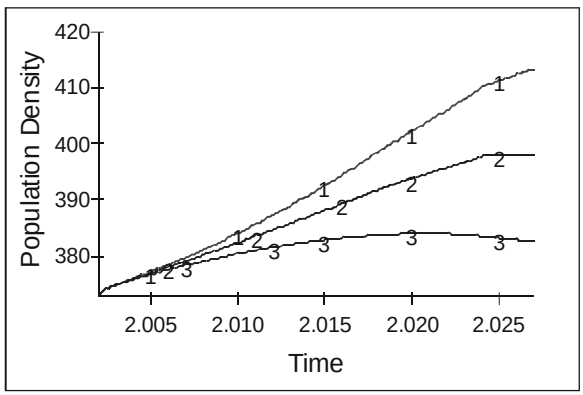

Figure 12: Demographic density; 1 ~ constant birth coefficient, basic scenario, 2 ~ decreasing birth coefficient and 3 ~ moderation of investments

Figure 13 shows the effect of the moderation of investments on Environment Attractiveness. As already mentioned, the attractiveness is higher if the building of new capacities is moderated (curve 2).

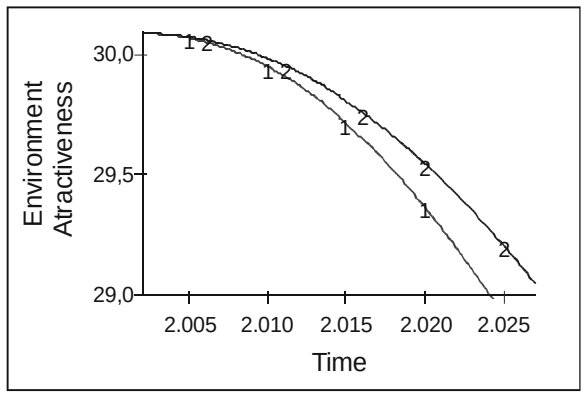

Figure 13: Environment Attractiveness 1 ~ continuation of investments, 2 ~ moderation of investments

According to our projections, various scenarios are possible in the future. From the perspective of the strategic and policy elaboration it is useful to outline the main characteristics of the more probable ones. We should follow the following methodological approach to build them: a) first of all, we identify the probable trajectory of some key variables, taking projections into account; b) secondly, combine them (for instance, one population trend, one of the tourist sectors, another of the industrial sectors, etc.). Each combination (scenario) ought to be internally coherent, in the sense that it is not admitted as a scenario that includes, for instance, two contradictory trends, as the increase of tourists interested in the environment and an economic model that destroy it. Each scenario has its internal logic. In the following section we will name each scenario according to this logic.

4 Future scenario preparation

In the preceding sections we have examined several possibilities of further development of the Canaries. According to the study of the dynamics of the key variables, several scenarios are formulated and should be tested in our future work.

By mixing the different trajectories of the five precedent categories it is possible to build 96 scenarios. But it does not make sense to construct all the mathematically possible combinations because some are not consistent with regard to the Canarian social system. A more practical way is to choose some logics and to build the scenarios according to them. With this approach we built the following scenarios.

Scenario 1. A non-innovative society, with a population and political leaders who are not really concerned with the environment and sustainable development. The importance of the immigration of elders and the constant increase of the total population. This scenario mixes trends of permanent population increase, the decline of tourism due to environmental degradation, stagnation of

the agricultural sector and persistence of non-innovative SMEs. It is not sustainable in the long term, because the crisis in tourism (and other activities boosted by it) and the degradation of the environment will reduce the immigration of elders. This contraction will reinforce the economic crisis and the increase in unemployment. The economic crisis will most likely be accompanied by social unrest and political troubles.

Scenario 2. A non-innovative society, with a population and political leaders who are not really concerned with the environment and sustainable development. Importance of immigration of the population in the working age. A permanent increase of the total population. This scenario is the same as the precedent, except that in the projection the aging of he population is lower. In this scenario the crisis will be more evident and stronger in the work market. In the medium and long term the degradation of the environment, the unemployment and social unrest will feed back between them.

Scenario 3. An innovative society, with where the population and political leaders arer really concerned with the environment and sustainable development. There is a great weight of elders in the population pyramid. There is a permanent increase in the total population. This scenario mixes trends of permanent population increase, the slow reduction of total tourism, the increase in agricultural production due to the increased productivity and augmentation of innovative SMEs. It is sustainable in medium terms, because there will not be a crisis in tourism (and other activities will be boosted by it) and the environment will not be destroyed. There will be opportunities to increase the quality of employment due to innovative activities and the demand of elders. Nevertheless, this scenario is not sustainable in the long term, because the increase of the population can't go on indefinitely. This scenario will be transformed into another one, as number 5 or 6.

Scenario 4. An innovative society, with a population and political leaders who are really concerned with the environment and sustainable development. The weight of the population is in the working age, due to immigration. There is a permanent increase in the total population. This scenario differs from the precedent only because the tendency of permanent population growth is replaced by a lower population-ageing factor. The sustainability in medium terms depends on the equilibrium in the work market and on the profiles of the immigrants. As the precedent, it is not sustainable in the long term because the increase in the population can't go on indefinitely. However, this scenario will be transformed into another one such as number 5 and 6.

Scenario 5. A non-innovative society, with a population and political leaders who are not really concerned with the environment and sustainable development. Immigration of elders is important. There is a decrease or constancy of the total population. This scenario differs from number 1 only because the population development is held so that there is a zero increase in population. It is one of the worst scenarios for the long term, because the reduction of immigration will be due to the crisis in tourism (and other activities will be boosted by it), the degradation of the environment and social unrest. A similar and undesirable scenario may be built on the basis of scenario number 2. It is important to observe that these two scenarios are not improbable because some political leaders have emphasized the importance of economic development in the short and medium term, without considering its impact on the environment.

Scenario 6. An innovative society, with a population and political leaders who really are concerned with the environment and sustainable development. The weight of the population is in the working age, due to immigration, but the rate of immigration is lower than in scenario 4. There is a decrease or constancy of the total population. This scenario differs from number 4 in the fact that the total population does not increase indefinitely, because the immigration rate is lower. With this scenario the sustainability of the improvement of the quality of life (that includes an increase in revenues, a low unemployment rate, high wages and an enjoyable environment) is possible. It is not the only scenario that may be built to assure the sustainable development of the quality of life. Another one may be constructed on the basis of scenario 3.

5 Conclusion and discussion

The development of the model from the influence matrix was a demanding task. The model itself represents a valuable tool for considering the strategic decisions of regional development. Several presented scenarios are the starting point for further investigation of possible strategic acts. The result of our study is the determination of 96 possible scenarios, which have to be examined in future work.

The scenarios throw light over future possible ways of societal development. None are pre-determined. The concrete way society will adopt changes depends on external factors and, more importantly, on the behavior of its population and leaders. In order to lead the social Canarian system towards a certain path it is necessary, first of all, to design and chose the path (let's say, for instance, one of the possible future scenarios), and to plan and implement the appropriate strategy and policies. An example of them is presented in Legna (2002). Future testing and improvements of models and scenarios are conditio sine qua non for development of a simulation system for decision assessment of public decision.

6 Acknowledgement

Part of this research was financed by the Ministry of Education, Science and Sport of the Republic of Slovenia; Program No. PP-0586-501 and Grant No. Z5-3313, and by the Canarian Government and the European Trade Union Confederation.

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Short biographies of the three autors are published on page 518.