Criteria and Indicators of the Economic Sector for Sustainable Development Model of Kuldiga Municipality

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Abstract. **The aim of sustainable development is to develop economy, but at the same time to preserve the environment. The goal of the research is to work out sustainable development model for Kuldiga municipality. For this purpose the methods of analysis, synthesis, mathematical statistics and system dynamics were used. The complicated system dynamics model will show the possible changes in the future, if we change some input data today. It is a necessary tool for decision making and it will help Kuldiga municipality to make more informed and effective decisions.**

Key words. **Sustainable development, quality of life, indicators, system dynamics model.**

INTRODUCTION

Sustainable development is the use of resources with the aim to meet human needs, but taking into consideration preservation of the environment. It is possible to speak about sustainable development when human needs are met not only at present, but also in the future. Sustainable development ties together natural system with the socio-economical challenges.

CONCEPTION OF SUSTAINABLE DEVELOPMENT

The field of sustainable development can be conceptually broken into three constituent parts: environmental sustainability, economic sustainability and sociopolitical sustainability (Fig.1.).

Fig. 1. The three pillars of sustainable development [1]

The well-being of these three areas is intertwined, not separate. For example, a healthy, prosperous society relies on a healthy environment to provide food and resources, safe drinking water, and clean air for its citizens. The sustainability paradigm rejects the contention that casualties in the environmental and social realms are inevitable and acceptable consequences of economic development.

W.M.Adams in his paper "The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Sentury" states: "The idea of sustainability dates back more than 30 years, to the new mandate adopted by International Union for Conservation of Nature in 1969. It was a key theme of the United Nations Conference on the Human Environment in Stockholm in 1972. The concept was coined explicitly to suggest that it was possible to achieve economic growth and industrialization without environmental damage. In the ensuing decades, mainstream sustainable development thinking was progressively developed through the World Conservation Strategy (1980), the Brundtland Report (1987), and the United Nations Conference on Environment and Development in Rio (1992), as well as in national government planning and wider engagement from business leaders and non-governmental organizations of all kinds" [1].

Sustainability is a paradigm for thinking about a future in which environmental, societal, and economic considerations are balanced in the pursuit of development and improved quality of life [2].

CRITERIA AND INDICATORS OF SUSTAINABLE DEVELOPMENT

To characterize sustainable development and quality of life, it is necessary to find out the appropriate indicators. The main criteria for selection of the indicators are the following:

- the indicators must contain all the most important parts of the system;
- the system of indicators must be well structured;
- there should be as few indicators as possible, but they should be sufficient;
- the system of indicators must be compact and easy understandable;
- the system of indicators must be worked out for a definite region.

One of the most popular indexes in the world that characterize quality of life, is Human Development Index, published in the United Nations Development Programme's (UNDP) Human Development Report. The three dimensions and four indicators, used to calculate this index, are shown in Figure 2.

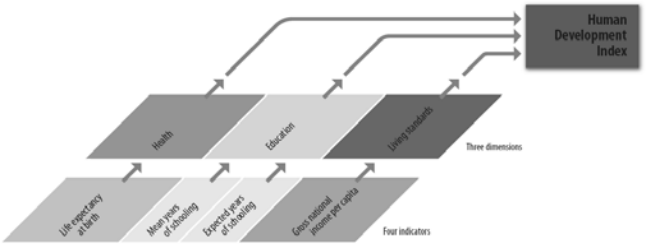

Fig. 2. Components of the Human Development Index [3,13]

"The Human Development Index (HDI) was a strategic element in the new approach. It symbolizes the shift in thinking, even if not fully capturing the richness of human development. As a composite measure of health, education and income, the HDI assesses levels and progress using a concept of development much broader than that allowed by income alone (Fig.2). And as with any aggregate measure and international comparison, it simplifies and captures only part of what human development entails" [3,13].

The Economist Intelligence Unit's quality-of-life index was based on a methodology that links the results of life-satisfaction surveys, which are subjective data, to the statistical information about quality of life indicators, which are objective data. The latest index was calculated in 2005 and it includes data about 111 countries. "The nine quality of life factors and the indicators used to represent them, are:

- Material wellbeing: GDP per person, at PPP in $;
- Health: Life expectancy at birth, years;
- Political stability and security: Political stability and security ratings;
- Family life: Divorce rate (per 1,000 population), converted into index of 1 (lowest divorce rates) to 5 (highest);
- Community life: Dummy variable taking value 1 if country has either high rate of church attendance or trade-union membership; zero otherwise;
- Climate and geography: Latitude, to distinguish between warmer and colder climates;
- Job security: Unemployment rate, %;
- Political freedom: Average of indexes of political and civil liberties. Scale of 1 (completely free) to 7 (unfree);
- Gender equality: Measured using ratio of average male and female earnings" [4].

"The Calvert-Henderson Quality of Life Indicators are a contribution to the worldwide effort to develop comprehensive statistics of national well-being that go beyond traditional macroeconomic indicators. A systems approach is used to illustrate the dynamic state of social, economic and environmental quality of life. The dimensions of life examined include: education, employment, energy, environment, health, human rights, income, infrastructure, national security, public safety, re-creation and shelter" [5].

The Quality of Life index was also worked out in Latvia by Commission of Strategic Analysis. The main indicators, used to calculate this index, are:

- Material welfare:
  - average income monthly per person;
  - average income per person from budgetary funds;
  - inflation;
- Employment - % of employed persons in the total number of population (15-74);
- Health, social security – life expectancy at birth;
- Education – educational level of population, etc.;
- Physical security – amount of crime per 100,000 inhabitants;
- Household – living space;
- Family – total birth rate;
- Inclusion;
- Leisure [6].

It is possible to find out those factors and indicators that characterize economic development, which is one of the main components of the quality of life. The summary of economic indicators in analyzed indexes is shown in the Table 1.

TABLE 1

MAIN ECONOMIC INDICATORS IN QOL INDEXES

Index	Economic indicators
Human Development Index (UNDP)	GDP per capita at PPP
Quality-of-life index (Economist Intelligence Unit)	GDP per capita at PPP Unemployment rate
Quality of life indicators (Calvert-Henderson)	Employment Income Infrastructure
Quality of life index (Latvian Commission of Strategic Analysis)	Average income monthly per person Average income per person from budgetary funds Inflation Employment

From Table 1 it is possible to conclude that the most frequently used economic factors are concerned with income, employment, infrastructure and inflation. To work out the system dynamics model for Kuldiga municipality all these indicators also are taken into consideration, but there is a wider range of indicators in this model.

THE SUSTAINABLE DEVELOPMENT MODEL FOR KULDIGA MUNICIPALITY

The sustainable development model for Kuldiga municipality consists of 3 big systems – human, support and environment system. Economy is a part of the support system (Fig.3).

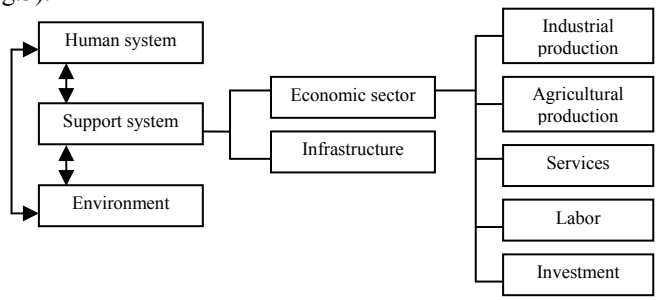

Fig. 3. Main factors of economic sector [developed by the authors]

The economic sector and infrastructure are 2 main parts of the support system. The main factors of economic sector are concerned with production (industrial, agricultural and service sector), employment, unemployment and also investments and budget of the local government.

The main indicators of economic sector that influence the quality of life, are:

- GDP per capita;
- Income fraction from industry, agriculture and services;
- Unemployment rate;
- Share of investment in GDP.
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MENTAL MODELS OF MAIN ECONOMIC INDICATORS

GDP per capita is calculated from input data of the support system and human system (Fig.4). From Figure 4 we can see that GDP per capita depends on the total GDP and total population of the region. And total GDP is calculated as the sum of industry, agriculture and service sector gross domestic products.

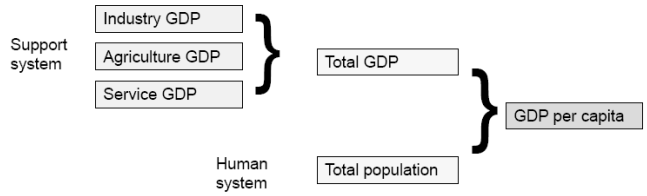

Fig. 4. Model of the calculation of GDP per capita [developed by the authors]

The mental model of industry and services sector GDP calculation is shown in the Figure 5. From Figure 5 it is possible to see that GDP of industry and services sectors depends on employment in the sector and productivity of the sector. Productivity can be affected by sector capital, development of technologies, energy prices, health and education of employees.

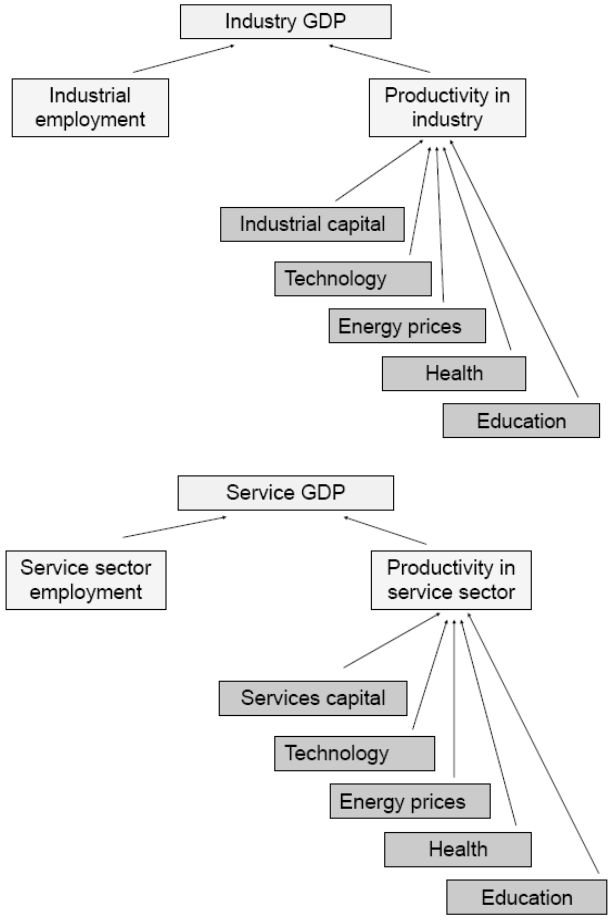

Fig. 5. Model of the calculation of industry and services sectors GDP [developed by the authors]

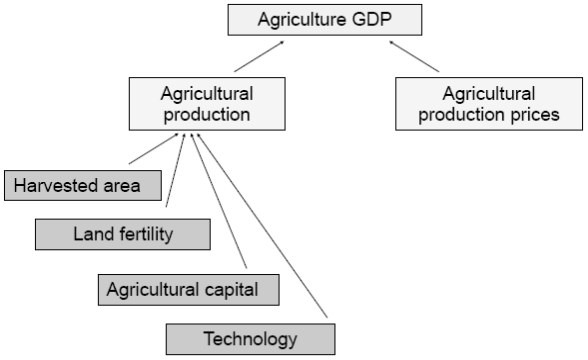

Fig. 6. Model of calculation of agricultural sector GDP [developed by the authors]

Calculation of the agricultural GDP is a little bit different and is shown in the Figure 6.

GDP of agricultural sector depends on agricultural production and its prices. The production is affected by the harvested area, land fertility, agricultural capital and also the level of technologies used in agriculture.

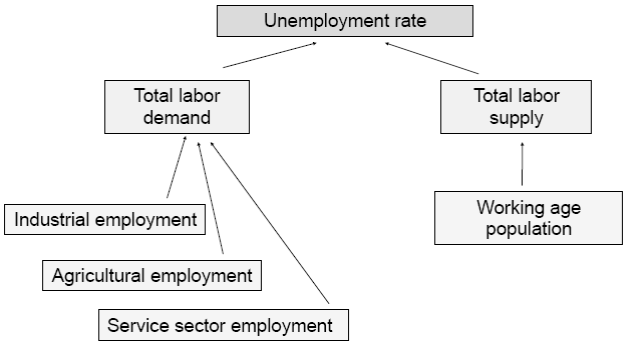

Fig. 7. Model of the calculation of unemployment rate [developed by the authors]

The 3rd indicator is unemployment rate, and its calculation is shown in the Figure 7. From Figure 7 it is possible to see that unemployment rate depends on the total labor demand and total labor supply. Total labor demand is the employees in the industry, agriculture and service sector, but total labor supply is working age population; the data for this indicator comes from the social system.

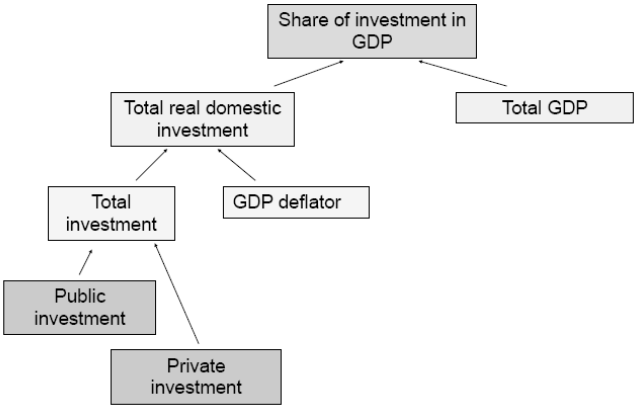

Fig. 8. Model of calculation of share of investment in total GDP [made by authors]

The last indicator is share of investment in the total GDP (Fig.8). Share of investment in the total GDP depends on the total real domestic investment and total GDP. Total real domestic investment is calculated from such indicators as total investment and GDP deflator. And total investment is subdivided into public and private investment.

SYSTEM DYNAMICS SUB-MODELS FOR ECONOMIC INDICATORS

System dynamics sub-models for each indicator were worked out. The system dynamics **sub-model for industrial production** is shown in the Figure 9. From Figure 9 we can see that the necessary input data to calculate industrial output are:

- Initial capital industry
- Average life of industrial capital
- Initial industrial capital intensity
- Industrial capital elasticity
- Annual working hours

Equations and formulas for industrial production model are the following.

*Industrial output = industrial productivity * industrial employment* *(1)*

Industrial employment, used in the Formula 1, comes from Labor sub-model, but industrial productivity is calculated by Formula 2:

*Productivity = Effect of Industrial Capital Intensity * Technology [industry] * Effect of Education on Industrial Productivity * Effect of Health on Industrial Productivity * (1 - Effect of Energy Prices on Industry)* *(2)*

In Formula 2 industrial technology, effect of education, effect of health and effect of energy prices come from other appropriate sub-models. Effect of industrial capital intensity is calculated by Formula 3:

Effect of Industrial Capital Intensity = (Industrial Capital Intensity / Initial Industrial Capital Intensity) ^ industrial Capital Elasticity *(3)*

Industrial capital intensity is calculated by Formula 4 and initial industrial capital intensity and industrial capital elasticity are input data.

Industrial Capital Intensity = Industrial Capital / Industrial employment *(4)*

Industrial employment in Formula 4 comes from Labor sub-model, and industrial capital is calculated by Formula 5:

Industrial Capital = Initial Industrial Capital + investment [industry] – depreciation [industry] *(5)*

In Formula 5 investment and depreciation in industry sector come from Investment sub-model.

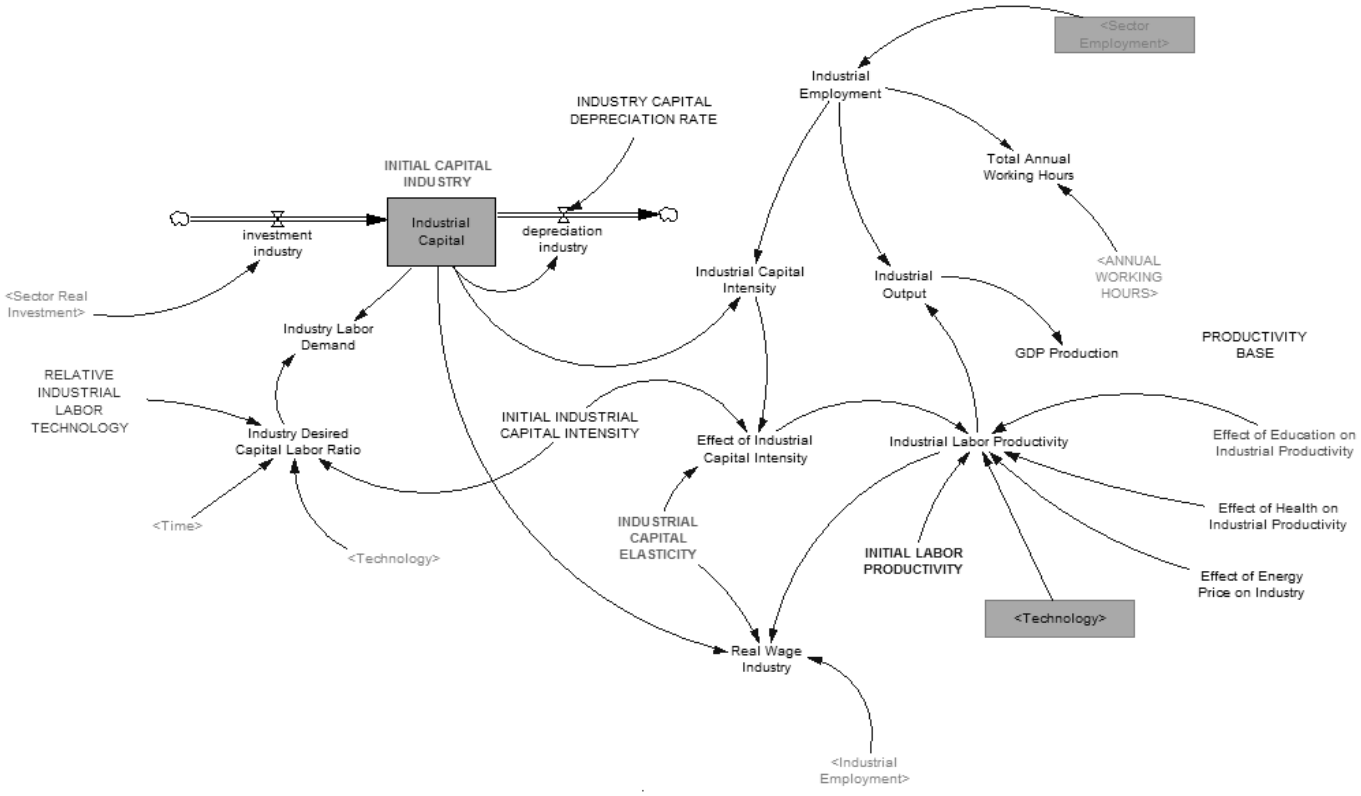

Fig. 9. System dynamics sub-model for industrial production [developed by the authors]

The system dynamics **sub-model for services sector** output calculation is shown in the Figure 10. From Figure 10 it is possible to see that the necessary input data are:

- Initial capital services
- Services capital elasticity
- Initial services capital intensity
- Initial services productivity
- Services capital depreciation rate

Equations and formulas for service sector output model are the following.

*Industrial output = Services Employment * Services Productivity (6)*

Services employment, used in the Formula 6, comes from Labor sub-model, but services productivity is calculated by Formula 7:

*Productivity = Effect of Services Capital Intensity * Technology [services] * initial services productivity (7)*

In Formula 2 services technology comes from Technology sub-model, initial services productivity is input data. Effect of industrial capital intensity is calculated by Formula 8:

Effect of Services Capital Intensity = (Services Capital Intensity / initial services capital intensity) ^ services capital elasticity (8)

Services capital intensity is calculated by Formula 9 and initial services capital intensity and services capital elasticity are input data.

Services Capital Intensity = Services Capital / Services Employment (9)

Services employment in Formula 9 comes from Labor sub-model, and services capital is calculated by Formula 10:

Industrial Capital = Initial Services Capital + investment [services] – depreciation [services] (10)

In Formula 10 investment and depreciation in services sector come from Investment sub-model, initial services capital is input data.

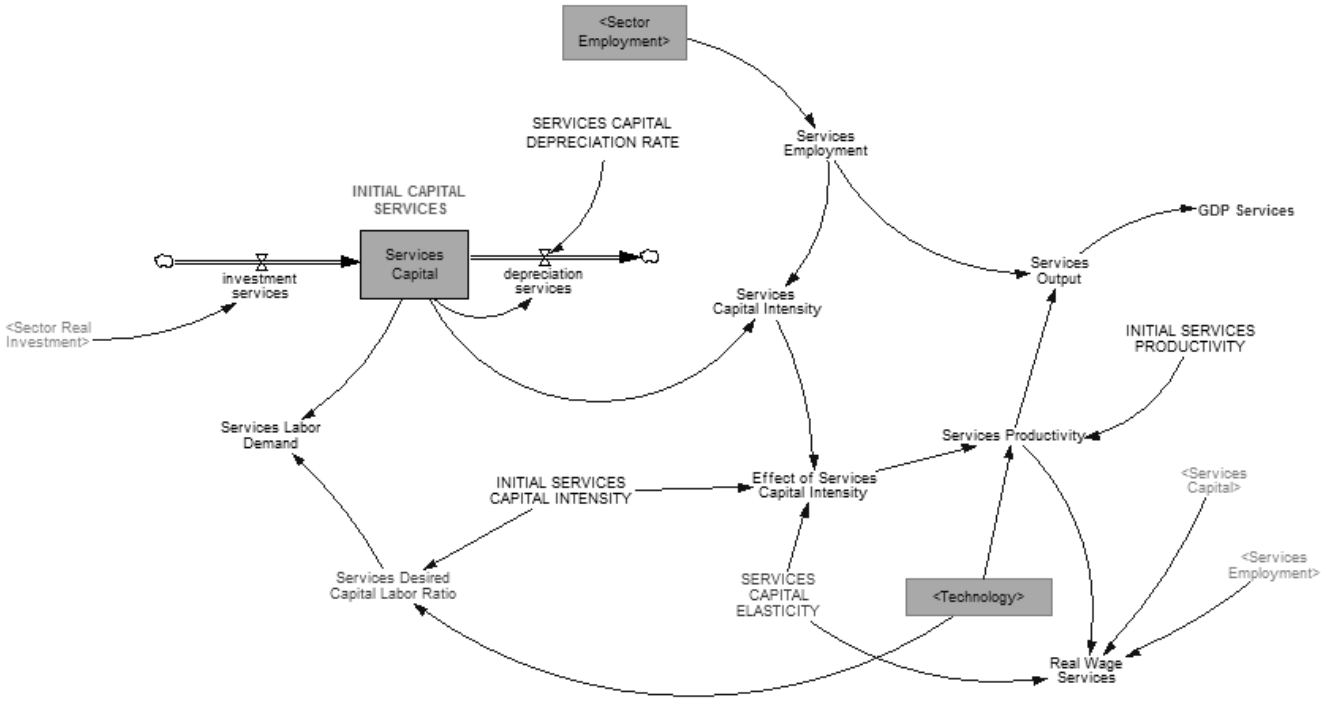

Fig. 10. System dynamics sub-model for services sector output [developed by the authors]

The system dynamics **sub-model for agriculture sector** output calculation is shown in the Figure 11.

The system dynamics model for agricultural sector is more complicated, because it is necessary to take into consideration the land fertility and other factors that have an effect on production of agricultural goods.

The necessary input data for agricultural output model are:

- Price of agriculture products
- Harvesting rate
- Processing loss
- Agricultural capital elasticity
- Initial agriculture capital

- Average agricultural capital lifetime

Equations and formulas for agricultural sector output model are the following.

*Agricultural Output = Agricultural production in tonnes * Agricultural production prices* *(11)*

Agricultural production prices used in the Formula 11 are the input data, but agricultural production in tonnes is calculated by Formula 12:

*Agricultural Production in Tonnes = harvested area * Land Yield* *(12)*

In Formula 12 harvested area depends on agriculture land and harvesting rate. Agricultural land comes from Environment sub-model, but harvesting rate is input data. Land yield is calculated by Formula 13:

*Land yield = Effect of Soil Quality on Yield * Agricultural Technology * Effect of Agricultural Productivity on Yield * (1 – processing loss)* *(13)*

In Formula 13 processing loss in input data, agricultural technology and the effect of soil quality on the yield come from appropriate sub-models. The effect of agricultural production on the yield is calculated by Formula 14:

*Effect of Agricultural Productivity on Yield = Last Year Effect of Capital Intensity on Yield * (1 + Agricultural Capital Intensity Change * Agricultural Capital Elasticity* *(14)*

Agricultural capital elasticity is function from input data. Agricultural capital intensity is calculated by Formula 15:

Agricultural capital intensity = Agricultural Capital / Agricultural Land *(15)*

Agricultural land in Formula 15 comes from Environment sub-model, but agricultural capital is calculated by Formula 16:

Agricultural Capital = Initial Services Capital + investment [agriculture] – depreciation [agriculture] *(16)*

In Formula 16 investment and depreciation in agriculture sector come from Investment sub-model, initial agriculture capital is input data.

It is possible to work out all other necessary system dynamics sub-models for each of the indicators.

CONCLUSIONS

This model will help Kuldiga municipality to get progressively richer understanding of some dynamic problems, and anticipate weaknesses in policy initiatives that would develop over time.

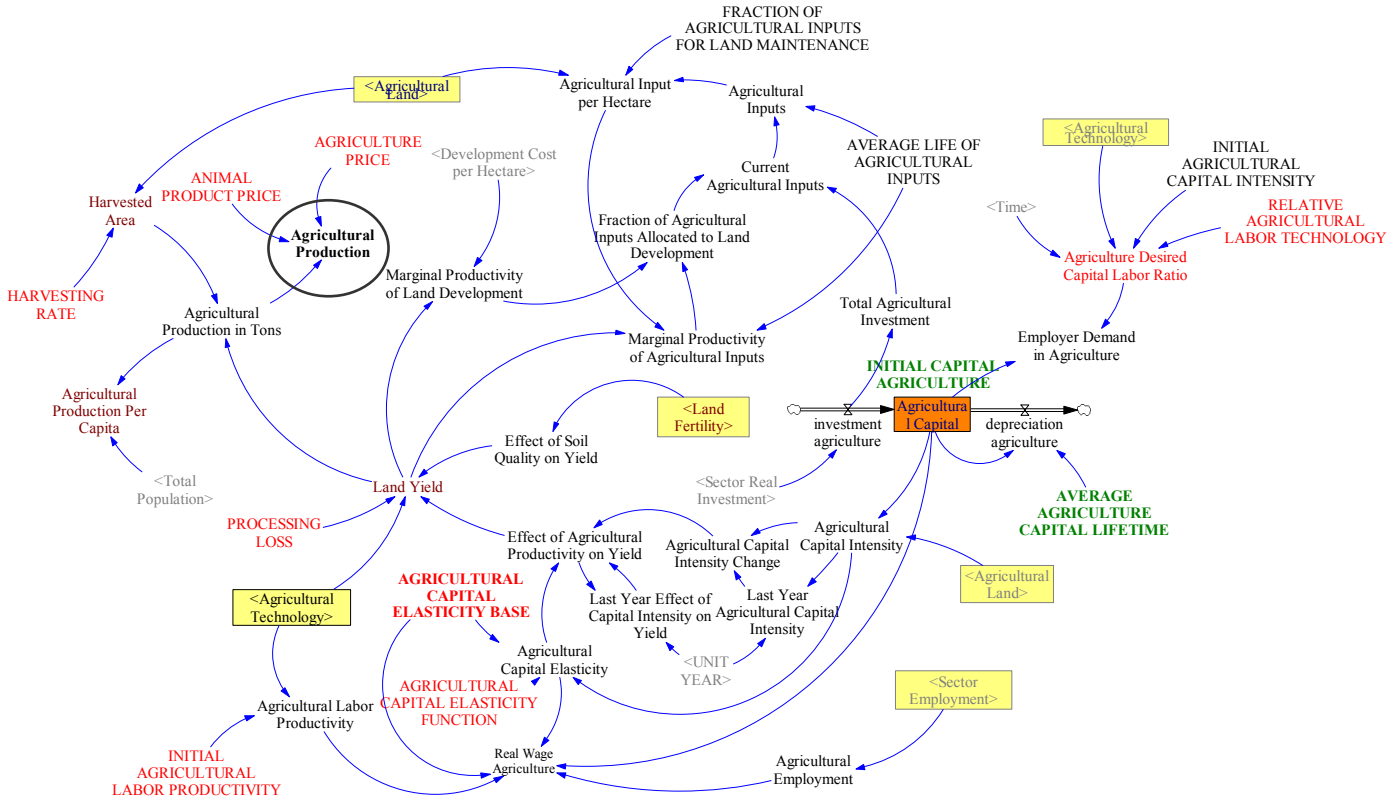

Fig. 11. System dynamic sub- model for agricultural output [developed by the authors]

System dynamics is an approach which can help to construct mental models which are more likely to be congruent with reality and then simulate these models more accurately. Decision makers will be able to see diagrams which specifically help them talk to each other about the parts of a system and how they fit together. It is a very good tool for decision making and will help Kuldiga municipality to make more informed and effective decisions. This model helps move from a static to a dynamic orientation and gain much better understanding of how things change over time.

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Ilze Judrupa, Galina Blagova. Kuldīgas novada ilgtspējīgas attīstības modeļa ekonomikas sektora kritēriji un indikatori
Ilgtspējīgas attīstības mērķis ir panākt ekonomikas attīstīšanos, bet vienlaicīgi ievērojot vides saglabāšanas principus, lai nodrošinātu labvēlīgu dzīves vidi nākamajām paaudzēm. Ilgtspējīga attīstība balstās uz 3 galvenajiem pīlāriem, tie ir: ekonomiskā izaugsme, vide un sociālais progress. Pasaulē pazīstami vairāki starptautiskie indeksi, kurus var izmantot dzīves kvalitātes novērtēšanai, piemēram, Tautas attīstības indekss (Human Development Index), Ekonomistu Inteliģences apvienības (Economist Intelligence Unit) izstrādātais Dzīves kvalitātes indekss, kā arī Kalverta – Hendersona (Calvert-Henderson) dzīves kvalitātes indekss. Arī Latvijā ir izstrādāts dzīves kvalitātes indekss, ko veikusi Stratēģiskās analīzes komisija. Pētījuma mērķis ir izstrādāt ilgtspējīgas attīstības sistēmdinamisko modeli Kuldīgas novadā, kas kalpotu par pamatu lēmumu pieņemšanai. Kuldīgas novada ilgtspējīgas attīstības modelis sastāv no 3 lielām apakšsistēmām – cilvēku, atbalsta un vides sistēmas. Ekonomikas sektors ir daļa no atbalsta sistēmas, un tā galvenie indikatori, kas ietekmē novada dzīves kvalitāti, ir IKP uz iedzīvotāju, IKP sadalījumā pa nozaru blokiem (lauksaimniecība, rūpniecība, pakalpojumi), bezdarba līmenis un investīciju apjoms % no IKP. Šo rādītāju prognozēšanai tika izstrādāti sistēmdinamiskā modeļa apakšmodeļi, kas ļauj noteikt minēto rādītāju izmaiņas nākotnē, izmainot ieejas datus. Kompleksais ilgtspējīgās attīstības modelis Kuldīgas novada lēmumu pieņēmējiem ļaus pieņemt efektīgākus un pamatotākus lēmumus, balstoties uz konkrētiem datiem. Tas ļaus noteikt lēmumu pieņemšanas vājās vietas, speciālās diagrammas ļaus pamanīt sakarības starp rādītājiem un lēmuma sekām. Šāds modelis palīdzēs precīzāk saprast sakarības un izmaiņas laika gaitā.

Илзе Юдрупа, Галина Благова. Критерии и показатели экономического сектора модели долгосрочного развития Кулдигского края
Целью долгосрочного развития является достижение такого уровня экономики, при котором соблюдаются принципы сохранения среды, обеспечивающие благоприятный уровень жизни будущим поколениям. Долгосрочное развитие основывается на 3 позициях: экономический рост, защита среды и социальный прогресс. В мире известны различные международные индексы, которые можно использовать для оценки качества жизни, например, Индекс развития человека (Human Development Index), Индекс качества жизни, разработанный Объединением экономистов (Economist Intelligence Unit), так же как и Индекс качества жизни Калверта – Хендерсона (Calvert-Henderson). В Латвии тоже разработан Комиссией стратегического анализа Индекс качества жизни. Задача исследования – разработка системно-динамической модели долгосрочного развития Кулдигского края как основы для принятия решений. Модель состоит из 3-х подсистем: человека, поддержки и среды. Экономический сектор – это часть подсистемы поддержки. Главными показателями, влияющими на качество жизни края, являются: валовой внутренний продукт на одного жителя; ВВП по секторам экономики (сельское хозяйство, промышленность, сфера услуг); уровень безработицы; объем инвестиций в % от ВВП. Для прогнозирования этих показателей в системно-динамической модели разработаны подсистемы, которые позволяют изменять эти показатели в будущем, изменяя исходные данные. Комплексная модель долгосрочного развития позволит принимать обоснованные решения, опираясь на конкретные данные. Появится возможность определить слабые стороны принятия решения, специальные диаграммы позволят разглядеть связь между показателями и последствиями решения. Данная модель поможет точнее понять последовательность связи и изменений во времени.