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How Can Systems Thinking Be Used to Support Rural Development Decisions in Latvia

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Abstract

The applicability of systems thinking for decision support in the context of Latvian rural development was tested. Modelling in the cases analysed was performed through constraint analysis and system mapping with the help of causal loop diagrams. The study encompassed three cases: assessing feasibility of growing blueberries at a farm; facilitating community discussion of improvements in the region under the umbrella of Local Agenda 21; providing support for organic farming development programme. In the first case, the modelling challenged assumptions of farmers, tested different scenarios and resulted in a better understanding about the range of system performances and limitations of the system. In the second case, the modelling took shape of brainstorming about quality of life determinants and exploring how different processes within the region influence those, however it did not leave a tangible influence on the result of the discussion. In the third case, modelling interconnectedness of different sectors of organic farming produced some changes in the development programme, resulting from better understanding about the system. The main conclusion is that the systems approach can be effective in supporting decision making for rural development in Latvia. However, it will have higher chance of success in cases where a particular problem is identified and acknowledged by all stakeholders. Moreover, motivation for cooperative problem solving is pivotal. The modelling needs to produce short-term results, however this may be contrary to general long-term orientation of the systems approach. A proper mix of qualitative and quantitative tools should be selected in each case, however in the rural context of Latvia, qualitative modelling seems more feasible to carry out. Ample resources need to be devoted to the interventions, and in order to be more effective, the systems approach should become an integral part of thinking and decision making. Professional facilitation, providing both external knowledge and eliciting the knowledge within the group, is required. Further research needs to be carried out to support findings of this paper, as well as a combination with other decision support tools needs to be studied. An additional concern for further research is the implementation success of the policies devised with the support of systems thinking tools.

Key words: systems thinking, rural development, group modelling, facilitation.

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Introduction

Systems thinking emerged in the 20th century as a discipline aiming at harmonising different spheres of knowledge for the solution of acute problems our world faces, more specifically the problems relevant to sustainable development. One of the arguments of the system approach is to view the world and particular problems as systems, that are unities of interrelated components, where the whole cannot be understood by mere separation and analysis of its parts, but should be analysed from the point of view of relationships between these parts. Systems thinking has been applied for a variety of problems on different levels. It has helped individuals, organisations and state policy makers to understand problems better and act on more informed understanding of problems and possible solutions and come up with successful change initiatives.

Along with the fascination about systems thinking, I am very interested in rural development. Systems thinking has been applied for the problems of rural development and community development, where complexity of problems, number of different actors and interests make this approach very useful (cf. Spruill et al., 2001; King, 2000). In Latvia, however, use of such approach has been limited. Therefore this research set out to demonstrate that it is possible and beneficial to use systems thinking for solution of rural development problems in Latvia. Thus, the thesis explores opportunities and potential pitfalls for using systems approach in particular issues of rural development.

The initial hypothesis was that systems thinking has a value in itself therefore can be applied in different situations. Hence the design of the study. Applicability of systems thinking was tested on three levels: individual farm, local municipality and state policy level. I spent five days at a farm to understand current issues and try applying systems thinking for a particular problem of the farmers: we tried to analyse viability of farmer's plan to cultivate blueberries. On municipality level, the community forum in Dundaga municipality was the focus of the study. We used systems mapping (causal loop diagrams) for sorting out ideas of the forum and establishing connections between different ideas, in order to identify possible leverage points for faster implementation of community initiatives. On state policy level, the organic farming development programme was evaluated using the methodology.

In all three cases, it was action research, and people were involved in attempts to apply systems thinking. The paper describes study results in each of the cases. Experience gained in each of the cases and methods used for solution of problems in these cases are described. As in each particular case the approach was different, the description of the method used in each particular case is given. This experience is then analysed from the point of view of applicability of systems thinking and its particular methods.

The thesis is structured in the following way. First, the context is established for the study: its importance and place in Latvian rural development. Then, the methodology addresses the issue how the research questions were answered, followed by the theoretical background for the modelling performed in the study. Finally the activity in the cases and achieved results are described, concluded by the analysis of impacts the modelling made and conclusions.

I acknowledge that the topic is very general and it was exactly the intention of the research. The idea of the research was rather practical, to contribute to solution of real life problems and to gain experience in modelling and facilitation. This vision was fulfilled and in addition, data for the thesis were collected. Rather than establishing some scientific facts, the thesis explores applicability of systems thinking in different situations that were confronted. In this respect, the thesis is not objectively scientific. Therefore, I am trying to be critical of myself and provide limitations of this thesis.

Limitations and scope

First of all, while reading this thesis, it should be understood that I started the research with fascination about systems thinking. Therefore, this thesis is approach-driven as opposed to problem-driven. I am attempting to answer the question how applicable systems approach can be, but I view this question in isolation, without explicit reference to other tools for decision support (for example, SWOT analysis or cost/benefit analysis). Therefore, the reader will not gain insight into the most acute problems of rural development in Latvia or how it is best to solve them. Neither are ways to effectively facilitate decisions for rural development described. Instead, this thesis will reveal some insights into how the systems approach can be effectively applied.

Moreover, the research is based on three cases that are different in many respects. Therefore, generalisation of the findings should be perceived with caution and it should be acknowledged that although the findings are valid for the cases considered, they might not hold in other similar situations. In this way, the research has contributed strongly to my own experience and learning, but the question regarding its academic value is out for a discussion.

Context of the study: Latvian rural development

Latvia became independent in 1990 and now is undergoing a major restructuring of its economy. First of all, the country is changing from the planned economy to market economy. Secondly, Latvia is reorienting itself from the former Soviet Union countries to the European Union, a member state of which it will become in May 2004. These changes directly influence rural areas, where 32.1% of Latvian population live (Ministry of agriculture, 2002), and the developments there.

Most of the population in rural areas are employed in agriculture and forestry - 31% of all employed rural population (Ibid.). Large collective farms have been reformed in the beginning of the 1990s and the land reform is currently underway, distributing land to individual farmers, who now have to take care of their own production and marketing. This is difficult, as many lack both production competence and ability to market their products. The situation is aggravated by 'learned helplessness', or lack of ability to take responsibility for oneself and lack of initiative, inherited as a part of old soviet mentality (Ministry of agriculture, 2003-2). The resulting effects are increasing income gaps between urban and rural areas, degradation of the rural areas and migration to cities (Ibid.), which exacerbates the problem.

Along with many problems in rural areas, there are plenty of opportunities. In agriculture itself, there are many options for increasing efficiency and productivity to make products more competitive domestically and internationally. Moreover, given Latvian relatively unspoiled nature, there is a potential for producing specialised niche products, like medicinal herbs, organic foodstuffs, berries, honey products, etc. Although forestry is becoming a major source of income in rural areas, immense potential for value added production is not yet seized, moreover agro-forestry is yet unexplored. Besides agriculture and forestry, the potential for tourism is great. Sooner or later this potential will be realised, the question is whether it will be local people or businesses coming from outside who will benefit from it.

The political priorities set in the rural development plan emphasise increasing productivity in agriculture, diversification into non-agricultural activities, as well as sustainability (Ibid.). Taking into account the need for balancing different development objectives, there is a need for holistic, interdisciplinary approaches to problem solving and decision-making. On the other hand, there is a need and stated priority for increased participation and increased initiative of rural population (Ministry of agriculture, 2003-2). Therefore, systems approach, coupled with participatory discussion, can prove useful for improving the situation and achieving sustainable rural development.

Methodology

Concept of the research

The approach of the thesis is subjective due to at least two reasons. Firstly, the selection of cases was random and opportunistic. Secondly, I was a part of the phenomena I studied – conducting group modelling exercises, the impact of which I measured. Therefore, the conclusions derived in this work are dependant on how I behaved in certain situations. To take this into account, I attempted to describe as precisely as possible the setting and course of the research, which would help interpreting results. Besides, in the course of the research I reflected not only on the subject of the research, but also on myself.

According to Andersen et al. (1997), studies for effectiveness of group modelling using systems approach can be done via experiments, surveys and case studies. Case studies, they argue, can be used to describe the process, testing particular research and data collection methods, however they are not suited to testing hypotheses. These studies, they advocate, can generate hypotheses, but testing these should be done in a more rigorous fashion through controlled experiments to have most important factors under control and to avoid the effect of confounding factors. Due to these reasons, the study is exploratory rather than explanatory. However, I also provide my insight of why a particular intervention was more successful than another one.

Selection of cases

An initial idea of testing applicability of systems approach in the context of rural development in Latvia led me to Dundaga municipality, where I became acquainted with the work of the EU LIFE project Livonian Green Coastal region 21, where local agenda 21 for the region is being developed. After having characterised main concepts and ideas of the systems approach, I suggested to apply it for the activities of the centre. It was agreed that I would visit several farms in order to find out whether people there had particular issues worth analysing from a systems perspective. I visited four farms and spent two weeks in two of them, observing and participating in the everyday life of the farmers. A problem somewhat relevant for applying systems approach was found in only one farm. This was the farm Jumari, which considered starting cultivating blueberries.

Later in the research, it was also agreed that the systems perspective would be used for a community forum, run under the framework of the Local Agenda 21 project. The idea was to analyse through systems approach, how different community ideas interrelate and determine, which ideas are the most important to implement.

Finally, I approached the Latvian organic farming association and as they were drafting the development plan for the industry at the time, I suggested using systems perspective for the discussion of the plan. Figure 1 shows the location of eventual cases.

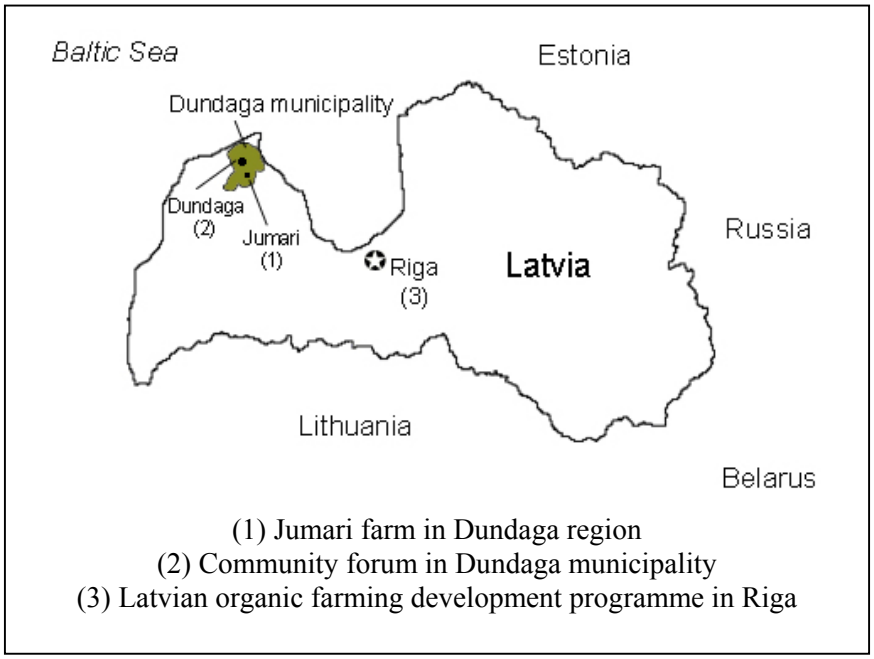

Figure 1. Location of cases

Modelling approach in different cases

The research was based on application of systems approach for particular cases and learning from the experience. It took form of individual and group modelling exercises, where an issue was analysed from the systems perspective by myself or through group discussions. Based on the knowledge of other case studies, experience and intuition, the approach varied in each of the cases, moreover, it was refined from one case to the next, following the 'learning loop'.

In the first case, the modelling took the form of a constraint analysis, where a group of farmers went through the process of cultivating blueberries from the perspective of availability of different resources. The analysis was conducted using a computer and a spreadsheet programme. In the second case, a group modelling exercise was facilitated during the community forum. The technique used for the modelling was a combination of causal loop diagrams with a game activity. In the third case, the organic farming development programme was analysed from the systems perspective, using causal loop diagrams. The description of causal loop diagram tool is given in the theoretical framework section, in the 'systems thinking tools' section.

Collecting the evidence: the impact of modelling

In order to understand how effective the use of the systems approach in each particular case was, I needed to measure the impact it produced. Where possible, tangible results were recorded, like improvement of practice or changes in policy, on individual, group and organisational level. In addition, interviews and questionnaires were used in the first two cases to elicit opinions of modelling participants. The participants were asked questions on the difference the modelling brought for the result of the discussion, as well as their own thinking. The interviews were used in the first two cases, and the questionnaire was used in the case of the community forum. The interviews were semi-structured, which ensured that the necessary components were covered, but also allowed for flexibility. Examples of questions asked in the interviews are given in Appendix 1. The questionnaire used in the community forum is attached in Appendix 2. My observations and reflections also formed a part of evidence and are reported in the description of cases.

Answering the research questions

The question of applicability of systems approach for the Latvian rural development context was answered, analysing the impact of the interventions on individual, group and organisational level. Moreover, these results were compared with the hypothetical business-as-usual way of dealing with the situation, as if the interventions would not have been carried out. These findings were compared across the cases and with the literature (which is presented in the next chapter), and conclusions were drawn based on this synthesis.

The road map of the study

In order to gain a clearer understanding regarding the development of initial ideas of the study, a road map of the journey taken is presented below (Figure 2). This diagram maps out how my interest in systems thinking and rural development resulted in three cases, where modelling from the systems perspective was attempted. The results of the cases were viewed through a prism of different analytical frameworks derived from literature, with the resulting synthesis modifying the initial hypothesis, thus concluding the learning circle.

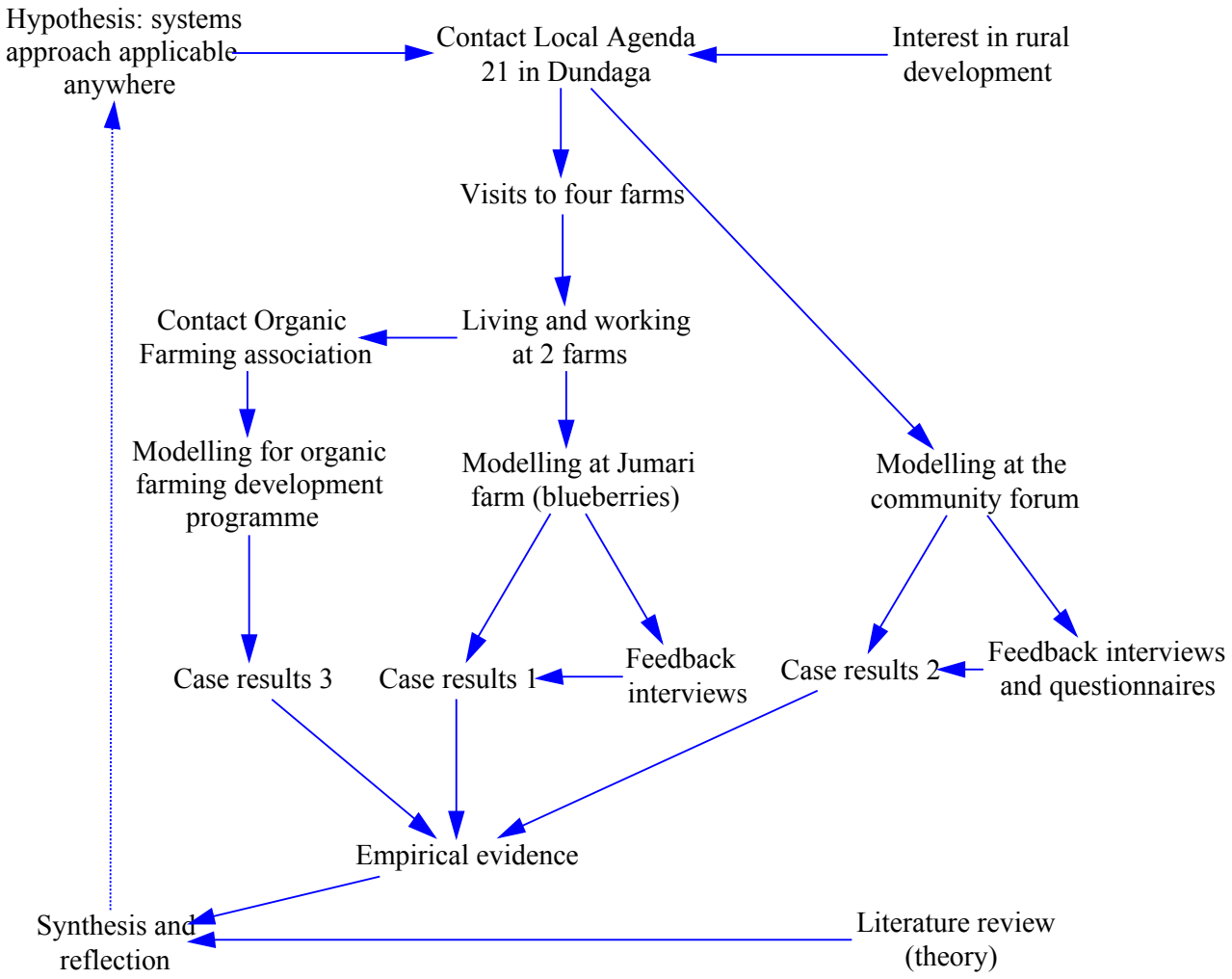

Figure 2. Road map of the study

Analytical framework: problems, systems and group modelling

This part is intended to provide a theoretical context in which the study was carried out. It starts with discussing the world's complexity and humans' incapability to deal with it, which results in many problems, including the problems relevant to 'unsustainable development'. Then the emerging body of knowledge that is claiming to come in terms with the complexity, the 'systems thinking', is characterised. Application of systems thinking tools for real life problems is exemplified. Particular tools for problem analysis are described, with the focus on causal loop diagrams. Further, application of systems thinking tools in a group setting is examined. Expected impacts of this approach are outlined and important issues in group model building are examined.

Unsustainable development and problems with thinking

This thesis is written within the Masters programme of environmental science and I share the belief that the world is in trouble. A body of literature summarises ample scientific evidence of the interlocking crises in social, economic and environmental domains (for example refer to WCED, 1987 or Brown et al., 2002, or Miller, 2002). As an attempt to solve these problems, the concept of sustainable development has emerged and there is a cohort of activities at global and local level targeted to support the 'Development that meets the needs of the present without compromising the ability of future generations to meet their needs' (WCED, 1987). Among these, the Earth Summit in Rio in 1992 and the world summit on sustainable development in Johannesburg in 2002 are worth special attention as these world-level events reinforced the need for developments at local level. The action plan for sustainable development, coined Agenda 21, was launched in Rio and one of the parts, called Local Agenda 21, focused at implementing sustainable development at local level, promoting dialogue between local governments and local community (Lafferty, 1999).

Despite these developments, problems continue and are not so easy to solve. According to some authors (cf. Bossel, 1998; Capra, 1996), the roots of the present crises are in the way we perceive the world. As Dana Meadows wrote in her book *The Global Citizen* (Meadows 1991, p. 3):

> System dynamics makes clear the overarching power of deep, socially shared ideas about the nature of the world. Out of those ideas arise our systems—government systems, economic systems, technical systems, family systems, environmental systems. So if we want to bring about the thoroughgoing restructuring of systems that is necessary to solve the world's gravest problems—poverty, pollution, and war—the first step is thinking differently. Everybody thinking differently. The whole society thinking differently.

Answering how the whole society can start thinking differently is far too ambitious for a Masters thesis. Therefore, given my interest in rural development, I attempted to see how differences in thinking can be brought about in Latvian rural development context. However, before I proceed with describing these attempts, the body of thought will be presented that influenced the research and shaped the prism through which the results of the study are analysed.

Overall context – complexity of problems

The complexity of the world is evident. However, we do not just sit back and accept this complexity as given. Instead, we try to understand and manage it in order to satisfy our needs. In the process of improving our situation we solve 'problems', defined by Checkland (1981) as '..conditions characterised by a sense of mismatch, which elude precise definition, between what is perceived to be actuality and what is perceived might become actuality'. Actions that we take to resolve this mismatch produce various effects, some of which are desired and some are not.

Apparently, the actual effects of our actions are quite far from the desirable, considering such properties of the modern world as poverty, environmental pollution, wars etc. In fact, many of the problems we attempt to

solve are rooted in our solutions for previous problems, due to the way we analyse problems and derive solutions for them (Sterman, 2000).

Real-world problems encompass many domains, however often we tend to neglect it. Indeed, the literature and media are full of examples when a problem is addressed from just one perspective, causing unintended consequences in other spheres. For example, drive for attracting foreign investment in Latvia brought a project of building a pulp mill, which would attract around EUR 1 billion of foreign investment. However, the environmental damage the project would cause and the disrupting effect on local forestry industry were not initially considered (Latvian Environmental Protection Club, 2003). Similarly, many problems in the world, like poverty in the third world, drug abuse, environmental degradation, and unemployment happen in part due to such short-sightedness.

Complexity is in part caused by the feedbacks found in real-world problems (Sterman, 2000; Vennix, 1996). The feedback, as defined by Richardson (1991), is 'a circle of interactions, a closed loop of action and information' (p. 1). The labels of feedback in social sciences include vicious circles, self-fulfilling prophecies and invisible hands. 'The core of these processes is the concept of a closed loop of causal influences' (Ibid., p. 5). Moreover, real-world problems are complex not only because they usually involve a large number of factors and stakeholders that are intricately interconnected, but also because systems representing these problems constantly change. Because of the delays inherent in such systems it is difficult to see what particular factor causes the problem. Most complicated problems have long-rooted history and long-term consequences, but this is often ignored, while analysing and solving these problems, because of our limited cognitive abilities and short-term interests.

The way we analyse problems and our cognitive limitations

The world's complexity is made much more difficult to comprehend considering the limited ability of human beings to cope with it. Contrary to widely held belief in superiority of human brain, numerous studies have proven its deficiency when it comes to situation analysis and making informed decisions (Vennix, 1996).

First of all, human beings manifest psychological phenomenon called selective perception and interpretation, which is seeing and interpreting things in accordance with what one expects to see or induced to believe. Vennix (1996) has made a very rich account of psychological literature related to the selective perception. One of the conclusions of such studies is that people perceive the same situation differently, depending on their personality and background.

Secondly, people create 'mental models' of their environment that shape their actions, which in turn affect the reality and provide a feedback to the mental models. Mental models are 'our internal pictures of how the world works' (Senge 1990, p. 174). Given the selective perception and interpretation, most mental models are limited, as they do not represent the reality in its fullness (Vennix, 1996).

Thirdly, due to limited information processing capability of the human brain and limited attention span, as well as lack of training in perceiving the wholes, we find it difficult to think holistically, that is, to perceive the situation fully. Different studies have shown that people tend to concentrate on details rather than a whole picture and neglect feedbacks, that are present in the real life situations (Sterman, 2000). Furthermore, according to Richmond (2000), we are not trained to think dynamically, and perceive the world as static, whereas it is constantly changing. Thus we think tend to look for immediate visible causes of problems, anticipate immediate effects of our actions and tend to ignore that things take time to happen. Moreover, lack of control over all factors in our experiences, unique nature of complicated problems and temporal and spatial distances between causes and effects, inhibit learning about the world and more informed understanding (Sterman, 2000; Vennix, 1996).

The limitations mentioned above have direct implication for concerted decision making. When a group of people need to analyse a common problem, it should be born in mind that they perceive the problem in

different light, and their different mental models of the situation lead to often contrary behaviour on the same issue. That is why it has been stressed by some authors (cf. Senge, 1990) that larger emphasis should be put on creation of shared vision in organisations, rather than expert analysis and development of effective strategies. Besides, in order to enable refinement of mental models and consequently take more informed actions, these models should be shared and challenged.

Considering the complexity of the world and our limited capacity of apprehend it, there is a need for approach that would help us deal with this complexity and elevate above mentioned limitations. A very influential method to deal with the complex phenomena is splitting a phenomenon into its constituent parts and explaining it from the point of view of the individual properties of the parts (Checkland, 1981). This approach, coined reductionism, proved to be very effective in understanding the complexity of the world and formed a base for the modern science as we know it, which in turn, contributed largely to the human development.

However, since the beginning of the 20th century, a new paradigm started to emerge. It opposed the reductionist approach and proposed that in order to understand the whole, studying its constituent parts is not enough. Instead, attention should be paid to the interconnections between the parts and the emergent properties of the wholes. The new paradigm was coined 'systems thinking'. (Capra, 1996)

Systems thinking and its applications

Systems thinking emerged as a reaction to science's difficulties to cope with so called organised complexity (Checkland, 1981). It claims to overcome reductionism inherent in traditional scientific thinking. Systems thinking was pioneered by Ludwig von Bertalanffy, who suggested to create General Systems Theory, as an attempt to unite the developments in various fields of science (for example, physics, biology, psychology) that had to do with holism as opposed to reductionism (Checkland, 1981). General Systems Theory deals with theoretical issues about systems, such as definition of systems, their properties and their activity.

Systems thinking is a very broad field. The history of the systems thinking and summary of different schools of systems thinking can be found in Checkland (1981) and Richardson (1991). Along with theoretical developments, problem-solving applications of systems thinking are numerous. Examples are management cybernetics, systems engineering and systems analysis, soft systems methodology, as well as system dynamics. The tools used in this research were mostly adapted from system dynamics, because of well-documented history of this school in analysing complex systems and developing robust solutions. Originally developed for industrial problems, the approach has been used to study dynamics of regional planning, research and development, commodity cycles, public policy, drug addiction, urban dynamics and a range of other areas (Richardson, 1991). Increasingly, system dynamics is used not only for business applications, but also for the problems of sustainable development (Saeed, 1998).

The system dynamic approach is thought to be extremely useful and effective because all real-world phenomena contain feedbacks and yet we tend to ignore them in our mental models. As a remedy, system dynamics uses its tools to make feedbacks explicit, explain the behaviour of some problematic system through its feedback structure, and propose policies to improve the situation, based on this understanding. (Vennix, 1996, Sterman, 2000).

There is evidence that systems thinking is applicable for the problems related to rural development. Weber and Schwaninger (2002) have used a range of systems thinking tools, including system dynamics, for solving problems in an agricultural trade organisation; King (2000) used soft systems methodology for work with farmers; Spruill et al. (2001) discuss application of systems thinking for community development and state its high relevance. Kudrenickis et al. (2003) describe application of systems approach for the development of Bartava municipality in Latvia, where possible impact of particular projects on environmental, social and economic factors was demonstrated.

The research was based on systems modelling in three different cases. It used a set of tools, mostly causal loop diagrams, which are described further. As the modelling was attempted in a group setting, the relevant literature on group model building, its impacts and facilitation concludes the theoretical part.

Systems thinking tools

The system thinking uses an array of tools to analyse complex systems and to gain deep insight into the problem. The tools can be divided into two large groups: qualitative and quantitative modelling tools (Vennix, 1996).

Qualitative modelling tools

Tools that are used mostly for structuring and learning about a system include causal loop diagrams (Vennix, 1996; Sterman, 2000), Soft Systems Methodology tools (Checkland & Scholes, 1990), Magnetic Hexagons (Hodgson, 1994). As I have used only causal loop diagrams as a qualitative tool in this research, I address the tool in more detail further.

Causal loop diagrams

'Causal loop diagrams (CLDs) are an important tool for representing the feedback structure of systems… A CLD consists of variables connected by arrows denoting the causal influences among the variables. The important feedback loops are also identified in the diagram' (Sterman 2000, pp. 137-138).

Causal loop diagrams are useful for the following purposes, according to Sterman (2000):

- capturing hypotheses about the causes of dynamics;
- eliciting and capturing mental models of individuals and teams;
- communicating the important feedbacks that are believed to be responsible for a problem;

An example of causal loop diagram is presented in Figure 3.

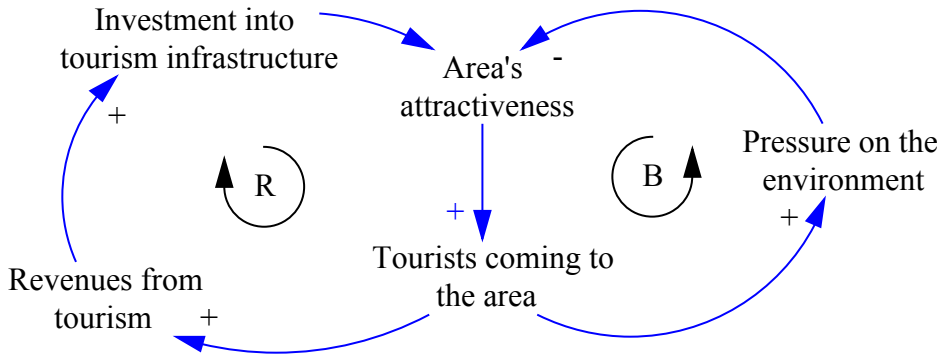

Figure 3. An example of a CLD with two feedback loops

In the causal loop diagram, five variables are shown. Arrows indicate causal links between the variables: between number of tourists and revenues or between number of tourists and pressure on the environment, for example. The '+' and '-' signs indicate the 'polarity' of the arrows. '+' means that the variables change in the same direction (with more tourists coming, revenues increase and with decreasing number of tourists, revenues decrease); '-' sign indicates that the variables change in opposite directions: (then more environment is degraded, the less the area is attractive, and vice versa).

Causal links form feedbacks. There are two types of feedbacks, both shown in the figure. The first one is 'reinforcing' feedback, meaning that a change in some condition will cause, through a series of causal links, the change in the same condition in the same direction. The more tourists are coming into the area, the higher the revenues, the more service providers can invest into new infrastructure, the more attractive the area

becomes, the more tourists are coming. And in opposite case, if the number of tourists decreases, the revenues and investment will decrease as well, thus making the are less attractive. The reinforcing feedbacks can be virtuous or vicious circles, depending on the direction the system is moving.

The other type of feedback is balancing feedback, where a change in condition in one direction will cause the opposite effect on the initial condition. The more the area is attractive, the more tourists are coming, which causes greater pressure on the environment and thus decreases the area's attractiveness. And the less the area is attractive, the less tourists will come, thus reducing environmental pressures and making the area more attractive.

There are many deficiencies in structuring the problem with causal loop diagrams. Sterman (2000) warns against the sole use of causal loop diagrams, as it is impossible to understand fully the behaviour of a complex system over time, using this tool. However, Vennix (1996) proposes that in many situations it is enough to use a qualitative model, moreover Senge (1990) states that most issues can be analysed through the use of 'system archetypes', or recurring structural templates. In his work, solely CLDs are used as a technical tool. Lane (1994) also stresses that the CLDs can be used not only the 'precursors' for quantitative modelling, but also on their own right, for 'they can give and provoke insights'.

Quantitative tools

Quantitative tools allow deeper insight into behaviour of a system and computer modelling is one the corner stones of system dynamics (Sterman, 2000). Software packages that model stock and flow structure of systems are numerous, and most popular are Vensim, Ithink and Powersim (Morecroft & Sterman, 1994). Along with software for modelling stock and flow structures, the spreadsheets are used as well (Lane, 1994).

Systems thinking and participation: group model building

The assumption behind the use of systems thinking for problem solving (Vennix, 1996; Sterman, 2000; Senge, 1990; Checkland & Scholes, 1990) is that this discipline creates better understanding of a problem, improves mental models, and, consequently, changes individual behaviour and organisational policies to suit the interests of the system as a whole and eventually leads to improved performance.

Most of the problems in the real world involve many parties, and to create a balanced view of the situation and take all relevant factors into account, opinions of different stakeholders need to be shared. Senge (1990), Vennix (1996), Checkland & Scholes (1990) discuss why application of systems thinking is most beneficial, when done in a group setting. Firstly, it is better for exploring the problem, as brings different opinions into discussion. Secondly, it creates a shared vision about the problem, which can resolve differences between the parties involved. Thirdly, such activities create commitment for a derived solution, as the ownership of the solution is created. That is why the group modelling was attempted in the research cases. Figure 4 shows Lane's (1994) vision for the group model building process, which is relevant for the modelling carried out during this research.

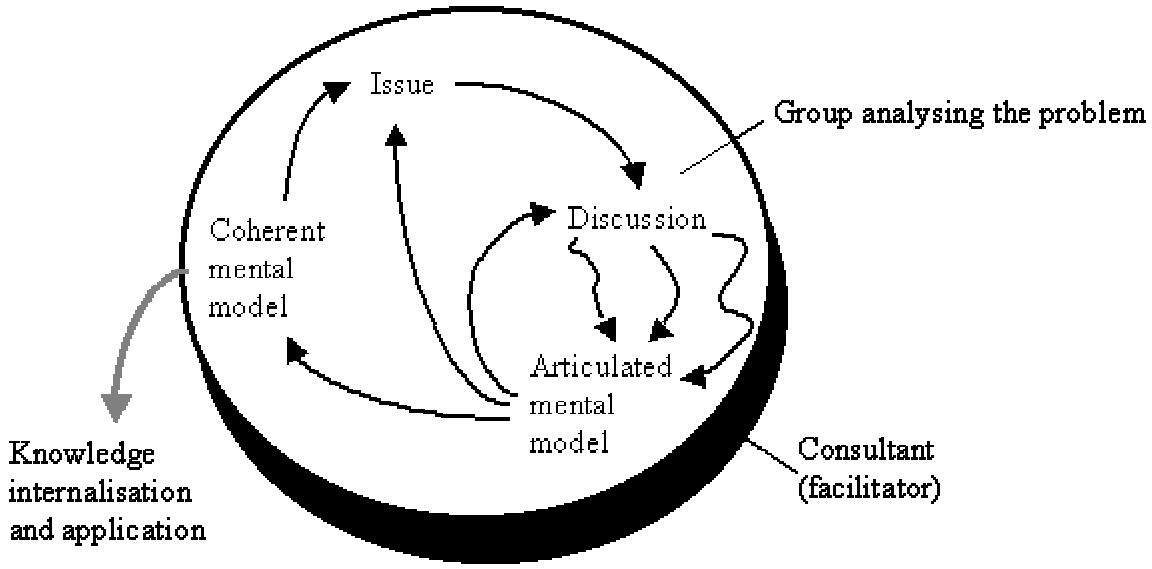

Figure 4. Model of group modelling as learning, by Lane (1994)

In group modelling, the discussion takes place to solve some real-world issue. During the discussion, opinions and ideas of participants are expressed and mental models are articulated, providing additional fuel for discussing things. As a result of the discussion and articulated mental models, a coherent mental model is formed, that addresses the issue and is used to solve the problem, through internalisation and application of knowledge. Alternatively, the group can find out that it has been concentrating on the wrong issue, and then reformulates the problem. The process can take place by the group itself, but is enhanced by the presence of a facilitator, who helps the group discuss the issues effectively.

Although facilitation is preferred (Lane, 1994), expert approach can also be used, in situations where time is limited or due to political and logistical reasons the facilitation is not feasible or desirable. The deeper discussion of the facilitation, as relevant to this research, is provided later in the section on facilitation.

Impact of systems modelling interventions

In order to gain insight on how effective modelling is, it is necessary to measure its impacts. By summarising literature about evidence regarding the impact of group modelling interventions, the following results can be generalised (Andersen et al., 1997; Rouwette et al., 2002):

1. Individual level: people improve their understanding of a particular situation, as well as learn to improve their general skills to deal with complexity;
2. Group level: different opinions and mental models are made explicit, assumptions are examined and challenged, shared understanding is fostered and the commitment with the proposed solution is supported;
3. Organisational level: decisions are made or policies are changed as a result of interventions, performance is improved as a result of improved understanding and policies.

In short, systems modelling interventions have shown potential to induce change in thinking, behaviour and performance. Accordingly, in order to see whether an intervention has produced results, these domains need to be analysed.

Different group modelling interventions have different composition and produce different results. Although the design of particular modelling activity is still more a craft than a science (Vennix et al., 1994), there is a

number of hypotheses that link the success of the group modelling with certain features of the process (Andersen et al., 1997), for example:

- What matters is the tool (certain tool of qualitative or quantitative modelling) used for analysing the problem;
- The success depends on the presence of a professional facilitator;
- What matters is group composition and whether or not the top management (authority) is committed to the modelling;

Consequently, in order to examine why a certain intervention succeeds or fails, the modelling activity needs to be examined in terms of (Andersen et al., 1997) pre-meeting activities (contracting and client-consultant relationship, participants, contacts with participants prior to the meetings), actual meetings (composition of groups and meetings, modelling procedure, aspects of facilitation and meeting logistics), as well as contextual factors, like history of the organisation. The cases will be further analysed using these features. Among the factors determining how successful modelling interventions are, facilitation is given further attention, as it was an important aspect of the modelling in the cases.

Facilitation

One of the cornerstones of the modelling carried out during this research, was facilitation of a group process. Effective facilitation is very important for the success of group modelling sessions (Vennix, 1996). Often the modelling is done by experts who collect information from the 'clients', model the system and communicate the solution back. Although this approach is effective when clients can not devote sufficient resources for the modelling, it has many deficiencies, summarised by Lane (1994). According to him, such 'expert' approach is deficient because 'clients' do not own the solution and it is not expressed in a language understandable to them; it might be perceived with a hostility or suspicion, if the parties do not trust experts; besides it might ignore 'soft' issues, like culture or power structures, that would strongly hamper implementation of a solution.

Instead, facilitation approach to group modelling has grown in recognition. According to Lane (1994), this approach can be characterised by the following features:

- Modelling is an integral part of the management discussion
- Consultants provide tools that capture and express the mental models of clients
- Soft issues are considered
- The models are owned by the clients
- The models are used and interpreted by the clients

In short, this approach 'helps people to know better what they know already' (Lane, 1994, p. 100). Vennix (1996) also supports this approach to modelling; moreover, he makes a specific inquiry into what constitutes good facilitation. In another work, Vennix et al. (1994) state that different techniques for knowledge eliciting should be used in different modelling settings, based on the number of people, the purpose of modelling, the stage of the modelling process, amount of time and resources available for the process. The authors state that in spite of the amount of research devoted to the topic, exploring group's knowledge is still more of an art, not a science.

Having summarised the literature regarding the rationale for systems thinking, its applications, as well as particular tools and modelling settings, the cases studied in the research will be described and analysed.

Cases and results

Systems approach was applied in three different cases. This section contains description of each case, the process of modelling and the results. The results of the cases are analysed in one common discussion thereafter.

Farmers and blueberries

Context of the case

Farm Jumari is a semi-subsistence farm, run by a large three-generation family. Their house with surrounding agricultural land and woods was returned to their family ten years ago through denationalisation. They provide themselves with food all year long, except for some exceptions like bread. They breed cows, sheep, pig, rabbits, chicken and grow cereal crops, vegetables and also have pasture land to provide fodder. They are able to pay for electricity, telephone, fuel and other food and non-food items through money earned during the winter and sourcing their woods for fuel wood and timber.

I was introduced to the farmers by the Local Agenda 21 representative, who and was invited to help them analyse some of their farm management issues. They were considering growing blueberries for profit as well as some eco-tourism activities in future. When I came to stay with them for a week, we decided to concentrate on blueberries, as eco-tourism was perceived to be more distant and not feasible activity at the moment. They invited me to help them assess feasibility of the project and identify possible problems.

The farmer Ivars Tropiņš had prepared a business plan for growing blueberries as an examination paper in the business and management course he took in Riga. This business plan served as a departure point for our discussion.

The study

The study took form of discussions involving Ivars, his wife Gunita and myself. We went through the process of investment into blueberry cultivation and identifying components of the system, including natural resources (soil, water), financial resources, as well as human resources (labour).

The initial business plan envisaged purchasing young sprouts of blueberries in spring, growing them in a greenhouse during summer, and planting them in November. The sprouts then would develop and start giving berries in the 4^{th} year. In order to provide specific soil, beneficial for blueberry growth and water for watering, the overgrown pond nearby was to be dug for its entire area (one hectare). (Ivars Tropiņš, farmer, July 15, 2003). The assumption of the plan was that cultivation could be started and carried out on 10 hectares. Our task was to challenge this assumption.

After examining the farm and the surroundings, we started with going through the process of blueberry cultivation. In systems thinking terms, we identified the boundary and components of the system. We assumed our functional unit to be one hectare and decided to make calculation of all necessary factors for this area.

First, we considered re-establishment of the pond. For one hectare, 3300 blueberry bushes were planned. Each bush, when mature, was assumed to require 8 l of water per day during active growth in seven spring and summer months, thus per hectare around 5000 m3 of water are required per year. Some amount of water required would come from rain and the rest would need to be supplied by artificial watering through pumping water from the pond and sprinkling it onto the field. (Ivars Tropiņš, July 17, 2003). Considering the most extreme situation of very limited rainfall, all the required water would come from the pond. Assuming the average depth of the pond will be 2 meters, to provide for 5000 m3, an area of 2500m2 would be required, that would be a quarter of total possible pond area. However, we also acknowledged that for long

term water availability, not the volume of the pond, but the inflow of water would be determining factor for how much water can be extracted. The pond is located in the natural lowland, therefore it was assumed, based on the previous experience, that before the watering season, the pond would be full with water from autumn rainfall and early spring snow melting, providing the necessary amount of water.

This calculation showed, that water, previously not considered to be a limiting factor in the system, will be critical. Moreover, it is unlikely that water available will be enough to grow blueberries on the initially planned 10 ha plot, as the entire volume of the pond in critical situation (no rainfall) would only be sufficient for watering 4 hectares.

Although the mental simulation showed certain concerns about water availability and made it possible to calculate amount of digging, it is not completely clear at this point how the system will operate in the real life. For example, why does the pond overgrow and will this process continue once the cultivation has been commenced? What if the pond overgrows because of the nutrients leakage from the manure pile situated uphill? How will digging of the pond interfere with the blueberry cultivation process? How much water escapes through evaporation and drainage? I posed these questions to Ivars, which from his experiences were not perceived to be real problems. With the manure pile, for example, he mentioned that the pond overgrew even when the pile was not there, besides the pile was situated away from the ground water channels. (Ivars Tropiņš, July 18, 2003). Thus, there are some issues that are not perceived to be problems (and therefore are not explicitly addressed), and only time will show is it really so.

Further, we examined the feasibility of obtaining young sprouts and growing bushes from them. The initial assumption was that it is cheaper to obtain young sprouts (0.50 Ls for a sprout), comparing with one-year-old sprout (0.80 Ls per unit) and grow them one summer in a greenhouse before planting. (Ivars Tropiņš, July 16, 2003) However, having calculated, how much space these sprouts will require, it became clear that existing and planned greenhouses could not provide the space needed. Moreover, this decision would mean one-year delay in blooming and berry harvest, therefore additional investment into more expensive sprouts was weighted against loan interest added to lost profit from one-year harvest. Putting the figures together, it became evident that both infrastructure limitations and financial consideration are in favour of more expensive sprouts.

Then we modelled the cash flows associated with growing blueberries. We put all the factors into an MS Excel spreadsheet and analysed cash inflows and outflows associated with the process. The spreadsheet is shown in Appendix 3. We used different scenarios for market price, yields, loan conditions, availability of subsidies, insurance etc. The analysis showed that with realistic conditions (average price and average yield), the project would reach break-even point in year five without a loan and year seven with a loan. In the most pessimistic scenario (low price and low yield) the break-even point was established in year nine without a loan and year eleven with a loan. The optimistic scenario (reasonably high price and high yield) gave the figures of five and six years, respectively.

Results

The modelling resulted in challenging original assumptions and creating a more feasible vision. Moreover, the exercise harmonised opinions of Ivars, who had high ambitions for cultivation and Gunita, who was more cautious about the situation (Gunita Tropiņa, farmer, July 16). In one month after the analysis was carried out, they actually planted 0,6 hectares of blueberries. The farmers attributed this action to the confidence the modelling gave them.

Some factors in the system, like water in the pond and greenhouse space for sprouts, were found to be limiting factors in production, being, in system dynamics terminology, the limits to growth, or balancing feedback loops. However, the discussion about these limitations was not carried out using systems thinking terminology or conceptual tools, like causal loop diagrams. Moreover, cash flow calculations using the spreadsheet were rather static and did not make explicit use of feedback structures.

Follow-up

Two months after the analysis and discussion, we met again to follow up on the intervention. I asked them questions regarding the impact of the analysis, with an aim to find out what changes are detectable in thinking, behaviour, and did the intervention influence the situation at the farm.

They were very satisfied with the analysis, as they moved on with the idea that they had had for 2 years. The analysis strengthened their confidence about the project as it demonstrated the range of possible futures, and had proven to them that if managed carefully, financial losses are highly unlikely. They also indicated that the analysis was quite trustable as coincided in large with previous calculations, and showed deficiencies in these. The use of computer was essential, as allowed to make calculations for a wide range of scenarios, whereas the previous business plan was prepared with just one set of assumptions. (Ivars Tropiņš and Gunita Tropiņa, September 18, 2003)

The farmers mentioned that after the modelling they understood that they cannot just plant a crop referred to as profitable by others, but actually need to take a wide range of local conditions into account. Although they acknowledged, that the analysis could have certain deficiencies and had not taken some factors into account (for example salaries of farmers, taxes), they confirmed that they will learn from future developments and alter their action as they go. The farmers also mentioned that they can do similar analysis themselves now. (Ibid.)

Community forum

The second case for applying systems thinking was community forum. The forum was conducted under the EU LIFE project Green Livonian Coastal Region 21 – a project aiming to establish Local Agenda 21 for the Northern Kurzeme region of Latvia.

Context of the case

The project was initiated by Institute for Environmental Management of the University of Latvia, local municipalities, Slitere National park and some other organisations to develop a local agenda 21 for the region involving 3 municipalities of Kolka, Roja and Dundaga. The initiative is financed jointly by the European Community and project partners. (Green Region 21, 2003)

The objective of the project is 'To focus the attention to the coastal region of NW part of Latvia to minimise the impact of different activities to the coastal zone environment and to integrate the sustainability in each sector of the zone'. (Ibid.) The ambition of the project is to create a base for integrated coastal zone management, which would harmonise interests of different stakeholders. These stakeholders involve municipalities, fishermen, farmers, timber harvesters, tourists, owners of summerhouses, national park, and others. It is evident that the interests and activities are very often opposing. Therefore, a need for such initiative as Local Agenda 21 is acknowledged.

I approached the Local Agenda 21 coordinator with a proposal to try applying systems approach for the activity of the centre. I described the approach and its application in other cases. We decided to attempt the methods of systems thinking for the activities of the community forum. Community forum is one of the activities the centre is organising and facilitating, which aims at promoting local sustainable initiatives. Representatives from different stakeholder organisations and all those who wish to participate are invited to the forum to share their ideas on the development of the area. The aim is to channel these ideas into specific projects to implement.

In the first session of the forum, a group of people from the community met for a day. They were asked to come forward with their opinion on what is important to do for the well-being of the region. People proposed many different ideas, which later were categorised in the relevant categories, like tourism, agriculture, environmental infrastructure etc.

I approached LA21 centre when the first session already had taken place. We therefore decided to apply systems approach for preparation and facilitation of the second session.

Objectives of the intervention

The objective of applying systems approach was to present a holistic picture of development in the region that would integrate different activity areas and initiatives. A hypothesis beyond this objective was that such holistic picture, or model of the reality, will give an additional meaning for different community initiatives (people will see how their activities fit into the bigger picture). Another hypothesis was that seeing how different activities interrelate and influence people's needs would help to identify, which activities or events reinforce others or balance others, to be able to select priority actions. Thus, the objective for the community forum was to test how applying systems approach changes people's perception and particular actions.

Therefore, it was sought to find out experimentally whether the systems approach is applicable to this kind of situation, what the effects of applying it are, and what are factors that influence how effectively it is applied.

Process of the intervention

The background for the case study was that the first community forum had already taken place and its results were available. Before the experiment, there was only a general idea of systems thinking application for the

case study, and there was no carefully selected and designed experiment procedure, instead it formed in the process, taking into account all relevant developments.

The process eventually organised in a following way:

Developing preliminary model
- Study of the ideas developed during the first forum, based on forum documentation
- Categorisation of all ideas into broader activity fields
- Summarising people's needs based on motivation theories and categorisation of these needs
- Finding out what influences satisfaction of the selected need categories, based on the case's context
- Connecting needs and factors satisfying them with activities groups, proposed by community forum, via a causal loop diagram
- Discussing the preliminary model with the Local Agenda 21 personnel

Community forum – group modelling
- Brainstorming about the quality of life indicators
- Summarising what can influence quality of life indicators
- Connecting the quality of life indicators with different development processes in the region and creating a causal loop diagram
- Discussing how different activities (or ideas) can influence quality of life indicators and development in the region
- Discussing and selecting activities for implementation in the workgroups
- Voting for activities to implement in the plenary session

Feedback about the modelling and its influence on results of the forum

All the steps presented above are discussed further in greater detail.

Developing preliminary model

It was decided in the very beginning that one of the elements in the forum will be interconnected (systems) view about different development initiatives within a community. It was not decided whether the view would just be presented or worked out together with the forum participants. In any case, it was decided to summarise the ideas that emerged during the first forum and build, in Vennix (1996) terms, a preliminary model.

To come up with factors for the model, I categorised all the ideas of the first session into meaningful categories. The activities were grouped arbitrarily, according to what area they concerned, in order to come up with a number of broader variables for the use in the conceptual model. This categorisation is shown in Appendix 4. The result was the list of 31 narrow categories (e.g. *historical objects (fixed), tourism routes, accommodation creation* etc.)

Then, all of these variables were put into the computer screen. Apart from these categories, additional variables were added, like *region's attractiveness to tourists*, *number of tourists in the area, public health* etc. that denoted my understanding of the necessary development indicators. Further, I attempted to connect these variables through causal links. However, at a certain point I realised that the resulting causal loop diagram would be complicated and large number of variables would make it difficult to understand, both for myself and for the forum participants. Therefore, I abandoned the modelling and the diagram stayed unfinished. The last sketch of the CLD is documented in Appendix 5.

Considering the CLD was too complicated, an alternative method was attempted. To present development in a more understandable way, I decided to concentrate on people's needs and on the ways how development satisfies or compromises these. I used a summary of motivation theories prepared by the authors of Changing Minds.org (2003), who identified 3 general groups of needs, based on James (1892), Alderfer (1972) and Mathes (1981) and identified three broad categories of underlying needs: material (existence, physiological)

needs, social (relatedness, belongingness) needs, and spiritual (growth, self-actualisation) needs. Based on this summary, I arbitrarily came up with the factors that need to be present in a community to provide for satisfaction of these broad needs, or, in other words, for the quality of life. These factors include healthy food, healthy environment, meaningful work, income for household purposes, personal growth opportunities, recreation opportunities, and public order.

These factors were entered into a screen together with key development factors, derived from the ideas of the community forum. Then the causal links between the factors were drawn, to connect it into a causal loop diagram. The resulting CLD is presented in Appendix 6.

Originally I planned to show the CLD to the forum participants without involving them, as an alternative view about the development in the region. However, my supervisor suggested that the modelling would not be helpful without participants owning the process, therefore I decided to make modelling an interactive activity.

Community forum – group modelling

I was given one and a half hour time allowance for a group modelling session during the community forum, which in total was supposed to endure for five hours, together with coffee breaks. The general schedule for the forum was as follows:

- Introduction and reporting last forum's results – 60 minutes
- Presentation by an NGO specialist from Talsi municipality about the experience in Talsi community forum – 40 minutes
- Group modelling – 90 minutes
- Discussion and sorting out of ideas in work groups – 60 minutes
- Voting for ideas and forming of workgroups for further implementation – 60 minutes

I faced the following dilemma. Firstly, the time assigned for group modelling (rather, it was presented to forum participants as 'alternative view at development initiatives', 'thinking exercise') was limited for a deep and qualitative discussion. Secondly, there was an intention to present the interconnectedness of different community initiatives, to test whether the forum participants make 'more qualitative decisions'. To resolve this, I decided to present the preliminary model in a way that would involve the community participants as well. Considering that the modelling had to happen after one hour of people listening to presentations, it was vital to activate people. I then decided to present modelling as a game, rules of which are described in the next paragraph. We came up with the rules during the discussion with Lauris Laicāns, an employee of the Local Agenda 21 centre.

The rules are the following. Forum participants are each given a piece of paper representing one factor from the preliminary model, for example *tree cutting* or *household income* or *quality of life*. Altogether, there were 25 factors. In order to provide for possible group sizes, all the factors are ranked, based on the perceived necessity to demonstrate major connections and feedbacks. This makes the game possible even when there are two participants (the factors selected as most 'important' were *income* and *business development*, because they form a reinforcing feedback loop). Once the sheets with factors are handed out to the participants of the activity, the game begins. The facilitator comes up to a person representing any factor and asks: 'who (what other factor) does this one effect?' Then the people 'managing' factors that are causally connected with the factor in question, raise their hands and explain, what is the connection. If nobody raises hands, then the facilitator asks all the participants whether they can notice that the factor affects their neighbours. In this way the group establishes whether there is a causal link and explains the connection. Once the connection is established, a small string is run from the 'cause' person's right hand to the 'effect' person's left hand. In such a way the group proceeds until all links are established. The result is a very complicated 'net' of strings connecting group participants. In the process participants acknowledge interconnectedness and complexity of the 'system', which is supported by the facilitator. The next step is demonstrating feedbacks. The facilitator specifies that if a factor changes, then the person representing it

pulls one's right hand. By pulling this string, the signal goes into the 'effect' people's left hands and when affected, they need to pull their right hand accordingly. The result is a chain reaction and provided there are feedbacks, the process never stops. The idea behind this exercise is that feeling the feedbacks through their own bodies, people will experience the interconnectedness.

The real activity unfolded differently. The community forum began later than expected and the talks took more time than planned. Besides, forum participants did not get involved in the presentations so there was apparent decrease in interest. By the time I was supposed to commence my task, it was felt that rather than theoretical discussions and one-way communication, people needed an interactive participation. Therefore I changed the plan and decided instead of using the variables of the preliminary model, to come up with the variables through brainstorming with the participants. This decision was also influenced by the advice from my supervisor, who advised to involve people as it would be more difficult for them to accept the model they have not created.

After the previous presenter finished, I introduced the activity and asked the participants to come up with the three most important things that determine the quality of life in the community. The participants had a possibility to think during a coffee break and then I started summarising their thoughts. Going one-by-one, I wrote the factors for quality of life on the flipchart and summarised these factors into five large categories (work, income, clean environment, healthy community, recreation opportunities). This grouping, although agreed upon by the participants, was largely influenced by the preliminary model. This whole section took more time than expected due to the number of people, their willingness to explain their ideas, discussions irrelevant to the questions asked and my inability to cut these abruptly.

After that the already mentioned five categories were put on a separate flipchart and after a short break I asked the participants what affects these factors. Having written around 15 variables, I decided to start the activity. Due to time pressure and high anxiety level I attempted to use the cards prepared based on preliminary model. Some of the cards had changed but most of them stayed original, although they largely coincided with the group's result (as formulated by myself).

Then the group started to identify links between the factors. It started with *residents income*. The process turned out to be much more complicated than expected. Firstly, people rose hands and advocated for connection between their variable and the 'cause' one, which arose discussions and arguing in the group. It was difficult to handle so not all connections were critically examined. For example, the causal connection between *personal income* and *meaningful work* wasn't evident to all (in the preliminary model, both these variables resulted from different business activities, like *tourism services, forestry, agriculture)*, but the person representing 'meaningful work' argued that without income, there can not be meaningful work, and the group agreed. Secondly, there were cases when two factors were connected, and participants skipped the connection. For example, the person representing *health care* argued that *personal income* affects her factor. However, it was challenged and supported by the person representing *municipality income*, who argued that health care is provided by the municipality, who taxes residents' personal incomes.

Thirdly, people raised hands and talked at the same time and the process was quite difficult to manage. At one point, an elderly gentleman asked 'when will we get down to business and quit this philosophical discussion?' This contributed even more to a confusion in the room, and I attempted to counter that by stating that this exercise was meant to find out linkages between different development factors to understand what effects can various community activities bring.

As the time allocated was exceeded, the group could not discover all the connections and instead it was suggested to analyse those factors that do not have a cause or an effect link with others (a person's right or left hand is without the string). After this was done, certain feedbacks in the system were demonstrated. For example, I showed the feedback going through *organic farming – personal income – municipality income – professional education – competent personnel – organic farming*, as well a couple of other feedbacks. Besides, I gave an example how some community initiatives might influence the system and affect various

factors. To demonstrate the feedback system better, I asked a person representing organic farming to pull his right hand, to imitate a change in the factor, and instructed the other participants to pull their right hands too, once they feel that their left hand is pulled. The result was not as smooth as envisaged, but provided an example of dynamic interconnectedness. Then the activity was concluded by summarising that it is important to be aware about the connections, as well to identify potential feedbacks, in order to know how different activities influence those who carry them out and others.

The result of the activity was an incomplete model, however the objective to demonstrate the interconnected view on the development was partly fulfilled.

Community forum – selection of activities for implementation

This part of the forum will not be described in as great detail as the modelling part, but a short description of it is needed in order to make a better picture of the context in which the modelling is analysed.

After the modelling activity ended, the participants were split into three work groups, each given a list of ideas that came up during the first forum. The lists were different and the aim of splitting into groups was to go through all the 120 ideas in the most efficient manner. Each group was asked to select ten ideas that they consider to be most important for implementation, including those on the list and others that they can come up with. After approximately 40 minutes long discussion, the groups placed their selected ideas on a flipchart. Two groups selected ten ideas each, and the other one selected six. All 26 ideas were put on flip charts; those ideas that were same or very similar were combined into one record.

The next step was voting for ideas to implement. Each participant was given two marks to select those ideas, in the implementation of which one would like to participate and three marks to select ideas, which one considers important for others to implement. After voting, several priorities emerged and corresponding work groups were formed:

1. Improvement of nature objects (Dundaga park, roadsides etc.)
2. Renovation of Dundaga People's house
3. Support for small business development and cooperation
4. Organic farming and eco-tourism

The people who voted for participating in particular activities then signed up for the work groups. The meetings of the work groups were planned for the week following the community forum.

Feedback about the modelling and its influence on results of the forum

Before leaving, the participants were given the feedback questionnaires to fill out. The questions asked where about participants' perception of the forum, their perception of the modelling and its usefulness. The example of the questionnaire is given in Appendix 2. Nine questionnaires were returned and they are summarised in the following table.

Table 1. Summary of community forum feedback questionnaires

Question	Mean	Standard deviation
Evaluate, on scale of 1 to 10, to what extent the approach that was used in modelling is useful for you personally? (N*=7)	6.7**	2.2
To what extent, on scale of 1 to 10, the approach has improved your understanding of development in Dundaga region? (N=7)	6.4	3.4
To what extent, on scale of 1 to 10, did the approach influence the result of the forum? (N=6)	6.8	3.4

* Number of responses

** The scale: 1 is the lowest score, 10 is the highest score.

It can be concluded from the table that the opinions were quite diverse (standard deviation compared with mean). Considering small number of questionnaires, the mean is not very indicative of the result. From the comments to the answers, it can be seen that people consider the value of the modelling to be in expanding their general understanding about the reality. However, from the answers it is not evident whether the modelling has influenced the result of the forum.

The follow-up interviews were carried out a week after the community forum. Six people were interviewed, and the interviewing gave the results described below.

Most of the people (five out of six) perceived that the objective of the modelling was to demonstrate the interconnectedness of different areas of region's development. Therefore, the exercise succeeded in achieving one of its objectives. However, most of the interviewees mentioned that the activity was not relevant for the community forum, the purpose of which was to discuss particular actions. Moreover, most of the interviewees mentioned that the activity did not influence the way discussions in work groups took place. However, two of them mentioned that the activity created better climate for discussion by bringing people together. Most of the people (five out of six) agreed that the activity did not influence the selection of the activities to be implemented. Three of them mentioned that the exercise challenged their thinking. Besides, two of them told they could use the presented approach in their personal activities.

Personal benefits derived from the modelling session were very diverse, and included thinking provoked by having to define three most important quality of life features (two respondents), possibility to communicate with people and express one's concerns (one respondent), no benefit (two respondents) and possibility to use the activity for reporting on the activity to the project's donor organisation. Four out of six interviewees commented that the form the activity took place was very attractive and relevant for activating people and establishing contact between them. However, three of them have noticed that the modelling game was too complicated and should have been done simpler, based on some very practical issue or involving fewer factors. Two people have mentioned that the approach could be effectively used in education for raising awareness about interconnectedness of different phenomena. Besides, two people proposed to use systems approach for policy analysis and for planning purposes. However, a comment was made that the problem under consideration should be narrower.

To summarise the results, no significant impact was observed on the outcome of the community forum, however thinking of some participants was challenged.

Organic farming development programme

Context of the case

Organic farming in Latvia is in its infancy. Currently, 0.7% of all agricultural land is cultivated organically. However, the development of the industry is seen as a part of sustainable rural development, therefore enjoys relatively high support from the state. The target for organic crop area for the year 2006 is 3% (Ministry of agriculture, 2003-1). The industry faces many problems, including lack of distribution channels (most produce is sold as conventional), low level of competence, unclear status of the certification institutions, lack of organic inputs, poor cooperation between farmers etc. (Baraškina, 2003-1; Runce, 2003) As an attempt to approach the development more strategically and have more controlled and balanced development, the organic farming development programme is currently being prepared.

Modelling

I approached the head of organic farming organisations' association and proposed to test application of the systems approach for the development of the organic farming in Latvia. The development programme for organic farming in Latvia was being prepared jointly by the association, the ministry of agriculture, as well as other stakeholders of the industry, such as food and veterinary service, research institutions, and the bank interested in developing this sector (Latvijas Hipotēku un Zemes Banka). The head of the association Dzidra Kreišmane therefore gave me to review the documents that constituted a draft for the programme (Baraškina, 2003-1; Baraškina, 2003-2) and asked to give suggestions for improving the programme.

After having reviewed the documents, I proposed mapping out the interconnectedness of different development factors and different sectors of the industry through a causal loop diagram, to assist drafting of the programme. The purpose of such diagram would be informing the process of discussing the programme and increasing the quality of made decisions. I showed a very rough example of a CLD to the head of the organic farming association, and she acknowledged that this method could be used for discussing different activities envisaged by the programme and linking them together (Dzidra Kreišmane, the head of Latvian organic farming association, July 8, 2003). It was therefore decided to use this approach for association's inner meetings and also possibly for the discussion that would involve all actors in the industry development that would take place later.

When the time came for discussing the programme, it appeared that the programme was drafted by the ministry of agriculture and other parties had added their comments; moreover, there was a lack of time to have modelling for association's inner meetings. It was therefore decided to use the modelling only at the meeting in the ministry of agriculture, where all major stakeholders in the industry development participated and discussed modifications to the drafted document. The aspiration was to have a causal loop diagram that would connect different sectors into one general context. A preliminary diagram, shown in Appendix 7, was prepared, based on the draft of the programme (Ministry of Agriculture, 2003-1).

The meeting was chaired by the ministry's specialist, who announced the purpose and the agenda of the meeting. Then a representative from Latvijas Hipotēku un Zemes Banka, presented the bank's view on the development of organic farming, and it turned out that he and his colleagues have prepared their own version of the programme. Then the ministry's representative went through the points of the original programme, which is the list of activities for development of specific fields (farm production and provision of necessary inputs, product variety and processing, market development, certification system, education and research, integration with other sectors). The purpose of each activity is stated, as well as particular actions, measurement criteria, responsible parties, deadline, as well as available and necessary financing.

The participants made their comments on particular aspects of the programme, proposing their modifications for different attributes of a particular activity. For example, one person proposed to increase financing for organic food processing, and another offered to alter a section on research. Overall, the discussion took more time than planned, therefore it had to be concluded quickly. The conclusion of the meeting was that the parties would send in their comments electronically and different plans (ministry's plan and the bank's plan)

would be combined. In general, it seemed that participants were dissatisfied with the meeting, as no practical result was achieved (Dzidra Kreišmane, the head of Latvian organic farming association, September 15, 2003).

During the meeting, a chairperson of the organic farming association offered to take a broader, more strategic view at the issue discussed (with the help of the causal loop diagram), however it was decided to go on with the list of activities. Moreover, the question regarding the clarity of strategic objectives was raised. The head of the organic farming association acknowledged that there is a lack of agreement on development goals. However, the ministry specialist stated that a year ago they had gone through the process of objective setting therefore this activity should not be repeated.

From the course of the meeting and the presence of two different versions of the programme, it was evident that there was no clear vision for the development of the industry. Moreover, the process of discussing programme activities happened without reference to a common picture. It can thus be concluded that considering apparent difference in views and uncertainty over common priorities, the development programme might not be fulfilled as planned.

Considering that there was no common vision due to political and logistical reasons, it was not feasible to continue with modelling on the level of entire working group. Instead, I proposed to the organic farming association to alter the approach and accomplish modelling with the association alone. The proposal was based on the latest draft of the programme and contained the following features.

Firstly, it was proposed to take the quantitative targets established by the programme (for example, crop area, sales volume, number of processing enterprises etc.) and analyse how they relate to one another as well as check, whether the activities proposed by the programme are sufficient to achieve these targets and whether there are any activities lacking. Secondly, considering the limited capacity of the association with regard to the activities it should be carrying out, I suggested to prioritise which activities are essential and which are minor.

It was agreed to meet and discuss these issues before the final discussion of the programme. In order to prepare for the meeting, I prepared a new causal loop diagram that attempted to connect the quantitative targets for the development of industry. First of all, all the targets (for example organic crop area, production volume etc) were written on one piece of paper. Then, I conceptualised how these targets are connected, through the market mechanisms. Then, it was contemplated how different major activities envisaged by the program would influence the variables in the created model. The resulting CLD is presented in Appendix 8.

Having analysed the model, I concluded that the activities offered by the programme address all the targets set out in the programme. To analyse with better quality the possible effect of proposed actions on target variables, more detailed analysis of particular actions should have been done. However, after establishing that in general, all major areas are covered with relevant policy actions, I paid greater attention to the activities where the organic farming association was involved.

It appeared that the association is almost solely (in some instances together with Latvijas Hipotēku un Zemes Banka) is responsible for the development of organic food market. Indeed, weak access of organic farmers to the market is acknowledged as one of the main problems in the industry (Runce, 2003; Baraškina, 2003-1). Therefore, it is considered to be one of the key areas for industry development. In the present programme, however, the organic farming association is responsible virtually alone for the development of this sector. Considering the limited human and financial resources of the association, it can be concluded that this area is very vulnerable.

Although I reached some insights while compiling the causal loop diagram and analysing how feasible the program is, the intention was not to make a thorough analysis, but rather prepare for joint modelling with the association representatives, to prioritise activities of the association. When I met the association's head

Dzidra Kreišmane to discuss the activity, she told me that they were completely overwhelmed with work and did not have time at all for 'theoretical discussions' (Dzidra Kreišmane, October 13, 2003). Moreover, she asked for a particular advice on what to alter in the programme. Therefore, I communicated my finding about likely failure of the association to meet the demands the programme placed upon it and the necessity to look for alternatives for organic food market development. Moreover, I stated that there is no apparent agreement on objectives and common vision for the development of the industry, which could lead to different parties working in opposite directions.

These conclusions were acknowledged which resulted in amending some parts of the drafted programme:
a) The modification concerning the market development section suggested state support for cooperative sales activities of farmers, and the creation of the marketing information system (annual market analysis and communication of its results);
b) The modification addressing the need for balanced development of the industry and stipulating a completely new section within the programme "Activities for the balanced industry development". The activities included annual follow-up on the development programme, joint stakeholder meetings for sharing visions for development of the sector, as well as creation of the work group that would oversee the realisation of the programme.

The modifications were presented to the ministry of agriculture who accepted a) but rejected b). Whether these amendments will be improved is pending, as the programme needs to go through the discussion with the union of agricultural organisations and then the Cabinet of Ministers. However, according to the head of the organic farming association, the quality of the programme itself will be higher Dzidra Kreišmane, the head of Latvian organic farming association, October 15, 2003).

Discussion

The initial question of the thesis, "How systems thinking can be used to facilitate rural development decisions?" will now be addressed. In order to do this, the results of the three cases will be summarised and some general insights will be derived.

The impact of modelling in cases studied

Using the framework for evaluating group modelling interventions (Andersen et al. 1997), the impact of the interventions in the three cases will be summarised. According to these authors, the impact of group model building happens and should be measured at three levels: individual, group and organisational. At the individual level, the changes are advocated to concern thinking, or improving mental models, as well as changing the attitude to a proposed policy. On the group level, the anticipated outcomes include alignment of mental models, creating agreement about a decision and generating commitment with a decision. On the organisational level, the outcomes may include process changes and performance changes. Table 2 summarises the results of the system modelling intervention in the three cases, at different levels. In addition, it states what the hypothetical outcome would have been, if the intervention had not taken place.

Table 2. Impact of the system modelling interventions at individual, group and organisational level

Jumari – blueberry cultivation	**Community forum**	**Organic farming development programme**
Result without intervention		
No activity, wait until money arrives and invest steadily, up to 10 hectares, the limiting factor is money	Voting on initiatives to take action; 'random' action; doing 'what feels right'; people choose doing what they like or can do.	Different parties make comments for the programme document; no common objectives established
Individual level		
Mental model of farmers changed, assumptions challenged (including the limiting factors), range of possible futures considered Confidence about the activity increased	Thinking of forum participants challenged; no impact on mental models or attitude for the particular situation	New insights provided by an expert; no change in individual thinking
Group level		
Common vision created in the family, previous differences resolved, commitment with the vision achieved	Little impact on group activity and group's result; some contribution to creating good working atmosphere.	No group activity carried out.
Organisational level		
Decision made to start cultivation, cultivation started.	No impact on the result of the forum.	Changes proposed to the development programme, however the changes proposed were arbitrary and did not result from the group modelling, but rather from the 'expert' advice

It can be seen from the table, that in the first case the intervention produced a large impact, whereas in the second it failed to deliver the anticipated changes. In the third case, although having a high potential, the intervention did not have ultimate outcome. Literature on application of systems thinking has similar contradictory results. Rouwette et al. (2002) state that the question regarding the success of group modelling interventions is not yet answered, because of the lack of scientific evidence. So far the evaluation of such interventions has been carried out on a case-to-case basis (for example Cavaleri & Sterman, 1997; Huz et al., 1997) and the thorough summary of different studies has first been attempted only in 2002 by Rouwette et al. Andersen et al. (1997) state that more research should be done on the impact of group modelling interventions, especially with respect to results produced by various mixes of tools, facilitation techniques, group structures, communication quality, etc.

Factors influencing the impact of modelling

In order to understand why in this study the first case was successful and the others not, key features of the cases will be compared. Based on frameworks laid out by Vennix (1996) and Andersen et al. (1997) the cases will be examined in terms of some aspects of the pre-modelling phase (nature of problem, parties involved in the problem) and the modelling phase (resources devoted to the intervention, analysis tools used and facilitation). Coupled with the evidence from the literature, such comparison may indicate what are the implications for applying systems thinking for solution of particular rural development problems.

Problem in question

The first question to ask is whether the approach chosen was generally applicable for the situation at hand. Initially the hypothesis was that systems approach is applicable in nearly all situations. The assumption was that it is important to understand the context and the interconnectedness of different factors when confronted with any problem. Making interconnectedness and structure of 'a system' explicit, I thought, could yield better results, in case a solution for some problem needs to be developed. During the research, however, I studied the literature on application of systems thinking and some of the authors were encouraging while some were not.

Checkland and Scholes (1990) state that systems thinking is applicable whenever a complex situation is present and there is a need to learn about this situation in order to improve it. Senge (1990) claims that most situations in the world, especially where human interaction is found, involve feedbacks and delays, therefore this approach is universal, especially where learning is to take place. On contrary, Vennix, specifically describing the applicability of system dynamics, states that this approach is appropriate where 'a) the situation is dynamically complex because of underlying feedback processes, and b) one looks for robust long-term solutions' (Vennix 1996, p. 106). Moreover, Richmond (2000) argues that system dynamics can be used in any case where a 'problem variable' can be identified and its behaviour can be traced over time. Spruill et al. (2001), summarising the use of systems thinking for community development, state that it should be applied, where 'dynamic complexity', as opposed to 'detail complexity', is present.

As we see from the cases, the problems considered in the research contained little dynamics complexity, or the dynamic complexity was not made the focus of the problem analysis. In the first case, the problem was to establish constraints, or 'limits to growth' in the farming system. The limits to growth, or balancing feedback loops, were addressed without using the conceptual tools of system thinking, simply discussing the issues and making simple calculations. The quantitative spreadsheet calculation was performed without making explicit use of feedbacks (except for the circular flow of money). Indeed, it can be argued that the modelling concerned 'detail complexity', not making 'dynamic complexity' explicit. In the second case, the problem concerned identification of policies (or activities) that would create leverage for regional development. The problem concerned complex system with many feedbacks, a problem variable, although set implicit, was 'quality of life'. In the third case, areas of organic farming development that were most at risk and were not covered by the programme, needed to be identified. The system involved many variables and several feedback loops, but again, there was no explicit focus on any particular variable.

This leads to a pertinent question: was the systems approach applicable at all in the cases considered? If we consider the feedback modelling to be the cornerstone of systems thinking, the answer is 'no', as modelling was not applicable due to various constraints, including perceived complexity of the process and my limited experience with using the tools of systems thinking. Sterman (2000) stresses exactly the point that systems approach, embodied in system dynamics, is most effective only with the computer modelling. However, system thinking, and even system dynamics is not only about quantitative modelling. In Vennix (1996) words (p. 109),

> .. only when a model is quantified and simulated on a computer can we learn to understand its dynamics… there is ample evidence that people cannot correctly infer the dynamics from a qualitative model which includes feedback loops. However, in the argument above the baseline from which one starts is the 'full' understanding of the system's behaviour… In (some) cases, practice frequently demonstrates that building a qualitative model is sufficient.

Therefore, if we understand systems approach as means for creating a shared language for interpreting situation, and creating a common picture of the reality, then the approach was useful for the cases discussed in this paper. Assuming that application of the systems approach was relevant for the general problem in each of the cases, the question is why only the blueberry case became a success? Thus, there should be other factors that would determine whether and how the systems approach can be applied successfully.

Parties involved in the problem

One of the drastic differences between the cases is the number and character of the parties involved in the modelling. The differences between the cases will be discussed according to a) perception of having a common problem and motivation for common problem solving, and b) control over the result.

Perception of having a common problem

In the farmers' case, there were only two people involved in the process of modelling, beside myself: the farmer and his wife. Certainly, there were differences in the way they perceived the situation, but the ultimate objectives were very similar: stability and prosperity of the family. Therefore, we can consider that their interests were quite homogenous and they had a perceived common problem. They both wanted to have the situation analysed and to see what limitations are there in their envisaged project, thus they had strong motivation to undertake the analysis.

In the case of the community forum, the context of problem was too large and the people came to the discussion to select different ideas for implementation, moreover they came largely to push their ideas through. The context in which the issues were discussed was so broad that different ideas they had did not clash and even if they could see that these ideas could contribute to each other, it did not influence their attitude towards them. Thus, the discussion about the 'bigger picture' was not perceived of direct relevance to them as it was too 'theoretical'. Even though the systems approach was relevant for the problem itself, through the interconnections between different areas of development and identifying leverage policies, the discussion was not appropriate in the group setting. It should rather have been carried out with the municipality decision makers, as firstly, balanced development of the region is (or should be) their direct concern, and secondly, they possess perceived control over many variables in the model. In this group setting, however, the approach proved to be valuable only for introducing the general context, and not for actual decision-making.

In the organic farming development programme case, group modelling never happened. Even though the value of the approach was acknowledged by the head of the organic farming association, due to lack of time or the character of the information flow or the institutional setting, the 'bigger picture' was not explored in a group of people who were involved in the development of the programme. This infers, that although there was an interest in resolving a common issue (the fact that the programme was actually being developed), it did not get to the point where there was a strong perceived need to create a shared vision. I can only

hypothesise what could make this need to occur: if the future developments show that the programme was not planned well, or when there will be more resources devoted to the sector, this need might appear.

From these three cases we can conclude that the modelling intervention will have higher chances to be successful if the parties involved in the problem perceive some problem to be common, resulting in the need to find solutions. Probably, this is easier to achieve when the number of stakeholders is smaller, as the first case indicated. Study undertaken by Rouwette et al. (2002) supports this point, as most real-world applications of group modelling concerned business organisations, where common purpose is explicit. However, Vennix (1996), addressing the issue of group size, states (p. 113): 'smaller group might be easier to work with, but it might go at the cost of model quality and acceptance of the results of the model-building process'.

Ownership of the problem

One of the issues that is hypothesised to influence the success of the system modelling intervention is the ownership (or control over) of a problem.

In the blueberry case, many of the variables that were modelled were under the control of the farmers involved. After all, it was their farm, their land and their money, so they were in a position to directly influence it. The perception of being in control is important for two reasons. First of all, it adds to motivation to perform the analysis, as the people know that the analysis is likely to help them make decision over a vital issue. Secondly, once the analysis is made, the fact that many variables are under control makes it easier to implement the decision.

In the community forum case, the parties did not have control over the bigger system, they owned the ideas they came with, and the context was too broad for them to feel the connection between these ideas and the development in the region. Therefore, modelling development of the region was not relevant and resulted only in informing participants' general understanding, which the people did not seek.

In the case of organic farming development programme, the would-be participants of the modelling had a control over certain variables in the system, it is therefore possible that if the group modelling had taken place, it could have been successful in improving the programme. For an example, based on the preliminary causal loop diagram some changes to the program were proposed, which were in fact added to the document. However, later, when the modified version was presented to the ministry of agriculture, some of the changes were rejected, which reinforces the argument that parties modelling the system should be able to control the policies they devise in the process of the modelling.

The cases provide ample evidence that in order for the modelling to be used for decisions that would impact the real situation, the parties need to have a control over certain variables in the system, if these variables are to be used for devising a policy to change the situation. The ownership is important both for increasing motivation for modelling and implementing the results of modelling. If the participants of the modelling do not have control over the variables they try to devise the policy for, the modelling approach is good for creating general insight about the situation and general learning. However, in the real life situations learning is not what many people are looking for, rather they seek to improve their immediate position (Spruill et al, 2001).

The argument concerning involvement of the important stakeholders is reinforced by Vennix (1996). He states that in order to be successful, modelling should involve those who can implement the decision (those who have a power to act) and those who influence acceptance of the results of modelling (informal leaders). An interesting perspective, relevant for the issue of the parties involved, can be found in Checkland & Scholes (1990). They differentiate between different roles in problem-solving: 'client', 'would-be problem solver' and 'problem owner'. It should be explicitly acknowledged, they argue, whether the party initiating the problem solving is also the one who will solve it, and moreover, it is important who owns the problem. In the first case all three roles were carried out by the farmers, which made the modelling possible and

beneficial. In the second case the modelling was initiated jointly by the Local Agenda 21 centre and myself, whereas the problem solvers were the discussion participants, but the problem owners were various stakeholders in the community. In the third case, the client was the head of the organic farming association, the problem solvers and problem owners were the parties involved in developing the programme. This discrepancy in the second and third case can take part of the blame for the failure of the interventions.

What would these findings imply for using the systems approach in Latvian rural development context? First of all, in order to use the tool effectively, it should address parties who have at least some control over the system being modelled. For example, issues concerning the development of a municipality should be modelled involving the local government and other influential stakeholders. Secondly, if the situation described above is not possible or there are many factors in the system that are not in direct control of the parties involved in the modelling, it would be an effective strategy to look for variables that one can influence. Richmond (2000) describes the benefit of such approach (p. 12): '..you can focus your time and energy on actions that you can actually initiate – which are the highest leverage actions there are!'

It is very important in Latvian rural context, where many people posses so-called 'learned helplessness' (Vennix, 1996). Attempts can be made to help people see what they can influence and act on these points. The same applies to local governments or organisations involved in the development of organic farming or any other sector, who often tend to blame central government or agricultural imports or any other factors perceived as fixed: they should look for solutions, not problems, and seek what they themselves can do to improve their situation. The question however, is how people can shift from this passive mode into more active. A perspective that might prove useful for answering this question can be found in Senge (1990), who addresses the issue of personal mastery and states (p. 172):

> No one can be forced to develop his or her personal mastery. It is guaranteed to backfire… [The leaders] can work relentlessly to foster a climate in which the principles of personal mastery are practiced in daily life. That means building an organisation where it is safe for people to create visions, where inquiry and commitment to the truth are the norm, and where challenging the status quo is expected – especially when the status quo includes obscuring aspects of current reality that people seek to avoid.

Clearly, creating such climate in the entire community will take a lot of time, and will require a number of 'change agents'. Summarising this section and considering the Latvian reality, from the point of view of problem ownership and commitment for solving the problem, the application of systems approach is likely to be more feasible on the level of individual farms and enterprises and to a lesser extent, different associations.

Resources devoted to the intervention

Another dimension in which the case differed substantially is the amount of resources devoted to the modelling intervention. According to Vennix (1996), the design of the interventions should vary depending how much resources can be devoted for a consultant (allowable project costs) and how much can be spent with the participants.

In the blueberry case, the analysis received full attention of the farmers and we consumed as much time as was needed to answer all the questions we had. Therefore the analysis was complete and the farmers felt they had explored the issue sufficiently.

In the community forum case, I had enough time to prepare myself for the community discussion and I spent several days analysing the results of the first community forum, categorising the ideas and composing the preliminary causal loop diagram. However, the time allotted for an actual discussion and modelling was only one and a half hour, and was clearly insufficient. We exceeded the time budget and yet did not carry out fully the activities planned. It was suggested by various participants that such activity could take entire day, and then it might have been more productive.

In the case with organic farming development programme, the resources devoted to intervention were even more limited. I managed to have some meetings with the head of the organic farming association, but their content was basically discussion of the modelling to happen and how to carry it out and involve people. In the end though, people were overly occupied with other activities and could not devote any time for the modelling exercise. Some results were achieved through conveying the insights of the preliminary modelling to the head of organic farming association. These could have been much better, had more time been spent for the modelling and discussion.

The evidence suggests that in order for a modelling intervention to take effect, whether in respect to general learning or improving the real world situation, sufficient time should be devoted to the intervention. Vennix (1996) states that the less experienced is the person facilitating the modelling, the more time should be spent on the project, preferably involving the preliminary model, as well as having several sessions for modelling itself. Despite having a preliminary model in the second and third case, it was not feasible to have the amount of time needed even for a single session. This poses a serious concern. The people who could use the systems approach most effectively, like decision makers, are often preoccupied with fire-fighting activities which makes it difficult for them to devote some time for the modelling that could improve their situation. If necessary resources are not available, Vennix (1996) recommends not to start the intervention at all or reduce the analysis to qualitative modelling only. One recommendation, with which Lane (1994) came up after having worked with busy management teams, is not to require too full commitment for the systems approach in the beginning of the intervention, rather make small steps that would produce early results, and let people see the benefits of the approach.

For Latvian rural development context, therefore, it can be derived that in cases where the resources for modelling are not immediately available, one should critically assess the needs of the stakeholders and illustrate visibly how application of the approach could satisfy these needs, illustrating rather quick practical results. However, it may run contrary to the idea brought up by many system thinkers (e.g. Richmond, 2000), that very often a problem will get worse before getting better, and long-term solutions might require short-term trade-offs.

Analysis tools

The initial ambition was to apply systems thinking tools that are most relevant for particular situations to find out what works best in Latvian rural conditions. The answer which tools are better in the context can be answered: it depends, in some cases computer modelling can be better, in some cases mental mapping and causal loop diagramming is appropriate. There are strong proponents of both quantitative methods (for example Sterman, 2000) and qualitative methods (for example Senge, 1990 or Checkland & Scholes, 1990). One of the objectives was to determine the extent to which different tools can be used. Considering that mostly qualitative tools were used in the research, conclusions about the use of quantitative tools are hypotheses only.

In the farmers' case the spreadsheet software to model the financial flows associated with the process of blueberry cultivation was used, therefore it was quantitative modelling. The model, however, did not contain feedbacks. In order to come up with limits to growth or constraints within the system, simple brainstorming was performed, so it was qualitative modelling. The computer modelling was very useful, and almost all needed information was available. Where information was lacking, assumptions were made.

In the community forum case, it was purely qualitative modelling with the help of causal loop diagrams. The tool itself was appropriate as enabled people to see the connections between particular factors, but the level at which it was used was too complicated: the modelling participants commented that the problem was too broad and instead a simpler, more practical system could have been considered. Just as in the argument above (section 'control over the system'), modelling in this particular context would have been more effective if it happened at the local administration level. In that case, computer modelling could be used to address certain problems in regional development and see what policies can be devised to cope with these

problems. In this case, however, a question of resources needed to do that kind of modelling would emerge, as well as the issue of data availability.

In the organic farming development case, the modelling was carried out with a CLD, and it proved to be effective, as made an opportunity to see the possible limitations in the programme. To see, however, whether particular quantitative targets, established by the programme (for example, the policy target for organic crop area), the computer modelling would have needed to be carried out. The same issue would emerge then, as with the municipality development model – how to allocate time for such activities, and how to get data necessary for the modelling.

The research shows that in many cases, qualitative modelling, through the use of mind maps or causal loop diagrams would be useful for analysing a range of problems related to Latvian rural development. It would give awareness of major interconnections and possible limitations within the system. On the other hand, it is quite time-efficient method, comparing to the computer (or quantitative modelling), so often it is a sufficient tool to use. The quantitative modelling can be carried out when there is both need and resources available to understand the behaviour of a particular system and see how can the system be changed.

Another dimension, which can help choosing qualitative or quantitative approach, is the trade-off between complexity and fullness of the model and people's ability to understand the behaviour of the model. Lane (1994) shows that complex models (which are often computer models) are in many cases less effective for producing an impact on real-world situation than simpler models, because it is more difficult to communicate the insights generated while modelling, and thus commitment for a devised policy or solution is impeded.

We find in Vennix et al. (1994) that choosing the approach is more often an art than a science, therefore the approach should be chosen based on experience and intuition. In this research, the models have been mostly qualitative because of the context, but also because I felt more confident about causal loop diagrams than computer simulation.

The model itself, be it a qualitative model like a causal loop diagram or a quantitative model like computer simulation, could be communicated in different ways. For example, in the community forum a 'living CLD' involving the participants was created. This approach proved to be quite effective in communicating the concept of interconnectedness and building good atmosphere in the group. In many computer simulations, 'flight simulators' are used (Bakken et al., 1994) that help visualise the behaviour of the model. More experiments on how the system models can be visualised, should be undertaken, to increase the effect of the insights gained through the use of models. Checkland and Scholes (1990, p. 45) emphasise that in modelling it is important to use visual information, like drawings and images, because 'human affairs reveal a rich moving pageant of relationships, and pictures are a better means for recording relationships and connections than is linear prose'.

In rural Latvia, many problems require overall understanding of dynamic complexity, therefore I consider that qualitative modelling tools will be more useful. With particular organisations or groups, quantitative modelling can be introduced, once general level of understanding about a problem is achieved. However, these situations are possible when an organisation or a group of people uses the systems approach not only once, but continuously, unless ample resources are devoted to one single intervention.

Facilitation

In all the cases considered in this thesis, the modelling approach was brought from outside, however it will be useful to examine effectiveness of the facilitation in each case, to draw some wider implications for the role of a consultant or a facilitator. The rationale for exploring this issue is because according to systems thinking and group model building literature (cf. Vennix, 1996; Andersen et al., 1997), professional facilitation is essential for the success of modelling exercises. Moreover, some literature (Lane, 1994; Spruill

et al., 2001) suggests that the role of consultant in modelling exercises may be of expert or facilitation character, depending on the situation.

In the first case the farmers were fully involved in the modelling, even though I performed the actual work with the spreadsheet. This approach was very effective, as the system was transparent for them from the beginning, it was constructed from their assumptions and ideas. All the insights were generated in the process of modelling, and they naturally got confidence about the system. The possible problem with this approach is that I alone challenged their assumptions, and therefore we may not have taken all the important factors into account. When we reflected upon this in the follow-up conversation, they told that even though all the important issues might not have been taken into account, they will see with time if any corrections should be made. In the language of learning loops, one has been completed, however it will depend on the farmers commitment if the next learning loops will be discovered. Given the situation, this approach was most effective, but the modelling could have been enhanced by some expert knowledge about agro-technical properties of blueberries, for example.

In the second case the approach was chosen to be that of a facilitator, not an expert. However, in order to prepare for the group session, I composed the preliminary CLD and quite naturally got attached to that, which was manifested in the way I facilitated the group session, even though the participants did not observe my bias. The facilitation approach proved to be quite effective, as it allowed expression of people's opinions. However, the model created did not contain all the important variables, according to some follow-up interviews (for example, the influence of municipal housing). Therefore, even though we have effectively used the knowledge present in the group it might not have been sufficient for the fullness of the model. Again, some kind of additional expertise could have been used.

In the third case, although the facilitation approach was intended, the modelling was carried out in an expert fashion, because the recipients of the modelling results did not have time to participate in the modelling. Consequently, there was a need to communicate the insights from the model I had created. If the expert approach had been envisaged from the beginning, it might have yielded better result, as I would have concentrated my effort on trying to understand the system fully and modelled in greater detail. The issue then would have been to communicate the insights generated. Ideally, the parties involved in the development of the program needed to be a part of the process, but it is again a question how to involve them. This approach would have been also more productive to generating a realistic model, as the model developed by one person (me in this case) might be deficient, which had strong evidence in this case.

Lane (1994) argues that the modelling is much more effective for learning and changing the reality if carried out in the facilitation fashion. In this case, he states, the insights are generated in the process and the commitment for the decisions taken is much easier to attain. A potential pitfall with facilitation is that the process and results achieved are not clearly visible, because they are owned and internalised. Expert approach is also useful, according to him, in the situations where so-called technical expertise is needed. Spruill et al. (2001), referring to community development, suggested that the expert approach can be preferred to facilitation approach if there is a shortage of time and a need for fast action. My research has shown that facilitation is clearly advantageous, however expert knowledge could prove useful in the situations where the knowledge within the group is not sufficient for modelling. The expert knowledge should be integrated with the group's knowledge and internalised in the process of modelling.

The correct 'mix' of expert and facilitation approaches needs to be selected for each particular case, with a purpose to assure quality in modelling. If the group possesses enough knowledge about the situation, then professional facilitation is sufficient, however expert knowledge may be used if the situation is different. The facilitation approach is more time consuming, but it provides results that are more likely to be implemented.

Regardless of the choice in favour of expert or facilitation approach, professionalism of the consultant or group modelling facilitator is crucial. The person will affect the method chosen to steer the discussion and will influence what information will be selected, to mention just two possible ways why this is important.

(Vennix, 1996) In the cases considered in the research, the results might have been favourable or not because of the way I designed and managed the process. For example, in the first case I clearly won trust of the farmers, whereas in the second case I was perceived simply as a student with an alternative viewpoint. Moreover, due to lack of knowledge and experience, in the modelling exercises I did not make explicit use of the delay concept, which is very crucial to understanding the behaviour of complex systems (Sterman, 2000). Even if this particular issue was irrelevant, as we didn't analyse dynamics of the systems with quantitative models, it indicates that I might have committed other omissions or mistakes, which I am not aware of and which led to the result as it was. Alternatively, the second case indicates that I was defensive about the preliminary model I developed and that was an obstacle in facilitating the discussion within the community forum. In the third case, the CLDs developed contained little number of balancing feedbacks, a mistake commonly committed by inexperienced modellers (Senge, 1990). To use a metaphor, if somebody is a bad musician, we shouldn't blame a composer whose symphony the one is playing. Or in other words, the success of the intervention depends not only on the problem itself and the context, but also on the expertise and the position of the facilitator. Lane (1994) supports this point by stating that perceived expertise of the facilitator is very important for establishing trust. Vennix (1996) states that a good facilitator needs to have attitudes of helping, authenticity and integrity, inquiry and neutrality. Moreover, such skills are emphasised as group process structuring, conflict handling, communication, concentration, intervention, as well as skills to build consensus and commitment and to handle different types of cognitive tasks. Clearly, I did not have many of these skills during the research, which was a limiting factor. Indeed, from this list of virtues it can be inferred that it will take much training and practice, or a gift, to develop these skills.

How to promote the systems thinking for rural development in Latvia – and should we do it?

Application of the systems thinking is a systems challenge in itself. In order to gain benefit from the approach, it should be applied. But it will be applied only when there is evidence that its application is beneficial. In the worlds of management and policy-making, people are overwhelmed by fire-fighting and it is very difficult to get their attention and time. However, this attention and time are imperative to reflect on their problems through a holistic prism. Hence another vicious circle. Moreover, bad publicity of different management fads makes it difficult to promote any idea, and even more so the idea of systems thinking. How do we overcome these barriers? There should be some leverage points in the system.

To start with, realistically the systems approach cannot solve all the problems. Even if it is relevant in some case, it does not mean that the application of it will be successful. Therefore we need to consider the context, is the approach relevant, is the time available, are results likely to be implemented? Moreover, political and cultural issues should be taken into account. Spruill et al. (2001) warn that the power structures need to be taken into account, moreover, sometimes powerful parties can take advantage of systems thinking tools at the detriment of the community. In the words of Checkland and Scholes (1990), the changes sought through the application of systems approach should be 'systemically desirable and culturally feasible'.

For a particular case, especially in Latvian rural development context, general tools should be applied first. Causal loop diagram or a system map will be sufficient in many cases. In some cases, the deep understanding about the relation and behaviour of the system will be required, and then the computer modelling may be useful. However, given the lack of IT competence in rural areas, the computer modelling may need to be carried out in an expert fashion.

Tools of systems thinking are not the only tools to use for decision support, it is just, in Spruill et al. (2001) words, 'another way of slicing the orange'. This approach should be compared with other analytical tools, like SWOT analysis, decision tree analysis, cost/benefit analysis, fish bone diagrams, etc. Combining the power of these tools to take minute detail into account; holistic view of the systems thinking tools, and the promise of participatory decision making, the decisions are likely to become more qualitative.

Finally it is the issue of implementing the insights developed using the systems approach model that is a challenge. This thesis touches upon it very marginally, and it should be the topic for further research.

Conclusions

The applicability of systems thinking for supporting decision making was analysed in Latvian rural context. The study was based on action research in three cases, therefore contributed greatly to my experience, produced tangible practical results, as well as provided grounds for deriving some general insights.

The cases where systems approach was attempted produced controversial results. These results indicate that the application of systems thinking tools may be considered relevant and beneficial, although multiple factors need to be taken into account that can contribute to a success or failure of interventions.

Systems thinking tools, especially when coupled with participatory discussion, can produce considerable results for rural development, where many problems are complex both because of the problem itself and the number of parties involved in a situation. The approach is most suitable for the problems of dynamic complexity, where the problem in question involves feedbacks. Interventions can produce greater understanding of the problems resulting in improved policies, as well as greater involvement and shared vision for a larger community, or stakeholders of some problem.

In case the approach is relevant for a particular situation, there should be perceived need for joint problem solving between the parties involved. It will contribute both to quality of the modelling process, as well as ensure that the policies developed have a better chance to be implemented. The question is whether existing power structures will allow for such transparent and shared approach. In order for interventions to be successful, parties involved should have many variables in the model under their control, or in cases when it is not feasible, try to establish what factors can be influenced.

Ample resources should be devoted in order for an intervention to succeed. However, the question remains how to attain these resources, given that decision makers potentially benefiting from the approach are very busy, permanently lack time, and have limited attention span. A proper mix of qualitative tools (for example causal loop diagrams) and quantitative tools (computer modelling) should be selected. Often qualitative tools are sufficient for creating understanding about a problem and sharing this understanding. Quantitative tools can provide even better insights, but can be problematic in Latvian rural setting, given the lack of technical infrastructure and computer literacy.

Although the facilitation approach is preferred to the expert approach, sometimes expert knowledge should be used to provide information for the model. In this case, attempts need to be made for modelling participants to internalise this expert knowledge. In both approaches, competence of a person facilitating the process of modelling is critical, both for application of relevant tools and building trust for the process and derived solutions.

Considering that in rural Latvia there's an urge for practical solutions and addressing issues in short term, the tools need to concentrate on particular problems and produce immediate tangible results. However, there will be a conflict between general long-term orientation of the systems approach and short-term nature of thinking and decision making in rural Latvia. Therefore, fire-fighting needs to be carried out, while simultaneously thinking about the reasons why it occurred and taking a systemic perspective on the problem, to avoid similar situations in the future.

As this was an exploratory research, more studies are needed to support or reject its findings. Further research should be undertaken about combination of systems thinking tools with other decision support methods, to suit a particular problem best. Besides, implementation success of devised policies is an issue, to be followed upon.

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Personal communication

Tropiņš, Ivars: farmer at Jumari
Tropiņa, Gunita: farmer at Jumari
Kreišmane, Dzidra: the head of Latvian Association of Organic Farming Organisations

Appendices

Appendix 1. Interview questions for receiving feedback on modelling

Interview questions for feedback in the Jumari case (blueberries)

1. What, in your opinion, is the essence of the approach that we took while analysing the feasibility of growing blueberries?
2. What would have your actions be if we had not had this exercise?
3. What will your actions be after the analysis?
4. Will your actions be consistent with the conclusions of the analysis?
5. How has analysis changed your perception of things?
6. What are the main things you learned and the benefits you derived?
7. Was the facilitation relevant (prejudiced, objective, etc.)?
8. What are the deficiencies of analysis, in your opinion?
9. What factors we have not taken into account?
10. How will you use this approach in future (can you do it yourself)?
11. Other comments?

Interview questions for feedback in the community forum case

1. What, in your opinion, is the essence of the approach that we took while having the 'modelling' activity?
2. How relevant was this activity for the community forum?
3. How this activity influenced the process of discussing community initiatives (compare with or without the activity)?
4. How this activity influenced the result of the forum (compare with or without the activity)?
5. What are the main things you learned and the benefits you derived?
6. Was the form of the modelling (game) relevant?
7. Was the facilitation relevant (prejudiced, objective, etc.)?
8. How has analysis changed your perception of things?
9. How will you use this approach in future (can you do it yourself)?
10. Other comments?

Appendix 2. Feedback questionnaire for the Community Forum

Thank you for participating in the round table forum!

The purpose of the first part of the questionnaire is to find out your satisfaction with today's event, as well as to find out your opinion about what we can improve in our work.

The second part of the questionnaire concerns the research undertaken by a Lund University student Jurijs Kondratenko about the application of systems approach for rural development in Latvia. Your responses will be used for the Master's thesis.

I. Questions about the Round Table Forum

1) Please indicate, **how you are satisfied overall** with today's Round Table Forum, on a scale from 1 t o10 (1 – completely unsatisfied, 10 – satisfied to the largest extent)?

Completely unsatisfied	1 2 3 4 5 6 7 8 9 10	Satisfied to the largest extent

2) In your opinion, **what can we improve**, while organising coming round table forums (in any context)?

II. Questions concerning presentation and discussion lead by Jurijs Kondratenko

1) Please indicate, how offered perspective (systems approach) seems **useful to you personally**, on a scale from 1 to 10 (1 – not useful lat all, 10 – useful to the largest extent)?

Not useful at all	1 2 3 4 5 6 7 8 9 10	Useful to the largest extent

2) How **can you personally use** the offered approach?

3) Please indicate, to what extent the offered approach has **improved your understanding about the development in Dundaga municipality**, on a scale from no 1 to 10 (1 – has not improved at all, 10 – improved to the largest extent)?

Has not improved	1 2 3 4 5 6 7 8 9 10	Improved to the largest extent

4) Has the proposed approach **influenced your perception** about things? Please, indicate in what way!

5) Please indicate to what extent, in your opinion, the approach and the discussion influenced the **results of the Round Table Forum**, on the scale from 1 to 10 (1 – Has not influenced at all, 10 – influenced to the largest extent)?

Has not influenced at all	1 2 3 4 5 6 7 8 9 10	Influenced to the largest extent

6) **In what way** the proposed approach influenced the results of the Forum?

Thank you very much for cooperation!

Appendix 3. The spreadsheet used to calculate different scenarios for blueberry cultivation

Cash flow calculation							
ha:	1		berry market price, Ls per kg		0,75		
Annual interest rate on the loan	10%						
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**
Expenses							
Pond digging	2000						
Field maintenance	67						
Fencing	430						
Sprout purchasing	2640						
Watering device	1000						
Fertiliser		20	20	20	20	20	20
Electricity for watering	48	48	48	48	48	48	48
Disease and pest management		30	30	30	30	30	30
Cooling device				1000			
Salaries for seasonal workers			20	200	850	1000	1000
Unforeseen expenses (10%)	618	10	12	130	95	110	110
Insurance premium	12	16	16	14	17	20	0
Loan interest	1000	1000	563	563	421	0	0
Total expenses	7815	1123	709	2004	1480	1227	1207
Revenues							
Subsidies		1500					
Sale of berries/insurance	0	0	113	1125	4500	6000	6000
Revenues, total	0	1500	113	1125	4500	6000	6000
Revenues - expenses	**-7815**	**377**	**-596**	**-879**	**3020**	**4773**	**4793**
Accumulated profit/loss	**-7815**	**-7438**	**-8034**	**-8913**	**-5893**	**-1120**	**3672**
Yield scenario, kg							
Optimistic			200	2000	8500	10000	10000
Realistic			150	1500	6000	8000	8000
Pessimistic			100	1000	4000	6000	6000
Financial data							
Insurance compensation	0	800	1300	1800	2300	2800	3300
Loan in the beginning of the year	10000	10000	5632	5632	4207	0	0
Loan repayment	0	4369	0	1425	4207	0	0
Loan in the end of the year	10000	5632	5632	4207	0	0	0
SAPARD		3069		500			

Calculation data	
1ha	
Bushes	3300
Sprout price	0,8 Ls
Sprout total cost	2640
Fence	430 Ls
Pond digging, volume	5000 m3
Digging cost, m3	0,4 Ls
Pond digging expenses	2000 Ls
Watering device	1000 Ls
Fuel, l	50 l
Fuel price	0,34 Ls
Fuel expenses	17 Ls
Herbicide	5 l
Roundup	10 Ls
Herbicide cost	50 Ls
Fertiliser	20 Ls
Water consumption per plant, l/day	8 l
Water consumption per ha, m3/y	5544 m3
Pump volume	0,33 Kwh
Pump throughput	1,5 m3/hour
Electricity consumption	1219,68 Kwh
Electricity cost	47,56752 Ls
Biocides	30 Ls
Cooling device (truck)	1000 Ls

Appendix 4. Categorisation of the ideas of the community round table forum

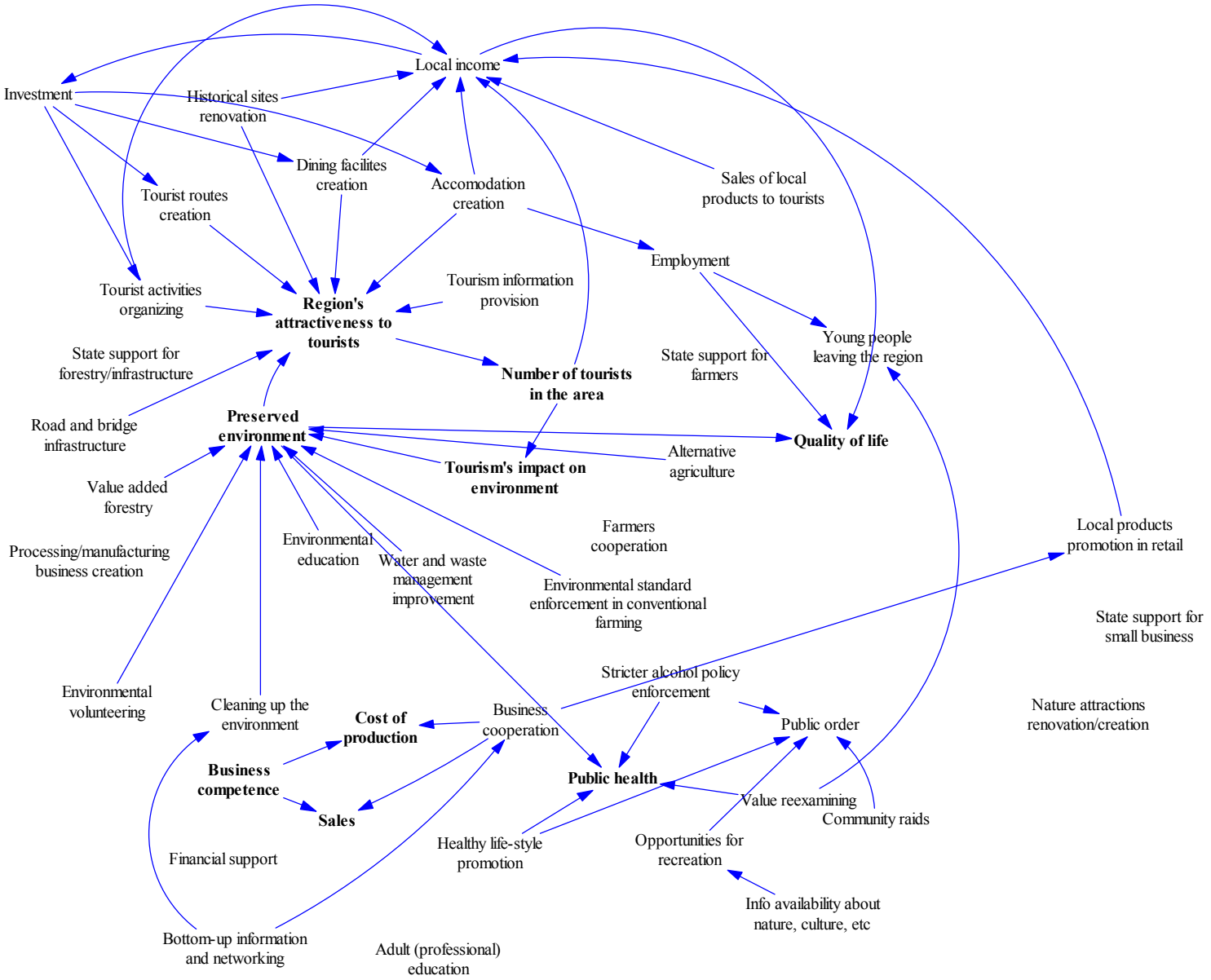
Initial ideas (in their original wording) are kept in regular text. Bold text denotes general categories, and bold-italic text denotes narrow categories.

Tourism
Historical objects (fixed)
Renovation of underground passages of Dundaga castle
Fix nature sites available for tourists
Tourism routes
Design of bike route around WW2 memorial sites connected to holocaust and prisoners of war
Develop tourism routes (nature trails, wild animal and bird watching, infrastructure, bike routes and bike rent)
Accommodation creation
Fund for developing bed & breakfast houses
Attract tourists, create hotels, as a result new jobs and market for agricultural produce
Dining facilities
Arranging infrastructure for the development of eco-tourism (dining facilities, traditional local food)
Tourism information
Information desks at particular sites
Provision of tourist information outside Dundaga Tourism Information Centre
Tourism activities
Fishing and active sports
Sales of products to tourists
Try finding a solution for purchasing of smoked fish in fishermen villages
Cooperation of tourism entrepreneurs with applied arts school (souvenirs)
Other
Develop Northern Kurzeme as a role model for Latvian eco-tourism
Greater state support to tourism
Forestry and timber industry
State support and infrastructure
State has to perform actions to ensure that small forestry enterprises are ensured at least 30-35% of total forest area
Integrate information about tree cutting quotas with state revenue service database in order to promote tax collection
Value added production
Create production facilities for furniture etc., not to send away produce with low added value
Agriculture
Growing alternative, innovative produce
Growing of different therapeutic plants for teas etc.
Organic farming
Cooperation
Cooperation in sales and processing of produce
Cleaning of garden cooperative “Ievlejas” surroundings, road renovation
State support
State support for farmers in land utilisation
Environmental standard enforcement
Limiting of intensive agriculture in certain territories in order to preserve pristine and clean

environment
Business
Processing/manufacturing business creation
Creating workshop for processing last year's grass
Develop business, create new jobs
Creation of new, non-traditional industries, for example sewing of military coats
Rejuvenation of remote villages
Cooperation
Entrepreneur cooperation
Promotion of buying local products
Support of local farmers and fishermen through buying their produce
State support for small business
How big is a small company (there's a charter for small and medium companies), if population density is smaller than 3,8 persons per square kilometre
Change tax policy for small businesses (from 25% to 10% - 15% income tax)
Other
Decrease social differences
Family with 2 and more children
Environment conducive for staying of young people
Infrastructure (roads and bridges)
Maintenance of roadsides
High quality roads (all main roads should be covered with asphalt)
Fixing of bridges
Nature, cultural environment
Environmental education
Promotion of biodiversity with an objective to understand and value this heritage
Nature attractions renovation/creation
Fund for cleaning up and maintenance of Pace river (involving landlords), fixing of trails and springs
Cleaning up of Dundaga park and its surroundings (fountain and its whereabouts, toilets, sports field, stage, lamps, benches), (Janele about estate parks)
Fixing of Pāce road sides (arranging of apple trees)
Watch towers erection in Zilo kalnu precipice bluff
Development of Vīdale spring
Volunteering
Involvement of people into cleaning up the environment, create volunteers organisation for taking care about the environment
Environment cleaning up
Involving pond holders association into Dundaga pond cleaning up (in April special species of grass carp will be introduced to Latvia)
Environment infrastructure (solid and liquid waste, water)
Waste separation
Quality drinking water
Information about waste collection and handling
Manure and sludge collection, processing and use in agriculture
Arranging of alternative sewage treatment technologies in small villages

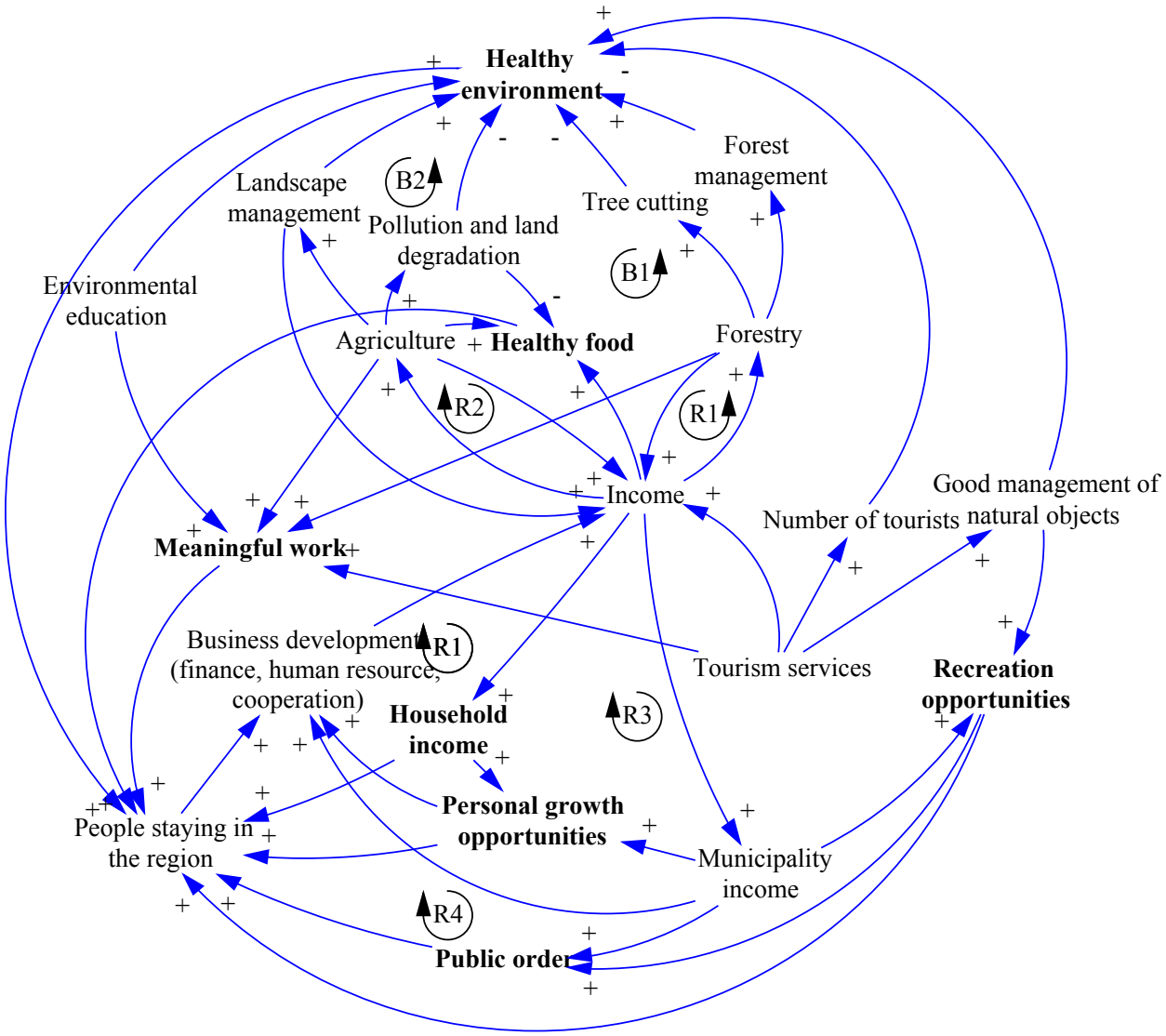
Public order
Stricter alcohol policy enforcement
Shutting down of illegal alcohol retail sites
Reinforce prohibition to sell tobacco and alcohol to young people
Community raids
Late night raids in Dundaga
Healthy life-style promotion
Promotion of healthy lifestyle, parents' patrol, participation in creating study programs
Other
Decreasing crime
Information, communication
Top-down information (info availability about nature, culture, etc)
Informing people about their rights and opportunities (in Dundadznieks newspaper)
Create information bulletins about issues and problems for informing public
Bottom-up information and networking
Multilateral communication
Education
Educating people about cultural opportunities
Adult (professional) education
Adult education, continuing education opportunities
Planning
Small scale construction
Culture, spiritual values
Value re-examining
Necessary to understand: do we want 'wishes' or 'needs'
Motivation of youth to stay (local patriotism)
Not limiting spiritual values from community life
Free time opportunities
Greening and renovation of Dundaga people's house
Creating cinema in Dundaga
Youth free time in Dundaga
It is important to get Ernesta Ābola brass band to Dundaga. Jautrite and other graduates are saying this

Appendix 5. A sketch of the causal loop diagram prepared during the preliminary model building for Dundaga community forum



The CLD sketch demonstrates that using too many factors in modelling makes the model difficult to understand. Thus, the model needed to be simplified.

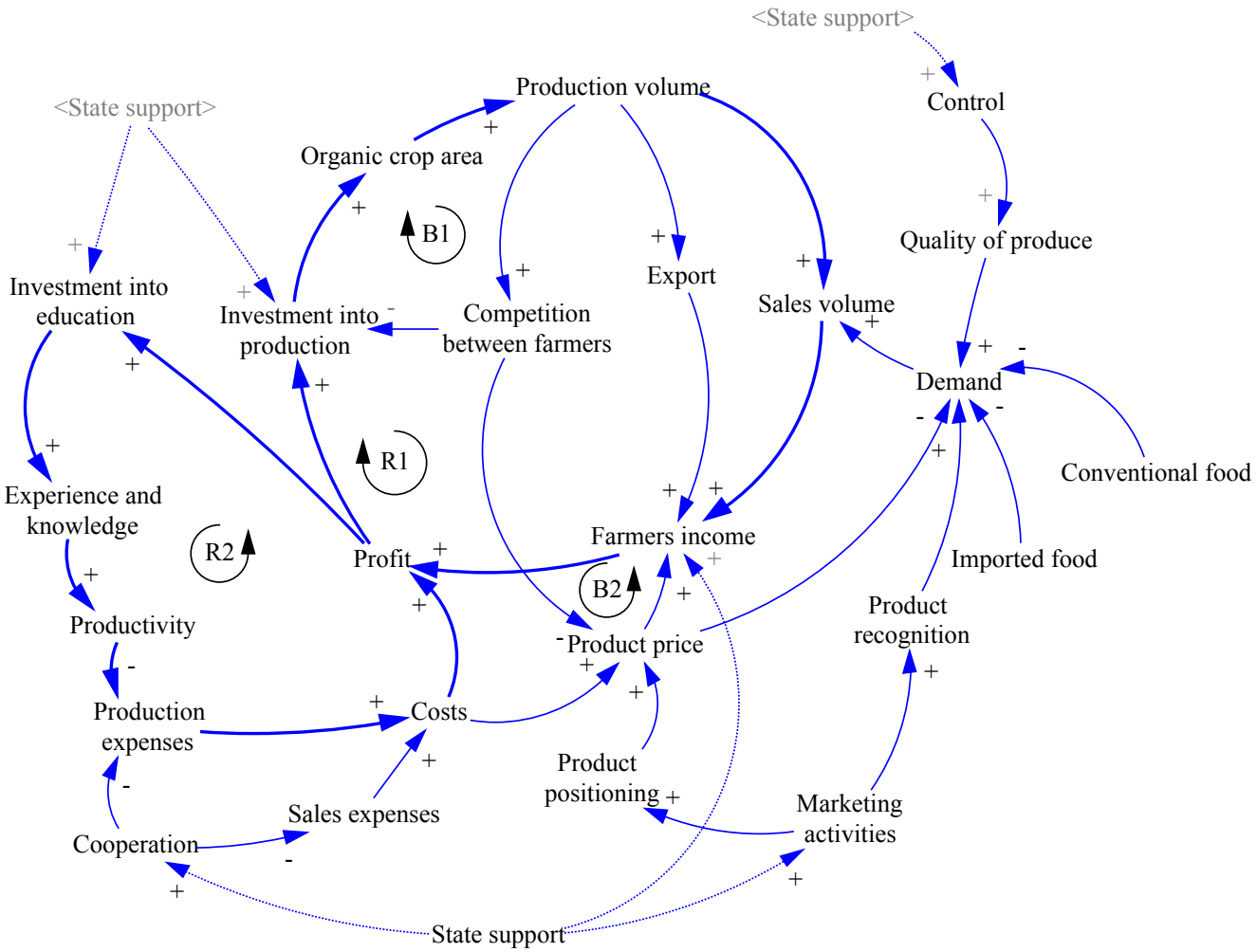
Appendix 6. The causal loop diagram representing a preliminary model of the development in Dundaga municipality to be used for the community forum



Several reinforcing and balancing feedback loops are shown on the map, forming, accordingly, 'engines for growth' or 'limits to growth'. Although there are more feedback loops, five loops are described below, to provide examples.

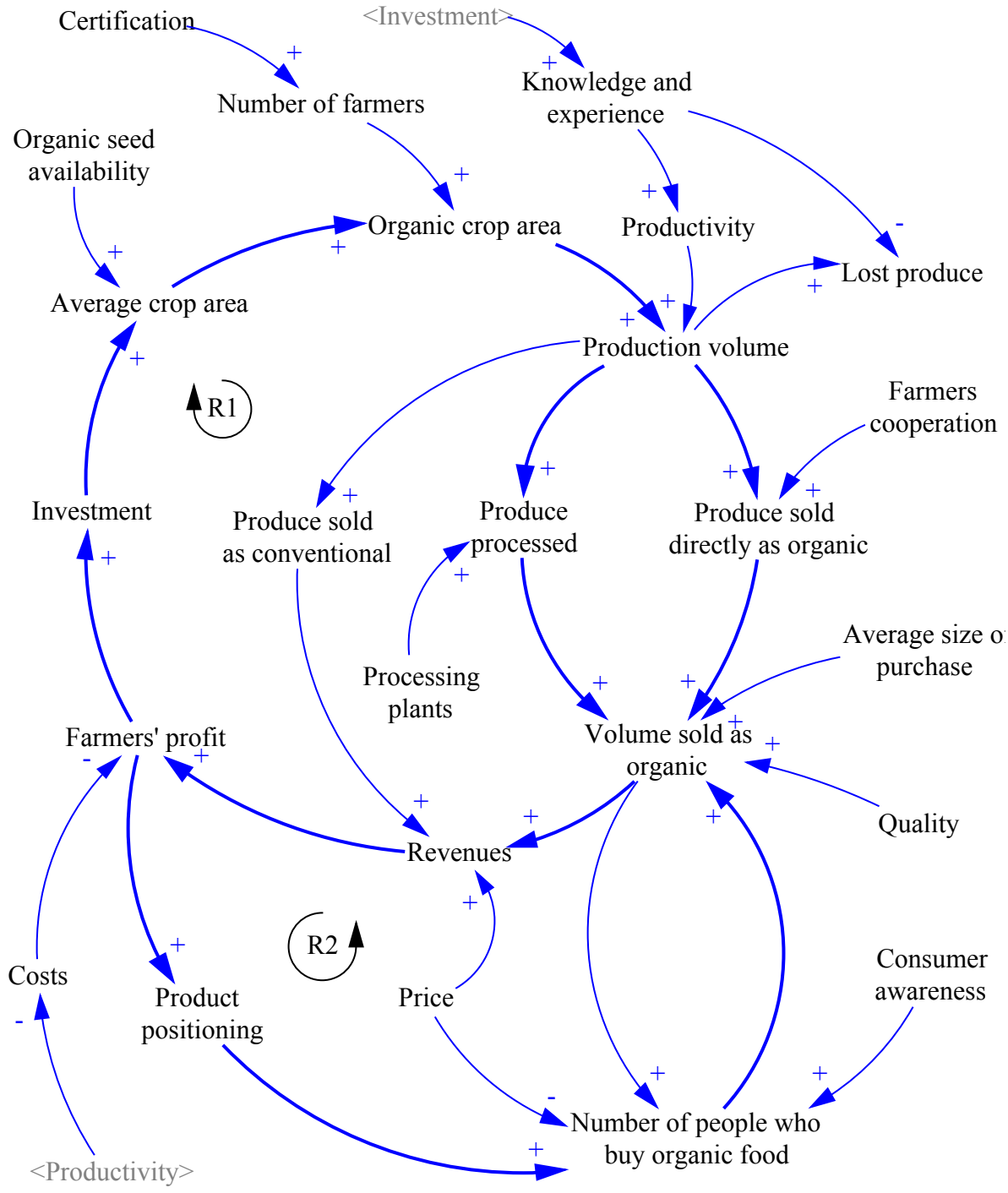
R1: forestry activities bring income, which can further be invested into expanding the activities,
R2: agriculture brings income, that can be reinvested to produce more;
R3: part of private income is transferred to the municipality, via taxes, and can further be invested into business development, that will bring more income;
R4: part of the municipality income is spent on safety in the neighbourhood and the public order is provided, making people stay in the region; people staying in the region participate in businesses and thus generate income for municipality;
B1: Forestry results in tree cutting that reduces quality of the environment, making the region less attractive to for people to stay; consequently, there are less resources for business development and thus the forestry is reduced;
B2: Similar effect to B2, but with agriculture and resulting pollution and land degradation that reduces quality of life.

Appendix 7. Preliminary causal loop diagram for the organic farming development, designed for discussing the industry development programme



The CLD demonstrates interconnectedness of various factors in the development organic farming and possible impact of state intervention. Several reinforcing and balancing feedback loops are identifiable, for example:
R1: With increase in production, farmers income increases through increased sales, thus increasing profit and allowing for investment into new production, which consequently increases the production volume.
R2: Higher experience and knowledge will evoke higher productivity and lower costs, which will result in higher profits. Some share of profits can be invested into education, increasing the knowledge and experience.
B1: Increased production volume will increase competition between farmers, who will invest less in new production, thus decreasing the growth of production volume or even a drop in production.
B2: Increased production volume will decrease prices, through increased competition, thus reducing farmers income and profits, decreasing the potential for further investment into the expansion of production.

Appendix 8. Causal loop diagram used for analysing the feasibility of the organic farming development programme



The CLD demonstrates interconnectedness of different focus areas of the organic programme development programme. The main feedback loops are the following:
R1: With increase in production, farmers income increases if the production is sold or processed, thus increasing profit and allowing for investment into new production, which consequently increases the production volume.
R2: With increased sales of organically certified food, increasing farmer revenue and profit makes it possible to invest into the product positioning, which increases the number of people buying organic food, which increases the organic sales.