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Artikel: A System Dynamics approach for the investigation of peripheral and agrarian communities

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A System Dynamics approach for the investigation of peripheral and agrarian communities[1]

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In this paper an alternative approach for the analysis of rural development in peripheral and agrarian communities in the Swiss Alps is developed. It is based on System Dynamics, a qualitative and quantitative methodology on the structure and behaviour of complex systems. In the qualitative part, system elements and their interconnections are identified and a descriptive network-type model of the strategically relevant issues faced by peripheral and agrarian communities is developed. In the quantitative part, a dynamic simulation model is built as a decision support tool for the evaluation of different policy measures. Preliminary results from the application of the methodology to the Muenstertal confirm the need for this holistic view of the processes affecting rural development. However, they also emphasise the need of a sound theoretical background and of the integration of other methodical approaches. Model simulations for the case study region strongly emphasise that sectoral policies are not sufficient for an integrated rural development. Policies have to be elaborated and implemented simultaneously and on an interdisciplinary basis. It is especially important to pay attention to the aspects of social changes and change of lifestyles as they showed a far reaching impact on system behaviour.

Keywords: rural development, decentralised settlement, regional policy, System Dynamics, simulation model

1. Introduction

In the process of the ongoing economic structural change as well as of social and political changes rural Switzerland faces a differentiation in

[1]This paper was presented in a similar form at the Regional Studies Association International Conference, April, 12-15, 2003, Pisa, Italy. See www.regional-studies-assoc.ac.uk /events/pisa03/kopainsky.pdf

economic, social and ecological conditions. Those locations confronted with a lagging or unfavourable development see their viability become at risk. Population decline and a narrowing economic base not only affect future development perspectives and a decentralised settlement of the country; they also put under threat the fulfilment of the functions rural areas have.

Traditionally, rural areas served the purpose of providing cities with food. Agriculture is however losing its predominant position in rural employment and settlement. On the other hand there is a growing demand for non-commodity uses of rural lands such as recreation for an increasingly mobile and leisure-oriented urban population and ecological compensation as a reaction to growing environmental problems (MÜHLINGHAUS 2002). Beside these functions that mainly satisfy the needs of external actors, rural areas serve the internal purpose of providing living space and space for economic activities for the rural population (HENKEL 1999).

Following the interests of these different groups in society, five main functions of rural areas can be distinguished: 1) housing and sociocultural activities; 2) economic development; 3) agricultural production; 4) ecological compensation; 5) recreation and leisure[2]. From an economic point of view the goods and services specifying the last two functions are mainly external effects as they are a by-product of agricultural production and other activities within the first and second function. As function fulfilment is closely linked to economic and social activities, the conclusion can be drawn that lasting fulfilment depends on the existence of viable communities.

The assignment of weights to the different functions is a fundamentally political process. The role of the academic researcher is to provide thorough bases of decision-making given the fact that public support for rural development concerns the allocation of scarce resources. With the re-orientation of Swiss regional policy this task has gained in importance as the focus of regional policy has shifted from distributive and infrastructure-oriented top down measures to efficient allocation of resources and cross-sectoral policies. More emphasis is now laid on competitiveness of rural localities, local initiatives and bottom up approaches (EXPERTENKOMMISSION "ÜBERPRÜFUNG UND NEUKONZEPTION DER REGIONALPOLITIK" 2003). As a consequence, the nature of policy measures has

[2]The functions are analysed in more detail in the paper presented at the conference, see www.regional-studies-assoc.ac.uk/events/pisa03/kopainsky.pdf

changed from heavy sectoral subsidies to a claim for truly effective and efficient investments. Decision-makers, therefore, face an increasing need for policy concepts based on an integrated view of the processes affecting rural development. In addition, local and regional actors are confronted with a marked increase in responsibility and the need to define, initiate and implement development processes. Hence, decision-support tools are required both for evaluating the effectiveness and efficiency of the new regional policy paradigm and for estimating the economic, social and ecological impacts and trade-offs of specific development projects.

A series of studies on the local, regional and national level in Switzerland provide information about the structure and development perspectives of different economic sectors (BUCHLI 2002, FLURY 2002, THIERSTEIN and ABEGG 2000), evidence on the general potentials and limitations of regional policy measures (STALDER 2001) and knowledge about their effects in selected case study locations (KÜPFER 2000, MÜHLINGHAUS 2002, SCHMID 2002). Insofar, no approach enabling an integrated and comparable view of economic, social and ecological development perspectives of policy measures and private initiatives has been elaborated for the local level, however. It is therefore necessary to integrate the existing knowledge into a synthesis allowing ex-ante evaluation of rural development initiatives and providing decision support for effective and efficient investment in economic as well as in social terms.

Such an approach is developed and tested in the research project described in this paper. It integrates existing knowledge and new research findings with the aim a) of tracing the processes that influence population development and the fulfilment of the functions; and b) of identifying the interrelations and feedbacks between the processes. The approach is preliminarily applied to the Muenstertal (see also BUCHLI ET AL. in this issue). Finally, several conclusions are drawn relating both to preliminary results and the agenda for future research.

2. Methodological approach

For our study, population structure and development at the community level stand at the centre of the analysis. With community we denote the smallest administrative unit in a nation state and at the same time the smallest unit with national census data available. For a discussion about

the value and definition of community we refer to the literature (compiled e.g. in REIMER 2002).

In this section we describe the methodological approach used for capturing the processes underlying population and function development and their influencing factors in Swiss mountain communities. The fulfilment of the functions is not only a question of population size and population structure. The different functions are also linked with each other forming a complex system of connections, feedback loops, and processes happening at different velocities. This becomes especially obvious with agricultural production, recreation and leisure, and ecological compensation where landscape related public goods, ecosystem functions, and biodiversity are provided as positive external effects of agricultural production.

Function fulfilment has been analysed by a broad range of studies using a variety of quantitative and qualitative methodical approaches (for an overview of the quantitative approaches see ISARD ET AL. 1998). As these approaches show either a sectoral or a disciplinary focus, it seemed useful for our purposes to perform any further research steps on the basis of a systems approach as it best takes into consideration the characteristics of a complex system.

2.1 Rationale of the approach

Systems approaches are based on systems theory. Systems theory builds on the fact that systems follow the same principles even though they are completely different as real systems. Systems theory therefore tries to develop general rules that describe the behaviour of systems as a function of its components and structural connections (BOSSEL 1992).

The challenge of how to move from generalisations about systems thinking to tools that help to understand complexity, design better policies, and guide change in systems can be met by System Dynamics. System Dynamics as an example of a systems approach is a method to enhance learning in complex systems (STERMAN 2000). According to COYLE "System Dynamics deals with the time-dependent behaviour of managed systems with the aim of describing the system and understanding, through qualitative and quantitative models, how information feedback governs its behaviour, and designing robust information feedback structures and control policies through simulation and optimisation" (COYLE 1996, p. 10).

System Dynamics has proved to be particularly useful for analysing why social, economic, ecological and other management systems sometimes behave in ways which are contrary to intuition and to the goals followed with management decisions (COYLE 1996). This purpose is achieved through adopting a feedback viewpoint as shown in Figure 1. The figure can be understood by following the loops. This shows that decisions (action) alter the state of the environment (information), leading to new decisions (consequences). The decisions not only alter the environment, they also trigger side effects, delayed reactions, changes in goals and interventions by others. These feedbacks may lead to unanticipated results and ineffective policies.

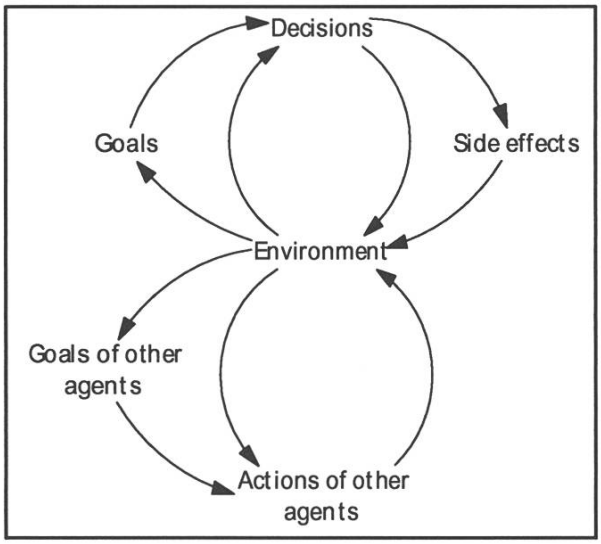

Figure 1: The information/action/consequences paradigm of System Dynamics

Source: Adapted from STERMAN 2000, p. 11

Much of the strength of System Dynamics comes from its ability to be used in two ways. On the one hand, it can be used qualitatively to portray the workings of a system in a diagram as an aid to thinking and understanding. On the other hand, the diagram can be translated into a simulation model for quantitative simulation and optimisation to support policy design (COYLE 1996).

The *qualitative part* of System Dynamics consists in conceptualising the system. For the purpose of this paper, the analysed system was a rural community with its population size and structure at the centre and their relevant influencing factors. Conceptualising the system is accomplished in a visual way, drawing a diagram with all the relevant system

variables and their respective relations. Information about the variables and their relations can be drawn from several sources among which the most important are theory, literature and expert knowledge.

In the *quantitative part* of System Dynamics the relationships identified in the qualitative part have to be quantified and converted into mathematical equations. Model structure and model behaviour are subsequently tested. The primary goal of model testing is to increase understanding of model behaviour. Another important question at this stage relates to the adequacy of the model, i.e. how accurately the model represents the system under study. System Dynamics software packages support a series of tests evaluating model structure and behaviour. Nevertheless, validation is not only a technical step but refers also to the process of building confidence in the soundness and usefulness of a model, both from the point of view of the researcher and the target group (VENNIX 1996). Expert knowledge plays an important role in the quantitative part of System Dynamics, too. It is necessary both for the quantification of relations and for the validation of model structure and model behaviour.

The primary purpose of System Dynamics is to build a model of a system with which one can conduct experiments for the purpose of: 1) a better understanding of the system's structure and behaviour and 2) designing robust policies to alleviate problems in the system (VENNIX 1996). The notion of robustness is a very important one as dynamic models are especially suited for the analysis of system stability (PFISTERER-POLLHAMMER and KNOFLACHER 1998). Policies are tested with the focus of improving system performance. Policy analyses focus on changes of decision points in the model and their effects on certain outcome variables.

The value of the System Dynamics approach to our project goals therefore lies in the analysis of system behaviour over time and the analysis of system stability. That way, leverage points can be identified. These points are important in two respects: 1) they are the points that policy makers have to pay attention to in order to maintain system stability and 2) they are the starting points for truly effective and efficient policy measures.

The consequences for the application of the System Dynamics approach to the issues analysed in this paper concern the level of analysis and are twofold:

We applied the System Dynamics approach to the perspectives and challenges faced by Swiss mountain communities with population related development problems. In Switzerland, these are peripheral and agrarian communities (ANDERHALDEN ET AL. 2001; see BUCHLI ET AL. in this issue). Other communities have their own problems with the fulfilment of some of the functions described in section 1. For the purpose of an unambiguous identification of a model purpose, however, we restricted our investigations to communities characterised by or threatened with population decline.

The influence diagram developed in the stage of system conceptualisation is valid for all peripheral and agrarian communities in Switzerland. The quantitative steps, however, can only be performed in selected case study communities. This is because parameter values and weights are highly dependent on the locally specific social, economic and ecological situation. In order to enable comparison of the results from case study research, a systematic framework is needed to identify and understand the extent and nature of community and regional differentiation (REIMER 2002). ANDERHALDEN ET AL. (2001) have developed such a framework with their typology of Swiss mountain communities drawn from cluster analysis of their demographic, social and economic structures. The implications of the work in case study communities can therefore be reasonably generalised in the sense that the findings from the case study can be cautiously transferred to all the communities belonging to the same cluster type.

2.2 Model structure and system conceptualisation

In this step a general description of the development issues faced by mountain communities is accomplished. At the centre of these issues lie population development and its multifaceted and interrelated influence factors.

Model structure was derived from demographic development and the concept of the Maslow pyramid. Population has a variety of needs ranging from basic needs to self-realisation. These needs are often depicted in the Maslow pyramid (see MASLOW 1970). The Maslow pyramid is based on the assumption that there is a hierarchy of needs and that needs from a higher level can only be addressed if the underlying needs are met to a satisfying degree. Five levels of needs are distinguished, ranging from 1) basic needs to 2) security, 3) contact, 4) recognition and acceptance to 5) self-realisation. The last two levels are especially diffi-

cult to operationalise. We thus had to assume that these levels are influenced positively by a favourable development of the lower levels, above all the contact level.

The model structure is shown in Figure 2. The figure is supposed to give an overview of the situation without being blurred by too many details. For clearness reasons the multifaceted relations between the left and the right hand side of the figure are therefore not shown in every detail but summarised in two main topics (population categories, migration/staying). For the same reason auxiliary variables are mainly omitted in the figure.

The left hand side of the figure represents the demographic model containing three population cohorts, starting from young to active to retired population. Population cohorts are shown in System Dynamics-specific stock and flow structure. The boxes denote stocks that are filled by inflows and drained by outflows. The outflow of one cohort is not at the same time the inflow of another cohort as important decisions are made at this transition. Young people have to find adequate employment for staying in the community. The same holds for people on the brink of retirement: the decision to stay in the community is influenced by the quality of the social network and the level of the relevant infrastructure and services.

The idea of the Maslow pyramid lies at the centre of the right hand side of the figure. The first three levels of the pyramid are covered: basic needs, security and contact. The three levels are plotted following the same logic: there is a demand side that is directly influenced by the size and structure of the population. On the other hand there is a supply side that itself depends on several factors. If supply and demand are brought together into a market the discrepancy between supply and demand has simultaneous and multifaceted effects on population, migration, the other markets and supply and demand themselves. We distinguished four markets:

- Goods market on the level of basic needs.
- Labour market on the level of basic needs.
- Political market on the level of security needs.
- Social market on the level of contact needs.

In the *goods and labour markets* regional economic cycles are captured. Goods and labour markets depend on each other as a certain amount of workforce is necessary for the production of a given amount of goods.

Five economic sectors were distinguished in the goods and labour market: agriculture, industry, private services, public services (close link to the political market and financial situation of the community), and tourism.

Agriculture is covered to some more detail in the left lower half of the figure where land use and livestock are shown in their mutual relations and their interdependencies with agricultural workforce and the overall economy. Although agriculture contributes little to gross regional product it plays an important role in the provision of landscape-related public goods for recreational and ecological compensation purposes.

The turnovers of the economic sectors, the incomes of the workforce and external income from regional policy measures generate tax income into the *political market*. The political market is a market of communal finances and their allocation to education, social welfare and health, culture and leisure, administration and security, infrastructure and development. Formal and informal networks are created or supported with the provision of culture and leisure services and the provision of infrastructure. Another qualitative aspect of the political market is its influence of the climate for innovation and development initiatives.

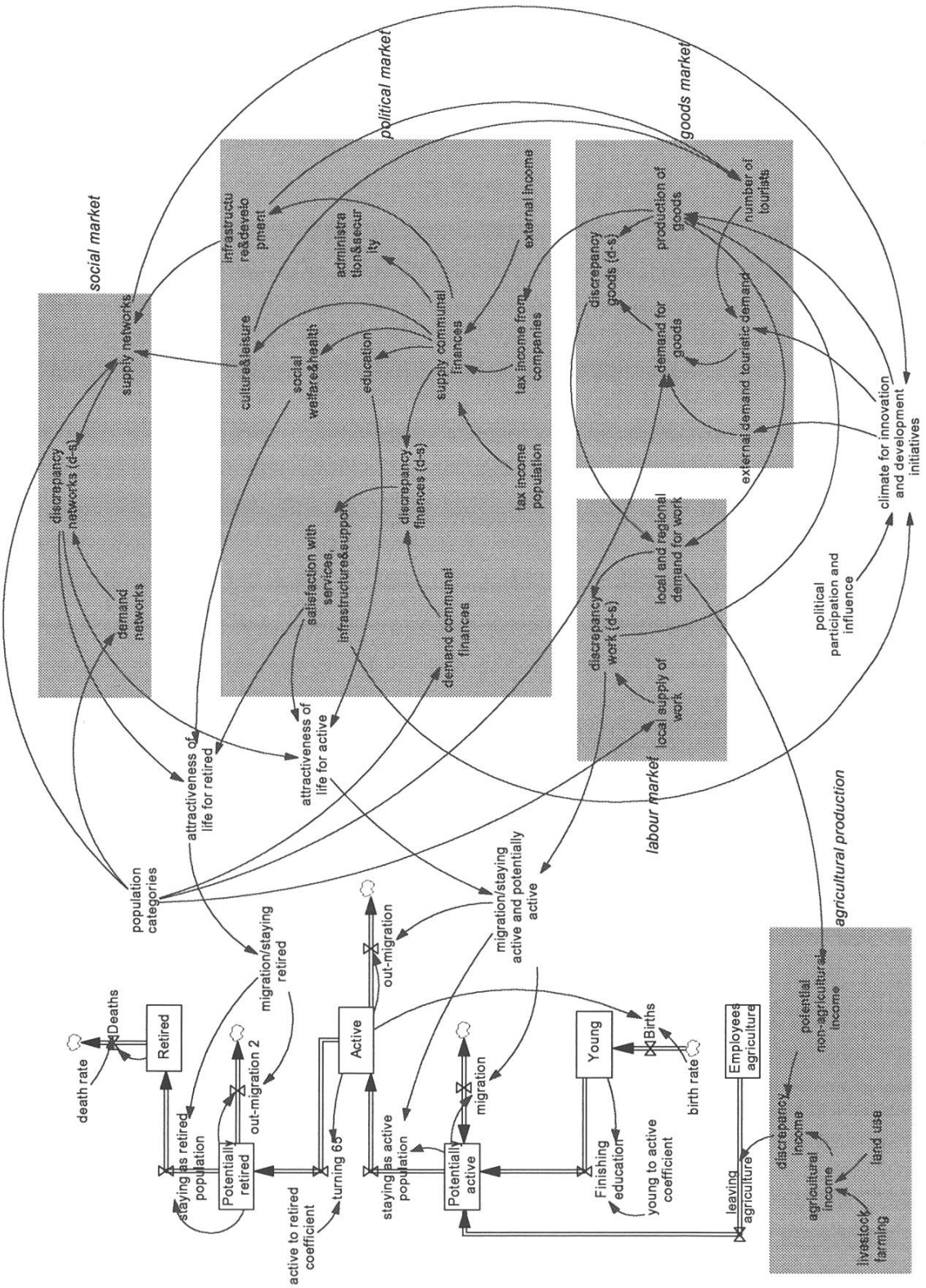

Figure 2: Structure of the community model

The climate for innovation and development initiatives is also influenced by the *social market*. On the social market, networks are supplied on a formal and informal basis by work places, private and public services such as restaurants, shops and post offices, by associations and by informal institutions such as family and neighbourhood. These networks provide forums for exchange and contact (supposed basis for recognition and acceptance) and for cultural activities (supposed basis for identity and self-realisation). The quality of the networks influence significantly the migration decisions: whether young people change into the active category, whether active change into retired, whether external workforce immigrates into the community and whether people formerly employed in the community look for new employment within commuting distance or decide to emigrate completely. The specific characteristics of the networks, combined with the political situation, determine the degree of innovation and development initiatives.

Relationships in the political and social market are difficult to operationalise and to quantify. In order not to imply misleading precision of these highly qualitative relations we used only few variables. However, these variables are at the same time powerful indicators for processes underlying them or arising from them. Quality of social life is for example not covered directly. Nevertheless, it can be derived from information about formal networks, satisfaction with services and infrastructure and attractiveness of live for active or retired.

As the situation in the political and social market is highly site specific the model has to be applied at a local level. In the realm of agriculture, labour and goods markets information can also be generated regionally.

2.3 Model quantification and combination with other approaches

In this step the variables identified in the previous section and their modes of action were analysed in more detail. The exact quantification of the relations required work in case study regions. At this stage, a general statement about the quantitative step has to be made. Prediction precision of a System Dynamics model is rather low as far as the values of single variables are concerned. This is due to several factors:

A series of assumptions have to be made for model quantification and equation formulation. The assumptions are especially numerous compared to other simulation models as decision rules for all the included

processes have to be determined. Unlike a linear programming model, for example, it is not possible to choose activities freely within given restrictions.

A System Dynamics model is of highly interdisciplinary nature (STERMAN 2000) which forcedly leads to lower disciplinary precision.

The main reason for using a System Dynamics model is the investigation of overall system behaviour and the identification of irreversible processes. With this focus less emphasis is laid upon the exactitude of single relations.

For this reason and in order for the model to be as precise and as credible as possible, maximum integration of existing knowledge was aspired. Results from the application of other methodical approaches used in our research group were integrated into the quantification of the System Dynamics model. These methodical approaches were mainly Linear Programming as used by FLURY (2002) for agricultural development and Input-Output-Analysis as used by BUCHLI ET AL. (this issue) for overall economic development in Swiss Alpine regions. The constraint of restricted prediction precision of a System Dynamics model could thus be considerably alleviated.

From the *linear programming model* about agricultural development in the Swiss Alpine region accurate information on the development challenges and conditions faced by the regional system was provided. Knowledge about the overall behaviour of the agricultural sector proved to be valuable for the quantification of the processes in the agricultural part of the System Dynamics model. A lack of this information would have implied estimating all the relations without further guideline and building exclusively on regional assumptions.

From the *input-output approach* both knowledge about the regional economic cycle and the way to analyse goods and labour markets were used. As the approach has been applied to several regions in the Swiss Alps so far, reasonable estimations of exchange relations can be made for a new region. The input-output approach is designed to show the whole economy of a region and allows structural relationships to be observed directly. It is based on a standard input-output-table that can be understood as the construction plan of a regional economy. With matrix operations the regional production multipliers can be obtained. These principles and operations were integrated into the System Dynamics model and linked to population development as well as the po-

litical and social markets. The input-output based part of the model has thus become both endogenous and dynamic.

The integration of other approaches is important for another reason. In causally closed systems that are the basis for a System Dynamics model, internal structure is much stronger to explain behaviour than external influences (RICHARDSON 1991). Assumptions on endogenous relations are therefore likely to have considerable impact on system behaviour. As a consequence, a strong theoretical background and the integration of other methods for higher model precision are of crucial importance.

3. Preliminary results

We applied the model to a first case study region, the Muenstertal (see BUCHLI ET AL. in this issue). The quantified model so far includes agricultural production, the demographic model, and labour as well as goods markets. The relevant variables from the political and social market are at present only included exogenously, i.e. they do not interact with the other variables during simulation but are treated as fix for a simulation run and varied in order to understand their influence on general system behaviour. As the social and political markets are up till now exogenous, results are presented on a regional and not on the community-level. We start with the description of the results from a detailed investigation of the agricultural production and continue with the labour and goods markets and their interaction with the demographic model.

3.1 Development of agricultural structures

In this section we present some of the dynamic patterns which the system dynamics model generated for the development of agricultural structures. We investigated agricultural development to more detail than the rest of the economy as agriculture is not only an important economic sector but also significant in the realm of the recreation and ecological compensation function.

3.1.1 Analysis of system behaviour

For the analysis of system behaviour, we distinguished between different scenarios concerning the evaluation of effects of different policy assumptions for direct payments as a sectoral policy measure and the evaluation of an endogenous development strategy based on regional marketing and agricultural self-help. We simulated and compared four scenarios:

1. Local processing: In the face of decreasing product prices the strategy of local processing and marketing has gained in relevance. This holds especially for mountain areas where consumers not only value product quality, but also the natural and socio-cultural assets that the region's name implies. The *local* processing scenario investigates the effects of a local development initiative where higher product prices can be realised through local processing and marketing of milk and meat.
2. *New direct payments*: All farmers in the mountain areas receive base payments of CHF 1'200. - per hectare. A main motivation for these payments is to ensure farmer's incomes in view of decreasing commodity prices. With the re-examination of Swiss agricultural policy a new type of direct payments is discussed, especially for mountain areas. Direct payments coupled to agricultural workforce instead of agricultural land aim at stabilising agricultural employment and thus at fostering agriculture's contribution to settlement, economic and social life. In the *new direct payments* scenario we study the effects of a change in the direct payments scheme.
3. *Combination*: For this scenario we combine the effects of the *local processing* and the *new direct payments* scenario.
4. The results of the previous scenarios are compared to *base run* where current development trends remain unaltered in the future.

The data used for the simulations are based on information on the situation of the year 2000, obtained from different sources which provide statistical information on Swiss agriculture and from expert knowledge about the case study region.

Simulation showed that the System Dynamics model produced virtually identical outcomes for all four scenarios and thus showed a high degree of policy resistance. In Table 1 only *base run* results are therefore dis-

played. The results cover a time horizon of twenty years and are given as percentages of the situation in the year 2000.

Table 1: Simulation results (*base run*) for the development of agricultural structures

Year	0	4	8	12	16	20
Agricultural Workforce (persons)	49	84 %	73 %	67 %	63 %	61 %
Units dairy cattle	389	76 %	57 %	42 %	31 %	22 %
Units nursing cattle	643	75 %	85 %	91 %	100 %	104 %
Extensive pastures (ha)	228	102 %	104 %	106 %	108 %	97 %
Fallow land (ha)	0	0	0	0	0	30 ha

The results show that agricultural workforce is reduced to a bit more than 60 percent and livestock experiences a marked shift from dairy to nursing cattle. This distinction is important in so far as the shift in livestock has a significant impact on agricultural workforce and agricultural income. Fallow land arises to a minor extent which has a negative impact on ecological quality of the areas concerned. The distinction of different land use categories allows drawing conclusions about the amount and quality of the landscape related public goods.

3.1.2 Analysis of system stability

Sensitivity analysis showed little influence of exogenous variables such as prices and direct payments on overall system behaviour. The opposite holds for assumptions on internal relations such as transitions between land use categories and relations between number of workforce and change in land use or livestock.

A linear programming model applied to exactly the same questions showed different and also oppositional results for the four scenarios (see KOPAINSKY ET AL. 2003). *New direct payments* as well as *local processing* resulted in a higher share of dairy cattle than in *base run*. Dairy cattle even increased to 113 % of their initial value when *new direct payments* and *local processing* are combined. This is a direct consequence of the income-maximisation feature underlying the model: as product prices for milk increase and as work is subsidised by the new direct payments, the work intensive cattle type (dairy cattle) is chosen. With a decline in land-related payments work extensive areas are abandoned which leads to fallow land of almost 10%.

The difference in the results can be explained by the fact that in the *new direct payments* scenario the change in the payment scheme occurs from year 8 to 12. By this time, however, some persons have already left agriculture and the change in livestock from dairy to nursing cattle has well proceeded. We find here an example of path dependency. Those persons that have left agriculture will not return as they have undergone re-education, found a job elsewhere in the regional economy or emigrated from the region. The same holds for livestock. Once the stables for dairy cattle are reconstructed this process will not be reversed. The desired effects of the new direct payments scheme can therefore not set in.

3.2 Development of the overall economy and the demographic structure

At this stage of the project and as mentioned above, we can present results from the simulation of the labour and goods market. The political and social markets are included as exogenous variables with which sensitivity analyses can be performed. Although these variables are not yet endogenous in the model their influence on system behaviour and stability can nevertheless be estimated.

3.2.1 Analysis of system behaviour

The data used for the simulations of overall economic development are based on information on the situation of the year 2001, obtained mainly from a survey carried out by BUCHLI (2002). The survey was realised in order to gather all the necessary information for the implementation of input-output-analysis.

In Figure 3 the simulation results for the development of the overall economy and of the population are displayed. The results cover a time horizon of twenty years.

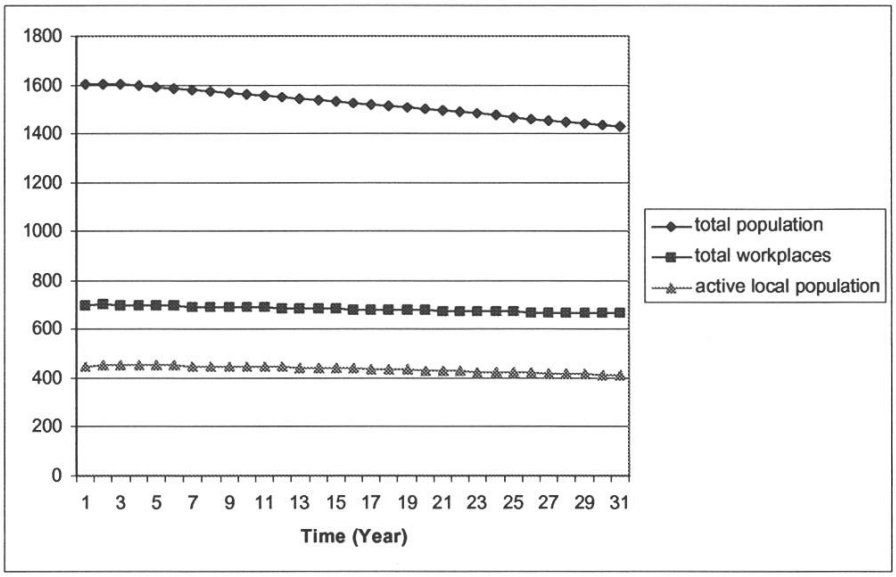

Figure 3: Simulation results fort the development of the overall economy and of the population

As the socio-political variables are exogenous the results hardly illustrate the characteristic behaviour of dynamic systems. Figure 3 shows that the situation on the labour market remains favourable during the entire simulation period. There is always abundant supply of workplaces for the active population. Population, however, declines constantly. The initial population structure seems to be insufficient to maintain itself over time. If the initial population size is to be held constant, a minimum number of people per year therefore have to fill the stock of active population. Going back to Figure 2, this is either reached by young people turning active and staying in the region or by the immigration of new population being attracted by the economic and socio-political situation in the region.

Population decline is consequently not a purely economic problem as the economy in the case study region shows sufficient potential. The problem lies in the current population structure, namely that the future active population is poorly represented. The problem is also one of attractiveness as not enough young people and not enough commuters decide to live in the region.

3.2.2 Analysis of system stability

Sensitivity analysis showed significant influence on system behaviour of mainly two factors: 1) assumptions about actors' preferences for employment in the different economic sectors and 2) assumptions about the values of the attractiveness variables from the social and political market. Combined with the results from the analysis of system behaviour, there are two main implications from these findings:

In the case study region, population development cannot only be stabilised by the economic markets as it is not only an economic problem, but more a problem of attractiveness. On the one hand, this implies raising the attractiveness of the available jobs as actors' job preferences proved to have a significant impact on system behaviour. On the other hand, this also emphasises the necessity of raising the attractiveness of the socio-political situation in the region's communities so that new population can be attracted or commuters can be convinced to come to live in the communities.

The future perspectives of the region in terms of population development cannot be improved by investments into the economic sectors with the highest multiplier effect on other sectors and the overall economy. Investments in the economic realm have to focus on the attractiveness of jobs (see also the conclusions in BUCHLI ET AL. in this issue).

4. Conclusions

The aim of the project described in this paper was to provide a decision-support tool for active rural development in agrarian and peripheral communities in the Swiss Alps. For this purpose, a System Dynamics based simulation model was elaborated. With the aid of the model, decision makers on the national level can evaluate the effectiveness and efficiency of the new Regional Policy paradigm. Decision makers on the local and regional level, on the other hand, are provided with a tool for the ex-ante estimation of the impacts that can reasonably be expected from endogenous development initiatives. First results of model application were presented. From these, a series of conclusions can be drawn:

The application of an approach allowing a holistic view of the development issues faced by mountain communities proved to be both suitable and valuable. It enables the analysis of system behaviour over time and the identification of the critical factors influencing function fulfilment.

These two aspects are of considerable importance for integrated rural development.

A successful application of the approach depends on a lot of existing knowledge. Related studies and methods therefore have to be readily available. If they are available, they can be combined and persuasive results can be generated as could be shown with the integration of findings from a linear programming model and the integration of the analytical logic of input output-analysis.

The importance of a synthesis of disciplinary or sectoral findings could be demonstrated both for the case of agriculture and for the overall economy. For the agricultural production path dependencies and irreversibilities could be identified. For the overall economy it was shown that the effect of labour and goods markets on population development can be outweighed by the effect of variables stemming from the social and political realm.

Input output-analysis provides exact knowledge about the economic cycles and thus forms the basis for efficient investment. With the linear programming model, optimal policy measures can be identified. The overall, System Dynamics based model, however, shows, which of these policies are feasible and which investments are truly effective considering the interactions of the economic markets with the social and political markets and their joint influence on population development.

From these findings it must be postulated that sectoral policies are not sufficient for an integrated rural development. Policies have to be elaborated and implemented simultaneously and on an interdisciplinary basis. It is especially important to pay due attention to the aspects of social changes and changes of lifestyles as they showed a far reaching impact on system behaviour in the case study region.

In order to achieve the overall project goal and to generate sound and truly dynamic results in all the fields covered by the qualitative model, more research is necessary in the political and social dimension. Subjective well-being and its impact on population development will be included as well as the social capital concept and political economy elements with their impact on innovation and development initiatives. Research will be based on existing knowledge and on further investigations in case studies.

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Zusammenfassung

Im vorliegenden Artikel wird ein alternativer Ansatz zur Untersuchung ländlicher Entwicklung in peripheren und agrarischen Gemeinden des Schweizer Berggebiets entwickelt. Er basiert auf der Grundlage von System Dynamics, einer qualitativen und quantitativen Methode über die Struktur und das Verhalten komplexer Systeme. Dabei werden im qualitativen Teil die wesentlichen Systemelemente und –verbindungen peripherer und agrarischer Gemeinden identifiziert und ein Einflussdiagramm erarbeitet. Im quantitativen Teil wird ein dynamisches Simulationsmodell entwickelt, welches als Entscheidungsgrundlage für die Evaluation unterschiedlicher Politikmassnahmen dient. Erste Ergebnisse aus der Anwendung des Ansatzes im schweizerischen Münstertal unterstreichen die Notwendigkeit einer ganzheitlichen Sicht der Prozesse im Bereich der ländlichen Entwicklung. Die Ergebnisse bestätigen aber auch die Notwendigkeit einer starken theoretischen Fundierung und die Integration anderer methodischer Ansätze. Modellsimulationen zeigen auf, dass für eine ganzheitliche ländliche Entwicklung Sektoralpolitiken nicht ausreichen. Politikmassnahmen müssen parallel und interdisziplinär ausgearbeitet und umgesetzt werden. Besondere Beachtung ist dabei den Aspekten des sozialen Wandels und der Veränderung der Lebensformen zu schenken, da diese einen zentralen Einfluss auf das Systemverhalten zeigen.

Keywords: Ländliche Entwicklung, dezentrale Besiedlung, Regionalpolitik, System Dynamics, Simulationsmodell

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