COMPARATIVE STUDIES OF REGIONAL PLANNING MODELS - WITH SPECIAL EMPHASIS ON A CASE-STUDY OF SOUTHWESTERN SKÅNE

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PREFACE

Since 1979, the Regional Development Task at IIASA is engaged in a case study of economic and demographic development, land-use and related problems in the region of southwestern Skane in Sweden. The case study is the third in a series of attempts made by the Regional Development Task to apply systems analytic methods to regional planning problems in regions with different economic structures, resource endowments and organizational settings.

The research in the Swedish case study is done in collaboration with the Southwest Skane Municipal Board, as a part of their ongoing work in physical and public transport planning for the metropolitan region of Malmo, and its neighboring municipalities. The research is partly sponsored by the Swedish Council for Building Research.

In the case study an integrated systems analytic package of models is used which has been developed within the Regional Development Task in cooperation with a group of Swedish researchers and planners. In that package, separate models have been developed for interregional economic and demographic problems, and for intraregional land-use problems.

The current paper sets the Swedish case study in relation to the three other case studies in the Regional Development Task. It is a first attempt to make a comparison of the variants of regional systems analysis adopted by the Task under different demo-economic and institutional settings. It should be followed by more careful comparative judgements in the future.

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1. INTRODUCTION

Problems of regional development have been picked as a topic suitable for multidisciplinary studies using systems analytic tools by several national member organizations of IIASA. Over a period of some three years efforts have been made at IIASA to do research on issues of regional planning in a set of member countries. The Regional Development Task has been launched as a starting point for a possible major programme of the kind currently represented by the Energy Program and the Food and Agriculture Program. However, it is fair to say, that there have been somewhat unexpected problems in gaining enough momentum in the research to actually render regional development a focal point of IIASA work.

The problems treated by IIASA should be of global importance. This means that they should either concern issues for the world as a whole or be present in similar forms in different parts of the world, i.e. represent universal problems. A reaction to the exclusively global problems, especially when they come to the stage of policy implementation has been that the recommendations are often too general to be applicable at a regional or local level. It is at this level that they should be fit into

*Paper presented at a conference on "Sweden and IIASA" in Stockholm, December 4-5, 1980.

the existing economic, organizational, and political structures with due notice of all the restrictions and ties acting in the real-world setting.

One reason for the problems in getting the larger scale regional programme running might simply be that regional aspects as such are not regarded as important enough by some member countries, especially those with an outspokenly market type economy. Another reason might be that the focus has not been, so to say, sharp enough to arrive at self-ignition in research having the regional dimension as the common denominator. Therefore a current reorientation of the task* might lead towards more specific regional development problems, either connected with industrial change (medium-term) or energy development projects (long-term). At the appropriate geographical level, any region is small and open to the world economy, and might be analyzed by tools developed for small, open economies in general, e.g., by other IIASA research.

2. A COMPARISON OF THE CURRENT REGIONAL CASE-STUDIES AT IIASA

As indicated above, the work in the IIASA Regional Development Task has not primarily been aimed at basic methological research but at developing systems of models to be applied in a series of case-studies. These case-studies have been chosen so as to achieve a broad range of alternatives to test the model packages. Although there is a special set of models developed for each of the case-studies the intention is still that there should be a comparative element of the case-studies in terms of both problems tackled and models used. This comparison should explicitly specify the institutional frameworks and problems encountered in the actual collaboration between IIASA and the regional authorities and planners.

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*Research with a regional dimension is also going on in several other IIASA project areas, i.e. in the Human Settlements and Services Area, and the Resources and Environment Area.

In the following table, we have tried to summarize some of the characteristics of the four case-studies currently underway.

Both the east-European studies concern agricultural regions where growth has been rather slow due to various shortage phenomena. Water supply has been a major point in question, partly because of the possibilities of increasing agricultural productivity by irrigation. In both studies, a series of linked models of the regional subsystems have been applied, where agriculture is given the central role and other economic processes are treated less comprehensively. The position of these regions in the national division of labor has been assessed by partial, local analyses. In the Bulgarian case-study there is also an alternative model system which ties the development in the Silistra region to the national and interregional economic development.

Table 1. Summary comparison of four regional development case-studies.

REGION	Main economic characteristics	Main development problems	Main collaborators	Main methods and models
Notec, middle Poland	Agricultural region	Shortage of water supply, outmigration	Central and regional level planners, water resource experts	Dynamic regional model, linked with elaborate agriculture and water supply models
Silistra, northern Bulgaria	Agricultural region	Slow growth, e.g. in the basic agricultural sector	Central level planners, various research institutes in Sofia	Linked models of agriculture, water supply, industry, etc., breakdown models
Southestern Skane, south Sweden	Specialization in agriculture, food industry and chemical industry	Rather slow growth with specialization in protected industry, land-use conflicts	Regional Planning Office of Southestern Skane (SSK), University of Lund (water problems), Swedish Council for Building Research	Hierarchical system of models with emphasis on multi-objective land-use models
Tuscany, middle Italy	Specialization in textile and leather industry, tourism	Vulnerable position in the world economy, exposed to competition	Regional economic planners in Florence, researchers at National Research Council, Rome	International and interregional trade models of industrial specialization, labor market models

It might be argued that for regions that play a minor role in the national economy, a local analysis would seem more warranted than otherwise. However, since the intraregional focus for small regions leads to problems of how to treat indivisibilities of plants and service facilities, the local area analyses tend to be no less complex from a methodological viewpoint, than the ones that might be used in larger regions. In the latter regions the interregional dependencies and feedbacks should be treated explicitly in the regional modeling, leading to an integrated approach in which national-regional ties are important to model. That outlook would tend to favor the use of hierarchical systems of models. Such lines of attach are therefore followed in the Skane and Tuscany case-studies.

Since the Skane study is the central topic of this paper, it is appropriate to indicate instead the character of the Tuscany case-study at this stage.

As noted in Table 1, the Tuscany region exhibits the same properties as many smaller economic regions; it is quite strongly specialized in industrial products that are traded on the world market under heavy competition, e.g. from countries in the third world. Its dependence on tourism also introduces a subordination to external conditions, since Tuscany in fact exports tourist services. Therefore, the Tuscany case-study deals rather with the formulation of alternative scenarios of future industrial specialization under uncertainty in world market development, than with the intraregional land-use and service facility location, more typical of the Skane study.

The Tuscany labor market in an example of an unusually free one, i.e. a market where intersectoral labor mobility is high, responding to structural demand changes and business cycle fluctuations. This volatile market is said to be one of the requisites for the rather fast economic development during the 1970s in Tuscany. However, part of the analytical problem consists in assessing quantiatively this property, and also to point out its negative distributional effects.

3. THE BACKGROUND OF THE SKANE CASE-STUDY

The case study of Skane was initiated by IIASA and the Southwestern Skane Regional Planning Office after the completion of the 1979 land-use plan for the southwest Skane region.* The intention was to test a new methodology for the next round of planning, i.e. not to develop models and methods to be used in connection with work on a particular planning document. The idea of having a land-use oriented case-study of Skane was related to the ongoing analyses at IIASA of water problems in the same area. Although there is a linkage between the two Skane studies, e.g. concerning the exchange of results of modeling experiments, we will refrain from going into this subject here.

The basic idea of the Skane land-use case-study is that the creation of scenarios is a necessary and fruitful feature of the planning process. Such scenarios can be developed through a purely verbal process which can also be guided by sketching as is often done in physical planning. However, ample experience shows that with such techniques, it is only possible to generate a small number of consistent alternatives. This implies that computer-aided planning procedures serve at least two purposes. Firstly, such methods allow a larger number of alternatives to be generated than with intuitive methods and secondly a larger number of dimensions can be treated simultaneously and in a consistent way.

In the Skane case-study, 27 economic sectors are discerned together with 35 subregions (most of them in southwestern Skane). The planning period is supposed to consist of at most 7 five-year periods, starting from the base year 1975. To give a complete representation of the sectoral, geographical and time development at least 6615 variables would be needed. It would be impossible to construct scenarios for such a system without the aid of a formal computer model. Even with such technology available the task is formidable. Special methods must therefore be developed

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*Professor Ake E. Andersson took the major initiatives in starting the study and also suggested most of the methods described below. The project leader of the collaborative study is Jörgen Schultz, Regional Planning Office of Southwestern Skane.

to manage the system of models so as to make the results readily useful to the planners and the decision-makers.

The policy problems in land-use planning are long-term in nature. This means that uncertainties are a rule rather than an exception. Furthermore, these uncertainties cannot be expected to be removed or sometimes not even reduced by deeper analysis. A development of scenarios seems to be one promising way of planning for uncertain events of this ill-defined type.

Among the uncertain factors are also the weights to be attached to alternative criteria for assessing the costs and benefits of a proposed plan, or even how to measure individual cost or benefit items. Although it has long been argued that regional planning is a field characterized by multiple and conflicting objectives, model applications using modern multi-objective decision analysis are quite scarce.

A short-hand characterization of the Skane land-use case-study from the point of view of IIASA as a research organization for applied systems analysis is therefore that it is one of the test-fields for such decision methods. Development uncertainties for Skane as a whole in the Swedish economy as well as for technical development are treated by the scenario technique. Uncertainties in the goal structures for the intraregional planning in (southwestern) Skane are treated by multiobjective decision methods, developed at IIASA and elsewhere. The aim is to generate a set of so-called non-dominated solutions for each external development scenario, i.e. to present alternatives that cannot be ameliorated in one aspect without reduc ng some other welfare-component. This methodology will be described somewhat further below.

4. A HIERARCHICAL APPROACH TO THE SKANE PHYSICAL PLANNING PROBLEM

There are two opposite principles to decomposing a regional policy problem. Although both principles are aimed at studying the development problems of an individual region they differ in the importance attached to interregional considerations.

A. This procedure constrains the policies possible for the region in question by analyzing successively international, national and interregional problems. It assesses the role of the region in the international and national division of labor, before treating intraregional allocation.

B. This procedure takes its starting point in an analysis of the various subsystems of the region in question (agriculture, industry, housing, services). It is more concerned with the internal working of these subsystems than with their interaction and the relations between the region and the rest of the world.

Although these two approaches are often termed top-down and bottom-up methodologies, respectively, we would argue that this short-hand characterization is too simplistic. The appropriate combination of methods A and B is the central field of work for regional modelers. The choice of approach should be performed with reference to the factual circumstances as well as the organizational traits of the application at hand.

The contention here is that procedure A is the natural starting point in a case as the Skane one. It should be stressed that the construction of national and interregional scenarios does not necessarily have to be tied to central research and policy-making institutions. Such scenarios might well be developed by planners in Skane itself. The methodology described here should in principle allow for such specially designed scenarios to be constructed.

The modeling steps acutally chosen in the Skane case-study are outlined in Figure 1.

The national development is analyzed with some emphasis on sectors of production with an especially large importance in Skane. The short-term national development follows the alternatives presented in the official planning documents. The long-term ones are oriented to possible developments of prices, commodity production and investment. They reflect different situations of energy supply, public sector expansion and foreign trade. In the Skane case-study, the scenarios draw on already published material in Sweden for the national

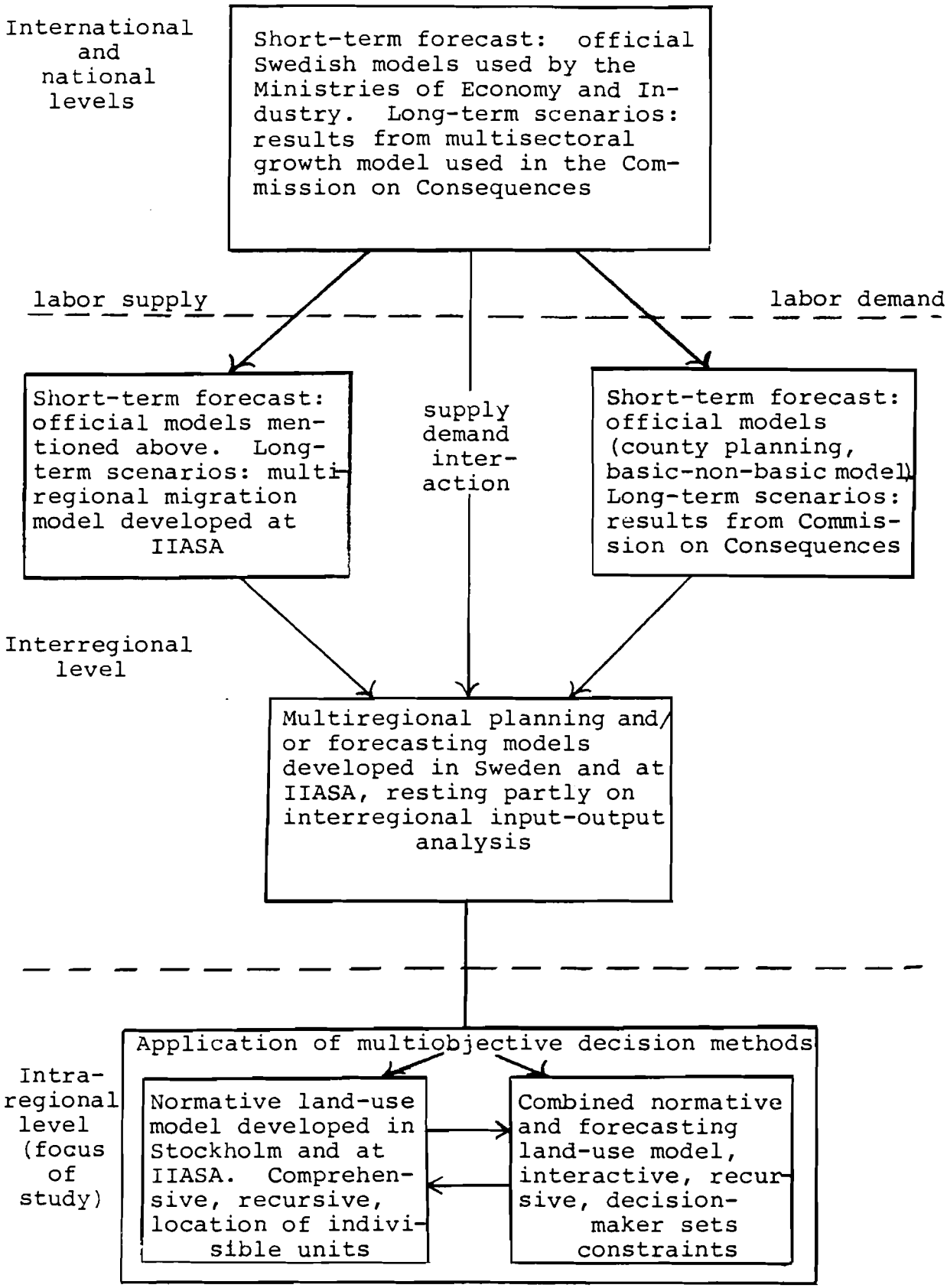

Figure 1. Hierarchical scheme of models used in the Skane case-study.

development. Parts of this material are derived by methods developed at IIASA.*

In the interregional step use is also made of the official planning documents in Sweden. This is done for the short-term development. Furthermore, official material is used to construct a reference alternative for the growth of the Skane economy even in the longer-term.

Three major types of models developed for the interregional analysis can be mentioned here. The first concerns a novel model type for regional labor supply projections. It concerns an application of so-called multiregional demographic projection methods, developed at IIASA.**

The population forecasting model has been applied to 25 regions in Sweden, i.e. counties plus a further subdivision of Malmohus county into two parts (nine municipalities in south-western Skane and the rest). By this method four different population development scenarios have been generated for Skane, using gross interregional migration patterns for four time-periods during the years 1968-1977 as basic data. Ingvar Holmberg, University of Gothenburg, has performed the main part of the work. It has an independent interest also for other regions in Sweden and, in fact, for the whole Nordic area.

The other two models pertaining to this regional level focus on labor demand and production, and have a less detailed treatment of the population development. Results of one of the most comprehensive regional economic models built for Sweden by Lars Lundqvist, Royal Institute of Technology, Stockholm, are available for use in the study although that model has not specifically been developed for the Skane case-study. The model contains input-output balances for each one of eight regions in Sweden as well as possibilities of computing regional energy use and it also allows for a variable utilization of capital. Since

*See the papers by Lars Bergman on multi-sectoral growth modeling for Sweden.

**These models have been extensively studied and applied by Andrei Rogers et al. in IIASA's Human Settlements and Services Area.

the model is of linear programming type it cannot be used offhand for forecasting purposes.

The third example of a model that is employed at the interregional level is a regional planning and/or forecasting model developed by Arne Granholm, University of Gothenburg, and the current author. It differs from the earlier mentioned model in two respects. Firstly, it is less developed as regards intersectoral and interregional linkages but more developed as regards public infrastructure and services. Secondly, it may be used both in a forecasting and a planning mode. In the planning mode, interregional allocations of private and public capital are sought which minimize private and/or public investment expenditures. In the forecasting mode, that location of production and employment in eight Swedish regions is sought which fulfills all technological as well as national or regional policy restrictions with a minimum reorganization of population and employment. The restrictions are made up from various public sector demand-supply standards and contain information from the population forecasting model. The application of this model to the Skane case-study yields a possible equilibrium on the regional labor market consistent with the national scenarios.

5. TWO MODELS FOR INTRAREGIONAL LAND-USE PLANNING

The regional forecasts for Skane with the help of the interregional models create the basis for the core of our analysis, the illustration of land-use conflicts at the local level in Skane.

The industrial development, and the specialization of industry in Skane, creates a demand for industrial land in different parts of the region. The load of pollutants on Skane will vary depending on the location pattern of the industrial sectors.

The agricultural development is attached to the policy of supporting agricultural production in Sweden. It has been shown in the IIASA case-study on water management in Skane that considerable productivity increases could be obtained in the

agricultural sector in Skane if irrigation were considerably increased. Everthing else given, this would tend to increase the value of agricultural land and accentuate the conflicts between urban and rural use of the land.

The tendencies in housing construction, recreation and weekend housing also imply an increasing demand for urban land not only within or at the fringes of the current urban areas. These tendencies may exhibit spill-over effects into the transportation sector in view of the consequent increasing commuting load on the transport network in Skane.

On top of these potential clashes between land-uses, southwestern Skane faces a number of important, long-binding decisions as regards energy supply. Remote heating of the city of Malmö is a focal point in this problem area.

In the development of the land-use models, the sectoral and regional subdivisions have been adapted to the above problem highlights.* The basic model devised to generate land-use alternatives can be employed to locate indivisible production units in subareas. This treatment of indivisibilities is an unusual element of models of this type.** However, it is a very useful property of a model aimed at a realistic treatment of land allocation at such a low geographical level that actual plants are the elements of the analysis. This property is of a more pronounced interest for those sectors which exhibit clear economies of scale. Another case in interest is sectors with a strong growth or decline in the area so that new investments or shutting down of existing capital are likely to occur.

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*The bulk of the work on data collection and detailed model specification for computer application has been carried out by Ulf Strömqvist, TEMAPLAN AB, Stockholm, and Bertil Marksjö, Stockholm Regional Planning Office.

**The model resembles the TRANSLOC model system developed for the Stockholm region in the early 1970s. Markku Kallio and Andras Por, System and Decision Sciences Area, IIASA, have developed the solution algorithm for the new land-use model.

The model is not intended to provide a detailed description of actual investment behavior but to guide the physical planners in formulating overall land-use policies. Therefore, a set of evaluation criteria is provided, consisting of at least the following elements:

- investment, demolition and operating costs;
- accessibility of sectors of production and consumption to other activities and prelocated resources (transport networks, terminals);
- congestion costs, e.g. in the form of density indicators; and
- environmental pollution costs (e.g. air- or water-borne pollution).

These cost indicators are not aggregated over time, but evaluated for the consecutive time-periods in question. If we were to employ each of the four indicators mentioned and study seven time-periods, every land-use pattern generated by the model that fulfills restrictions on available land as well as production and population scenarios, should be judged from 28 aspects. Two model solutions should be compared in 28 aspects. Even with multiobjective methods this number is simply too high to be useful. Aggregation over time-periods, e.g. into short-term and long-term periods should therefore be a part of the analysis.

The successive comparison of solutions produced by this land-use model to assess so-called dominance properties can be accomplished by various methods of multiobjective analysis. The aim of these methods is simply to remove such solutions from the set of alternatives to be further considered which are, in the sense of the objectives, inferior to other solutions. Mathematical techniques for performing this filtering of solutions have been developed at IIASA and elsewhere*.

*The method developed by Andrej Wierzbicki of IIASA's System and Decision Sciences Area is quite general and has been implemented practically.

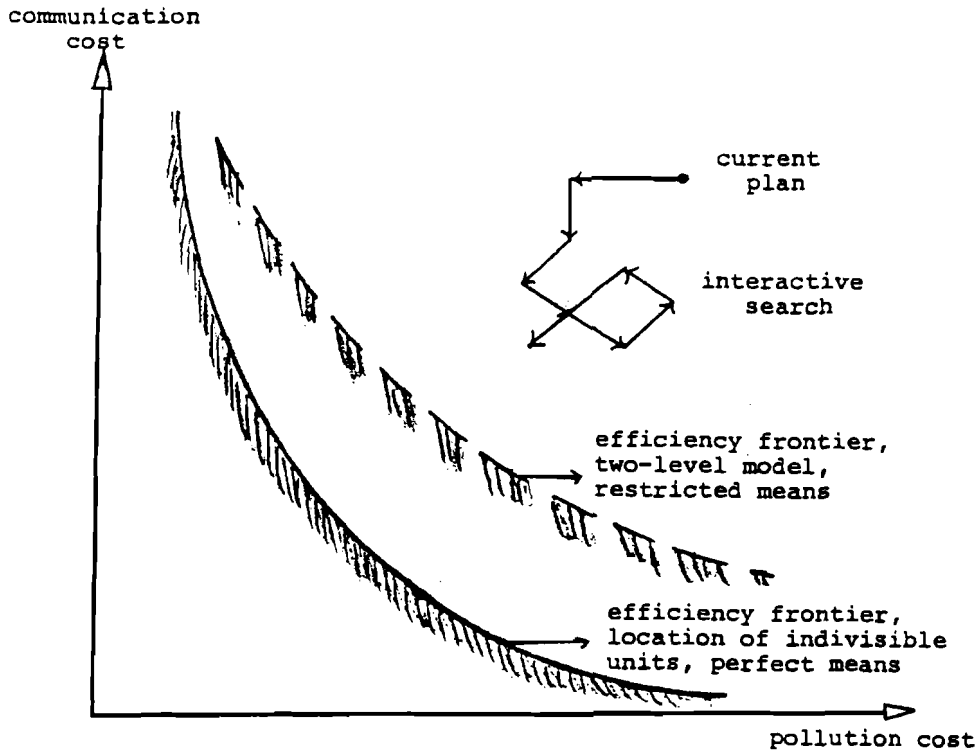

Figure 2. Comparison of ideas behind two land-use models for Skane.

pattern pertaining to that point, may also be computed. The dashed curve represents the lowest attainable communication cost that a decision-maker planning only aggregate land-use at the municipal level can arrive at for the given level of pollution costs.

The main result of the study is intended to be the specification of such curves for all (or the most important) of the objectives involved. Also, the Skane planners and decision-makers will be given the opportunity to search interactively for land-use patterns that might dominate the currently proposed regional plan for the southwestern Skane area. A methodology for dealing with the abovementioned version of the land-use model, using modern graphical computer techniques has been developed at IIASA specifically for the Skane project by Geoffrey Roy, University of Western Australia.

Although the model outlined above is quite general in nature and at the same time possible to solve by numerical methods, it still does not provide a realistic interface with the model user. To compare two land-use patterns generated by the model, several thousand variables must be compared individually. Therefore, a modified version of this land-use model has been developed. It is more restricted than the general one, since it cannot treat indivisible plants. On the other hand, it is intended to specify an explicit role for the decision-making bodies that are going to use the model.

In this model version we assume that the physical planners can mainly constrain land-use at a coarse regional level and for a few aggregate land-uses (agricultural, industrial, residential, commercial and recreational land). In the model developed for the study, the planner is assumed to specify interactively aggregate land-use in five categories in nine aggregates of the 35 subareas in Skane (the nine municipalities in southwestern Skane)*.

However, the planners are still assumed to wish to use indicators for the performance of their plan that make use of other than land-use variables (average travel-time to work, accessibility to services and recreational areas, the above-mentioned objectives, etc.). These indicators are defined at the local level, for each of the 35 subareas. Therefore, given the aggregate land-uses defined by the planners, a forecasting model is applied to derive the detailed land-use pattern consistent with the planners' restrictions, which is in a certain sense closest to the existing demo-economic structure.

Figure 2 illustrates the relation between the approaches in the case of two objectives and a single time-period.

The leftmost curve in Figure 2 represents the set of non-dominated solutions for the comprehensive land-use model. For a given level of the pollution cost the curve specifies the lowest attainable communication cost. Of course, the land-use

*A set of special local level constraints may also be used. These may concern zoning regulations, composition of the housing stock, etc.

6. CONCLUDING REMARKS

Some of the activities underway in the Regional Development Task at IIASA have been described with a special treatment of the southwestern Skane study.

From the point of view of IIASA, this work is a test of the applicability of systems analysis techniques to regional planning problems in various organizational settings. In these tests, planning methods not in general use should be attempted, to gain some comparative experience. It is not the main intention of IIASA to provide the case-study collaborators with full-fledged press-the-button systems which can be used off-hand to solve planning problems. The collaboration has the learning process of both parties as a quite significant element.

This balance between specificality and generality is quite difficult to achieve. One pitfall is to suggest too general methodologies which the planners, after being left on their own, find difficult to actually use. The other pitfall from IIASA's point of view is such a deep involvement in the actual organizational structure with its political connotations that the objectivity might be at stake.

Of course, a case-study such as the Skane one would not be complete if IIASA scientists did not take part also in the dissemination of the results. Several target groups can be identified:

- regional and planning scientists;
- planners in Skane and other regions;
- policy-makers at national, regional and local level; and
- the general public.

It is obvious that the presentation and discussion of methods and results must be adapted to the different frames of reference for these groups.