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Contents

Public Facility Location

G. Leonardi *

Although facility location problems are common to many fields, these problems are analyzed in such diverse ways that it is often hard to believe they share any common features.

According to urban geographers, regional scientists, and many other social scientists, the geographic distribution of human activities and settlements results from the interplay of complex social, economic, and physical factors. These social scientists have developed the discipline of location analysis to obtain a deeper understanding of such interactions. They usually explain these interactions in terms of the trade-offs that people are forced to make in regard to the spatial separation of needed goods, services, and commodities.

In contrast to this perspective, a vast literature on optimal location models has been produced in the fields of Operations Research (OR) and Management Science (MS). These models often appear under such labels as "plant location problems", "warehouse location problems", and, in a more abstract way, "location—allocation problems"; these names reflect the origins of the models, which have been developed mainly as management tools for private firms. The OR and MS view of the problems is somewhat narrower than the social scientist's perspective. Most of the effort is placed on developing algorithms to solve the resulting mathematical programs (which are usually very complicated).

*Dr. Giorgio Leonardi, of the Polytechnical Institute of Turin, Italy, joined IIASA's Human Settlements and Services Area in October 1979 to work on problems of normative location modeling.

In order to synthesize these polar perspectives (as well as those that lie between), IIASA held a Task Force Meeting on location problems in June 1980. A selected group of scholars from both East and West discussed the differences and similarities of their own perspectives, in order to identify areas of unsolved problems and to propose new themes for future theoretical and applied research. A short account of the main conclusions of the Task Force Meeting is given below.

The Problem Areas

Some well-defined problem areas were identified at the meeting, for which the current state of the art seems to provide unsatisfactory answers.

One set of problems is related to the decision-making processes implied by location questions. It has been recognized that at least two types of actors are involved in the process of deciding on a location: the *customer* and the *decision maker.* Most current models either ignore this distinction or account for it in an oversimplified way.

Another set of problems is related to the *costs* that a locational decision usually implies and to the *constraints* to which it is subjected. Although many effective techniques are available to handle different types of costs and constraints, some unsolved problems still remain. These problems are of a socio-economic rather than a technical nature, since they relate to who provides the funds and to the way the existing structures are accounted for.

Continued page 2

Public Facility Location

Continued from page 1

The Behavior of Customers and Decision Makers

The participants at the Task Force Meeting agreed that there is a definite need for a better understanding (and better models) of the mechanism through which *demand* for services arises and by which customers make choices among different alternatives in *space*. Two contrasting examples may be used to clarify the problem.

In a classic warehouse location problem, a firm must locate a set of warehouses for a homogeneous good, which in turn will be shipped to some demand points. The firm will obviously seek to minimize the total shipping costs plus the costs of establishing the warehouse. It is well known that this cost-minimizing criterion implies that each demand point will be served by the *nearest* warehouse only. It is important to note that no model for customer behavior is required, since the quantity demanded is assumed to be given and the good is *delivered* from the warehouses to the demand points.

In the case of a shopping center location problem, a firm must locate a set of shopping centers where a good (or a variety of goods) can be sold to attracted customers. It is clear that in this case the customers, and not the firm, will decide where to go shopping, and everybody tells us that they will not always go to the nearest shopping center. A behavioral model that assumes that customers will choose only the nearest facility is a poor model for real behavior; shopping behavior is determined by many rational and nonrational factors: differences in taste, imperfect information, trade-offs between distance traveled and quality (or price) of goods, competition with other shopping centers, and so on.

These two examples have been taken from the private sector, but they can be easily generalized to public facility problems. There are many similarities among customer-choice processes relating to shopping centers, high schools, hospitals, libraries, theaters, or even places of work and residence. These similarities suggest the need for a new interdisciplinary modeling effort.

Closely related to the question of customer behavior is the definition of the role of the decision maker. The two problems are intimately tied together even in the simplest cases, as can be seen from the two examples given above. In the warehouse location problem, the same decision maker (the firm) decides both the location of facilities (the warehouses) and the trip pattern (the delivery of goods from the warehouses to the demand points). In the shopping center location problem, the firm decides the location of facilities (the shopping centers) but not the trip pattern, which instead results from customer choices.

Such examples can also be found for the public sector. For instance, in a primary school location problem the same decision maker (a public authority) usually decides both the location of facilities (the schools) and the trip pattern (the assignment of children to schools). This is not true for a post office location problem, where the public authority decides the location of facilities (the post offices), but cannot force the customer to always use a specific facility.

The general issues raised by these examples are the amount of control a decision maker can exert and the relationships between the goals guiding his decisions and the goals guiding those of the customer.

It usually makes a big difference whether the decision maker is maximizing his profits, as in the shopping center example, or maximizing customer welfare, an obligation of every public authority. It also makes a difference whether the location questions are posed in a market economy or in a planned one, since many private problems in the former become public problems in the latter and vice versa.

Costs and Constraints

Some questions related to costs and constraints in location problems are well known and lead to discussions of a very technical nature; these will be mentioned but not pursued here.

These questions touch on the introduction of economies of scale in the cost of establishing the facilities and the indivisibility requirements placed on the units to be located. In the mathematical literature, problems of this sort are known as nonconvex and combinatorial optimization problems. The difficulties associated with solving them still constitute a challenge for applied mathematicians.

Two other problems related to costs and constraints deserve more detailed discussion here. One is related to costs – not so much the way cost functions are modeled as where the money to pay the costs comes from. Most location problems are formulated as if there were no direct relationship between the customer using a given kind of facility and the money available to establish and operate the facility. It has been shown, however, by means of some simple examples that charging prices to customers and adding the resulting revenue to the available budget usually improves the overall performance of the system, not only in private, profit-making cases but also in the case of a public authority concerned with customer welfare. If this is the case, why should we think of location problems only as pure "physical planning" problems (i.e., location and size being the only decision variables), rather than allowing pricing policies to be introduced as well? And why shouldn't we also introduce taxation policies? The new type of location problem would then have a list of decision variables made up of the traditional physical ones (size and location of facilities), plus some suitable pricing and taxation rules.

When a stock of facilities already exists, however, the location of new facilities may not be required; instead, pricing and taxation policies may become the main tool for providing equitable access to all customers. Education, health care, and housing are typical examples of urban services where taxation policies, welfare schemes, and public allowances are much more effective than geographical distribution.

The issue of constraints does not so much concern the topology of the set of feasible location patterns, but rather the proper definition of constraints arising from the existing environment in which a location problem usually has to be solved. Indeed, most location problems are formulated for very improbable human settlements where there is demand, but no available facilities. This formulation, artificial as it is, does not constitute a serious limitation in many *developing* countries, where the stock of existing facilities is limited. However, this is not the case in most developed countries. Every kind of facility already exists in most urban areas, so the literal implementation of an "optimal" location pattern, as would follow from the above formulation, would result in a crazy pattern of demolition and reconstruction. Something is therefore missing in the standard formulation: expanding or demolishing the existing stock of facilities is not accounted for in the usual list of decision variables, nor is the implied cost of such actions. Decisions to expand or demolish lead to a dynamic formulation of the location problem, since they cannot be considered on a daily basis without taking into account the future performance of the system. As with pricing and taxation policies, capacity expansion or reduction may be needed even when new locations are not required. When many facilities already exist, decisions to locate new ones may be unreasonable, but the fluctuation of demand over time and space may require adjustments in the size of the existing facilities.

National Food Policies in an International Setting

K.S. Parikh*

IIASA's Food and Agriculture Program (FAP), which began in 1976 under the leadership of Ferenc Rabar of Hungary, has the following objectives:

- To evaluate the nature and dimensions of the world food situation;
- To identify factors affecting it;
- To suggest policy alternatives at national, regional, and global levels;
- To alleviate current food problems; and
- To prevent future problems.

The program initially focused on policies for a 5–15-year time horizon, but it soon became clear that a longer-term perspective is also required for a comprehensive understanding of the world's food problems. For this reason the original objectives were supplemented with the following qualification:

Solutions to current problems should be consistent with paths that lead to a

- sustainable,
- equitable, and
- resilient world,

that can meet the food needs of the global population, which may double by 2030.

Two major tasks have been organized within FAP to tackle the Program's objectives: Task 1, called "Strategies: National Policy Models for Food and Agriculture", explores current short-term policy problems; Task 2, entitled "Technological Transformations in Agriculture: Resource Limitations and Environmental Consequences", investigates the questions raised by a long-term perspective. In this article I will describe the background, issues, approach, point of departure, and the status of these two tasks in turn, and will also indicate the connection between the tasks.

Task 1: THE FOOD PROBLEM – PRESENT AND PRESSING

What is the food problem of the world? What are the problems of developing and developed, exporting and importing countries? What are the major short-term and long-term concerns?

We began with the following set of perceptions:

- Though adequate amounts of food are available globally, large numbers of people go hungry in the world today. This is true even in nations that have sufficient food on the average, because of improper distribution of income and food.

  That the extent of the problem is significant is obvious from estimates of the number of people in absolute poverty. The World Bank estimated that around 780 million people did not have enough income to buy adequate food and a minimum of clothing in 1980 in developing countries (excluding China and other centrally planned economies). The FAO estimates show that in the 1972–74 period 455 million people in these countries had food intake below the critical limit.
- National policies calling for increased production and/or more equitable distribution are of greatest importance in dealing with the problem of hunger.

  Increasing food production in food-deficient countries may seem to be the obvious answer to meeting the problem of hunger. But the production increases we may anticipate from trend rates in the developing countries will be inadequate and in fact would lead to reduced self-sufficiency in food production. Both increased availability of inputs and capital resources and effective national policies to persuade producers to increase their output are required to step up agricultural growth rates beyond current trends in developing countries.
- Although national governments are the highest decision-making bodies in the world, the interdependence of nations may have a critical effect on many national policy options. Trade in food and agricultural products forms a sizable part of the total trade of many countries, and these countries are affected by the policies of other countries.
- The uncertainty inherent in agricultural production implies that even normally self-sufficient countries may need to depend on trade in exceptional years.
- The agricultural sector is embedded in the national economy and should be studied in that context. In most countries food and agricultural policies dominate economic policies, since food prices affect everyone.

In summary, we conclude that the problem of inadequate food consumption by a large number of people results from insufficient income and improper distribution, and is accentuated by uncertain climatic conditions. The food problem is mainly amenable to national policies that in turn are constrained by the actions of other countries. Thus the global food and agricultural system is best viewed as a set of interacting national agricultural systems, each embedded in national economies and affected by the policies of national governments.

Issues and Approach for Task 1

The major question that emerges from the above discussion is, What national and international policies promote agricultural growth, encourage efficiency in production and reduce inequities of distribution? A number of specific policy questions follow from this broad question:

National Policies for Growth:

- What is the impact of price policies? To what extent do price incentives lead to increased production?

Continued page 4

*Professor Kirit Parikh, from the Indian Statistical Institute, New Delhi, was with IIASA's Food and Agriculture Program from 1976 to 1978 and rejoined the program in May 1980 to serve as Acting Leader.

Continued from page 2

Some Conclusions

Pricing, taxation, expansion, and reduction considerations pose a new challenge for location research. They suggest that optimizing location is an unnecessarily restrictive approach to urban management and not necessarily the best one. The goal of improving access to urban services can be reached by using many other tools, and the resulting decision problems require the development of new models and techniques.

Models of customer choice also deserve attention in future research activities. Although the literature on location models deals with this problem unsatisfactorily, much progress has been made in related fields, such as transport models and housing-market models. An interdisciplinary effort would therefore greatly improve the state of the theory and applications of customer-choice models.

A third theme for future research underpins the whole discussion, although it has never been stated explicitly. On the one hand, when the locations of some facilities are changed, new traffic flows of people and goods are generated, thus affecting the transport network. On the other hand, a new geographical distribution of facilities causes a new distribution of land values and residential preferences. As well, changes in the transport network and in the location of households lead to changes in facility locations. A true systems approach is therefore required, taking into account interactions among the main subsystems of the urban system, including housing, transportation, and other services.

National Food Policies in an International Setting

Continued from page 3

- What is the impact of the development of irrigation on production, prices, and consumption?
- How do fertilizer availability and prices affect agricultural production?
- What is a desirable pace for the introduction of advanced technology and mechanization?
- How does agricultural growth affect employment and migration patterns?

National Policies for Equity:

- Does a price increase in the cities benefit the farmers in the countryside? Does it reach the small farmers?
- When the average agricultural income goes up, do the poor farmers benefit?
- How can sufficient food be provided to poor consumers? How effective are public food-distribution programs?
- What role can a food-for-work program play in relieving rural poverty?
- How do changes in landholding patterns and in tenancy structure affect production and consumption?

National Policies for Stability:

- Is price stabilization desirable? Do stable prices benefit producers?
- What is an appropriate national buffer stock policy for stabilizing prices?
- How can a stable income for farmers be ensured? What are the costs and benefits of alternative schemes of deficiency payments and land reservations?
- What is an appropriate agricultural self-sufficiency target for a country? How can this be realized? Is food aid or general aid more effective?
- What are ways of effectively utilizing food aid?
- What are appropriate trade policies? To what extent should the country insulate domestic markets from world markets? What are the impacts of trade quotas, tariffs, and export incentives?

International Policies:

- Would adoption of large-scale programs of alcohol production/energy plantations be effective in energy-deficient countries with a food surplus?
- Would it be beneficial to establish an international buffer stock agency that tries to ensure that prices for specific commodities remain at a given level or remain within a prescribed range?
- Would it be worthwhile to pursue international agreements to keep world market prices at given levels by adjusting internal prices for all nations or for a subset of nations?
- Could one devise a compensatory finance scheme in which developing nations are indemnified against adverse developments on the world market to implement the agreement proposed in the above policy question?
- What are the costs of establishing a buffer stock of the size required to withstand a shock such as might result from a series of crop failures? Who would bear the costs?
- Would it be possible to implement international food transfers of the size required to banish hunger within a prescribed time limit?

Policy Evaluation

Growth, equity, stability, and sustainability — both political and ecological — may be considered the general objectives of the economic policies of national governments. Specific policy instruments, even policies relating primarily to agricultural issues, have to be evaluated in the context of these larger objectives.

A policy analysis framework, or model, is needed to help determine the impact of alternative policies on different national objectives. Descriptive general equilibrium models of open national economies linked together in trade, aid, and capital flows can provide such a framework. In IIASA's Food and Agriculture Program such models are used to attain the Program's objective of evaluating short- and medium-term policies to alleviate food problems.

National policy models are the basic elements of the FAP system of models. A particular national model must reflect the specific problems of interest to that nation. For this reason the national models differ from each other in their structure and in their description of government policies. Still, they must have a common sector classification, use the same units, and conform to some additional, fairly reasonable, technical requirements. Even though the national models differ from each other, their broad structure is similar. Thus they can be linked.

It may be noted that any international agency — such as a buffer stock agency — can be represented as an additional nation and linked to other nations. Thus the effectiveness of the agency's policies can be evaluated in a framework in which national policy makers react to the policies.

The approach used in the FAP is certainly ambitious; but if the policy issues raised here are to be adequately explored, we believe that such a level of complexity is unavoidable.

A Network Approach

It is not feasible for one Program within an institute of IIASA's size to attempt to build detailed national agricultural policy models for all the countries of the world. Clearly we had to select a limited set of countries to include in our analysis. Fortunately, it proved possible to restrict the number of countries to a feasible size and still cover the world agricultural system adequately for the analysis of the policy issues under examination.

The 21 countries or groups of countries with common agricultural policies listed in Table 1 account for nearly 80 percent of the important agricultural attributes of the world, such as population, land reflecting potential agricultural productivity, actual production, and imports and exports. Most of the remaining countries of the world have only a very small impact on the international system and thus can be treated as one group — "the rest of the world".

But even the development of 21 policy analysis models is a task that goes beyond the resources of a single organization like IIASA. Fortunately, IIASA provides the opportunity to capitalize upon the efforts of a number of groups and institutions around the world by involving them in a collaborative research activity. This is the approach we have followed and today we have a network of 12 collaborating groups and institutions involved in developing the various models.

IIASA's Food and Agriculture Program started out with the development of methodologies for linking national models and for computing domestic equilibrium under the influence of government policies. Simultaneously the Program also initiated a few national case studies. The interaction between these two activities enriched the results of both. The national models have become more rigorous in conception, and the linkage and equilibrium algorithms now permit the evaluation of more realistic policy options.

The FAP research team subsequently also developed a system of simplified versions of selected national models and linked them together. This involved building a data bank at IIASA based on data obtained from international organizations. The development of the simplified sys-

Continued page 5

tem of models served to demonstrate the feasibility of linking various national models and to establish the computational efficiency of the algorithms that the Program had developed.

Specialists from different countries are now developing an intermediate version of the system of simplified national models, called the "basic linked system". This system has two purposes:

- It provides a background system for running an individual national model when it is ready, without waiting for the completion of all national models.
- It permits analysis of selected international policies and provides experience in policy analysis using the linked system.

On the one hand, IIASA provides its collaborative institutions access to its computational algorithms, its basic system of simplified national models, and its data banks. Moreover, IIASA's accumulated experience in building policy models can substantially reduce the time required to construct a detailed national model.

On the other hand, the collaborating institutions contribute knowledge and expertise about specific countries and commit manpower of their own to developing national models. Moreover, they serve as contact and dissemination points for national decision makers and serve to ensure that the work of FAP will find real-life applications.

Task 2: THE FOOD PROBLEM IN THE FUTURE

If one takes a longer-term perspective, questions about the availability of resources to produce sufficient food, the efficiency of agricultural techniques, and environmental consequences come to the fore.

The following trends will characterize the agricultural situation in coming years:

- Land will have to be cultivated with much greater intensity than at present.

  The pressure on land will arise from the increasing population; with increasing incomes this larger population will want to consume more animal proteins and other food. By the year 2000 more than 60 percent of the population in developing countries is projected to be living in countries where no scope exists for further expansion of arable land. At the same time, increases in yield of more than 60 percent are projected to be achieved between 1980 and 2000. All of these factors call for intensified cultivation of land.

- Significant increases in inputs will be needed to raise yields, and the costs of some of the inputs will rise substantially. The use of arable land is likely to reach its potential limits, and exploitation of water may approach its upper limits as well.

  The pressure on water resources will arise mainly from the limited availability of these resources. As the development of irrigation progresses to the limits of its potential, water will become more scarce and more expensive. This would be further accentuated by increased industrial use of water — such as for power generation. Increased urbanization and the improved sanitation standards of the growing population of the developing countries would also heighten the demand for water.

  Development of water resources becomes increasingly expensive, as the more accessible and easier-to-exploit sites are exhausted. Similarly, fertilizers will also become more expensive in the future, for the prices of fertilizer feedstocks (the most widely used being naphtha) are likely to rise with energy prices.

  A significant intensification of inputs is indicated by a look at the year 2000, which is only 20 years ahead. Ever greater intensification will occur after 2000.

- As the basic agricultural resources — land, water, and fertilizer — become more scarce and more expensive, a technological transformation of agriculture will have to take place. The required higher yields and changes in the relative prices of inputs will clearly lead to changes in agricultural production techniques.

- Increasingly expensive and uncertain energy supply will, on the one hand, intensify the pressure on land and, on the other hand, make it harder to obtain higher yields through conventional techniques.

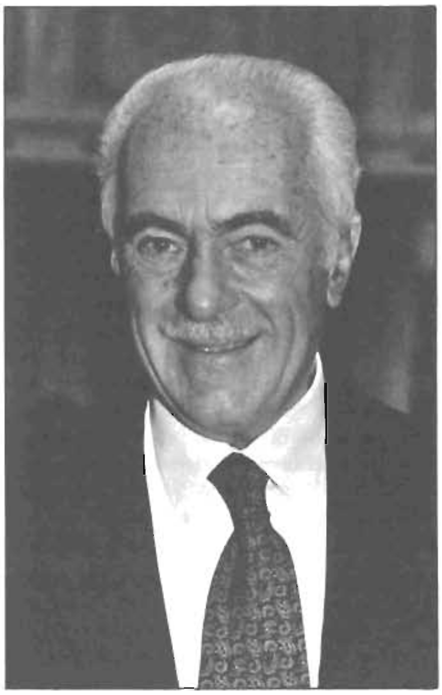
  Expensive energy increases the price of fertilizer and lift irrigation as well as tempts energy-deficient countries with food surpluses to use their land

Continued page 8

	Population	Production	Land	Imports	Exports
USA	5.3	12.3	9.8	8.07	18.85
Australia	0.3	1.6	1.3	0.25	5.00
New Zealand	0.1	0.5	0.1	0.14	2.09
Canada	0.6	1.2	2.0	1.99	3.25
EC*	6.4	11.9	3.3	38.83	26.05
Japan	2.8	1.8	0.4	8.36	0.05
Austria	0.2	0.4	0.1	0.62	0.31
Sweden	0.2	0.3	0.2	1.13	0.42
CMEA**	9.0	16.7	17.5	12.72	5.74
Subtotal	24.9	46.7	34.7	72.11	61.76
Pakistan	1.8	0.9	1.4	0.34	0.34
China	21.4	13.2	17.3	1.64	1.81
Nigeria	1.6	0.5	1.6	0.50	0.40
Argentina	0.6	2.0	1.7	0.14	2.86
Indonesia	3.4	1.6	1.5	0.64	1.02
Mexico	1.5	1.5	1.3	0.35	0.82
Thailand	1.0	1.1	1.1	0.18	1.23
Brasil	2.8	4.7	4.0	0.75	5.55
Bangladesh	1.9	0.7	1.1	0.34	0.11
Egypt	1.0	0.7	0.3	0.94	0.56
India	15.5	6.7	14.6	1.06	1.30
Kenya	0.3	0.2	0.2	0.06	0.33
Subtotal	52.8	33.8	46.1	6.94	16.33
Total	77.7	80.5	80.8	79.05	78.09

*European Community.
**Council of Mutual Economic Assistance.
SOURCE: Based on data from FAO's Production Yearbook.

Table 1. Share of total world population, production, land, imports, and exports of selected countries or groups of countries, 1976.



Second IIASA Distinguished Lecture

The challenges mankind will be facing in the coming decade and possible strategies for coping with them were the focus of the "Second Distinguished Lecture of the IIASA Forum on Applied Systems Analysis", held on November 21. Dr. Aurelio Peccei, President of the Club of Rome and one of the Institute's founding fathers, delivered the talk. Dr. Peccei suggested that challenges unprecedented in man's history will lead to a future qualitatively different from anything experienced in the past.

According to Dr. Peccei, the complex nature of the problems to be solved requires global managerial responsibility and new avenues of action. He particularly stressed the importance of a new way of learning: "In the past it was enough to learn how to keep situations as they were, to improve some of them incrementally. Now we have to learn how to innovate, prudently and boldly at the same time".

This presentation was the second in a series of "Distinguished Lectures" organized by IIASA on an annual basis. This series allows distinguished scientists to address the scientific and decision-making communities at large and to challenge them with syntheses of recent scientific developments. The first lecture in this series was delivered by Prof. George Dantzig in June 1979. It focused on "The role of large-scale optimization models in determining national economic models".

The text of Dr. Peccei's lecture, "Facing Unprecedented Challenges — Mankind in the Eighties", will be published by the Institute. Single copies can be ordered free of charge from the IIASA Publications Department.

National Food Policies...

Continued from page 5

for energy plantations. A large-scale adoption of alcohol programs by the current major food exporters could have profound implications for other countries and for the world food system. It would mean that the other countries would have to get even higher yields from their land.

- Estimates of the world's ultimate production capacity show a wide range. Some estimates show a potential to feed more than 8 billion people, while one indicates that as many as 150 billion could be fed. Some of these estimates do not account for environmental feedbacks, which may call into question the sustainability of the production techniques implied by these estimates.

Issues and Approach for Task 2

The technological transformation of agriculture that may be anticipated over the coming decades will thus be constrained by resource limitations and could have serious environmental consequences. This realization raises a number of important questions:

- What is the stable, sustainable production potential of the world? of regions? of nations?
- Can mankind be fed adequately by this stable, sustainable production potential?
- What alternative transition paths are available to reach desirable levels of production potential?
- What are sustainable, efficient combinations of food production techniques?
- What are the resource requirements of such techniques?
- What are the policy implications of sustainable production potential at national, regional, and global levels?

Stability and sustainability are desirable properties, with regard to both intergenerational equity and political stability and peace. Environmental considerations are of critical importance in answering the above questions.

Our approach differs from past approaches, for we hope to take into account both environmental feedbacks and economic considerations in an integrated framework.

In addition we will carry out a number of case studies that will help in validating our approach and in understanding the complexity of the system. The case studies will be selected so as to represent different agricultural and economic organizational systems. We will also obtain a global perspective.

Finally, the results of our work in Task 2 will feed back into the short-term strategy analysis models of Task 1 and lead to modifications of medium-term policies on the basis of long-term considerations of sustainability.

In Task 2 our attention will focus especially on the following elements:

- Description of existing technologies. Quantitative descriptions of production processes for crop production, livestock production, and food processing will be needed. In addition to conventional descriptions of inputs to production processes, associated quantified environmental effects (both harmful and beneficial) will be included in our activity analysis framework.
- Environmental feedbacks. Negative environmental effects at the process level will have to be aggregated to obtain region-level effects. These effects will have to be further translated into their impacts on the quality of the resource base. For example, it will be necessary to quantify how soil erosion changes fertility of soil from one period to the next.
- Detailed analytical framework and computer software. These will be developed at IIASA.
- Country case studies. At present the countries or regions within countries being considered for case studies are Hungary, Czechoslovakia, the USA, the USSR, Italy, Japan, Kenya, and Thailand.
- Global perspective. An integrated perspective will have to be formed from the case studies and supplemental analysis.

As in Task 1, we will follow a network approach here, especially for carrying out national case studies.

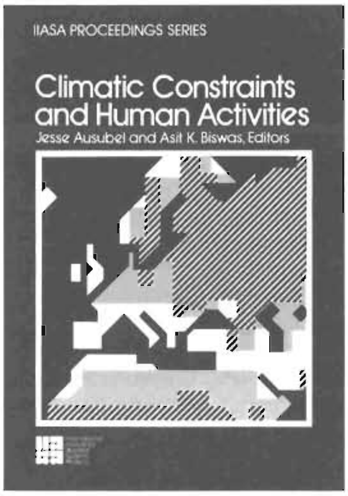
The two tasks are viewed as complementary. Both are essential to develop a real understanding of the food and agricultural systems.

The findings of Task 1 will provide a starting point for the scenarios of Task 2, giving a realistic basis for long-run investigations. In turn, the findings of Task 2 might modify Task 1's representations of permissible intensities of technologies. Present policies and actions may have to be constrained to keep options open for technological transformations in later decades.

New Books from IIASA

Climatic Constraints and Human Activities

In February 1980, IIASA organized a meeting on the "Nature of Climate and Society Research," the third major event in the field of climate studies at the Institute. The first such event, a meeting on "Carbon Dioxide, Climate, and Society," took place in early 1978. In April 1978, the Institute hosted the conjoint sessions of the "International Workshop on Climate Issues." It was organized by the Climate Research Board of the US National Academy of Sciences in preparation for the World Climate Conference of the World Meteorological Organization (WMO). After this promising start on international collaboration and research on climatic questions, climate was included in IIASA's research plan. To help define promising avenues of research with respect to climate, to explore the potential for climate-related research within IIASA, to coordinate IIASA's climate activities with outside groups, and to examine a possible role for IIASA within the World Climate Program, the Institute's "Resources and Environment Area" organized a third meeting in February 1980. This meeting provided the basis for the tenth volume in the IIASA Proceedings Series, *Climatic Constraints and Human Activities,* edited by J. Ausubel and A.K. Biswas.



The book contains a summary essay and seven invited papers written by participants at the meeting. The introductory essay examines the differences in research methods directed to questions of short-term climatic variability and longer-term climatic change, and identifies some important areas for future research. The following seven papers look at different aspects of the interaction between man and the climate system. For example, the paper by Dr. K. Meyer-Abich surveys, from a political point of view, the reasons why regulation of activities that could control or prevent climatic changes is unlikely to take place. Dr. Meyer-Abich explains why adaptation is the most likely path to be followed, especially given the current weakness of the interdisciplinary analysis of the problem of climatic change.

Climatic Constraints and Human Activities, edited by Jesse Ausubel and Asit K. Biswas, ISBN 0-08-026721-1, can be ordered from Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, England. The price is US $30.00.

Global Modeling: Input–Output Approaches

Ever since its creation, IIASA has assumed a monitoring role in the field of global modeling. Each of the first four global modeling conferences organized at IIASA was devoted to a major global model that was nearing completion. The models were presented and then discussed in depth by an international group of scholars working in the field. The Club of Rome–Pestel Mesarovic Model, the Model of the Argentinian Fundacion Bariloche, the Dutch food and agriculture model MOIRA, the SARUM Model developed by the Department of the Environment of the UK, and the MRI Models of the Polish Academy of Sciences were treated in this way.

The Fifth Global Modeling Conference, held at IIASA in September 1977, deviated from this scheme, for it was methodology-oriented rather than model-oriented. The main purpose of the conference was to make a critical (yet constructive) survey of the role that input–output techniques have played, and may play, in global modeling work. The first part of the conference was devoted to the foremost model in this field, "The Future of the World Economy," developed in the United States by Wassily Leontief, Ann P. Carter, Peter Petri, Joseph J. Stern, Richard Drost, *et al.*

The Japanese FUGI Model was also presented, although it is not entirely based on input–output models. The presentation included a survey of global modeling in the USSR.

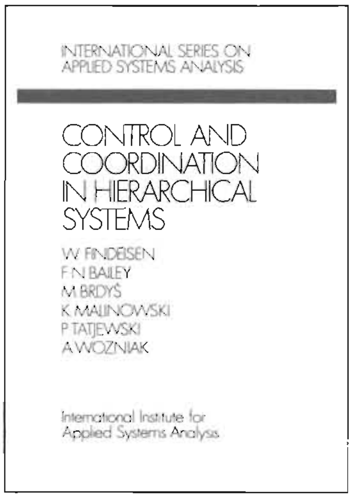
The last part of the Conference was devoted to discussion of other ongoing global modeling activities.

The proceedings of the Fifth IIASA Global Modeling Conference, *Input–Output Approaches in Global Modeling,* edited by G. Bruckmann, have just been released as volume nine in the IIASA Proceedings Series published by Pergamon Press. Twenty papers presented at the meeting, as well as the discussions they engendered, are included in the volume.

Input–Output Approaches in Global Modeling, edited by Gerhart Bruckmann, ISBN 0-08-025663-5, can be ordered from Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 0BW, England. The price is US $100.00.

Controlling Hierarchical Systems

Very often the control of complex systems is structured hierarchically. The reasons for such a hierarchical structure vary. For example, a hierarchy in an organization can extend the limited decision-making capacity of an individual. A hierarchical structure can help to overcome problems that arise when the different parts of a complex system are so far apart that communication is limited, when there are costs, delays, or distortions in transmitting information, or when subsystems need to make decisions autonomously using private information.



The problem of controlling and coordinating such complicated systems is the focus of the ninth volume of IIASA's "International Series on Applied Systems Analysis," *Control and Coordination in Hierarchical Systems.* This book is a joint product of W. Findeisen, M. Brdyś, K. Malinowski, P. Tatjewski, and A. Woźniak of the Institute of Automatic Control at the Technical University, Warsaw, and F.N. Bailey from the University of Minnesota. It presents a new theory of control and coordination in hierarchical systems – i.e., in systems where the decision-making responsibility has been divided. Because this theory has been designed to be useful for applications, it encompasses not only the basic, general, and abstract principles of coordination, but also such practical features as constraints, use of feedback information, time horizons, and the differences between models and reality.

The book is addressed to research workers, high-level practitioners, and students of control science and decision theory in organizations.

Control and Coordination in Hierarchical Systems by W. Findeisen, F.N. Bailey, M. Brdyś, K. Malinowski, P. Tatjewski, and A. Woźniak, ISBN 0471 277428, may be ordered from John Wiley & Sons Ltd., Baffins Lane, Chichester, West Sussex PO19 1UD, England. The price is US $67.50.

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