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Author(s): George Lindsey

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7-11 October 1974

SECOND IIASA SYMPOSIUM ON GLOBAL MODELLING

SUBJECT OF THE SYMPOSIUM

Although global modelling is not one of the research programs of the IIASA, it is of course a subject of the very greatest interest to applied systems analysts.

The premier effort, sponsored by the Club of Rome, carried out at the MIT by Forrester and Meadows, and subsequently given worldwide publicity by the book entitled "The Limits to Growth", has drawn severe criticism (as well as admiration) from many quarters, and has stimulated further efforts, of which two are attracting wide attention. One is the model associated with Mesarovic and Pestel. The main objective of IIASA's first symposium on global modelling was to expose this model for discussion and criticism. The other is the Latin American World Model constructed by the Fundacion Bariloche in Argentina. The main objective of the Second IIASA symposium on global modelling was to enable systems analysts from many countries to hear the presentation of this model. However, time was also allowed for brief reports from other institutions on a variety of studies connected in some way with large-scale modelling. The symposium was held in Baden, Austria, on 7-10 October 1974.

It should be emphasized that the role of the IIASA was to provide a forum for presentation, discussion, and criticism. The Institute was in no way associated with the projects discussed. In fact, the interest of IIASA's own studies is concentrated on the

problems of the developed countries, whereas the emphasis of the Latin American World Model is on the underdeveloped Third World.

FUNDACION BARILOCHE PARTICIPATION

The Fundacion Bariloche is located in San Carlos de Bariloche, Argentina. Their involvement in the global modelling project began with a meeting of the Club of Rome in South America in 1970. A committee was appointed in 1971, and after an initial contribution arranged by the Club of Rome, substantial funding was provided by the International Development Research Centre in Ottawa.

Many of the project team are not permanent staff members of the Fundacion Bariloche but hold other appointments, in many cases in Buenos Aires.

The directors of the various parts of this project are listed below:

| | |
|-----------------------------------|--------------------|
| Project Director | Amilcar Herrera |
| Co-Director | Hugo Scolnik |
| Natural Resources model | Amilcar Herrera |
| Demographic model and mathematics | Hugo Scolnik |
| Economic model | Juan Sourrouille |
| Education Model | Gilda Romero Brest |
| Energy model | Carlos Suarez |
| Food model and pollution model | Gilberto Gallopin |
| Health model | Abram Sonis |
| Housing and urbanization model | Jorge Hardoy |
| Social and political model | Marcos Kaplan |

Most, but not all of these directors were present at the Baden symposium, as were several other members of the project teams.

Each member of the team appeared to have impressive academic qualifications for his own subject, but as can be seen from the list above a very wide range of disciplines were represented. The modus operandi of the team permitted a considerable expression of individual opinion, and the symposium did not appear to be a carefully orchestrated team presentation of an agreed institutional position paper.

OUTLINE OF THE LATIN-AMERICAN WORLD MODEL

From the outset it was made clear that the "world model" is normative, that is to say that it attempts to point out the way to achieve desired goals, rather than to forecast what is likely to happen in the absence of a systematic redirection of effort.

The general objective is to improve the lot of the most underdeveloped parts of the world, if necessary at the expense of the developed countries. It is the belief of the team that this is physically and economically possible within a period of a few decades, but only if fairly drastic social and political changes are made. The concept is very much one of egalitarian socialism, firmly directed by the State. Political ideas permeate this model, to a far greater extent than for the earlier world models. Indeed,

there was serious misunderstanding over the meaning of the word "model", which could mean a collection of words and ideas to the social scientists, but a series of equations and computer algorithms to the physical scientists.

The measures of living standard selected for particular attention were food, housing, and education. Goals were set for all three, considered to represent a "decent minimum", actually 3000 calories per person per day, a house (or equivalent shelter) for every family plus buildings for public use, and twelve years of education for 98% of the population. The per capita Gross National Product is rejected as an adequate measure of standard of living, although it is retained as a key index of the economy and as a measure of growth. The function which is maximized in the computer model is the life expectancy at birth, which depends on food, housing, education, and other factors such as urbanization and health care.

The model does not attempt to reduce population growth, crowding or pollution directly. It does predict the changes in these variables as a result of changes in food, health, education, consumption, and industrial activity, based on historical experience. In general its concern is with the underdeveloped countries, but it suggests that the developed countries will need to curtail consumption and economic growth, and transfer a proportion of their resources to the underdeveloped world.

The outlook for depletion of the world's natural resources is more optimistic than the MIT model. The argument is made that only a very small proportion of the earth's crust has yet been explored for minerals, using the best techniques, and that ingenuity, efficiency

and substitution can compensate for such shortages as may arise. Oil may become scarce, but uranium will gradually replace it as the main source of energy. Crippling rises in price are not foreseen. It should be remembered that the time-scale of this model is rather short -- a few decades only.

The most serious obstacles to adequate provision of food are believed to be socio-political. The model claims to demonstrate that the area of usable land, properly farmed (with appropriate use of capital, labour, fertilizer, and irrigation) is sufficient to provide the 3000 calories for everyone in a considerably enlarged world population.

The world is divided into four sectors:

- (1) Europe, USA, USSR, Japan, Canada, Australia, New Zealand, Israel, Lebanon
- (2) Latin America and the Caribbean
- (3) Africa
- (4) Asia, including Turkey, and Oceania

Countries with populations below one million are ignored.

PRELIMINARY RESULTS OF THE COMPUTER RUNS

The computer was programmed to accept a very large number of relationships among the many variables, and to place a large number of constraints on the maximum practical rate at which changes could be effected. It then distributed resources, within each of the four world sectors, so as to maximize life expectancy for the coming year. The process was repeated annually. Because of the great differences in the costs of attaining the minimum levels of food, of education and of housing, (increasing in that order), progress was most rapid in nutrition and slowest in housing.

First it was assumed that no aid was given between sections. For this case the Developed Countries attained the desired minimum levels within a few years, and Latin America within about forty years. Once the minimum levels are attained, consumption and economic growth are curtailed in order to conserve natural resources and reduce pollution. However, for Africa and Asia the economies are unable to provide the desired results, are overcome by the rapidly increasing population, and show living standards which rise slowly at first, but eventually turn downwards (first in Asia, just before the year 2000, and then in Africa just after 2000).

Next, it was assumed that aid, in the form of capital, goods, money, and technical assistance, is contributed by the DC's to the UDC's, within constraints and according to specified priorities. It would amount to 2% of the GNP of the DC's by 1990. Naturally this has an adverse effect on the donors, but it allows Asia to achieve the minimum standards in 57 years and Africa in 65 years. The population growths came down, eventually achieving equilibrium.

The report concludes with the assertion that "the developed countries, by allocating to economic aid half the funds they are now devoting to the arms race, can decisively contribute to rescue more than half of mankind from its present misery".

CRITICISMS OF THE BARILOCHE MODEL

A primary purpose of this symposium was to expose the work to expert criticism. In the event, this is exactly what did occur. Criticism was offered by many participants, always in a courteous and constructive manner, but in some cases of a rather devastating nature.

Perhaps the most serious questions concerned the optimization model. It assumed that the plan for year $(n+1)$ was calculated on perfect information for year n , and that effects would follow causes with zero delay (i.e., complete feedback with no lag). There was scepticism regarding the wisdom of "myopic" one-year planning when the results were clearly going to take many years to achieve. It seemed very probable that inefficiency, incomplete information, and imperfect cooperating (including outright conflict) would produce results far inferior to the assumed ideal. As an offsetting factor, it was also probable that technological innovations would improve the efficiency of some processes well above the levels assumed on the basis of present knowledge.

A partial answer to some of these criticisms was made by a proposal to alter the computer model, and it was even possible to run a couple of variations through the computer in the course of the conference. In one variation, an allowance was made for improved technology, applied to the underdeveloped economies in the future on

the basis of experience with developed economies in the past. The result was to expedite the development of Africa and Asia very considerably. For example, the prediction for Asia in the year 2000 without aid changed from 63.8 to 75.1 years life expectancy, 0.31 to 0.89 houses per family, and \$118 to \$658 GNP per capita. In the other variation, it was assumed that the improvements would be less than the theoretical potential and would appear with a delay. Applied to Latin America, the overall effect on the prediction over the next thirty years was not very great.

Another reaction by the mathematical group was to devise a new algorithm for the computer which would allow a particular value of some objective function to be attained in the minimum time, subject to constraints.

The speed (and willingness) with which the mathematics group were able to reprogram the computer to accommodate changes in the inputs, assumptions, or constraints gave evidence that the computer was the servant and not the master of the project.

Some agreed with the selection of life expectancy at birth as a suitable objective to be maximized. It was pointed out that this does not imply that total population is to be maximized. But there were others who would have preferred to maximize the proportion attaining some chosen age, while still others questioned the overriding value of a long life. An objection to choosing life expectancy at birth is that, in the absence of constraints, maximization would probably require a heavy concentration of health

care on the very young and the very old, which may not be consistent with support of the general health of citizens of all ages.

There were several requests for measures of sensitivity or stability of the model to small changes in the inputs. The designers were unwilling to provide the statistical measures usually employed to indicate these characteristics.

Except for the variations in which aid was given by the highly developed to the underdeveloped regions, the developing of each of the four regions was treated as if they were entirely self-contained. This criticism was answered by saying that neglect of the interactions among regions was equivalent to assuming them to be in equilibrium.

POLITICAL CONTENT OF THE BARILOCHE STUDY

Perhaps the most fascinating feature of the Bariloche study is its interactions of science with politics. Certain aspects such as the computer model and the treatment of natural resources, energy, and urbanization, were primarily objective and similar to the factors normally included in other examples of systems analysis (as was the case for the MIT model). But much of the economics and the treatment of education, demography, food, and health included assumptions or deductions that would be considered by many observers to have a large content of political judgement or even ideology.

The perspective of the Latin-American World Model is very much that of the underdeveloped Third World. The philosophy is clearly

anti-capitalist. But the USSR and the Second World appears no more popular than the USA or the First World. If there is a central ideology, it is egalitarian and internationalist, with great faith in central planning, and the efficacy of education in causing large numbers of people to cooperate in an efficient manner. The cruelest comment made in the public sessions, exaggerated but graphic, was that we were being subject to "computerized science fiction about a world dominated by economaniacs".

Much of the philosophy is revealed in a series of papers distributed at the symposium and labelled "preliminary report: not to be reproduced or quoted". Only a fraction of the material in these was presented verbally. It would not be fair to criticize these as if they were the final output of the Fundacion Bariloche. But they do offer proof of the far-reaching political content of the study.

No consideration was given to the means by which the plans could be implemented. Amongst the comments from symposium participants, there were congratulations for avoiding this subject, not the province of systems analysts, and also the prediction that implementation could only follow social and political world revolution.

CONDUCT OF THE SYMPOSIUM

IIASA administered the symposium, including invitation of participants, and provided the chairmen for the sessions. These were chaired with great skill, in a manner enabling incisive

criticism to be proffered, but without permitting the discussion to be diverted into political channels.

The Fondation Bariloche had not prepared their oral, visual, or written presentations with the care that might have been expected. They did, however, overcome the Spanish-to-English language barrier very creditably.

A press conference, largely for the benefit of Austrian television, did pose a language problem, since few of the Argentinians could speak German. However, between one of them and an Austrian member of the IIASA the interviews were well handled.

OTHER MODELLING EFFORTS

The last day and a half of the symposium was devoted to presentations by representatives of other groups. There was a common theme of modelling, though in most instances it was on a scale considerably less than global.

Two of the most interesting of these were about a multi-nation-link economic model, by Drs. Onishi and Kaya from Tokyo, and about food and population, by a team from the University of Amsterdam led by Prof. Hans Linnemann.

The Japanese study examined the economic interdependence between 16 advanced countries and 15 developing countries. It postulated a typical history of industrial development which began with low activity and the need to import, grew through self-sufficiency to a position of net export, and then declined until self-sufficiency was lost again. Forecasts were made on the

alternative assumption that the economies would be concentrating on development or on production. It was evident that a major objective of the study was to examine the relationship between growth in the Japanese economy and development of the poorer countries in East Asia.

The Dutch study was directed towards worldwide agricultural management, with the objective of being able to feed a population double that presently alive. Unlike the Bariloche model, which measured nutrition in calories, they used consumable vegetable protein, which aroused considerable discussion. The analysis dealt with the allocation of capital, labour, land, fertilizer, food, and energy, and assumed a fairly high degree of central planning.

Other activities described included:

Science Policy Research Unit, University of Sussex. R.C. Curnow and Dr. R. Clark

Global Modelling in Relation to the Developing Countries
Dr. M.S. Iyengar, Department of Science and Technology, New Delhi

Non-economic and Economic Factors in Societal Development: The General Production Function. Prof. J. Millendorfer and Dr. C. Gaspari
IIASA and Study Group for International Analysis, Vienna

Systems Research Unit, Department of the Environment, London.
Dr. P.C. Roberts

Department of Systems Science, City University, London, Prof. P.K. McPherson

Instituto Ricerche Applicate Documentazione Studi Rome Dr. E. Masini

Siberian Academy of Sciences Novo Sibirsk Academician Marchuk

Citizen Involvement in Education and Health Care Delivery,

Dr. I.M. Jarett, Southern Illinois School of Medicine

A Comparison of Models and an Ecological Model, Dr. S.I. Ghabbour,
Cairo University

VISIT TO IIASA

The three Canadian delegates had various opportunities to talk with members of the IIASA staff during the symposium, and made a visit to the Institute at Laxenburg on 11 Oct. However, the impressions recorded here are necessarily fragmentary, and not based on any real familiarity with the Institute.

The striking feature of IIASA is the cohabitation of scientists from West and East. From all indications, the choice of projects and the atmosphere are allowing useful cooperation to develop.

In addition to the research produced by its own resident staff, several of the Institute's other activities may well turn out to be equally valuable. The Handbook of Systems Analysis, expected to cover many subjects such as foundations, methodology, applications, case studies of failures as well as successes, bibliographies, and lists of workers and projects, will be organized and edited by IIASA staff, but most of the writing is expected to be done by others. Already there have been opportunities for the Institute to serve as a clearing house to put organizations in touch with others equipped to cooperate. And the symposia such as

the one described herein provide a unique forum for the exposure of new projects to truly international audiences.

Still in its early infancy, IIASA has not yet settled down to a stable existence. But there are real concerns over finance, and the provision of high quality research staff to replace the "first generation" which will be departing in the coming year. To date, recruiting has been mainly on an individual basis. But one aspect of staffing which may deserve further attention is the establishment of understandings with institutions in the sponsoring nations which would be able to provide (on a rotating replacement basis) a suitable staff member.

Efficient management of frequent large international symposia requires a very competent administrative staff. This IIASA clearly has. It is also needed for the many forms of support required by scientists, many coming from distant parts of the world, some with families and some for short periods. Although English has been established as the working language of the Institute, it is obvious that there are important language problems to be faced. It appears that very good use has been made of the varied talents of the wives of staff members, many of whom have part or full-time employment in the administrative structure. As well as contributing to the multinational character of the staff, this prevents many of the difficulties likely to arise due to loneliness or lack of contacts during a prolonged stay in a foreign country.

Perusal of the institutions from which conference visitors come suggest that quite a few would not be able to attend except

with the financial support of IIASA. This must represent a considerable sum of money, but it is responsible for much of the value of the conferences.

It is fervently to be hoped that this excellent administrative support, together with other facilities such as the library and adequate travel funds (both for residents and visitors) are not cut back in economy drives in such a way as to undermine the effectiveness of the resident scientists or of the conferences.

CANADIAN COMMITTEE FOR THE IIASA

It is obvious that the IIASA depends on the active and sympathetic support of its National Member Organizations. This involves many services, from helpful criticism of the research program through provision of Canadian financing and finding of suitable recruits for the scientific staff, to arrangements for appropriate participation in IIASA conferences.

Even in the early stages of its existence, a very considerable quantity of paper (partly administrative and planning, but, increasingly, reports of research completed or in progress) has come back from Laxenburg, and it is the Canadian Committee for the IIASA which has to disseminate these to the proper people in Canada. In the reverse direction, IIASA is very anxious to receive reports of systems analyses conducted in Canada. These could be in any one of a wide variety of fields, for example, science policy, communications, energy, urban studies, or water resources. The occasion of the 11 Oct visit was used to give IIASA material concerning the work on metagame analysis being conducted by the CONAN institute in Ottawa.

It is probable that the national member organizations are going to be asked to contribute to editorial boards for the supervision of IIASA publications.

In many ways, the CCIASA has a responsibility for switching traffic between the various appropriate people in Canada and the Institute. This task is likely to grow as IIASA develops, produces more publications, and broadens its international contacts. Its growth will follow that of systems analysis itself, which is clearly expanding at a rapid rate.

To date, CCIASA has managed to discharge its responsibilities very efficiently, due in the main part to hard work by a very few members of MoSST. The workload will probably increase, and it is to be hoped that the means to discharge it will continue to be provided.

G. R. Lindsey
Chief
Operational Research and Analysis Establishment