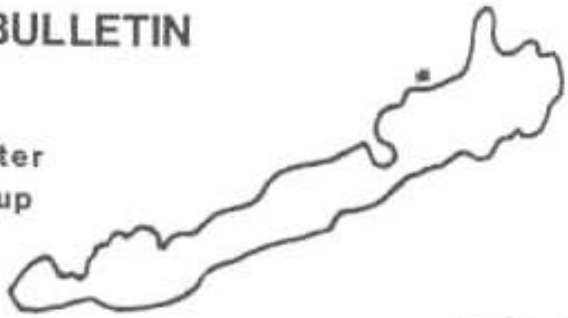
THE BALATON BULLETIN

A quarterly newsletter
of The Balaton Group



MAY, 1983

CONTENTS

Preparations for the Second Annual Meeting....1
Reports from The Balaton Group 2
The Electronic Mail System 7
Fund Raising Efforts....7
Job Openings 7
Interesting Meetings 8
Publication of the Book....9
The Sustainable Agriculture Project 10
Resource Dynamics Models and Textbook....12
Conference Questionnaire 17

PREPARATIONS FOR THE SECOND ANNUAL MEETING

It is time to begin plans for the technical content and the administration of The Balaton Group's second annual meeting. In this section of the newsletter I will tell you where things stand at present and then ask you to offer your opinion on several questions about the meeting. The last page of this newsletter is a formal questionnaire. Please fill it out and send it back at your earliest convenience. The information you provide on it is an essential input to our plans. Most of the items are self-explanatory. But I will add some information below that may be helpful to you in completing the form.

Purpose: During the second meeting we need to re-examine and perhaps revise our purpose statement to reflect our collective experience over the past year. Then we must work out the details of a three-year program for The Balaton Group and agree on a joint effort to raise the funds that will be needed by our member centers for each of them to carry out their part of the group's total program. We should also discuss criteria for membership in the group and participation in its meetings. That done, we should identify several new groups who will be invited to join The Balaton Group.

Date: We agreed at the end of the first meeting to reassemble September 3-9, 1983 in Hungary. Recently, however. The Club of Rome announced that it will hold a meeting in Budapest

September 26-30 on the topic, "Feeding Six Billion." This issue is of substantial interest to The Balaton Group, and the two organizations have several members in common. Thus someone has asked about the possibility of postponing our meeting for one or two weeks. Probably it will be impractical to change the date for our meeting this late.

The Csopak conference facility may be unavailable, and many of our members may have other commitments. However, the question is worth exploring, and I would like you to rank different conference dates on the questionnaire.

Membership: It may be appropriate to invite representatives of several new centers to the conference this year. I would appreciate receiving any nominations you may care to offer. Of special interest would be high quality institutions in the Third World. Please review the membership criteria listed on page 2 of Balaton Bulletin #2 before deciding which groups might be suitable.

Finances: I announced to many of you earlier that we had received a grant from the United Nations Environmental Program to support some activities of The Balaton Group. While we probably will get support from UNEP, my announcement was based on incorrect information; no grant has yet been officially awarded. That means we currently have no funds to provide in support of travel expenses to the meeting. This will likely change before the meeting, but there seems little prospect of total support. Therefore I would appreciate your looking to your own institution and to organizations friendly to your group to see about securing the funds you will need to arrive in Budapest. On the other hand, no one who came last year should be denied participation this year just because of money. If you absolutely cannot find the money you need for travel, list your requirements on the questionnaire. I will try to find modest funding for a few of the Balaton members. Of course all your room and board expenses in Hungary will be covered once again by our gracious Hungarian hosts.

REPORTS FROM THE BALATON GROUP

Jane King , Population Division, UNESCO, Paris

Jane has secured approval from UNESCO to host one or two interns from Dartmouth for the summer. These students will work on the Carrying Capacity project in Paris and will likely participate in the September meeting. The Kenya case study has been approved to start in late August? there is seed funding for the Sri Lanka (Marga Institute) and the Thailand (Mahidol University - Tuntawiron) studies. The Koreans have also expressed an interest in joining the study. Jane would like to organize a meeting of the principals along with interested members of The Balaton Group. She asks about the possibility of inviting potential future collaborators in the Carrying Capacity project to the second Balaton meeting.

Horacio Menano, Gulbenkian Foundation Institute, Portugal

Horacio participated with Hartmut Bossel in a UNESCO Working Group meeting on Long-range Scientific Forecasting in Rome April 26-29. The session was organized by Augusto Forti,

Interim Director of the Division of Scientific Research and Higher Education in the Science Sector. It was held to gain insights about future directions for some of UNESCO's programs. Among the recommendations of the group was:

" 1. - Innovative international and interdisciplinary research efforts presently underway should be strengthened.

The Working Group recommends that interdisciplinary undertakings be supported by UNESCO whenever the quality of the researchers involved and of the output produced justifies the effort. It is important for success, however, that UNESCO support only those international undertakings, which can be expected to make significant contributions on their own.

The Working Group recognizes as pertinent in particular the research programs of the International Federation of Institutes of Advanced Study (IFIAS), of the International Network of Resource Information Centers (INRIC, also known as 'The Balaton Group'), and of the International Institute of Applied Systems Analysis (IIASA)."

Horacio remains interested in organizing a teaching seminar at the Gulbenkian Foundation in 1984 on topics related to the work of The Balaton Group. It is projected to last two weeks; to involve scientists, administrators, and researchers; and to address "Linking Systems Analysis and the Management of Natural Resources."

Hartmut Bossel, The University of Kassel, Kassel, F.R. Germany

Hartmut is directing his environmental systems analysis group on a project to develop sustainable energy concepts for the city of Kassel (180,000 inhabitants) . The work was commissioned by, and is done in close collaboration with, the city council. The procedure is to map the local potential for conservation, renewable energy sources, decentralized systems using co-generation of district heat and electricity, etc. Four feasible and competing paths for the next 50 years will be devised and compared with regard to their relative merits. The goal is to find a strategy to provide energy services with the least social and ecological costs in a flexible and resilient way, keeping as many options as possible open.

Work is also being completed on a project to determine the potential of small scale hydropower in the state of Hesse. In this hilly part of Germany many mills along small streams produced electricity well into the 60's and 70's. The equipment is still there, but the big power companies have succeeded in closing down practically all of these plants due to very restrictive conditions. The project is funded by the state government and makes extensive use of computer-drawn maps.

The group is also continuing work on the simulation of forest ecosystems. Work has been completed on models for ecological succession (a 280 page report has been published in German), and the group is now focusing on the effects of acid rain on the different parts of the forest ecosystem.

The work on cognitive systems analysis has been completed. An 80 page summary report on "Cognitive Systems Analysis, Processing of Concepts and Simulation of Behaviour" has just been published (in German). In this work the likely response of actors (from the Social Democratic, the Christian Democratic and the ecological parties) to energy and environmental problems was simulated using cognitive maps of their knowledge and values and the non-numerical simulation procedure DEDUC.

Hartmut is now on a sabbatical at the Resource Policy Center of Dartmouth College until August 25th. He is doing work for the sustainable agriculture project and for the book on resource dynamics.

Ivan Futo, Institute for Coordination of Computer Techniques, and Etele Barath, Institute for Town and Regional Planning, Budapest, Hungary

Ivan and Etele are collaborating on a project that examines the effect of geographical patterns of energy use on the long-term development of a region. During 1983 they intend to expand their spatial model. Their work will include:

- conceptualizing the model's primary levels for the 195 urban districts specified in the National Physical Plan,
- defining the variables and relationships among country-wide and county-wide levels in the model,
- elaborating submodels and defining criteria to govern their integration into the model. These should be developed especially to facilitate integration of the energy demand submodel, and
- simulating a preliminary version of the model with a variety of objective functions; test and adjust the sample model; prepare a summary report

They intend to develop long-term forecasts for the important sectors of society, disaggregated by urban districts. They will include projections for:

- industry
- demography,
- housing,
- water supply,
- energy
- agriculture
- welfare infrastructure,
- recreation and tourism
- transportation, and

From this work it should be possible to develop much better forecasts of long-term energy demand.

Victor Gelovani, Institute for Systems Studies, Moscow, USSR

Victor reports that his department is working on 7 main topics for their contribution to The Balaton Group's book:

1. Human resources
2. Capital
3. Mineral resources
4. Energy
5. Resources of agriculture
6. Forest, water, soil
7. Resources of atmosphere and climate.

Plans are to complete this work and submit drafts of the papers in April.

His team has worked out a set of programs simulating individual resource sectors for use in the management game. These programs are written in DYNAMO Unfortunately the DYNAMO compiler available to his group makes it impossible to link up the sectors of the model. Either they will get an improved compiler or change the language of the model to PASCAL.

Maurice Levy, Universite Pierre et Marie Curie, Paris, France

Maurice has been working to identify an institute in France that might become a member of The Balaton Group. One possibility is the effort headed by Michael Grenon, formerly of IIASA. Michael has organized an all day meeting at his place, in Sophia Antipolis (near Nice) which Maurice attended on 11 February. Other participants included Guillemin (mineral resources, from BRGM), Margat (water, also from BRGM) and Michel Batisse, Deputy-Director General for Environmental Affairs at UNESCO. The group, to whom Maurice explained the Balaton philosophy, reached the following conclusions:

1) They think that a French group looking at the problem of resource interactions is important and needed, even if it is not affiliated to the Balaton network.

2) They believe that an essential resource which did not appear to be covered, except perhaps indirectly, in Balaton is space (land use, if you prefer) . Talking of "beauty" may not cover all the aspects of the problem. Batisse went further in talking about the "four E's" as essential resources (in French): Espace, Energie, Eau and Especes (living species, including human life and genetic stocks).

3) The group felt that it was reasonable to choose, as a starting point, problems for which a sufficient quantity of preliminary studies have already been done, in order to be able to move quickly to the essentials. Two types of problems were discussed:

    a) The French Land Use Agency (DATAR) had established in the late 60's and early 70's an elaborate forecasting methodology and derived a diversified spectrum of scenarios for French development (ranging from the "business as usual" to the "unacceptable"). The idea would be to go back and look at this very comprehensive work from a critical point of view, taking into account the energy crisis and the new awareness for the resource problems and their interactions.

    b) The "Blue Plan" of Grenon has made a preliminary study of the environmental problems in the Mediterranean region. This second idea would use this work as a basis for a resource modelling exercise limited to the western part of the Mediterranean region (Spain, France, Italy, Tunisia, Algeria, Morocco), in which important interactions are taking place. The difficulty there is that one cannot, for a given country, separate the Mediterranean coast from the rest of the territory, since the decision making process takes place at the national level. A

country like France, for example, has far more interactions with the rest of Western Europe than with its Mediterranean neighbours.

The group finally decided to take the first programme, because it is easier and more self-contained, and it concentrates on "space," which the group felt was an important neglected resource.

For the time being, Maurice is the only link between French groups and The Balaton Group. The problem of enlargement will be discussed at the September meeting in Hungary.

Dennis and Dana Meadows, Resource Policy Center, Dartmouth College, Hanover, NH, USA

The Meadows visited Enrique Campos-Lopez in January and attended an exciting symposium in which he drew together several of the leading resource experts from various research institutes of North Mexico. The group analyzed the interlinked problems of falling water table, deforestation, overgrazing, immigration, and unemployment, and discussed how the different institutes could work together to produce an interdisciplinary framework for understanding the long-term development possibilities for the region. Dana and Dennis will take an intensive 10-day course in Spanish in July and then return to Saltillo for a workshop on System Dynamics. They also plan to visit Costa Rica, to meet resource analysts there and to look for a center that might join The Balaton Group.

Dennis is planning a trip to West and East Europe May 27-June 18. This will take him at least to Paris, Zurich, Vienna, Budapest, and Sofia. The last city is the site for the 14th Annual meeting of the International Simulation and Gaming Association (described later in this bulletin). He will work to plan the fall meeting and to meet with a variety of people and groups who are in a position to support The Balaton Group. If any readers of this letter have suggestions for additional cities or meetings Dennis might add to his tour to promote our general activities, let him know immediately.

Laszlo Kapolyi, Secretary of State for Energy, Budapest, Hungary.

Laszlo has just been honoured with receipt of the Hungarian State Award, which is offered once every five years to an individual who has made an , outstanding contribution to the country. He is planning a trip to the U.S. for several weeks in late June, and he will play a central role in the Club of Rome meeting in Hungary next fall.

Csaba Csaki, Karl Marx University, Budapest, Hungary

Csaba spent much of the winter in Iraq working on an FAO consulting project. In April he visited the U.S. to arrange for faculty and student exchange programs between his university and several schools in the United States. He will be in Mexico with Campos-Lopez during most of August.
Jorgen Randers

The bad news is that Jorgen will not be joining us at the second meeting. The good news is that he is staying home because of the imminent birth of his first child.

Leif Ervik

Leif has left The Petroeconomics Group for a position as senior planning assistant to the Director of the Norwegian National Oil Company.

THE ELECTRONIC MAIL SYSTEM

The Balaton Group members agreed last September that it was important to create an electronic mail system that offers the possibility of routine daily communication. Ultimately this system will be designed to run through the standard minicomputers we will acquire. To get started before we have solved all the technical and financial problems related to the microcomputers, we have developed a mail system based on TELENET and the Dartmouth College time sharing system. Dartmouth has a simple but versatile computer program specifically tailored for use in electronic mail. The user's manual for this has been distributed to all the principal centers in The Balaton Group, and Dartmouth has offered financial assistance to those who cannot afford the dollar costs of TELENET. The approximate cost is $30/month per user. Those connecting to the system so far are Malcolm Slesser, Dennis Meadows, Dana Meadows, Tom Adler, Enrique Campos Lopez, IIASA, and the Hungarians. Jane King expects to join the network within a few weeks. We will evaluate the utility of the system at the September meeting to determine whether it should be continued, expanded, or abandoned. Anyone receiving this newsletter who would like to join the system should write to Tom Adler for additional information.

FUND RAISING EFFORTS

This section of each newsletter should be used to report on the progress and the problems of joint funding efforts by two or more members of The Balaton Group. A Dartmouth request for $40,000 is being considered by UNEP. These funds would support participation by Third World centers in our network. A decision should be made in May. Jane King's Carrying Capacity project has been officially approved by the UN. Money is slowly becoming available to support the work.

JOB OPENINGS

The Resource Policy Center at the Thayer School of Engineering, Dartmouth College, wishes to appoint- a visiting faculty member for the 1983/84 academic year. We would appreciate it if members of the Balaton Group brought this job opportunity to the attention of anyone potentially interested and qualified. This position is for a one-year appointment, but possibilities exist for a continued association with the program. We are anxious to fill this opening, so anyone interested should contact us as soon as possible.

Applicants should have an earned doctorate and a teaching and research interest in one or more of the following areas: natural or human resource systems analysis, policy analysis, resource economics, systems modeling or operations research. The faculty member will be expected to

teach courses and advise students in the MS Program in Resource Systems and Policy Design. Opportunities exist for cooperative research efforts with faculty in the areas of resource management, energy analysis, transportation, environmental assessment and human resource management. Salary and rank will be consistent with the candidate's qualifications and experience. Starting date is negotiable, though we would prefer to have this person join our group during the summer 1983. Applicants should send their resume and the names of three references as soon as possible to Professor Thomas Adler, Resource Policy Center, Thayer School of Engineering, Dartmouth College, Hanover, NH 03755.

INTERESTING MEETINGS

The Fourteenth Annual Conference of the International Simulation and Gaming Association will be held in the National Palace of Culture in Sofia, Bulgaria, June 13-18, 1983. The conference will bring together a large number of scientists from Eastern and Western countries and provide them with opportunities to present their ideas in the field of simulation modeling and gaming, to exchange experiences, and to demonstrate games that are used or can be used in solving practical problems as well as in various forms of training. Of special interest will be computer-based business games. Many different computers will be available to facilitate demonstrations.

The conference fee is $100, payable on arrival. English and Russian will be spoken, and there will be simultaneous interpretation. Hotel reservation forms and conference registration materials can be obtained by writing:

N. Kolarov,
Secretary of the Organizing Committee,
XIV Open Annual Conference of ISAGA
Pionerski Pat 21, Sofia 1635 Bulgaria

Tel. 55-10-08, 5-68-11 (250)

The International Symposium on the Biosphere, will be held at Miami Beach, Florida, April 16-18, 1984. John Richardson has written to provide the following information. The symposium is presented by the Clean Energy Research Institute of the University of Miami in cooperation with the International Association for Hydrogen Energy.

The objectives of this symposium are to provide a forum for the latest research findings on the environmental effects of the above-mentioned activities, to consider what must be done, first to reduce and/or eliminate these effects, and then to improve the environment and the quality of life, not only for humans, but also for all the fauna and flora of the biosphere.

The symposium is intended for the environmentalists, ecologists, pollution experts, biologists, scientists, engineers and researchers from universities, foundations, industry, research laboratories, government agencies and international organizations, who are involved in research into environmental and ecological problems, their causes and solutions. The symposium will be open to others who may consider participation in the symposium beneficial to their present and future activities.

Three days of invited lectures, paper presentations and discussions are planned. The symposium committee welcomes your prospective papers or other presentations, and intends to publish the full-length papers soon after the symposium. Please send your typewritten abstract (approximate length: 200 words), together with title and authors' names, affiliations and addresses, as soon as possible, but no later than 1 October 1983 to:

Dr. T. Nejat Veziroglu
Director, Clean Energy Research Institute
University of Miami
P.O. Box 248294
Coral Gables, Florida 33124, USA

The corresponding authors of the abstracts will be informed by 15 December 1983. A two-page extended abstract must be received by 15 February 1984 to assure inclusion in the proceedings of condensed papers. Final manuscripts (the original and two copies) will be due 15 March 1984.

PUBLICATION OF THE BOOK

John Richardson had lunch with Carol Franco and Robert Runck of Ballinger Publishing Co., a subsidiary of Harper and Row. They publish books in the general area of our proposed textbook. They gave John several ideas about conditions for a successful publication; John summarizes the discussion below.

1. Checking out the market:

For a textbook to be considered, publishers would like to plan on a guaranteed sale of from 1500 to 2500 per year for several years. A normal first printing for Ballinger would be 3,000. Each year, they publish about 30 books.

It is important to collect detailed information - as detailed information as possible - about the potential market, specifically:

> What are the names of centers/departments which are teaching in this area and the names of courses that might use the book?
>
> Who teaches these courses?
>
> What is the enrollment; how often are they taught?
>
> What books are being used now?
>
> What is the format of those books; how much do they cost; how well are they selling?

The/ Ballinger staff suggested that we obtain copies of relevant syllabi as we'll as aggregate information including them as part of a proposal to a publisher.

2. Content and Market

Ballinger has no direct experience and could communicate little information about selling in foreign markets. They suggested that the international division of Harper and Row might be willing to market the book overseas. Their advice was to pitch the book to the U.S. domestic market, but with sufficient breadth to be more widely attractive. They were concerned about examples produced by particular national groups that would reflect national or regional parochialism.

3. Artwork

The amount of artwork that goes into a book affects its cost. Line drawings are not much of a problem, especially if they are provided by the authors. Photographs are, of course more expensive. Books with a wider market, are, of course, more attractive prospects. They can be printed in larger volume, lowering the cost per unit. Since artwork is a one-time, up-front cost, the projected sales are particularly relevant here.

Publishers can provide a more useful reaction to the design of a book and particularly to matters of artwork if the author(s) prepare an illustration list. This is a list, by chapter and page, indicating each type of artwork, where it fits into the text, and the type of idea it is intended to communicate.

4. Initial Review

Ballinger would be pleased to review a draft of even one chapter of the book to give a reaction and communicate ideas. Their review can be more useful if the authors are fairly clear about the market before submitting materials for review.

5. Supplementary Materials

They felt that our proposed supplementary materials made the book more attractive, especially the issue of Scientific American, if we could pull it off.

Members of the network could support the process of meeting with publishers by investigating potential markets in their own countries. I would suggest sending a draft outline of the book to a potential publisher and then setting up a meeting to get ideas about exploring markets. Then follow up. It would be particularly helpful if members of the network from Eastern Europe could write to John about potential markets and book publication in their countries. Obviously it is not necessary that we use an American publisher. However the U.S. is the largest potential market.

6. Authorship

It is important that the book not look like a collection of papers. The Ballinger staff suggested having one author or two and then listing additional participants "contributors."

REPORT ON THE SUSTAINABLE AGRICULTURE PROJECT

Debra Jones and Hartmut Bossel are working at the Resource Policy Center on the Sustainable Agriculture Project. (In-tribute to the states of New Hampshire and Vermont, where syrup made from maple sap is an important agricultural product, the project should probably be given the acronym SAP). Debra is collecting data on the state of organic agriculture in the United States, while Hartmut has access to data from Western Europe which the Oeko-Institute in Freiburg, FRG has collected. Hartmut also works in close collaboration with his colleague at the University of Kassel, Hardy Vostmann, who is the first and only professor of organic agriculture in West Germany.

In our work we use the definition of organic agriculture provided in a U.S. Department of Agriculture publication,

Organic farming is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic farming systems rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks, and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients, and to control insects, weeds, and other pests. (USDA, "Report and Recommendations on Organic Farming" July 1980)

From the survey of the data, some conclusions already emerge, which are strikingly similar on both sides of the Atlantic:

- Thousands of commercial farms in both Europe and the U.S. practice organic technologies to produce food.

- Yields on organic farms are on the average 5 to 10% lower than current national averages of conventional agriculture (but they are much higher than the yields from conventional agriculture even a few years ago).

- The labour requirements are some 5 to 10% higher, but total farm production costs are considerably lower (20-30%) because of lower costs for commercial fertilizers and pesticides.

- The total energy consumption (figured on a primary energy basis and including indirect energy consumption) is some 15 to 50% lower,

- Experience over several decades indicates that organic agriculture is sustainable at high yields, with no loss of soil fertility.
- Due largely to the crop rotation schemes used, pests are not a major problem in organic agriculture, even though no chemical pesticides are being used.

- A high level of plant-available nitrogen in the soil can be maintained without application of any chemical nitrogen fertilizer by crop rotations using legumes and by returning organic residues (crop wastes and dung) to the soil.

- Organic agriculture is a viable alternative to conventional agriculture even for the solution of food problems on a global scale. However, in order to be successful, it does require careful systems management.

Organic agriculture therefore does not at all imply the return to medieval agricultural practices. On the contrary, it efficiently combines science and the systems approach for high sustainable yields with a minimum of ecological deterioration and resource wastage.

Hartmut has developed a small dynamic model of agriculture which demonstrates some of the long-term effects of different modes of agriculture, but he will probably develop a more extensive model which could be used to test the consequences of more realistic management decisions.

RESOURCE DYNAMICS MODELS AND TEXTBOOK

Dana Meadows and Steve Chapra have circulated very rough, very preliminary drafts of chapters on human resources and water resources. Helpful comments are coming back from many of you. One of the most common replies is that the chapter must be based on clear simple models that capture the primary dynamics of each resource. Without that model base all we can produce is a boiled-down compendium of the material already in standard single-resource textbooks. With it, we can give deep structural descriptions of each resource and its inherent dynamics, and we can link resources together. Hartmut Bossel has written the following suggestions for the contents of those resource models.

The models to be developed for the textbook on resource dynamics should be able to deal with the most important environmental and resource issues on a regional as well as on a global scale. The structures of these models must therefore capture those essential relationships between the major system variables that are valid irrespective of region-specific quantification. Ideally, a model user would simply enter the parameters and constants peculiar to the region he wishes to study in order to obtain a reasonably reliable dynamic simulation of the behaviour over time to be expected.

Since the models are primarily to be used for teaching about resource dynamics and about interconnected resource and environmental issues, they must of necessity be relatively small (of the order of two to six levels). This means that too much should not be expected of them as far as accurate prediction of national (or even local) developments. However, in some respects the intention of the project is even more ambitious: it is expected that a decision-maker having a full understanding of the structural relationships and their dynamic implications will be able to devise prudent policies for the management of resources in his region, even if the models will not be able to supply him with exact predictions of the outcome.

While the dynamic models of the component resource systems (water, forests, mineral resources, etc.) should provide meaningful results if used in an isolated mode, a major objective of the exercise is the study of the dynamic relationships between the different resource sectors and of the long-range development of the total system. Hence the component models must be capable of linkage to study either the dynamics of several connected sectors or the dynamics of the total system on either a regional or global level.

The range of issues to be studied using the set of models is the range of resource, environmental, and economic problems most prevalent on the globe today. It is obvious that a set of models of relatively small size will not be able to deal with all problems, but it should be capable of addressing most of the issues dealt with in publications such as - for example - Global 2000.

The set of issues identified by Global 2000 will be used below to derive the specifications for the individual component models.

The component models and their major linkages have already been identified (see also the Resource Policy Center diagram):

POPULATION	PRODUCTION
AGRICULTURE	MINERAL RESOURCES
ENERGY RESOURCES	WATER
FORESTS	

We will now look at the component models in turn in order to determine their major variables from a list of the issues which each component model should be able to handle.

Population

The population model should be able to deal with - on a global, regional, and national level - such issues as population growth, the demographic transition, the time lag induced by the age structure, 'waves' in the age structure, the quality of the population and its relationship to employment, rural and urban population,, the infrastructure requirements induced by age structure and settlement patterns, as well as nutrition and hunger.

Major elements of this model will therefore have to be: births, deaths, migration, family planning policy, differentiation by (at least three) age groups, by skills, and by location (urban, rural); indicators of health, and the state of basic needs satisfaction.

The model should provide for major links with the production and agricultural models.

Production

The production model encompasses industrial production as well as household, community, or commercial services; in fact, all economic activity except for agriculture. It must include formal as well as informal activities providing goods and services (i.e. non-profit organizations, neighbourhood help, the non-monetary economy).

The production, model should be able ,to deal with such issues as: material standard of living, industrial development, social and environmental costs (including those of the military sector), unemployment, social security and welfare, the effects of conservation, pollution and environmental protection, the distribution of wealth and poverty, decentralization vs. centralization, sustainability and resilience in adverse conditions. (This is a very tall order, indeed. A simple model will not be able to capture all of these issues. However, the model structure to be developed should eventually be expandable to include the relevant variables).

The major variables of the production model will have to be: capital-producing capital, consumer-goods-producing capital, military-goods-producing capital; service-producing capital; household capital," capital in the informal sector; consumption rates for energy, resources, labour; environmental degradation and social costs; output rates of goods and services. The model structure should be complete enough to generate short-term, medium-term, and long-term economic cycles, those ranging from 4 to 50 years.

The production model must provide for major linkages to all of the other component models; population, agriculture, mineral resources, energy resources, water, and forests.

Agriculture

The agriculture model should be able to deal with the following issues: the long-term prospects of conventional vs. organic agriculture, including their effects on soil fertility, yields, water pollution and ecosystem degradation, mineral and energy inputs, nutrient recycling, erosion and nutrient loss, total crop and livestock production, the economics of different production systems. If at all possible, the model structure should permit the study of the dynamics of the international agricultural market, including the effects of specialization vs. production for self-sufficiency.

The major variables of the model would therefore have to be such quantities as: capital in agriculture, major field crops, major livestock kinds, crop and animal wastes, organic matter and humus, fuel, pest control, irrigation, land ownership, debt and income, etc.
Major linkages will have to be provided to the population, production, mineral resource, energy resource, water, and forest sector models.

Mineral Resources

The mineral resources model should demonstrate in particular the dynamics of resource discovery, use, and depletion, and the effects of technology and of conservation. It should provide estimates of environmental pollution and degradation associated with mineral extraction, and of the internal as well as the external costs of extraction. The model should capture such basic behavioural modes as the Hubbert natural resource depletion life cycle.

The major variables of the model should describe the main categories of renewable and non-renewable resources, exploration effort and success, capital in mining/pumping and refining/processing, remaining resources, demand, and ecological cost.

The major linkages of the model are those to the production model.

Energy Resources

The energy resources model will be similar in structure to the mineral resources model, except that it will not have provisions for recycling. The model should be able to demonstrate the processes of discovery and depletion of non-renewable energy sources, the effects of conservation and of the use of renewable energy sources on supplies and sustainability, and the magnitude and accumulation of emissions having severe environmental effects (carbon dioxide, sulphur dioxide, photochemical smog, radioactive wastes, etc.).

Major elements of the model will have to be: fossil and nuclear energy sources, energy-producing and energy-consuming capital, cogeneration of electricity and heat, energy demand (especially as affected by conservation measures), emissions in energy conversion and use. The model will have major links with the production and population models.

Water

The water model should be able to deal with - on the level of a region, a nation, or a watershed - the following issues: regional water availability, water system balance (inflows, outflows), demand dynamics, dynamics of the ground water table, water losses due to evapotranspiration and industrial processes, surface water and ground water pollution, loss of groundwater input due to accelerated runoff, flooding, salinization, and pollution dynamics.

These tasks require the inclusion of precipitation, evaporation and transpiration, surface water, ground water, water quality, irrigation, industrial, and household use of water, water pollution sources, surface conditions (forest cover, sealed surface, etc.).

Major linkages must be provided to the population, production, agriculture and forest models.

Forests

The forest model must be capable of describing in particular the long-term biomass dynamics of forests, of nutrient recycling in the forest, of cutting policies, deforestation and desertification, as well as the effects of pollution (acid rain) or of pests. The model should be able to deal with the particular problems of tropical forests (tight nutrient cycle) and with forest destruction as a result of fuel and fodder needs. The model should allow the study of reforestation policies and of their effects on water management and agricultural production. Finally, the model should permit analyzing the development of the forest industry and of associated employment.

The major variables of the model should therefore be approximately the following: standing biomass, harvesting, nutrients, fuelwood and industrial use, forest products industry and associated labour, demand and harvesting, reforestation, wood export, pollutant deposition and their effects, losses due to fires and pests, etc.

The model must provide for major linkages with the agriculture, water, and production models.

Ecological Systems

The ecological systems model is not intended to be linked to the other models. It will be designed to demonstrate common processes in ecological systems such as: the food chain with its recycling of nutrients, its losses of energy at each trophic level, and the accumulation of pollutants; the predator/prey system with its equilibrium points, possible limit cycles, and application to pest control; the concepts of carrying capacity, crowding, breakdown of populations, and stability regions; the spreading of disease, with applications to pest outbreaks; the phenomenon of pest resistance, prey resistance and predator extinction; and the process of ecological succession, the transition from a period of growth to a mature ecosystem.

Most of these fundamental processes can be captured by an ecosystem model containing one or two species each of plant, herbivore, and carnivore.

Determining Systems Viability

Computation of the development of system states with the set of models under given condition may give results which in many cases will be open to interpretation: what means enviable growth to some is the prelude to catastrophe for others.

It is therefore necessary to determine, in a more objective fashion, what the current system state means for the viability of the system considered - either the component system or the total system.
Viability is multidimensional. It means not only that energy and material flows necessary for the life support of the system must be assured continuously and in the foreseeable future (existence needs, security need), it means also that the system must be able to deal adequately with its partially unpredictable and changing environment, i.e. it must have a measure of 'resilience'.

For systems viability, the law of the minimum holds: the viability is as low (or as high) as that viability dimension which is currently in its lowest state. A self-organizing system would normally turn its attention to eliminating that particular shortcoming, before attending to anything else.

A brief chapter of the book will deal with the methodology of translating the current system state into an expression of its viability by mapping relevant system indicators on the system orientors: existence, security, freedom, efficiency, and adaptivity.[*]* This approach can be used for the component systems as well as for the total system. In the human sphere, this discussion translates into one about values. Obviously then, the discussion of the role of values will have to be an essential and important part of the book from a systems theoretical point of view. Since they provide orientation to human systems, their relationship to long-term systems viability and sustainability will have to be clearly pointed out.

[*] * c.f. H. Bossel, M. Strobel: Experiments using an "intelligent' world model, Futures June, 1978, pp. 191-212.