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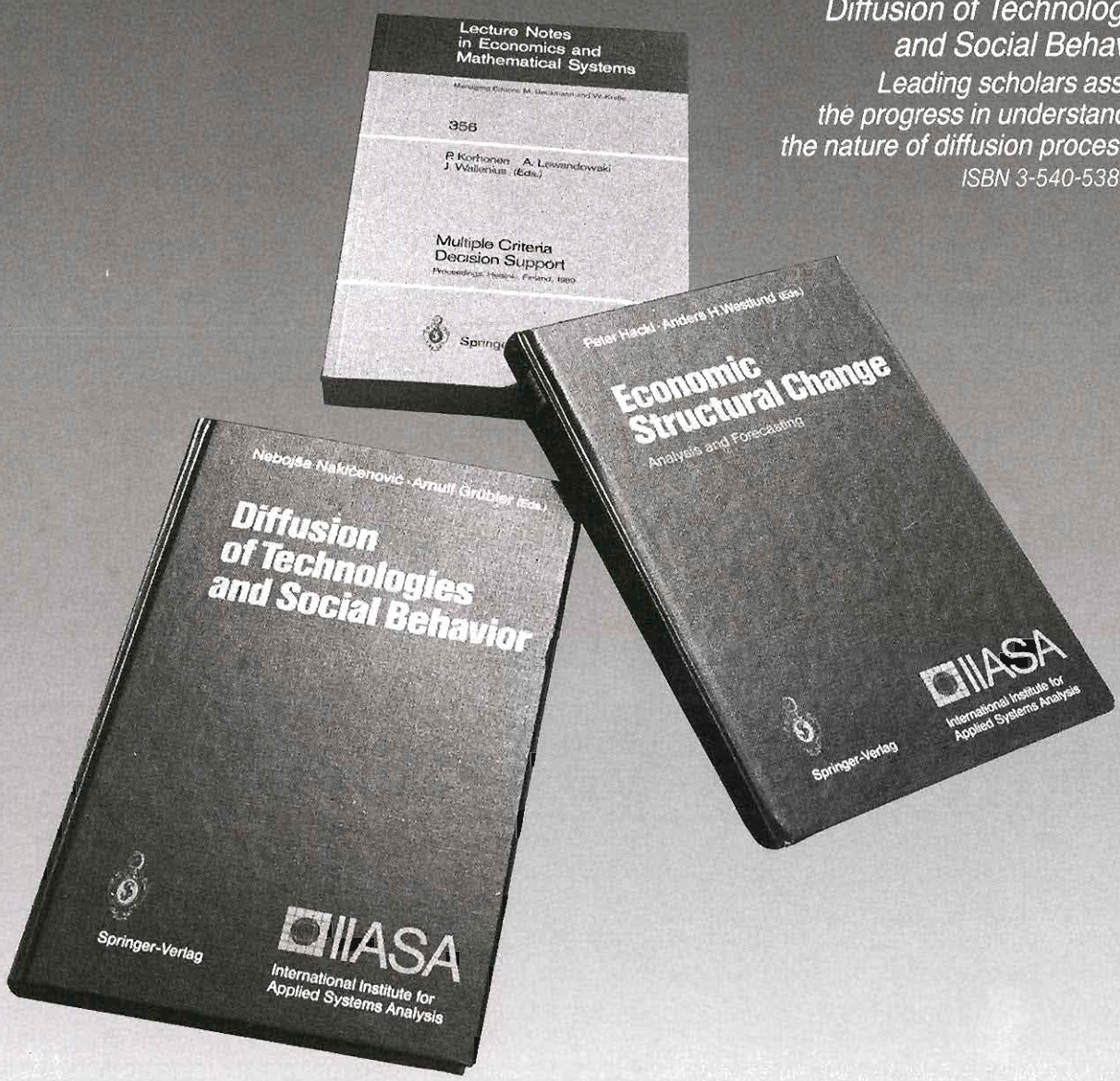

options

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Used worldwide, IIASA's results and products have established IIASA as a frontrunner in applying systems analysis to the examination of international issues.

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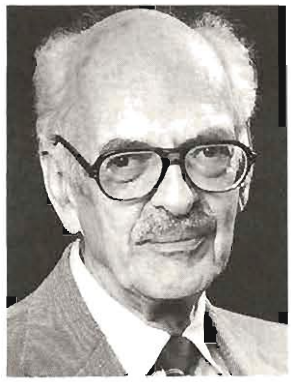
E D I T O R I A L



Not things as such but the connectedness of things is what scientists study and do experiments on, try to disentangle and then to reassemble in understandable form, each particular science within its own domain. The volume of a gas decreases in proportion to the pressure under which it is contained; the calf derives half of its genes from each parent; wages at the margin of cultivation determine rents at the center; these are relations within physics, biology, and economics respectively. Discovery and clarification of such relations within disciplines provides most of the knowledge we have of the physical and social world in which we live.

Interdisciplinary study, and that at IIASA in particular, is different in that it studies connections that cut across such lines as those separating biology and economics. Government policy in Brazil that provides cheap fertilizer and so increases soybean production affects the income of wheat farmers in the United States; we have here a political decision producing a biological outcome that has economic consequences for a far away country. IIASA's food and agriculture model estimates the amount of this effect and many other linkages as well.

IIASA's most ambitious study to date, and one that shows best the interdisciplinary character of its researches, was concerned with energy. The mix of energy sources among coal, oil, gas, and nuclear is determined by prices, and these in turn by political as well as economic events and circumstances. From the mix of fuels follows the time to exhaustion of supplies, the CO_2 content of the atmosphere, mortality in coal mines, risks of radioactive contamination. The energy project made use of specialized engineering, social and political, biomedical, and other branches of science, but it did not add to knowledge in these specialties; it drew its conclusions from the interactions among them.

Earlier issues of *Options* have presented the results of IIASA's large-scale analyses of food and energy, and have discussed the impact of population on both. The present issue does something less ambitious: it considers four much simpler mechanisms. Such elementary mechanisms are not merely didactic, but a necessary first step in the creation of more realistic and hence more complex models; each furnishes a skeleton on which details and finer distinctions can be hung.

Nathan Keyfitz

Nathan Keyfitz
Leader, Population Program

C O N T E N T S

FEATURE

Interdisciplinary Analysis in Four Fields

by Nathan Keyfitz

IIASA Population Program Leader

Systems analysis transcends individual disciplines with their constrained perspectives. Scientific knowledge comes in packages called chemistry, economics, or paleontology, but the world is not so divided – any phenomenon or real decision problem involves several sciences at once. The best one can say for each discipline is that in abstracting one aspect of what it deals with it projects the real-world round phenomenon onto a flat screen; the representation can be recognizable, but it is never self-contained.

Yet interdisciplinary study has turned out to be more difficult than anticipated over the half century in which systems analysis has been spoken of. Much of what is claimed to be interdisciplinary is multidisciplinary, in the sense that writers refer to economic and social "factors" operating more or less independently in a given situation, but fail to show the linkages among them. Or a scholar carries out a purely economic analysis and then refers its shortcomings to political constraints, perhaps political interference that hampers the good performance of the economic model. This attribution of residuals to another discipline, as alien factors, as noise in relation to the given discipline, is less than helpful if one cannot say how and when those other factors operate.

Calls to interdisciplinary study go unheeded because of the organization of academic life. Disciplines are practiced in separate departments, with separate budgets, separate national societies, separate journals. Each has its own criteria for selection of students, its isolation of practitioners starting with the beginning of graduate study, its distinct vocabulary. Students are selected, and ultimately given degrees; they are hired as assistant professors and elevated to tenure or not, their researches are funded or not, all according to the judgment of practitioners in one single field. That does not make a discipline a mutual admiration society. Work within any discipline is subject to the harshest of criticism, but always by other practitioners of the same discipline, with both the critic and the criticized animated by the same loyalty to a certain body of thought.

> *"Calls to interdisciplinary study go unheeded because of the organization of academic life."*

To master the body of thought of any one modern academic discipline is hard enough that few are capable of, or willing to put the effort into, mastering two. This being so, interdisciplinary study often becomes a refuge for those who do not know any discipline well.

Having said this much about why interdisciplinary study is so slow to establish itself, I proceed to four positive examples, four interdisciplinary research agendas.

Economic-Biological Explanation of the Drain on Renewable Resources

Let us try to explain why an ecological crisis can come on so suddenly, how equilibria that have existed for thousands of years can be upset in a decade or two, and a major resource (say a forest or fishery) diminished or destroyed. Population has been growing for a long time; why does the growth of just this last decade or two have such dramatic effects? The matter is especially puzzling in that the rate of increase is actually going down; if the planet could stand a growth rate of 2.0 percent per year in the 1970s why can it not stand a growth rate of 1.8 percent per year now? I submit that the answer cannot be found in economics or biology alone, but only in the interaction between the growth of population and human institutions on the one side and the natural system on

the other. It is in this interaction that nonlinearity turns up, and that makes the study very difficult.

The ocean fisheries are an example of the interaction between two systems. In them the world fish market confronts the biology of fish reproduction. There is harmony between the two as long as the population and its demand for fish are satisfied with no more harvest than the sustainable production of the ecological system. Let that be exceeded, and the fish population starts to be reduced by overfishing; then even without any further increase of human population or of demand, in relation to the smaller fishery the overfishing will by itself intensify. Though fish are scarcer, the higher prices may make them more interesting to producers. Further capitalization in the competition to catch what fish are left can be a rational economic response. Depending on how the price change compares with the change in fishing effort, all per kilogram of catch, rising prices can bring new entrants into the fishery just in the phase of declining capacity of the biological system. When the fishery needs a rest, the market impels more intense search and capture. The interaction between rising prices and declining supplies produces cumulative stress on the fish ecology, among other effects leading to the capture of immature fish. If the fishing is selective for commercially usable species these will be replaced in the waters by unusable species.

After a certain phase in the decline in productivity it will no longer pay to put out to sea, and the vessels will rust in harbor. If we have been fortunate there will have been sanctuaries for the commercial species to hide, so that recovery can slowly take place. Under competitive conditions a small amount of recovery would make it profitable for the ships to put to sea again, and so with some oscillations the fishery would continue at a low

Fifty Years of General Systems Theory and IIASA's Systems Analysis

The pioneer of systems theory was Ludwig von Bertalanffy, an Austrian born in 1901 who worked mostly in Canada from 1949 onward. He is said to have talked of general systems theory in the 1930s, but his writing on the subject dates from 1950. Von Bertalanffy was a theoretical biologist whose organismic approach would

> represent organisms as wholes or systems that have unique system properties and conform to irreducible system laws. . . . The whole of nature is a tremendous architecture in which subordinate systems are united at successive levels into ever higher and higher systems.

Thus every individual cell is a system by itself, and also a subsystem of an organ of the body, the organ is a subsystem of the body as a whole, the body a subsystem of an ecological system. Important for von Bertalanffy was the irreducibility of each level; unlike Laplace or Newton he did not believe that the action of the body could be explained by even the most perfect knowledge of all of its organs; at each stage in the sequence of higher and higher levels of organization there emerge genuinely new properties, not reducible to the properties of the lower levels.

Herbert Simon asks us to think of two watchmakers, both assembling watches containing 1000 components. The first watchmaker assembles by adding components one by one until the whole thousand are in place, the second by making subassemblies of 10 components, then putting together 10 of these to make a larger subassembly, and 10 of the larger subassemblies to make the watch. The telephone rings occasionally, and any work not complete has to be started afresh. If the telephone rings at random moments on the average after 100 parts are put together, then the second watchmaker will only be slightly slowed down by it; the first will almost never complete a watch. This system's argument has had an influence on biology, showing as it does that the evolution of species need not have taken as long a time as previously thought.

That sequence of successive levels of organization does not appear clearly when one comes closer to social science, perhaps because we have not succeeded in discerning the structures of our world as biologists are coming to do of theirs. Perhaps because it was taken up by social scientists, the meaning of systems theory changed between the 1950s and the 1970s, when IIASA was formed. Thus when Lawrence R. Klein, a respected economist, writes the foreword of the *Systems and Control Encyclopedia* he stresses the multidisciplinary aspect, but is silent on the hierarchy of systems and other original ideas that had been found exciting in the 1950s.

Is this a vulgarization of von Bertalanffy? Or is it making the best of the present limitations of knowledge in social science? Klein would not have thought there was anything new about one discipline learning from another; the ideas of Malthus influenced Darwin, the methods of physics made their way into economics with neoclassical theory, those of biology with Alfred Marshall, those of Pareto into sociology with Talcott Parsons, Gabriel Almond, and other political scientists adopted the pattern variables of Talcott Parsons.

Interdisciplinary study accepts the world in the round, observes feedback, hierarchical structures, relations that are essentially nonlinear, that do not show through the prism of any one discipline. It is this pursuit that characterizes systems analysis and IIASA's work in particular. *N.K.*

level of productivity. If there was no sanctuary the fishery would be permanently destroyed. It would also be destroyed even with a sanctuary if the noncommercial species got such a start that they prevented the recovery of the commercial ones.

The fisheries exemplify issues common to forestry, soils, fur bearing animals, etc.; in all such cases realistic study requires analysis of the interaction between a social system and a biological system. Some systems that are not biological but still limited, like fossil water deposits, can show a similar effect.

A further example is the rain forest of Sarawak, a province of Malaysia located on the island of Borneo, the fourth largest island in the world.

> *If the planet could stand growth of 2.0 percent per year in the 1970s, why can it not stand growth of 1.8 percent per year now?*

On the natural side, we have the valley of the Baram River and the tree-covered mountains running south to the border with Indonesia. The forest of tropical hardwoods covers some 6.2 million hectares. From it come about one-sixth of the world's supply of tropical hardwood logs, taken in 1987 from 310,000 hectares. The logs are turned into plywood in Japan and other countries, most of which is used in construction for forms in which concrete is poured. After the concrete has set, the plywood is removed and is of little further use. Each hectare yields 50 to 125 tons of logs – once.

The systems analyst looks at flows, asks where does this thing come from, where does it go. The physical side of the process here discussed starts with a rain forest, whose cut logs flow over the oceans in freighters, and end up in the consuming country as used plywood decaying and putting carbon dioxide into the atmosphere; while on the other hand back in Malaysia the process ends with a desolate landscape, that will take decades, even centuries, to recover. So much for the physical side.

The physical flow has a counterpart in a financial flow. Each year those timber exports bring Malaysia $2 billion, a more than appreciable part of its total export earnings amounting to $21 billion in 1988. Per ton the timber sells for M $800 (about US $300). Between M $13 and M $28 of the M $800 goes to the state and federal governments as royalties; this small part of the take is all that is paid for the resource as such. The rest is divided among the licensee, the contractor who has the wood cut and shipped, and the laborers who do the work, mostly hired from among the 1.6 million residents of Sarawak.

A major actor on the social side is the national government in Kuala Lumpur, which is pressed for finances for the development of the country. A certain part of the capital goods needed, as well as consumer goods of all kinds, come from abroad – to the amount of $17 billion in 1988. This healthy balance of $4 billion on merchandise trade would have been half as large without the logs.

The social structure behind all the logging is as complex as the forest it confronts. No one is required to buy the forest on which he proposes to log, but only to procure a license. The licensee can collect about M $75 for each ton that is cut by the contractor. The licensee pays M $28 or less in royalties, and collects M $75, all while sitting at his desk in Kuala Lumpur. One of the more complex facets of the social arrangements is the determination of who gets the licenses. While the rent collected by the licensee is less than 10 percent of the export value of the logs, it is a large part of what motivates the whole process. To say that the licensee has good relations with the authorities is an understatement.

> *Rising prices can bring new entrants into the fishery just in the phase of declining capacity of the biological system – a case of destructive positive feedback.*

One aspect of the social structure is the ethnic groups to which the actors belong. The licensees would usually be Malaysians from the mainland, sophisticated and well-connected cosmopolitans. The contractors are ethnic Chinese who have little standing in Malaysian society. The labor is recruited on the ground from the Sarawak population of 1.6 million.

Economic-Political Explanation of LDC City Growth

The standard theory of migration to the city is in terms of the expected income over a period of years if the peasant stays in the

UN photo

countryside, and his expected income if he comes to the city. Certainly there is much unemployment and underemployment in the city, but there is also the chance of a fortune, and the latter weighs heavily in the peasant's anticipation of the economic return to his migration.

This economic theory of internal migration, associated with the names of John R. Harris and Michael Todaro, is indeed valid, but one may doubt that it is the whole explanation of a phenomenon as vast and as persistent as the rural exodus of the less developed countries. That movement is the largest of any time in history; cities of the third world are overflowing. Mexico City, now approaching 20 million, is followed by Cairo, Calcutta, Jakarta, and many others. Governments strain to provide low-priced food, adequate schools, and streets for the newcomers, not to mention houses and clean water; they know the political pressure to provide these benefits that can be exerted by concentrated millions, and they fear above all the sanctions in the form of riots and strikes that such masses can exercise. As the United Nations says of Jakarta:

> Of far greater importance than explicit spatial policies have been such factors as highly subsidized public services, which have created a bias in favor of the larger urban centres; the importance of physical proximity to central government officials for obtaining licenses and permits.
> (*Jakarta*, Population Policy Paper No. 18, UN 1989)

The availability of cheap foodstuffs alone would support movement to the city. As the result of the pressures exerted by city masses, governments pass legislation ensuring that grain is priced low. The peasants are forced to submit to below-market prices for their output, and even where there is no price fixing by government but instead subsidies for city markets, the subsidies may well be paid for by peasants through taxes.

> *"Political pressure completes the positive feedback loop within which the economics operates, and is creating third world cities of unprecedented size."*

Yet price is not the only consideration; supply is even more important. In hard times in the past, depressed conditions pushed people out of the cities onto the land; now it is the opposite: the city

is where food is to be found. The international trade in cereals means that the city no longer has to be supplied from its own hinterland, its neighboring countryside. Foreign aid plus the sale of raw materials provides the needed foreign exchange. Governments persuade their farmers to produce peanuts or other export crops, whose sale price it can collect and then only partly funnel back to the peasant. Food policies alone would initiate a circuit with positive feedback and expand the cities without limit. (Note that it is population pressure, especially in the cities, which inspires bad economic policies.)

What makes this a systems issue is the reciprocal action: on the one hand, the presence of masses of people close to the seat of government exercises pressure for various benefits; as these benefits are dispensed they make the city more attractive to other immigrants. Thus *political pressure completes the positive feedback loop within which the economics operates*, and is creating third world cities of unprecedented size.

Economic-Sociological Explanation of Fertiliy

Explanations of fertility rise and fall are to be found at three levels, the well-known proximate, economic, and sociocultural determinants. The proximate (in particular the means of birth control) and the economic can never contradict one another, the former being the means through which the latter operates. In brief, the economist explains why couples use birth control, and does so in terms of economic motives. In fact many kinds of behavior that on the surface have little to do with economics have recently been brought within its scope.

A relation similar to that between the economic and the proximate exists between the sociocultural and the economic. One economic explanation is that children have become more expensive as standards of quality rise, so that though we are now richer than ever before, we can afford fewer of them. Undoubtedly true, but what about shoes; their quality and price also have risen, but people do not go barefoot as a result. In fact, as people grow richer they could even

UN photo

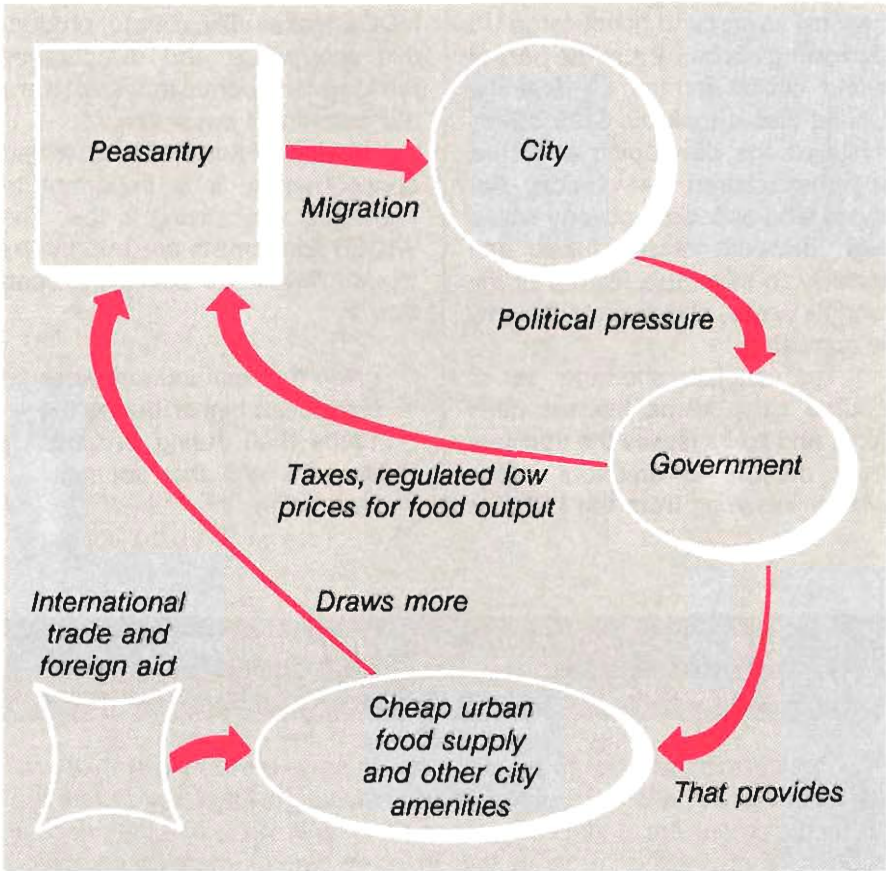
afford to buy more shoes. That children are different from shoes is a feature of the culture of industrial societies, and this is what requires analysis. Without explaining why children are different from shoes the economic explanation is incomplete.

Another economic explanation attributes the fall in childbearing to the increased opportunity cost of women's time as the demand for their services in the labor market increases. Also true; but the same demand and consequent increased value of time would also raise the cost of watching television, yet television continues. The cultural question is why raising children is seen like ill-paid work in the labor market, rather than offering the satisfaction we are told that it had in the past, or that is now offered by television.

> *"Just as the economic determinants are needed to explain the proximate determinants, so the sociocultural determinants are needed to explain the economic."*

When women themselves are asked why they work, they are likely to reply that they and their families need the money. Yet back in the 1920s families had much less money than now, and jobs went begging. But standards of consumption have risen: people have more needs now, it is replied. That is exactly true, and it is a social fact (certainly not a physiological fact) that underlies the economic phenomenon of women moving out of the home into the labor market. Explaining that increase of felt need is a task for sociology rather than for economics.

Hence our conclusion: just as the economic determinants are needed to explain the proximate determinants, so the sociocultural determinants are needed to explain the economic. The policy researcher, advising on how to raise fertility to where the population will reproduce itself, must answer such questions as what will make people want childraising as they want television, rather than avoiding it as they avoid domestic service. It is the popular interpretation of an activity that is the heart of sociocultural explanation, needed to validate and complete the economic analysis, on the one hand, and to engineer change, on the other.



Depiction of the positive feedback loop that encourages growth of third world cities.

Economic-Cultural Explanation of Debt

The three examples above are from the field of population. Explanation of debt combines the wider fields of economics and culture change.

As an example of the way that cultural change can underlie what looks like a purely economic problem, consider the imbalance in the world economy, as it is seen by a distinguished group of scholars, all economists, with the World Institute for Development Economics Research (WIDER) of the United Nations University (O. Blanchard, R. Dornbusch, M.A. King, P. Krugman, R. Layard, Yung Chul Park, and L. Summers). They start with the worldwide capital shortage, created, say this group, by low US

national saving and hence large US borrowing abroad. From the pool of world capital formed in 1988 the United States took out $135 billion, while all the developing countries together shared $46 billion. For those who associate poverty with a high discount of the future and inability to save, this feature of the world's largest and richest economy is confusing.

The capital shortage is of course what keeps interest rates high, and so increases the transfers from debtors to creditors everywhere, including from the LDCs to MDCs, makes difficulties for productive enterprises, and discourages the long-term commitments that are the essence of development.

In view of these and other bad consequences, it is important to know just why saving is low. The WIDER economists are puzzled by the decline in US savings, in particular,

> given that real interest rates have been higher during the 1980s than during previous decades and that tax rates have fallen,

two factors that should stimulate saving. They adduce as possible explanations

> demographic changes, a reduction in business saving caused by the increased use of leverage and the resulting commitment...to interest payments, continuing increases in the availability of consumer debt of all kinds, and reductions in the perceived need for retirement saving. . . .
>
> [In addition,] measures like the off-budget guarantees given to the US savings and loan institutions increase private wealth and [so] raise private consumption.
>
> (*World Imbalances*, WIDER, 1989 Report)

> *No single purely economic explanation seems able to cover the US government deficit and the other ways by which we enjoy the present and send the bills to our descendants.*

There can be no question of the validity of these explanations, nor that the decline of US private saving, plus government deficit spending, requires capital from the rest of the world, and so leads us back to the fact that in 1988 the US borrowed almost triple the total of all LDC borrowings.

Yet these thoroughly argued and agreed-on explanations cannot be the whole story. One has to ask

The Semantic Trajectory of "Interdisciplinary" and its Final Victory

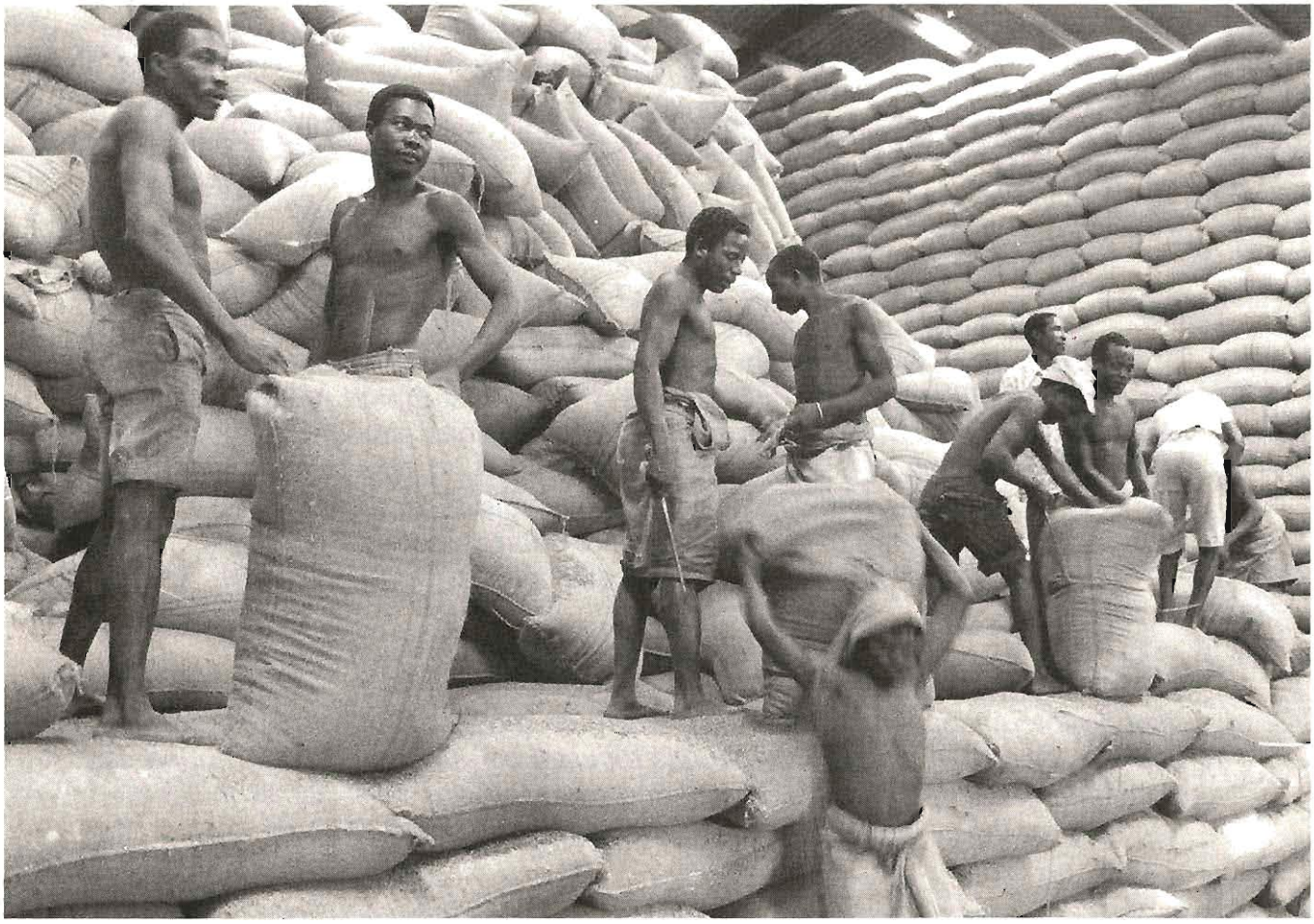
'Interdisciplinary' is as much as anything a creation of the Social Science Research Council of New York. At least the first record of its use is by the organizers of that body, that started up in 1923, with the principal object of promoting research that involved two or more of its seven constituent (disciplinary) societies. R.S. Woodsworth, one of the early presidents of the Council, used the word publicly in 1926, evidently thinking of it as a synonym of 'coordinated.' Its use was part of a movement for cooperation and collaboration among the social sciences and humanities.

Even at that time the idea was not new. In 1912 George Ellery Hale, later the first president of the National Research Council of the National Academy of Sciences, proposed that the Academy should foster research on subjects lying between the old-established divisions of science. Much used in the 1930s, alongside 'interdisciplinary,' were 'overlapping projects,' 'interrelated research,' and 'borderlands' and 'borderland research.' Margaret Mead called for 'cross-fertilization' in the social sciences, and books published in the 1920s stressed 'interrelations,' 'interdependence,' 'interfiliation,' and 'interaction' among the social sciences. The other words are rarely heard now; 'interdisciplinary' is the principal survivor. A social movement does not need more than one banner, especially when the alternatives do not throw further light on its methods and purposes.

So compelling was the idea that it even spread to the humanities. Said one distinguished writer in the early 1970s, "English must become interdisciplinary . . . for self-preservation." Presumably he did not mean the preservation of the English language, that is sturdy enough, but of English Departments and their budgets.

The word 'interdisciplinary' has indeed won out, but the activity it was intended to promote has lagged. My purpose in reviewing the calls to be interdisciplinary that extend over most of 60 years is to suggest that exhortation is the easy part. The hard part is constructing models in which the concepts of two or more disciplines are applied and actually intermesh. The founders of systems analysis – von Bertalanffy, Boulding, Simon, Rapoport – did have such intermeshing in mind. *N.K.*

FEATURE



FAO photo

simultaneously why the US budget deficit, and why less private saving, and the answer can only be in a certain myopic character of the actors on the economic scene. The US after all is a democracy; the Administration and the Congress are sensitive to the interests of their constituents, to the point where the main complaint is that they exercise too little leadership, they just do what the polls tell them people want. If they tolerate a budget deficit it is because they have ascertained that their constituents prefer that to the alternatives of higher taxes or lower expenditures.

Acceptance in peacetime of a national budget deficit comparable with that of the worst times of national danger in war is the heart of the puzzle. It does not have the purpose of investment; if it were being spent on roads and bridges there would be a return in the future, but in fact these also are deteriorating and in a sense we are adding their deferred replacement to the sums we convert to current consumption. On social security, instead of saving for our old age, we spend the premiums that the next generation is paying, leaving our children to dependence on the next generation, i.e., on our grandchildren. On preservation of the natural environment the US may be ahead of most of the world with catalytic converters and cleaner output from smokestacks and municipal waste systems, but net deterioration of its ecosphere continues.

Thus on various economic and financial fronts we see the same tendency to value future consumption much lower than present consumption. No single purely economic explanation seems able to cover the US government deficit and the other items listed. What does cover them all is a shift in the underlying culture in the direction of emphasis on the present. That change is explicit in much of the talk, songs, popular books, of the "me-generation." Everywhere the theme is instant rather than deferred gratification; no one sees any reason to wait. A systematic content analysis of current novels, compared with a similar tabulation for novels of the early part of the century, would show the change from deferred to instant enjoyment unambiguously. We need first to establish the facts more solidly than my conjecture here, and then go deeper into how the culture change takes place. That is not a simple research agenda, but nothing less will account for the diverse economic phenomena listed above. ■

FEATURE

Global Environmental Issues: An International Seminar

In two decades the study of Earth systems has grown from a minor facet of science into a mainstay of research. Indeed, so many organizations now study global change that it can be difficult to track who is doing what. Last month representatives of some of the most important of those organizations attended a two-day media seminar in London, organized by IIASA, to brief journalists on some of their current activities and their goals. On the following pages are short sketches based on those presentations.

Two points became apparent at the seminar: first, the extent of cooperation among international organizations working on global change; and second, that, in the short term at least, attention is focused on June, 1992, when hundreds of national leaders, senior scientists, and policy advisers will gather in Brazil for the UN Conference on Environment and Development.

Global Environmental Research Centre

London

The host of the seminar was this new research organization, part of the Imperial College of Science, Technology and Medicine. The GERC was formally opened in December, 1990, as the United Kingdom's first interdisciplinary think tank studying global environmental issues. It will focus on four areas:

Global Climate Change – The mechanisms and impacts of global climate change.

Global Pollution – Sources and transport of pollutants and their impacts.

Clean Technologies – Including safer methods for the application of pesticides in agriculture, waste management and minimization of waste, improved fuel technologies and renewable energy resources.

Policy – Analysis and research on the interface of science, technology, and policy.

Other projects include plans for a program on East European environmental problems, and for a £2-million expansion of the library of the Imperial College Centre for Environmental Technology into a major specialist environment library.

Initial projects in policy analysis include a seminar on the way that environmental issues affect the conduct of British foreign policy and a report on the contributions of various institutions to sustainable development.

International Council of Scientific Unions

Paris

ICSU is a nongovernmental organization comprising 20 international scientific unions and 75 national science academies and research councils. ICSU serves a critical function as a coordinator of international research on global change.

The ICSU Conference on an Agenda of Science for Environment and Development into the 21st Century (ASCEND-21) will form a major input into Agenda-21, the agenda for action that will emerge from the 1992 UN Earth Summit, described below. IIASA is cosponsoring the next meeting of the ASCEND Conference, to be held in

November in Vienna, at the invitation of the Austrian chancellor.

At least 10 member unions and 12 committees and commissions of ICSU study aspects of global change as part of their regular programs. In addition, ICSU has established three bodies specifically for the study of environmental and global change: the *Scientific Committee on Problems of the Environment*; and two focused research programs, the *International Geosphere-Biosphere Programme: A Study of Global Change* and the *World Climate Research Programme*. The last-mentioned was organized jointly with the World Meteorological Organization, and is described under the WMO entry.

Scientific Committee on Problems of the Environment

Organized in 1969, this committee assesses major international environmental problems and identifies those that are interdisciplinary and tractable; brings together relevant knowledge, critically assesses it, and synthesizes it into a coherent form; points out gaps in knowledge and needed research; and publishes the results (44 books).

International Geosphere-Biosphere Programme

The IGBP was established in 1986 to deal with chemical and biological processes involved in global change, as opposed to the WCRP focus on physical processes. It has five core research projects:

- The *International Global Atmospheric Chemistry Programme* focuses on the chemistry of the troposphere (the lower atmosphere) and its interaction with biological sources and sinks of trace gases, including carbon dioxide.

- The *Joint Global Ocean Flux Study* considers the interaction among ocean biogeochemical cycles and physical aspects of climate, through a core project on fluxes of carbon and associated biogenic elements in the oceans.

- The *Biospheric Aspects of the Hydrological Cycle Project,* jointly supported by the WCRP, couples field and remote-sensing measurements to explore interactions among vegetation, the hydrological cycle, and the atmosphere.

- The *Global Change and Terrestrial Ecosystems Study* develops a predictive capacity, through *inter alia* modeling, of changes in ecosystems in order to provide inputs to global models of climate and biogeochemistry.

- The *Past Global Changes Project* is a study of past variations in climate, biogeochemistry, and biomass, and the interactions among them.

UN Conference on Environment and Development

Geneva

The purpose of this conference, to be held in Rio de Janeiro in June, 1992, is to move environment issues to the center of economic policy and decision-making. Maurice Strong, secretary-general of the UNCED Secretariat in Geneva, has predicted that the Earth Summit, as it is also known, will mark "a sea change in relations between countries and peoples."

Dozens of government leaders and heads of state are to attend the Conference, where environmental change, particularly global warming, is expected to be a major theme. It is expected that participating nations will ratify one or more international conventions covering carbon dioxide emissions, forest management, and protection of bio-diversity, which are currently under negotiation by the UN Intergovernmental Negotiating Committee. The hope is that firm national targets for reduction of greenhouse gases will be considered at the conference.

The Conference is also expected to ratify a short Earth Charter, a sort of Bill of Rights for the planet, and Agenda-21, an action plan containing estimates of financial resources and assignments of responsibilities for the remainder of this decade and beyond. Nitin Desai, UNCED deputy secretary-general, said that an IIASA study commissioned by the secretariat "is expected to contribute significantly to the design of the Agenda-21 – the agenda for action emerging from the Conference." The study is described under the IIASA entry (page 15).

The UNCED Secretariat is coordinating efforts with literally hundreds of governments, agencies, and organizations around the world. A Preparatory Committee has met twice in plenary session, and will meet twice more, in Geneva in August and in New York in February or March.

In December representatives of nongovernmental organizations from around the world will gather in Paris to prepare for the Earth Summit. The main result is expected to be a draft "Brazil Document" giving a nongovernmental perspective on environment and development.

FEATURE

In collaboration with the World Data Centres, the IGBP is also developing a data and information system for the study of global change. Particular attention is being paid to the interpretation and distribution of the vast quantities of data produced by satellite-borne sensors.

An IGBP Interagency Coordinating Committee has been formed with the UN Environment Programme, UNESCO, and the World Meteorological Organization. An IGBP secretariat has been established at the Royal Swedish Academy of Sciences.

World Meteorological Organization

Geneva

The WMO has worked with many international organizations to organize and coordinate a wide array of environmental monitoring and research programs. Some of those joint WMO programs, including the Intergovernmental Panel on Climate Change, with UNEP, and the Global Ocean Observing System, with UNESCO, are described in entries under those organizations.

The **World Climate Research Programme** was jointly established in 1979 by the WMO and ICSU to determine to what extent climate can be predicted and to assess humanity's influence on climate. UNESCO is also integrally involved in the program through its Intergovernmental Oceanographic Commission, described in the UNESCO entry.

The WCRP's focus is on understanding the physical processes of climate; the International Geosphere-Biosphere Programme, described in the ICSU entry, complements it by concentrating on the chemical and biological aspects of climate. The WCRP comprises three major projects:

The *Tropical Ocean and Global Atmosphere Study* assesses the crucial climate-regulating interactions between tropical ocean basins and the atmosphere, with a focus on the monsoon and the El Niño/Southern Oscillation.

The *Global Energy and Water Cycle Experiment* studies, models, and predicts the transport and exchanges of radiation, heat, and water within the atmosphere and at the sea surface, as well as the impact of climate change on patterns of rainfall.

The *World Ocean Circulation Experiment* provides, for the first time, almost simultaneous observations of all oceans, as a basis for the development of models of ocean circulation and heat transport.

The principal WMO activity described at the London briefing was the *International Conference on Water and the Environment: Development Issues for the 21st Century,*

UN Environment Programme

Nairobi

With a relatively small annual budget of $40 to $60 million, UNEP concentrates on coordinating and catalyzing international action on environmental matters, rather than in-house research.

UNEP was instrumental in the development of the Convention on International Trade in Endangered Species (1975), the Montreal Protocol on Substances that Deplete the Ozone Layer (1987), and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989). Its Oceans and Coastal Areas Programme has been responsible for eight international conventions and 15 protocols and agreements on the protection of regional seas, as well as 10 regional programs involving 120 countries. The same approach is now being applied to river basins.

UNEP's current priorities are to follow up the Montreal Ozone Protocol and support efforts to minimize climate change. It is coordinating monitoring of ozone levels; monitoring compliance with the Montreal Protocol, encouraging more countries to ratify it, and considering adjustments to it; overseeing development of a fund proposed by Protocol signatories that will ease the transition of developing countries from ozone-depleting to environmentally benign chemicals; and supervising evaluation of those replacement chemicals.

UNEP believes that the Montreal Protocol marks a critical step toward a global law – or complex of laws – to protect the atmosphere. The next major step is an agreement to limit climate change, primarily by reducing emissions of CO_2 and other greenhouse gases.

In 1988 UNEP and the WMO cofounded the Intergovernmental Panel on Climate Change, the principal international effort to analyze emissions of greenhouse gases. A UNEP/WMO joint IPCC secretariat is located at the WMO office in Geneva, where it continues to coordinate and synthesize research on issues of climate change. Research priorities identified at the Second World Climate Conference include clouds, greenhouse gases, and the carbon cycle; ocean/atmosphere interchanges; paleo-climatology; polar ice; and terrestrial ecosystems.

UN Educational, Scientific, and Cultural Organization

Paris

The description at the London briefing of UNESCO's work on global environmental change focused on the *Intergovernmental Oceanographic Commission*, established in 1960 to develop and coordinate research on the world's oceans.

The IOC cooperates closely with other international organizations on many global and regional studies, including the World Ocean Circulation Experiment, the Tropical Ocean and Global Atmosphere Study, the Joint Global Ocean Flux Study, and the Global Energy and Water Cycle Experiment, described under the ICSU and WMO entries.

Most recently, the Commission worked with the WMO and UNEP to establish the Global Ocean Observing System. GOOS is a complex system intended to collect, analyze, and distribute physical, chemical, and biological data on the world's oceans. It is in part an attempt to address the woeful lack of information available on the crucial role that oceans play as regulators of the world's climate through storage and circulation of heat – the oceans can store about 1000 times as much heat as the Earth's atmosphere – absorption and release of carbon dioxide, and so on.

GOOS will form a key part of the Global Climate Observing System called for by the IPCC. It will be built on the Integrated Global Ocean Services System, which has been collecting data since 1967. Full implementation of GOOS will take at least a decade. At the London briefing it was emphasized that it could be 30 years before scientists have a reasonable understanding of deep ocean systems and their crucial contribution to climate.

The Commission promotes numerous other scientific activities, including the Global Sea-Level Observing System; the International Oceanographic Data and Information Exchange; and the International Tsunami Warning System in the Pacific.

to be held in Dublin, Ireland, 26-31 January 1992. The major objectives are: to assess the current status of the world's freshwater resources and relate them to future demands; to develop coordinated approaches to managing these resources; to formulate environmentally sustainable strategies for the 1990s and beyond, to be presented at the 1992 UN Conference on Environment and Development; and to focus the attention of national leaders and policymakers on key issues and actions regarding freshwater.

The Conference will serve as the formal entry point for the introduction of freshwater issues at the 1992 UNCED summit meeting.

International Institute for Applied Systems Analysis

Laxenburg/Vienna

IIASA is an international, non-governmental research institution sponsored by scientific organizations from 15 countries. Since its founding in 1972, environmental issues have been an important theme of its research. Current activities include studies on:

Environment and Development – At the request of the secretariat of the 1992 UN Conference on Environment and Development, IIASA's interdisciplinary Global Environment and Development Project is examining links between human society (population change and structure, life-styles and economy, institutions), the stresses that these place on the environment (resource use, waste disposal, toxification, climatic change), and the effect of shortcomings on global life-supporting systems (agriculture, forestry, water supply). The project examines some of these links in case studies; explores boundary conditions for sustainable development; examines and illustrates ways in which environmental degradation is rooted in the structure of existing social and political institutions; and identifies policy options to achieve sustainable development.

Global Modeling – The current focus is on completion of a dynamic model that can predict transitions in the global biosphere caused by various influences, including climatic change, deforestation, drainage of wetlands, airborne emissions of chemicals, and ultraviolet irradiation.

Work also began in 1990 on a simple, personal-computer-based, time-dependent, radiative energy balance model to be incorporated in IMAGE, the Integrated Model for Assessing the Greenhouse Effect, developed in the Netherlands. The model will allow policy analysts to quickly assess the consequences of different greenhouse gas emission scenarios.

Forest Resources – IIASA is currently finishing the first consistent, continent-wide assessment of the forests and forest industries of Europe and the European parts of the USSR. The study assesses emissions of acidic air pollutants, their effects on forests, the economic impacts, and policy implications. Work has also began on the first comprehensive study of the forest industries and forests of Siberia, which comprise one-fifth of the world's growing stocks.

FEATURE

Water Resources – Activities are concentrated on analysis of vulnerable water resource systems, particularly in regions that are currently marginal.

In a major regional study, IIASA is developing the first overview of the sources, accumulations, and distribution of heavy metals and other contaminants since 1950 in the Rhine River Basin, one of the most densely populated and heavily industrialized areas on Earth.

Regional Air Pollution – IIASA's Regional Acidification INformation and Simulation model (RAINS) simulates the complete cycle of acidic air pollution in Europe, from generation through atmospheric transport to deposition. RAINS has been selected by the UN Economic Commission for Europe as the main scientific tool to support renegotiation of the Convention on Long-Range Transboundary Air Pollution.

Eastern European Environment – The focus is on near- and medium-term responses to Eastern Europe's environmental problems, including interim measures such as development of smog alarms for major cities and industrial centers.

Energy Studies – Work has begun to develop a coherent framework for the development of environmentally compatible energy strategies. It includes the preparation of a comprehensive inventory of options for reducing energy-related emissions of greenhouse gases, including technical information, reduction potential, costs, and prospects for implementation. Scenarios of future energy use have been developed and forecasts made of energy-related CO_2 emissions.

In conjunction with Stanford University, USA, IIASA also organizes the annual International Energy Workshop to collect and compare projections by energy analysts from around the world. ■

RESEARCH

Environmental Information System for Bohemia

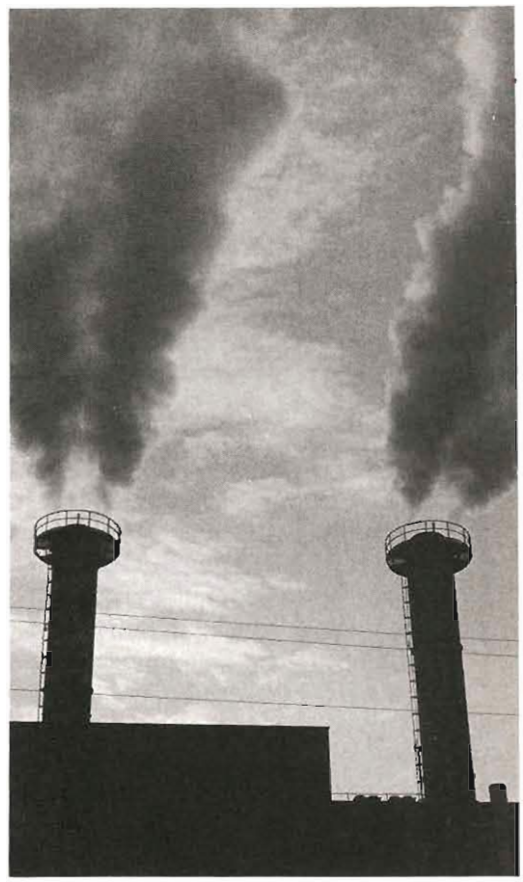
The ČSFR Commission for the Environment is supporting the creation by IIASA of a regional environmental information system for air quality management in Northern Bohemia, in and around Usti nad Labem. The system will provide interactive tools to display and analyze environmental information on a regional scale, using multilayer air quality models to cover the region as well as selected urban and industrial centers. It will simulate environmental control and mitigation strategies and evaluate their effectiveness and investment requirements. The focus will be on air pollution from industrial sources. (Contact: *Kurt Fedra*, IIASA)

Interactive Modeling and Support Systems

The Japan Institute of Systems Research and IIASA have signed a two-year agreement to collaborate on the design of new decision support systems and to introduce new systems developed in Japan to IIASA. Research will focus on: methodologies for developing structural, impact, and evaluation models; development of algorithms for interactive optimization or satisficing methods; methodologies for group decision making; design of user-friendly computer systems for modeling and optimization or satisficing; and applications of methodologies and systems to management or environmental problems. (Contact: *Marek Makowski*, IIASA)

Sources of Heavy Metals in the Rhine River Basin

IIASA and the Research Center for Water Resources Development (VITUKI) of the Hungarian Academy of Sciences in Budapest will continue collaboration for another 14 months, supported by the Hungarian Committee for Applied Systems Analysis, to study the contributions of five elements – cadmium, lead, zinc, nitrogen, and phosphorus – to pollution of the Rhine River Basin. (Contact: *William Stigliani*, IIASA)



Smog Alarm Systems

The Regional Environment Center for Central and Eastern Europe in Budapest has given IIASA a two-year contract to provide technical support for the setting up of smog alarm systems in major East European cities and industrial centers. (Contact *Joseph Alcamo*, IIASA)

UNCED Research Scholar

With support from the International Institute for Sustainable Development of Winnipeg, Canada, and the Rockefeller Foundation of New York, USA, researcher Gilberto Gallopín of the Fundacion Bariloche of Rio Negro, Argentina, will join IIASA for the second half of 1991 in a study to demonstrate the usefulness of a systems approach in identifying key links between human development and environmental change, and to provide an input to the secretariat of the 1992 UN Conference on Environment and Development. (Contact: *Roderick Shaw*, IIASA)

Recent Conferences

The Influence of Organization and Management on the Safety of Nuclear Power Plants and Other Complex Industrial Systems, Vienna, Austria, 18-20 March.
Organized jointly by the International Atomic Energy Agency and IIASA, this meeting was intended to assess the extent to which the management sciences can provide guidance for the practical management of organizations in which safety is a major concern. A report will be prepared on conclusions regarding the possibilities for exchanges of useful managerial practices and published by fall 1991. (Contact: *Björn Wahlström*, IIASA)

CO_2 Reduction and Removal: Measures for the Next Century, Laxenburg, Austria, 18-21 March.
This workshop assessed CO_2 reduction and removal strategies worldwide and reviewed studies and technological options being considered in different countries. The 48 participants represented more than 11 disciplines from academic, private, and public organizations from 15 countries. A summary of the workshop, which was co-sponsored by the Global Industrial and Social Progress Research Institute of Tokyo, Japan, was published in April. (Contact: *Nebojša Nakićenović*, IIASA)

Trade and Environment, Laxenburg, Austria, 21-22 March.
Consultants and IIASA staff met to discuss common problems and potential cooperation as an input to the OECD policy statement on this subject to be presented, at the ministerial level, to the OECD Council meeting in June. Participants included representatives of the four Austrian ministries that are financing the study and three high ranking staff members of the environment, trade, and the agriculture directorates of OECD. (Contact: *Friedrich Schmidt-Bleek*, IIASA)

Agriculture in Eastern Europe, Laxenburg, Austria, 21-22 March.
At this meeting of IIASA's Food and Agriculture Network, three topics were seen to have priority: agriculture and Soviet reform (decentralization and macroeconomic stabilization); consequences of Soviet reform on world trade; and land reform in the ČSFR, Hungary, and Poland. It was also reported that two-thirds of the network's funding requirements had been secured. (Contact: *Günther Fischer*, IIASA)

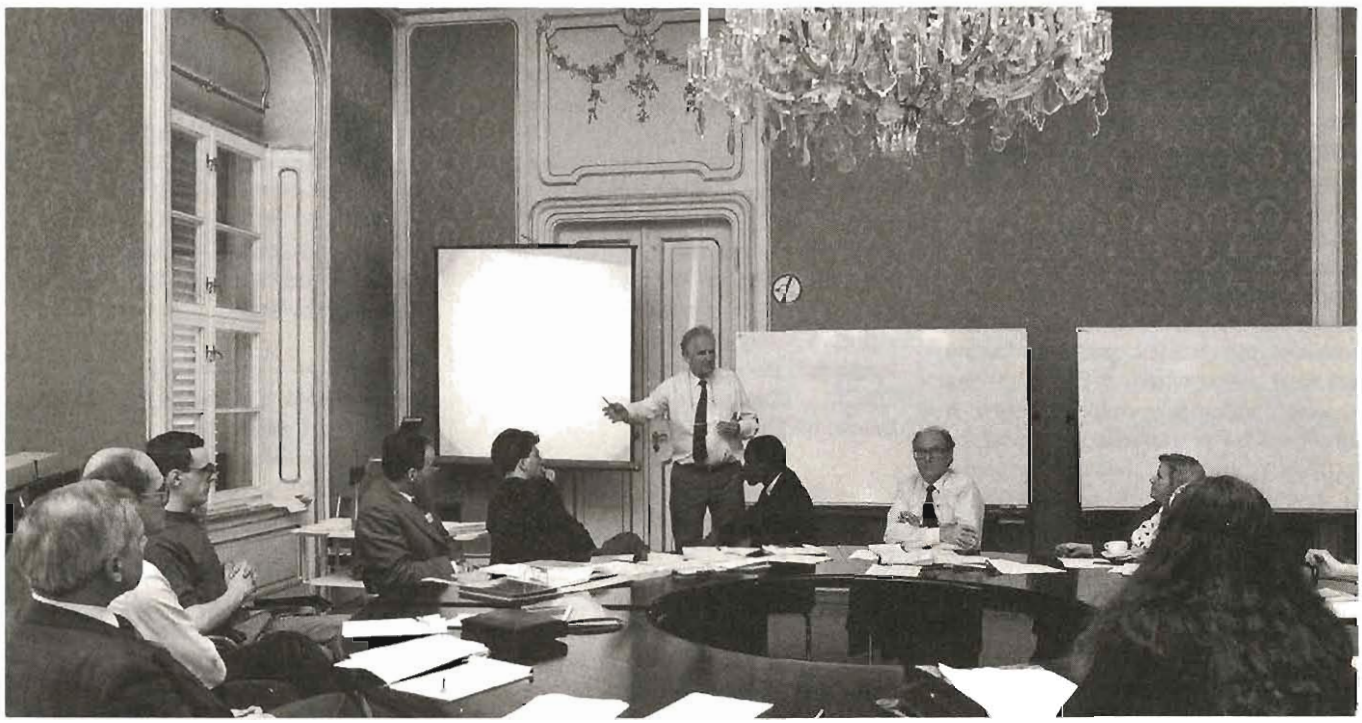
The IIASA workshop on CO_2 reduction and removal held March 18-21 (below) was to be followed June 24-26 by a workshop on energy and life-styles. ▽

Regional Development: Problems of Countries in Transition to a Market Economy, Štrbské Pleso, ČSFR, 21-24 April.
This meeting of 70 participants from 13 countries was organized by IIASA with the cooperation of the Slovak Ministry of Strategic Planning and the Konzultex company in Košice. Proceedings of the meeting are forthcoming. (Contact: *Tibor Vaško*, IIASA)

Emissions Inventory for the Pentagonale Countries, Laxenburg, Austria, 2-3 May.
Fifteen scientists and officials from eight countries cooperating under the Pentagonale framework met to discuss the development of the common inventory of major air-pollutant emissions in the Pentagonale countries (Austria, the ČSFR, Hungary, Italy, and Yugoslavia). It was decided that the Pentagonale inventory will closely follow the CORINAIR System currently used by the European Community. IIASA is coordinating national activities at the request of the Italian Ministry of the Environment. (Contact: *Markus Amann*, IIASA)

East German Economic Transition: Experiences and Outlook, Wolfsburg, Germany, 7-9 May.
Twenty participants attended this conference, which was jointly organized by IIASA and the International Partnership Initiative, to discuss the German experiences with regard to unification

CONFERENCES



Friedrich Schmidt-Bleek at a March 22 meeting that was held as part of a five-month study of Trade and Environment issues.

from an economic point of view. Topics discussed included stabilization of external trade, private and public investment, privatization, and structural transformation. (Contact: *Petr Aven*, IIASA)

Global Environment/Development Policy: Pragmatism and Effective Policy-making, Abisko, Sweden, 13-16 May.
This workshop brought together 20 people from within and outside the scientific system to clarify and exemplify the principles needed to support viable developmental pathways, along with the institutional changes and scientific support upon which they depend. The meeting was jointly organized by IIASA and the Swedish Council for the Planning and Coordination of Research (FRN). A summary of discussions will be available in the fall of 1991. (Contact: *Paul Weaver*, IIASA)

Electricity and the Environment, Helsinki, Finland, 13-17 May.
Over 300 participants from 66 countries and 26 international organizations attended this senior expert symposium, hosted by the government of Finland and organized jointly by 11 international organizations, including IIASA. The objective was to discuss ways of meeting future electricity needs, considering both demand and supply options in light of their comparative economic, environmental, and health-related impacts, and to suggest a framework in which these factors could be considered in planning for electricity production and use. The output from the symposium is to be published late in 1991. (Contact: *Björn Wahlström*, IIASA)

PC-MARKAL Workshop, Laxenburg, Austria, 15-17 May.
Fifteen people attended this training session on the use of the PC version of the MARKAL-MUSS energy model. The session was organized by IIASA with the cooperation of the International Energy Agency's Energy Technology Systems Analysis Program and the Netherlands Energy Research Foundation. (Contact: *Markus Amann*, IIASA)

Energy/Environment Analysis, Laxenburg, Austria, 21-24 May.
Thirty-five participants met to report on national MARKAL model activities; to exchange information with East European modelers; to be introduced to IIASA's research results; and to contribute to the RAINS data base. (Contact: *Markus Amann*, IIASA)

Forthcoming Conferences

The following conferences will be sponsored or cosponsored by IIASA:

August 5-23, 1991: Summer School in Applied General Equilibrium Modeling, Laxenburg, Austria (Contact: *Lars Bergman*, Stockholm School of Economics, P.O. Box 6501, S-113 83 Stockholm, Sweden).

August 16-18, 1991: Study Experiences with Modern Water Resources Planning and Management Methods Taking into Account Risk Factors, Laxenburg, Austria (Contact: *Kazimierz Salewicz*, IIASA).

August 27-29, 1991: Applied General Equilibrium Modeling, Laxenburg, Austria (Contact: *Lars Bergman*, Stockholm School of Economics, P.O. Box 6501, S-113 83 Stockholm, Sweden).

September 9-13, 1991: User-Oriented Methodology and Techniques of Decision Analysis and Support, Warsaw, Poland (Contact: *Marek Makowski*, IIASA).

October 4-8, 1991: Culture and Negotiation, Laxenburg, Austria (Contact: *Bertram Spector*, IIASA).

October 9-10, 1991: Systems Analysis Techniques for International Negotiation, Laxenburg, Austria (Contact: *Bertram Spector*, IIASA).

October 2-25, 1991: Environmental Training in Engineering Education, Laxenburg, Austria (Contact: ENTREE, UETP-EEE, The Engineering Society in Finland STS, Ratavartijankatu 2, SF-00520 Helsinki, Finland).

January 28-30, 1992: Energy-Ecology-Climate Modeling and Projections, Laxenburg, Austria (Contact: *Iouri Siniak*, IIASA).

NEWS

In Memoriam

Dr. John M. Blewer, member of IIASA's Advisory Board and President of the Pacific American Investors Inc. in Salt Lake City, Utah, USA, passed away on 7 April.

Visitors to IIASA

Among recent visitors to IIASA were:

Academician Nikolai Petrakov, Director of the Market Research Institute in Moscow, and former Economic Adviser to the President of the USSR; Professor Åke Andersson, Director of the Swedish Institute for Future Studies in Stockholm; Dr. Daniel Matuszewski, Director of the International Foundation in Washington, DC, USA; Professor William P. Pierskalla, President of the International Federation of Operational Research Societies (IFORS), Lyngby, Denmark; Mr. Shepard Forman, Director of the Ford Foundation in New York, USA; Academician Domokos Kosáry, President of the Hungarian Academy of Sciences in Budapest; Mr. Valeri Mikhailov, First Deputy Chairman of the State Committee for Science and Technology in Moscow; Dr. Andras Szöllösi-Nagy, Director of the Division of Water Sciences at the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in Paris; and Dr. Stephen Kahne, Chief Scientist at the MITRE Corporation in McLean, Virginia, USA, and President-Elect of the International Federation of Automatic Control.

PUBLICATIONS

IIASA Reports

The following reports are available from Robert McInnes, IIASA Publications Department, for the amounts indicated.

Recent and Future Development of Emissions of Nitrogen Oxides in Europe. M. Amann. March 1991. Reprinted from *Atmospheric Environment* Vol. 24A, No. 11, 1990. RR-91-3. US $10.

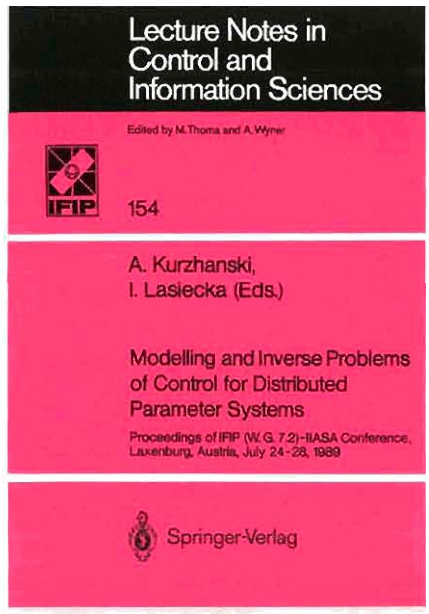
Technology Diffusion in the Coal-Mining Industry of the USSR - An Interim Assessment. A. Astakhov, A. Grübler, A. Mookhin. May 1991. Reprinted from *Technological Forecasting and Social Change* 38(3):223-256(1990). RR-91-4. US $10.

The Future. C. Marchetti. May 1991. Reprinted from *Proceedings of the International School of Physics Enrico Fermi*, G. Caglioti and H. Haken, editors. RR-91-5. US $10.

How to Solve the CO_2 Problem without Tears. C. Marchetti. May 1991. Reprinted from *International Journal of Hydrogen Energy*, Volume 14, No.8 (1989). RR-91-6. US $10.

Chemical Time Bombs: Definition, Concepts, and Examples. W.M. Stigliani, editor. January 1991. ER-91-16. US $10.

Forest Potentials and Policy Implications: A Summary of a Study of Eastern and Western European Forest. S. Nilsson, O. Sallnäs, P. Duinker. February 1991. ER-91-17. US $10.



The RAINS Model of Acidification: Science and Strategies in Europe. J. Alcamo, R.W. Shaw, L. Hordijk, editors. January 1991. ER-91-18. US $10.

The Soviet Economic Crisis: Steps to Avert Collapse. February 1991. ER-91-19. US $10.

IIASA Books

The following books are now available from your regular book supplier or direct from the publisher.

Multiobjective Problems of Mathematical Programming, Proceedings, Yalta, USSR, 1988. A. Lewandowski, V. Volkovich, editors. Springer-Verlag, Berlin/Heidelberg/New York, ISBN 3-540-53432-6.

Chernobyl: A Policy Response Study. B. Segerstahl, editor. Springer-Verlag, Berlin/Heidelberg/New York, ISBN 3-540-53465-2.

Land Use Changes in Europe. Processes of Change, Environmental Transformations and Future Patterns. F. Brouwer, A.J. Thomas, M.J. Chadwick, editors. Kluwer Academic Publishers, Dordrecht/Boston/London, ISBN0-7923-1099-3.

Multiple Criteria Decision Support, Proceedings, Helsinki, Finland, 1989. P. Korhonen, A. Lewandowski, J. Wallenius, editors. Springer-Verlag, Berlin/Heidelberg/New York, ISBN 3-54053895-X.

Economic Structural Change - Analysis and Forecasting. P. Hackl, A. Westlund, editors. Springer-Verlag, Berlin/Heidelberg/New York, ISBN 3-54053839-9.

Modelling and Inverse Problems of Control for Distributed Parameter Systems, Proceedings of IFIP (W.G.7.2) IIASA Conference, 1989. A.B. Kurzhanski, I. Lasiecka, editors. Springer-Verlag, Berlin/Heidelberg/New York, ISBN 3-540-53583-7.

Diffusion of Technologies and Social Behavior. N. Nakićenović, A. Grübler, editors. Springer-Verlag, Berlin/Heidelberg/New York, ISBN 3-540-53846-1.

◆ Capital Cities of NMO Countries

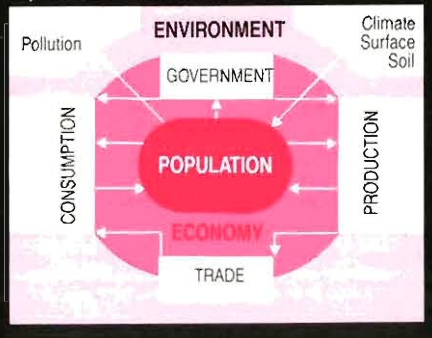
IIASA

International Institute
for Applied Systems Analysis

IIASA's ROLE

The International Institute for Applied Systems Analysis is an international, nongovernmental research institution sponsored by scientific organizations from 15 countries. IIASA's objective is to bring together scientists from various countries and disciplines to conduct research in a setting that is non-political and scientifically rigorous. It aims to provide policy-oriented research results that deal with issues transcending national boundaries. Resident scientists at IIASA coordinate research projects, working in collaboration with worldwide networks of researchers, policymakers, and research organizations.

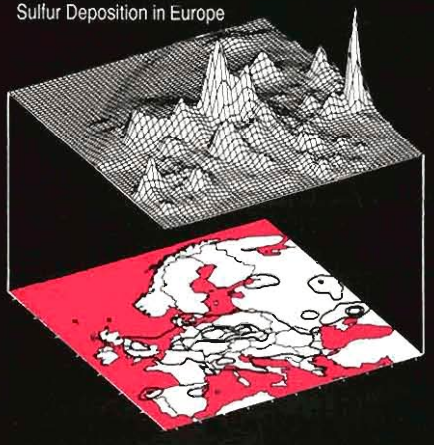
Population /Environment Interactions



RESEARCH

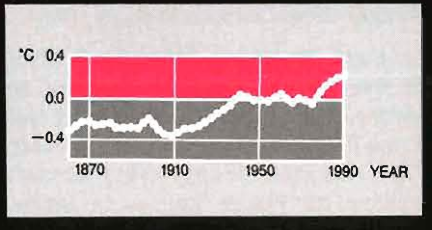
Recent projects include studies on global climate change, computer modelling of global vegetation, heavy metal pollution, acid rain, forest decline, economic transitions from central planning to open markets, the social and economic implications of population change,

Sulfur Deposition in Europe



processes of international negotiations, and the theory and methods of systems analysis. IIASA applies the tools and techniques of systems analysis to these and other issues of global importance.

Global Mean Temperature



MEMBERSHIP

IIASA was founded in 1972 on the initiative of the USA and the USSR, and now also includes eleven European countries, Canada, and Japan. IIASA has member organizations in the following countries: Austria, Bulgaria, Canada, the Czech and Slovak Federal Republic, Finland, France, Germany, Hungary, Italy, Japan, the Netherlands, Poland, Sweden, the Union of Soviet Socialists Republics and the United States of America.

FURTHER INFORMATION

Further information about IIASA and its work is available from: The Office of Communications, International Institute for Applied Systems Analysis, A-2361 Laxenburg, Austria, Telephone (02236) 71521-0.