The RAINS Model of Acidification

Science and Strategies in Europe

From the systems analytical perspective afforded by RAINS—IIASA's Regional Information and Simulation model—the book provides a comprehensive and quantitative overview of European-scale acidification and of possible policy responses. Soon to be published by Kluwer Academic Publishers.
Central to IIASA’s function as an institute for applied systems analysis is the requirement to provide the tools, information, and advice, needed by those who face and must respond to real world issues, problems, and opportunities. Our clients are fellow scientists, practitioners, policy experts, and decision makers in government, industry, and business. The needs of each, though often similarly formulated in terms of generalities, must ultimately be met through customization.

Customization can mean many things, but it always starts from a precise understanding of the client’s – the ultimate user’s – specific needs. Only then can research be undertaken to meet those needs effectively, whether they be for information, an evaluation, a scenario analysis, an analytical tool, a decision support system, an expert system, a monitoring system, or an improved mathematical procedure. The list of custom uses of research results, like the list of needs to be filled, is almost endless.

This issue of OPTIONS has articles on work undertaken at IIASA for specific client communities: Professor Nilsson’s work which has provided recommendations on silvi-cultural practices to the European timber industry; Dr. Fedra’s customized software systems, such as those for the Dutch Ministry for Physical Planning, Housing, and the Environment; and the workshop organized by Professor Schmidt-Bleek that is bringing together experts and policymakers from East and West as continuing expert groups to find ways of smoothing the path to economic reform in Eastern Europe. Each article tells the story behind a customized application of general systems analysis and modeling – which, by its usefulness and relevance, emphasizes IIASA’s growing utility to a widening constituency.

Robert H. Pry, Director

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Cover photo: IIASA’s Advanced Computer Applications (ACA) Group
IASA’s Applied Computer Applications (ACA) Group, led by Dr. Kurt Fedra, has signed a new two-year extension of their contract with the Dutch Ministry for Physical Planning, Housing, and the Environment (VROM), under the terms of which ACA will continue to develop an interactive information and decision support system for environmental risk analysis in the Netherlands. Current extensions include the integration of several databases, such as a list of major sources of pollution and a hazardous chemical inventory, and porting the system’s graphical user interface from GKS to ACA’s application interface tools – the AI ToolKit, based on Xlib.

The results of collaboration with VROM last year, including a dynamic simulation model to analyze spills of toxic material in the Rhine River and display and analysis software for the Environment Ministry’s noise division, have already been installed in the Netherlands. The new contract marks a phase of intensive activity by ACA, with several continuing contracts, some new commissions, and a set of recent product installations.
Recent Installations

As part of the Ecological Research Program Hanover, ACA is implementing an environmental information system for the environmental division of the city of Hanover. The implementation is part of an interim project evaluation by the sponsor, the Ministry for Research and Technology of the Federal Republic of Germany. The software includes a geographical information system (GIS) for interactive construction and analysis of both digital and vector-based maps; integrated databases; and a two-dimensional finite difference groundwater flow and contamination model, developed at the University of Hanover. Built with ACA's A1 ToolKit, the system offers an easy-to-use graphical interface and is designed for users with little or no computer background.

New Projects

In addition to the work for VROM, ACA will start a new research project, funded by the Austrian Research Foundation Fonds zur Förderung der Wissenschaftlichen Forschung. As part of a bilateral agreement between the Austrian Foundation and the Natural Science Research Foundation of the People’s Republic of China, ACA will collaborate with the Management Information Systems Department of the School of Economics and Management of Tsinghua University, Beijing, to develop a decision support system for environmental planning. Combining classical numerical approaches with expert system technology, the hybrid system is designed to address discrete multi-criteria problems. ACA’s partner in the project is Professor Chunjun Zhao.

Completed Work

Finally, in collaboration with the Institut National de Recherche sur les Transports et leur Sécurité (INRETS) of the French Département Evaluation et Recherche en Accidentologie (DERA), a study on transportation risk assessment has recently been completed. In the first phase, a prototype system has been developed for the region of Haute Normandie. The system, including an integrated GIS and relational database management, coupled to an intelligent path generator and risk assessment routines featuring interactive definition of transportation scenarios, was installed at INRETS during a workshop on the results of the study.

For further information about the Advanced Computer Applications Group, contact Dr. Kurt Fedra at IIASA.
Across Europe approximately 3 billion m³ of timber (over 20% of the total timber inventory) is already suffering pollutant-induced damage. With almost 80% of Europe’s coniferous forest areas and around 40% of its deciduous forest areas suffering excessive levels of pollutant deposition, this situation will deteriorate further unless actions are taken. IIASA’s Forestry Project estimates timber losses through pollution will be around 85 million m³ yr⁻¹ for the next 100 years.

In addition to revising emission-abatement strategies (which will take time to implement and have an effect), large-scale felling and replanting can be used to combat the problem and maintain healthy growing stocks of commercial tree species. But this will heavily influence future patterns of wood supply to industry. In the short term, there may be timber gluts. In the longer term, maintaining sustainable growing stocks will force harvest levels down.

Forestry Practices Inefficient

Latest findings from IIASA’s Forest Study show that forestry practices across Europe are inefficient, and have been for a long period. Potential harvest levels have been higher than actual harvest levels resulting in an overall discord between the current structure of forests and the structure that would now exist if handbook silviculture (those silvicultural programs defined by scientists as ideal for each country) had been practiced. Moreover, if handbook silviculture is considered important to maintaining high levels of forest vitality and resilience, most countries in Europe have allowed their forests to get into a condition of high risk to stress factors, both natural and anthropogenic.

Effects of Atmospheric Pollutants

Even if conditions were stable, forest practices would be ripe for change. In practice, however, they also need to be adjusted to new economic and environmental realities, and especially to the conditions caused by continuing atmospheric pollution. The impacts of pollutants in reducing the rates of tree growth and in forest dieback are greater than they would have been had better silviculture been practiced. Given the current structure and high vulnerability of forests, new forest policies will be needed to keep forest resources vital. To maintain sustainable growing stocks will reduce the annual harvest potential by about 85 million m³ yr⁻¹ for the next 100 years.

The growth and vitality of European forests are affected by several atmospheric pollutants: oxides of sulfur and nitrogen, fluorides, heavy metals, ozone, and dust. Since the sensitivity of different forest ecosystems to pollution varies, for example, with soil type, rainfall, geology, and tree species, there is no single level of pollutant deposition permissible. Rather, there are ranges of critical and target loads – quantitative estimates of deposition levels not to be exceeded if forests are to remain healthy.

In the long term, over all Europe, better silviculture could improve biological harvest potential and growing stocks

Professor Sten Nilsson, Principal Investigator of IIASA’s Forest Study
Despite current emission-control agreements, the majority of Europe's forests will still be suffering from excessive sulfur and nitrogen deposition in the year 2000 and that this will affect both the growth rate and life expectancy of trees.

Scientists of IIASA's Forest Study have estimated the effects of this excess deposition of acids on trees of different type and age using the Prognosis and Decision Support Model for Environment Conservation (PEMU) developed in the German Democratic Republic. This model translates the effects of exceeding target loads into damage and decline patterns by calculating the life expectancy of affected trees and the time that affected trees spend in each of four recognized damage classes indicated by the level of leaf or needle loss. Defoliation is an important indicator of a tree's state of health and of its growth rate. Taking middle-aged stands (50 years old) as an example, annual growth rates of acidity-affected coniferous trees (with 25% needle loss) are commonly between 60% and 80% of those of undisturbed trees, depending on the rate of deposition.

Combining information on acid deposition, critical loads, forestry resources, decline cycles, and growth impacts within their Timber Assessment Model, scientists of IIASA's Forest Study have made forecasts, under several scenarios, of the development of timber resources within Europe over the next 100 years as a basis for testing policy options on emission abatement and silvicultural practices.

**Decline in Harvest Levels**

What emerges is that, under present emission-control agreements and given a continuation of present silvicultural practices, an overall decline in potential harvest levels is inevitable if, at the same time, sustainable growing stocks are to be maintained at current levels. Compared with biological harvest potentials determined by the Forest Study under several no-pollution scenarios, harvest potentials under projected conditions of acidification (obtained using RAINS and based on the likely levels of emissions to the year 2000 given current international emission-control agreements) are about 85 million m$^3$ yr$^{-1}$ lower. These lower harvest levels will have to apply for the next 100 years if growing forests are to be kept at sustainable levels and in sustainable condition.

The split of harvest losses across countries and regions is far from even. The worst affected countries are the Federal Republic of Germany, Poland, and Czechoslovakia, each with an annual harvest loss of between 9 and 12 million m$^3$ yr$^{-1}$. In Scandinavia, Sweden and Finland will each lose
silvicultural measures can be taken to increase stand vitality, delay the decline process, and save commercial wood. Possible measures include delayed regeneration, intensified thinning, shortened rotation periods, and changed species composition. Around 5 million m³ yr⁻¹. The worst affected regions will be Eastern Europe and the EEC-9 (Belgium, Denmark, France, the Federal Republic of Germany, Ireland, Italy, Luxembourg, the Netherlands, and the UK), with harvest losses amounting to about 35 million m³ yr⁻¹ and 25 million m³ yr⁻¹, respectively.

Remedial Actions

So, what can be done to remedy the situation? “Current international commitments on emission reduction are clearly insufficient,” says Professor Sten Nilsson, leader of IIASA’s Forestry Study. “Deposition abatement strategy should be changed immediately from that of general emission reduction to one of optimized, targeted reductions.”

But aside from the question of emission abatement, the study highlights a finding of special interest to timber growers and to the timber industry: the importance of tree age as a determinant of resilience to acidic conditions. Essentially, younger trees are much more able to withstand acidic conditions than more mature trees, and will continue to grow in conditions where older trees would cease growing or even die.

The effect of age is quite marked. In comparison with middle-aged stands, the process by which trees pass through different damage classes (stages of defoliation and reduced growth on the path from planting to death) operates about 20% faster in older stands and about 20% slower in younger stands. This means, for example, that whereas a young tree growing in an area of medium sensitivity to sulfur deposition and experiencing up to 4 g S m⁻² yr⁻¹ will suffer no ill-effects on its growth rate for, on average, 24 years, an older tree would begin to suffer retarded growth after only 16 years.

Viewed in this light, the existing age structure of forests across Europe is imbalanced in favor of mature trees. A notable feature of the distribution of growing stocks of timber per unit area across Europe is their wide range (from a high of 364 m³ ha⁻¹ in Switzerland to a low of 68 m³ ha⁻¹ in Spain). In general, the countries of Central Europe have high standing volumes per unit area, partly because the age-class structure of their forests is biased with large proportions of mature and over-mature stands. IIASA’s research indicates a change in forest practice, involving large-scale felling and replanting.

Such an adjustment would have major implications for the environment and landscape. It would also pose problems for decision makers in the timber-processing industry who would face, at once, the prospect of a short-term timber glut, for which the industry is undercapitalized, and a mid-term timber shortage, which could leave markets unsatisfied and new equipment idle.

Another possible solution investigated by the Forest Study would be to convert agricultural land to forest and to rehabilitate degraded forest. For the EEC countries, at least, the conversion of arable land and pasture would be in line with moves to reform agricultural policy while for other countries throughout Europe land conversion and upgrading hold potential for boosting future timber supplies and ensuring healthy growing stocks in an otherwise decline situation.

For Europe as a whole, the Forest Study looked into the effect on growing stocks and harvest levels of an expansion in the land area devoted to forest by an overall 5% over the period to 2020. The results indicate that this would increase harvesting potential in comparison with the basic no-pollution scenarios by nearly 27 million m³ yr⁻¹ by the end of the simulation period. The level and development of the growing stock are essentially identical for the two scenarios. The harvest potential of both coniferous and deciduous species would increase smoothly throughout the whole simulation period.

Dominating the results for Europe is the effect of the large potential expansion of forest in the EEC countries. The Forest Study scenarios assume a 24% expansion of EEC forest area (from about 29 million ha to about 36 million ha) gradually phased in over the period to 2020. The effect is to increase potential harvest levels by 19 million m³ yr⁻¹ by the end of the simulation period in comparison with the base scenario. The total potential harvest level increases smoothly throughout this period.

Results from IIASA’s Forest Study are soon to be published in a three-volume set. The books, now in preparation, investigate different potential silvicultural and policy responses to the development of forest resources within Europe.
Underlying the work of the Biosphere Project is the need to establish the role of climate in determining vegetation patterns—only when this is clarified can the likely impact of climate change on vegetation be projected. To do this requires an accurate and complete knowledge of current climate. Given this background, it may seem surprising, then, that our ability to describe current climate has, to date, been very limited. But now, by interpolation of a large set of readings from weather stations worldwide to a grid of land cells with a resolution of 0.5°, scientists from IIASA’s Biosphere Project have developed probably the most accurate data set on current climate yet constructed.

The data set, based entirely on weather records, is embodied within a geographical information system that permits instant visualization of current climatic conditions and data manipulation for a wide range of applications. While the immediate use for the data set is in specifying accurate life- and vegetation-zone types and boundaries and in projecting the impact of any future climate changes on vegetation patterns (see OPTIONS, September 1989), its range of future applications is immense, especially for agricultural, biogeographical, and ecological studies.

Inadequacy of Existing Data

To date, a complete, objective picture of global climate has been difficult to obtain and scientists have often resorted to rather crude approximations of climatic zone boundaries using less than ideal surrogates, like vegetation distributions. In effect, our knowledge of climate has been built using a combination of weather readings and non-weather indicators. Climatologists have inferred climate from vegetation patterns while biologists have drawn upon spatial classifications of climate to adduce the influence of climate on vegetation. The circularities involved mean that it has been virtually impossible to calculate the true influence of climate on vegetation.

At the root of the problem has been the absence of complete and representative weather records covering the whole globe. First and foremost, this is because of the uneven distribution of weather stations worldwide. Some areas, especially those that are inhospitable and sparsely populated, have no or few stations. While more stations have recently been established in such areas, only short time-series data are available for these as yet.

Second, there have been few systematic attempts to collate available weather data and to use appropriate interpolation routines to infer conditions at sites for which no field data are available. Instead, weather conditions in such areas have been inferred, where possible, from prevailing vegetation. But prevailing vegetation is not necessarily a good surrogate for climatic conditions. Specific edaphic and hydrological conditions and vegetation dynamics influence species composition and vegetation structure. Also, humans have eradicated natural vegetation or replaced it with agricultural species across large areas so that, for these, no (or only very approximate) inferences about climate can be drawn.

The problem is compounded by the understanding, from data that have been available, that climate is not constant and that, irrespective of any buildup of atmospheric greenhouse gases, indicators of average global temperature and precipitation exhibit considerable variation between years. These variations occur in the form of waves overlying the general warming trend. They imply that, to obtain an unbiased impression of climate and of how climate is changing, one must study a time series of weather records embracing several years that fall midway between the peaks and troughs of the weather cycles.

Approach

The Biosphere Project of IIASA’s Environment Program set out...
Figures:

1. Growing degree days above 5°.

2. Continentality index (Conrad, 1947).

3. Annual mean precipitation (in millimeters).


5. Percentage cloudiness for July.

6. The Holdridge life-zone classification (the color indicates the clustering used in the Holdridge life-zone world map).

7. The Holdridge life-zone world map.

Dr. Rik Leemans of IIASA's Biosphere Project together with Dr. Wolfgang Cramer of the University of Trondheim, Norway, collated data from several sources both published (Weather Bureau, 1959; Walter and Leith, 1960-67; Meteorological Office, 1972; Müller, 1982) and unpublished (China, USSR). The different data sets were separately screened for errors, outliers, unreliable stations, and doublets. An observation record of between 10 and 40 years (if possible a period of 30 years between 1931 and 1960 which, trend analysis indicates, corresponds to an average interpeak period) was used for calculating mean monthly temperature and precipitation values. The final data set contained readings for around 6,100 stations characterized by longitude, latitude, and altitude.

This array of selected stations was used to create a global monthly temperature, precipitation, and cloudiness database for land areas...
on a grid with a resolution of 0.5° (around 55 km² at the equator).

The interpolation scheme used for each variable was a smooth surface fitting on a triangular network based on all stations. Temperature values were corrected to mean sea-level before the interpolation and, afterward, readjusted to the modal height of each cell (obtained from a topography data set supplied by the US National Geophysical Data Center). Figures 1–5 show world maps with climatic parameters derived from the data set.

Holdridge Life-Zones

The resulting data were then used to develop sets of indicators relevant to the Holdridge life-zone classification system: a scheme that relates vegetation zones to weather indicators that can be derived from basic monthly temperature and precipitation readings. The three indicators upon which the system relies are biotemperature (based on the length of and temperature during the growing season), mean annual precipitation, and a potential evapotranspiration ratio that links biotemperature with annual precipitation and defines different humidity provinces. The three climatic indicators are displayed graphically in a logarithmic system, so that each separate life-zone becomes equally significant (Figure 6).

Using a combination of these three indicators derived from the climate data set, the Biosphere Project was able to develop a global life-zone map (Figure 7) that, by comparison with actual vegetation zones, can be used to test the real and direct contribution of climate in determining vegetation patterns. Also, because of its high correspondence with these patterns, the map can be used as a basis for assessing the effect on vegetation zones of future climate change.
At a remarkable and historic meeting organized by Professor Friedrich Schmidt-Bleek, Leader of IIASA’s Technology, Economy, and Society (TES) Program, leading Western policy advisors and top Soviet and Eastern European policymakers came together to discuss ways of achieving economic reform in Eastern Europe and to establish a continuing program of research and consultation on the reform process mediated through IIASA’s Economic Reform and Integration (ERI) Project. In organizing the meeting, Professor Schmidt-Bleek was greatly aided by Dr. Peter Aven also from TES. As a result of a unique agreement reached at the meeting, the USSR is to refer draft legislation on economic reform for constructive comment to one of five expert working groups established by IIASA.

The agreement signals a remarkable first in international cooperation – with leading US, Western European, and Japanese economists pledging practical assistance to help guide the Soviet and Eastern European economies during a period of major transition, and the Council for Mutual Economic Assistance (CMEA) countries committing to inject the experience and judgment of Western experts into their policy development.

The goal of all parties is to achieve an effective and efficient transition toward more market-based economies that will also avoid the more unacceptable effects of massive dislocation and structural adjustment currently being experienced.

The agreement, along with several other outcomes from the meeting, also registers a key role for IIASA, and in particular for the ERI Project of the TES Program. It establishes IIASA’s ERI Project as the central, neutral, scientific, and objective mediator and coordinator of a unique process of international consultation that will help chart the economic future for 250 million Soviet citizens. It also offers comparable assistance to all other CMEA countries wishing to participate in the dialogue. Indeed, the process of widening the scope of the Project to embrace the full set of CMEA countries is already underway.

In turn, through IIASA, an opportunity has been created for key US, Western European, and Japanese policy analysts and advisors not just to contribute to the process of economic reform in Eastern Europe, but to be given confidential, early, and comprehensive access to legislative proposals that will determine the future economic architecture of the Soviet Union and Eastern Europe – the architecture that will set the frame for all forms of future East-West economic cooperation and relations.

Background

The ERI Project at IIASA, which masterminded the meeting, was established on the initiative of Academician Stanislav Shatalin, a member of the State Commission on Economic Reform and of the Presidium of the National Academy of Sciences of the USSR. A close observer of the Soviet economy and one of the architects of economic reform, Academician Shatalin’s concern was to establish a scientific dialogue through IIASA between Eastern policymakers and Western experts familiar with the management of market economies to help translate perestroika into tangible economic results at a time of fundamental structural readjustment. While there had been a great deal of talk at the highest levels about the need for such cooperation, until his initiative there had been no practical steps taken to establish such a dialogue.

Academician Shatalin’s concerns were based on his analysis of the current state of the Soviet economy and of the failure of perestroika, to date, to deliver much-needed results. At the root of the problem is the low efficiency of the Soviet economy, which results from the intrinsic logic of the economic system with its emphasis on growth and quantity rather than on efficiency and quality as the criteria of performance. Low efficiency, in turn, is partially responsible for the shortages now being experienced and, owing to the excessive and wasteful application of raw materials in production processes, has also contributed to severe ecological damage that now needs to be repaired. Past policies, which diverted ever-more resources to inefficient production, aggravated the problem.

Perestroika, which is designed to implement a market economy in place of the central-planning system and to decentralize decision making to individual enterprises, has so far only worsened conditions by adding confusion. Essentially, the process of dismantling the old system has proceeded more
FEATURE

rapidly than the creation of a replacement, leaving a vacuum and creating severe problems of dislocation. This has resulted in the need for some tactical backtracking and the decision to seek a dialogue with Western experts on an appropriate path to a more market-oriented economy.

To establish and organize the ERI Project, a planning meeting was held at IIASA, 11–12 December 1989, attended by policy experts and analysts from ten countries, both East and West. At that meeting, an array of economic problems in Eastern Europe needing urgent attention was used as the basis for structuring the research and consultancy work of the Project into five key areas, each to be addressed by a broad-based study group of experts drawn from several countries and chaired by an internationally renowned expert in the relevant field. The five study groups cover: capital markets and privatization; the labor market and employment; the opening of the economy; economic stabilization; and prices/indexation.

High-Level Participation

The Laxenburg meeting, held 1–3 March 1990, was the first international meeting of the study groups and attracted the highest level of participation from all parties. Participants included: Professor Ivanov, First Deputy Chairman of the USSR Commission on Foreign Economic Relations; Professor Yasin of the USSR Commission on Economic Reform; Professor Shokhin, Economic Advisor to the Foreign Minister of the USSR; Professor Khandruyev, Director of the Scientific and Research Institute for Money and Banking of the State Bank of the USSR; Dr. Brom, Deputy Chairman of the Czechoslovakian State Committee for Technology and Industry; Professors Haustein (GDR), Lutowski (Poland), and Tardos (Hungary); and Dr. Gacs of the Institute for Economic and Market Research and Informatics, Hungary.

The advisory group included: Professor Friedman, of Harvard, Professor Kahn of Cornell, Professor Rees of Princeton, and Professors Montias, Nordhaus, and Peck of Yale; Dr. Solomon of S.G. Warburg & Co. Inc.; Professor Cooper; Dr. Il Sakong, the Former Minister of Finance of South Korea; Professor Nishimura, Chief Economist at the Industrial Research Division of the Long-Term Credit Bank of Japan; Professor Takana, the Deputy Director General of the Administrative Management Bureau, the Prime Minister's Office, Japan; Professors Nuti and Frey (Italy); Kivikari (Finland), and Wibe (Sweden); Dr. Mencke-Gluckert (Federal Republic of Germany); Mr. Loeser of the Central Advisory Group of the President of the European Commission of the Communities; and Professor Albeda, President of the Scientific Council for Government Policy in the Hague and Chairman of the Board of MERIT.

In total, more than 50 internationally renowned experts participated in the meeting, which was attended also by representatives of international organizations including the Economic Commission for Europe (ECE), UNIDO, the World Bank, and the Commission of the European Communities (CEC). Ambassadors and the Vienna-based representatives of 14 countries attended an informal gathering during which they were briefed on the meeting and its results.

Apart from the obvious high caliber of its participants, the meeting was characterized by the candor and sincerity of the participants regarding the problems faced and by their intent to agree on measures that might be taken to solve them. The discussions were lively and informed, often drawing on historical parallels in other countries and regions where major reforms had been initiated. The variety of views and approaches expressed, not only among Western experts of different schools, but also among the different Soviet and Eastern European participants, reflected the keen and high level of economic debate currently under way in Eastern Europe and the significance for political and economic stability of finding the right solution.

Results

The main outcomes of the meeting included several agreements:

- To establish priorities across relevant issues within each of the five study group areas and to act to address them.
- To refer relevant draft legislation on economic reform in the USSR, through IIASA's TES Program and the ERI project, to study groups for constructive comment and guidance on the content, timing, relevance, sequencing, feasibility of actions, etc.
- To prepare detailed discussion papers on priority issues in the USSR. These papers would also set out current thinking and approaches.
- To invite and encourage other Eastern European countries to follow this procedure, using ERI as the mediator.
- To develop topics for future research in each of the main study areas.

Already, as a follow-up to the meeting, Professor Schmidt-Bleek has visited Prague to invite full Czechoslovakian involvement and has been requested by the Czechoslovakian authorities to solicit comments on their current draft plan for attaining a market economy.
Professor Robert Ayres

"a new industrial revolution is under way"

climate change – were not foreseen at all. It's probable that the consequences of the present revolution may be as far-reaching (and as unexpected) as the consequences of the first, and it is not a moment too soon for those in responsible positions to anticipate some of the changes that lie ahead and consider the policy options likely to be available - or unavailable - under various plausible scenarios. The urgency of the situation is compounded by the scope and speed of the change in physical production technology and its simultaneous diffusion in nations across the globe.

Q... What is computer integrated manufacturing and why is IIASA involved in studying its diffusion and impact?

A... A new industrial revolution is under way. If the first industrial revolution was the substitution of steam power for human and animal muscles, the present revolution is the substitution of electronic sensors for human eyes and ears and of computers for human brains - at least in a certain category of routine on-line manufacturing operations. The industrial importance of steam power was, of course, obvious to the entrepreneurs who developed it; but the larger and longer-run implications - from satanic mills and child labor to acid rain and new capabilities to manufacturing was the need for greater flexibility. By implication, the barrier to be overcome was the rigidity of so-called "hard automation" and, for that matter, the mode of industrial organization (often called "Fordism" or "Taylorism-Fordism") that evolved with it. However, this is a rather simplistic and incomplete view. While no one would seriously doubt the importance of flexibility, the logical connections between computers and flexibility are less robust than they at first appear. Computers are certainly not more flexible than humans, so the flexibility argument – at least in the narrow sense – is only applicable to the substitution of programmable-for-hard-automation. While there are examples of this sort of substitution, the true situation is more complicated. It has to do with the need for better quality and to be able to manufacture, cost-effectively, a greater variety of products, which are generally
more complex than before and which must often be customized to the buyer’s specific requirements. Behind all this, has been a complete change in the market pertaining to manufacturers: a breakdown of oligopolies, the globalization of markets, and an intensification of international competition.

Q... Could you elaborate on the background to the market changes that led to increased competition and on the role of CIM in enabling manufacturers to meet these new market challenges?

A... Most of the changes have occurred over the last 10 to 15 years. During that time, many artificial barriers to trade imposed by national governments or by trading blocs were simply negotiated away. The concept of US producers monopolizing the US market or of French producers monopolizing the French market is disappearing or has disappeared. In the new, global market, all producers need to export and all have to compete with, among others, Japanese manufacturers. The Japanese have had a tremendous impact on manufacturing technology and management everywhere. They were early adopters of some of the CIM technologies, notably robotics, and were able to reap the benefits in the marketplace of the cost and quality advantages CIM gave them through, for example, low defect rates on products and components. In a highly competitive market, the benefits of CIM continue to show.

Q... What will wide-scale adoption of CIM mean for employment in the manufacturing sector?

A... It's certainly the case that a lower percentage of the work force will be employed in the manufacturing sector in the future. What's less clearcut is that CIM will in any way be the responsible factor. We currently have an anomalous situation. We are at the tail end of a period with a large middle class of which a significant component consists of unionized workers who are essentially unskilled, at least by modern standards. The situation is relict from the days of the oligopolies when producers with guaranteed shares of domestic markets and operating under a strict division of labor were able to concede large pay increases (unwarranted by productivity) and were vulnerable to pressures by organized labor. With the end of protected markets and oligopolies, these days are over — the privatization of publicly owned corporations is the last act of the drama. With the oligopolies gone and formerly national markets now becoming international, the share of unionized employment in the manufacturing sector will decline, and manufacturing wages will lag behind wages in other sectors. To date, the Federal Republic of Germany and Japan have been able to resist this trend only by increasing their market share in the engineering sectors. Over the next few years, direct labor will continue to decline and will bottom out, say 30 years from now, at between 5% and 10% of the work force – like in agriculture.

Q... What does CIM imply for capital productivity?

A... Capital costs now typically account for 25% to 30% of final manufacturing costs. The main impact CIM has on manufacturing costs is through the flexibility, reliability, and intensity of use of capital equipment. If a machine is flexible enough to be controlled by a computer program, it's only the program and not the plant that needs to be changed to produce a different product. While numerical control machines cost more than manual machines, they are not dedicated to produce one specific product, so fewer are needed to produce a given range of products. Each machine is likely to be used more intensively. One big capital saving this implies is in the productivity of factory buildings. A few small, multi-product factories can replace the need for many large, dedicated plants — and this is likely to happen in the future especially since energy (and, by implication, transport) costs will increase. Indeed, we stand at the point of a historic shift in the driving force for economic growth from economies of scale to economies of scope. The prospects for the economies of the developed world look very good since several mutually supporting trends (greater capital and labor productivity, reduced inventories, more complete integration of functions, smaller factories, decentralization, etc.) will come together during the next decade and will accelerate the rate of productivity growth. CIM will play a major part here.
RAINS

Several new research contracts have been signed by IIASA’s Transboundary Air Pollution Project for the further development, adaptation, and application of its Regional Acidification Information and Simulation (RAINS) model.

A contract has been agreed with the Austrian Ministry for Science and Research to calculate critical loads for acidic deposition in Austria. Critical loads are those rates of acidic deposition (resulting mainly from transboundary air pollution), above which damage is likely to occur to sensitive ecosystems such as forest soils and lakes. The work, which will be carried out in collaboration with institutions in the Netherlands, Finland, and Austria, will provide the scientific basis for the Austrian contribution to the United Nations Economic Commission for Europe (ECE) Task Force on Mapping Geographical Areas where Critical Acid Loads on Forests and Lakes are Exceeded.

A one-year study agreement has been signed with the V.M. Glushkov Institute of Cybernetics of the Ukrainian Academy of Sciences in Kiev, USSR, supported by the Academy of Sciences of the USSR, for the adaptation to the USSR of the microcomputer version of RAINS. The work will involve several modifications to include regional models for the USSR that will treat emissions and atmospheric transport in finer detail; to develop and distribute a Russian-language version; and to augment the optimization routines in RAINS using latest advancements in decision support systems. The study has been agreed upon through the Transboundary Air Pollution (TAP) Project and the Adaptation and Optimization (ADO) Project.

SOIL ASPECTS OF SUSTAINABLE AGRICULTURE

Advanced Study Courses in Hungary

The Center for Advanced and Postgraduate Studies (CAPS), Budapest, Hungary, invites applications for an advanced study course it plans to hold from 1-21 October 1990 covering soil aspects of intensive, low-input, sustainable, and organic agriculture.

Field programming, quality control, input rationalization, and long-term environmental protection require adequate information on climatic, hydrological, and soil conditions and their interrelation, and on the mass and energy regimes in the soil-plant-water-atmosphere system. The course will look at different approaches to the control of the relevant processes, from the standpoint of their potential, their limits, and their environmental consequences.

Teaching will be through a blend of lectures, demonstrations, laboratory exercises, fieldwork, site visits, and discussion groups. Tuition will be by an international group of professors and will be in English language.

Topics covered will include:
- soil survey, analysis, mapping, and monitoring;
- modeling of soil processes;
- the plant nutrient regime and its control;
- systems for applying fertilizers and for recycling organic residues;
- risk assessment and stress analysis;
- the environmental impact of intensive, low input, sustainable, and organic agriculture.

The course is intended for young scientists keen to broaden their knowledge in these areas from the perspective of their teaching, research, or extension-service activities.

Further details are available from the course coordinator, Professor Dr. György Váallyay, Director of RIS-SAC, H-1525, Budapest, PO Box 35. Telex: 22-7223 AGROK-H.

TAP has also reached agreement with the Finnish Acidification Research Project (HAPRO) of the Ministry of the Environment and the Nuclear Engineering Laboratory of the Technical Research Center of Finland (VTT) to modify the optimization module of the RAINS code. This joint work seeks to develop a cost-optimization program for comparing alternative control measures of air pollution, implemented and tested for use as part of the Finnish Integrated Acidification Model (HAKOMA) (Contact: Dr. Roderick W. Shaw, IIASA).

In addition, IIASA’s Advanced Computer Applications (ACA) Project and TAP are discussing the possibilities of implementing a work station version of RAINS under UNIX (or VMS) and Xlib (X-windows) graphics. The proposal is in response to requests from current and some prospective RAINS users whose inquiries about extending and modifying the model go beyond TAP’s current research agenda. Proposed features of the work station version would include:
- Improved user interaction through a largely symbolic, menu-driven interface.
- High-resolution, dynamic, color graphics and coupling to standard geographical information system (GIS) formats (such as DLG) for detailed background maps, allowing interactive construction of topical maps and overlays, zooming, and a basic set of GIS functions for the output display and spatial analyses.
- Integration of expert system technology for highly interactive and rule-based scenario definition, analysis, and comparison with fully transparent database management.
- Integration of more complex nonlinear and dynamic optimization capabilities as well as multi-criteria comparison and discrete optimization of alternative scenarios in a highly interactive decision support approach.

It is expected that work on a work station version of RAINS, apart from leading to a new implementation, would also complement and benefit the continuing program of work on the PC version. (Contact: Dr. Kurt Fedra or Dr. Roderick W. Shaw, IIASA)
Recent Conferences


Twenty experts attended this meeting to prepare the basis for a joint IIASA/IRSA (Water Research Institute, Rome, Italy) study. Other objectives were to review and discuss crucial issues of water management in the Po Basin; review existing and available models, methods, and tools that may be useful to the study; and create mutual understanding for collaboration among participants. It was agreed that the study focus should be on water quality management problems related to eutrophication in the Po Basin and the adjacent Adriatic coastal zone. (Contact: Professor Zdzislaw Kaczmarek, IIASA)


Members of the Advisory Committee on IIASA’s Processes of International Negotiations (PIN) Project met to discuss final publishing arrangements for the current monograph. In addition, the Committee discussed the launching of a new monograph on international negotiations in the area of environment and interviewed candidates for the Project leadership position. (Contact: Professor Victor A. Kremenikou, IIASA)


Within the context of contractual work between IIASA and the Central Research Institute of Electric Power Industry (CRIEPI) of Japan, some 30 scientists met to discuss energy and CO₂ issues, especially with reference to the USSR and Eastern Europe where economic reforms and the changing goals of economic and social development now require new approaches to projecting energy demand and supply. (Contact: Professor Yuri Sinyak, IIASA)

Forest Study Policy Meeting, Laxenburg, Austria, 15 February.

Forest-policy experts from 12 countries met to discuss policy implications arising from continued forest decline in Europe, based on the results of IIASA’s Forest Study report, Potential Futures for the Forest Resources of Western and Eastern Europe. (Contact: Professor Sten Nilsson, IIASA)

Forthcoming IIASA Conferences

May 9–11, 1990: RAINS User Workshop, Warsaw, Poland, organized by IIASA and supported by the Committee for Coordination and Cooperation with IIASA of the Polish Academy of Sciences. (Contact: Dr. Roderick W. Shaw, IIASA)

May 28–29, 1990: Social Security, Family, and Household in Aging Societies, Rome, Italy, organized jointly by the University of Rome “La Sapienza” and IIASA. (Contact: Dr. Jean-Pierre Gonnot, IIASA)

May 28–June 1, 1990: Model-Oriented Data Analysis, St. Kyriak near Plovdiv, Bulgaria, organized by IIASA and supported by the Bulgarian National Committee for Applied Systems Analysis and Management. (Contact: Dr. Vladimir Veliov, IIASA)

May 29, 1990: Global Climate and Aerosols, Utrecht, Netherlands, jointly organized by Clean Air Netherlands and IIASA. (Contact: Dr. Joop F. van de Vate, IIASA)

June 6–8, 1990: Support for Research and International Contacts among Young Scientists in the Field of New Management Methods, Varna, Bulgaria, organized jointly by UNESCO, the Bulgarian Ministry for Science and Higher Education, and IIASA, supported by the Bulgarian National Committee for Applied Systems Analysis and Management. (Contact: Professor Tibor Vasko, IIASA)

June 7–8, 1990: International Energy Workshop, Honolulu, Hawaii, USA, organized jointly by the Energy Program of the Resource Systems Institute of the East–West Center and IIASA. (Contact: Dr. Leo Schrattenhoder, IIASA)

June 12–15, 1990: INRIA/IIASA 9th International Conference on Analysis and Optimization of Systems, Antibes, France. (Contact: Professor Alexander B. Kurzhanski, IIASA)

Conference Preview


This international study conference will provide extensive tutorial reviews of basic theory and applications, presented by internationally renowned scientists from different fields. One aim is to make a largely self-contained course/school/conference, demonstrating when and how newly acquired knowledge on system dynamics complexity can be applied in new fields—especially in those dealing with environmental issues. The event is primarily designed for emerging scholars (advanced graduate level) who wish to become familiar with the theory of dynamic and complex systems, and to show its relevance to their own field. It is also well suited for established scientists and others who are active in an area where the application of these new ideas is still in its infancy. Further details are available from Mrs. G. Fornell, Institute for Physical Resource Theory, Chalmers University of Technology, S-412 96 Goteborg, Sweden

Ethics and Environmental Policies, Padova, Italy, 31 August–1 September 1990.

The Fondazione Lanza, in association with the Human Dimensions of Global Change Program (HDGCP), is organizing this international conference to study how ethical convictions and cultural values can affect environmental policies and attitudes at every level. Special attention will be paid to the themes of the theoretical foundations of environmental ethics; ethics and environmental policymaking; and ethics and practice. HDGCP is a joint IFORS/ISSC/UNESCO/UNU initiative. The conference would be of value to persons with expertise or special interest in the following general topic areas: environmental ethics; ethics and public policymaking; planning and the decision-making process; public participation; the role of industry in environmental protection; social justice; and quality of life. Direct inquiries to Dr. Peter Timmerman, HDGCP Secretariat, IFIAS, Toronto, Ontario M5R 2S9, Canada.
External Relations

Several information sessions were convened during IIASA Director Dr. Robert H. Prü’s visit to Tokyo, Japan. A news conference was held, 31 January 1990, covering IIASA’s research activities and possibilities for improving cooperation with Japanese scientific and governmental organizations. The meeting was hosted by the Environment Agency. On 6 February, two briefing sessions were held covering aspects of IIASA’s East-West character and experience. The first, hosted by the Research Development Corporation of Japan, was attended by 150 representatives from Japanese corporations and agencies. The second, hosted by the National Institute for Science and Technology Policy, had 40 participants. Two more news conferences were held in February at the Press Club Concordia in Vienna, Austria. On 16 February, members of IIASA’s Environment Program presented results of research relevant to the environment in Eastern Europe and the USSR, and which demonstrate some important relations between environmental conditions in Eastern and Western Europe. On 28 February researchers from IIASA’s Population Program and the French National Institute of Demographic Studies (INED) jointly presented estimates of the current extent of Human Immunodeficiency Virus (HIV) infection and AIDS and gave their projections on the future demographic impact of the HIV epidemic.

Several other presentations and briefings were made to visiting delegations: to Chinese researchers from various universities in Beijing (6 December 1989) and from the State Science and Technology Commission (SSTCC) (15 January 1990); to Messrs. Frigyes Geleji, Zoltan Kiraly, György Banffy, Ernő Raffay, and Attila Zsigmond of the Hungarian Parliament (12 December 1989); to two US Congressional delegations, the first headed by Representative Robert Roe, Chairman of the House Committee on Science, Space, and Technology (2 January), and the second headed by Representative James W. Scheuer of New York (13 January); to a group of 30 industrialists and managers from Poland and Czechoslovakia (31 January); to 23 Soviet managers (6 February); and to Dr. František Reichl, Czechoslovak Deputy Prime Minister and Chairman of the State Commission for Technology and Investments (24 February).

Awards

Leader of IIASA’s Water Resources Project, Professor Zdzislaw Kaczmarek, has been awarded the 1990 International Hydrology Prize of the International Association of Hydrological Sciences (IAHS).

Training Course in Water Resource Management

Water resource managers from Malawi, Mozambique, Tanzania, and Zimbabwe participated in a training course, 15 January–14 March 1990, organized by IIASA’s Water Resources Project. The course was cosponsored by the Southern African Development Coordination Conference (SADCC) and UNEP. The course covered the concepts and methods of a systems approach to water management and demonstrated the value of IIASA’s Interactive River Simulation (IRIS) software to solve water management problems. In collaboration with the course participants, a prototype IRIS-based version of a computer-based decision support system has been developed for the Zambezi River Basin.

IIASA Books

Two new IIASA books, now off press, are available from your regular book supplier or direct from the publisher.


IIASA Report

In addition, the following IIASA report is now available from the Publications Department at the price indicated.


Other IIASA Publications


For further details contact Robert McInnes.
IIASA's ROLE
The International Institute for Applied Systems Analysis is a non-governmental research institute sponsored by scientific organizations from East and West. It brings together scientists from more than 20 nations and a variety of disciplines. Its purpose is to develop practical options to deal with issues of international importance through the application of system sciences. The Institute's effectiveness is rooted in its international sponsorship and focus, its nonpolitical status, its freedom to choose its research agenda from a variety of pressing international issues, its interdisciplinary base, and its worldwide network of collaborating organizations.

RESEARCH
Recent projects have included studies on global climate changes, world agricultural potential, energy resources, acid rain, computer integrated manufacturing, the social and economic impacts of demographic changes, and the theory and methods of systems analysis. The basis of IIASA's scientific research is the development and use of computer models to help define how global issues and problems may evolve in the future. The objective is to develop viable policy options that can be implemented through international cooperation.

MEMBERSHIP
IIASA was founded in 1972, on the initiative of the USA and the USSR, with the eventual participation of another 14 countries in the East and West. IIASA has member organizations in the following countries: Austria, Bulgaria, Canada, Czechoslovakia, Finland, France, the German Democratic Republic, the Federal Republic of Germany, Hungary, Italy, Japan, the Netherlands, Poland, Sweden, the Union of Soviet Socialist 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) 71 521-0.