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Future Challenges in Renewable Natural Resources

Proceedings of a National Workshop, January 22-25, 1979 Rosslyn, Virginia

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This workshop brought together top authorities from the fields of futures forecasting and renewable natural resources to help the USDA improve long-range planning and programming. Participants identified an array of factors and trends believed to have potentially significant impacts on renewable natural resources, assessed such impacts, and took the first steps toward developing scenarios on the long-range future of these resources.

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U.S. Department of Agriculture
Forest Service
Science and Education Administration
Soil Conservation Service

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Preface

This workshop was a major initial step in a joint effort by the three conservation, research, and education agencies of the U.S. Department of Agriculture (USDA) to improve legislatively mandated long-range planning and programming. Specifically, it was called to explore how the concepts and techniques of futures forecasting could be incorporated in such planning. The total effort involved pre-workshop and workshop identification of an array of factors and trends believed to have potentially significant impacts on renewable natural resources, assessing such impacts, and combining both in the development of scenarios on the long-range future of these resources.

The Forest Service, Science and Education Administration, and Soil Conservation Service were the three co-sponsoring agencies. Cooperating organizations were the National Association of Conservation Districts, Natural Resources Council of America, Pinchot Institute for Conservation Studies, and the Renewable Natural Resources Foundation. Each of these agencies and organizations was represented on the steering and planning committees that provided overall direction and support.

Special technical support was provided by: the Congressional Research Service of the Library of Congress; the Economics, Statistics, and Cooperatives Service, USDA; Rocky Mountain Forest and Range Experiment Station, Forest Service, USDA; the U.S. House of Representatives Committee on Agriculture; and the U.S. Senate Committee on Agriculture, Nutrition, and Forestry.

The various articles, presentations, and workshop summaries in the proceedings that follow reflect the opinions of the authors and workshop teams, and -- therefore -- do not necessarily represent official positions of the U.S. Department of Agriculture.

John Gray
Workshop General Chairman

Contents

Executive Summary[1]

The workshop was designed to bring together key people from futures research and renewable natural resources in a setting where they could systematically consider the future. The objectives were to: identify probable global national, and regional trends and developments over the next 6 to 50 years, (2) assess the nature and magnitude of their impacts; and (3) suggest strategies, policies, roles, programs, and organizational and research priorities for the U.S. Department of Agriculture.

The goals were ambitious. But the workshop participants quickly realized that future challenges called for such an idealistic point of departure. The workshop was thus a pioneering effort at getting futurists, economists, and a broad range of renewable natural resource specialists and program leaders to sit down together and hammer out possible approaches for anticipating and solving complex long-range issues. Workshop accomplishments are a tribute to organizers' efforts and participants' dedication.

An understanding of futures research is critical to appreciating the workshop's significance. As Selwyn Enzer, Center for Futures Research, University of Southern California, explained, "We aren't forecasting or predicting the future; we're developing simulation models to help us understand how various human actions and physical/biological systems may affect the future." This sharpened understanding will help us take intelligent action to shape the future.

To stimulate interaction among the various disciplines represented, the workshop featured a mixture of formal presentations, statements of expectations, small-group work sessions, and team reports. A concluding panel discussed ways to incorporate workshop findings into long-term planning by the U.S. Department of Agriculture.

Secretary of Agriculture Bob Bergland's opening remarks set the stage for global perspectives on challenges facing the future of renewable natural resources. In recounting the President's budget recommendations for FY 1980, Senator John Melcher of Montana speculated that current budgeting priorities,

[1] Compiled by Leroy Quance, Economics, Statistics, and Cooperatives Services, USDA, Washington, D. C., and R. H. Hamre, Research Information Group, Rocky Mountain Forest and Range Experiment Station, USDA, Fort Collins, Colorado.

resulting from any necessary compromises and trade-offs, probably do not adequately recognize future challenges and opportunities in renewable natural resources.

Rupert Cutler, Assistant Secretary of Agriculture for Conservation, Research, and Education, reminded the participants of the need to maintain a broad perspective so that they might "begin an important new dialogue that results in critical examination of new and different concepts and alternatives.... The Department of Agriculture has major responsibilities for long-range planning and conservation of the Nation's natural resources, but simply having these authorities doesn't mean we now possess the ability to ask all the right questions, or develop solutions to all the difficult problems!"

What did others expect of the workshop? James Giltmier, Senate Committee on Agriculture, Nutrition, and Forestry, outlined the impact it could have on Congressional activities and staff members and on interest groups. Hyde Murray, House Committee on Agriculture and now Majority Clerk of the House, pointed out the dichotomy between long-term policy planning and biennial elections in the House of Representatives. He underscored the need to reach a consensus on what the problems really are, and the alternative solutions.

Marvin Cetron, Forecasting International Ltd., told us Sweden is a precursor to the United States in terms of societal experience. Examination of Swedish attitudes and actions provides insights into possible U.S. changes that can be useful in formulating natural resource policies and assessing their impacts.

Lester Brown, the Worldwatch Institute, discussed global stresses evident in each of the four major biological systems -- oceanic fisheries, grasslands, forests, and croplands -- that humanity depends on for food and industrial raw materials. (All formal presentations are documented in the full workshop proceedings).

At the first plenary session, futurist Robert Theobald challenged the group, claiming disagreements about societal goals, personal motivations, and methods of effecting and coping with change are so great that effective policy-making currently is impossible. He questioned whether workshop participants would "...try for agreement when it is not feasible rather than accept the inevitability of profound disagreement, and recognize that sorting out the causes of this disagreement, would bring new understanding...". At the workshop conclusion he thought it "...possible that, taken as a team, we could be effective."

Leroy Quance, Economics, Statistics, and Cooperatives Service, USDA, in an overview of related futures studies in food and agriculture, provided four stereotype scenarios for the future of renewable natural resources: Malthusian doomsday, technology-induced abundance, conservation and no growth, and unfolding supply-demand management. He pointed to the USDA's historical concern for the long-term future as the primary reason the unfolding supply-demand management scenario has prevailed in the USDA. "The Department seeks a balanced future in which both quantity and quality of human existence are valued. Rather than rejecting the machine, having blind faith in science, or giving up in despair, we are developing a future where science and man get on with the job of rational analysis and positive action."

The first workshop task was to identify the five most pressing issues in each of six discipline-related areas. Pre-conference work coordinated by Dennis Little, Congressional Research Service, provided summaries of over 200 probable issues in a document entitled "Renewable Natural Resources: Some Emerging Issues" (to be published by the Senate Committee on Agriculture, Nutrition, and Forestry). The issues were organized according to the six disciplines. Thus, work groups, consisting of a chairman, rapporteur, and 8 to 10 participants, struggled intensely to select those 5 issues or issue areas that would most significantly affect global, national, and regional trends and developments over the next 6 to 50 years. The six disciplinary groups and issue areas selected were:

1. Fish, Wildlife, and Recreation
   * Changing demands
   * Environmental protection
   * Environmental enhancement
   * Changing values
   * Management

2. Energy
   * Public acceptance
   * Socioeconomic and institutional barriers
   * Efficiency
   * Renewable natural resources as an energy source
   * Synthetic food and fiber

3. Forests and Grasslands
   * Public vs. private role
   * Resource management
   * Resource decisions
   * Regional shifts
   * Improved knowledge about forest and rangeland ecosystems

4. Environment, Land Use, and Land Management

   * Information/data base
   * Soil degradation
   * Environmental protection
   * Land allocation
   * Linking to resources through people

5. Air, Water, Weather, and Climate

   * Impact of air quality on resource productivity
   * Water allocation and supply source
   * Water quality
   * Water resource management
   * Climatic change and variability

6. Research, Technology, and Education

   * Resource management
   * Product safety and quality
   * Improved plant and animal production and processing
   * Adequacy of basic and applied agricultural research
   * Renewable natural resource education

Statements of these issues, including visibility, anticipated public pressures, and implications for programs and policies of the U.S. Department of Agriculture, are summarized in the workshop proceedings.

Armed with the issue selections, the participants were re-organized into three scenario teams. Each team was given the charge of writing a scenario for managing the long-range future of our nation's renewable natural resources. In developing such an unfolding scenario, participants were to identify those developments that would cause the most persistent problems -- pitfalls that would tend to throw policy makers and program managers off course -- precursors to developments that might, if not anticipated and managed properly, actually lead to a future of scarcity, technological excess, or the need for extreme conservation.

Although seeking the same manageable journey through time, each team saw some different problems along the way, as reflected in their reports to the workshop plenary session. But a concensus scenario could be summarized as follows:

Globally, the long-range (6 to 50 years) prognosis is for neither feast nor famine, but an unfolding supply-demand managed future.

Demand for renewable natural resources, driven by population and income growth, has probably passed an inflection point, shifting from increasing at an increasing rate to increasing at a decreasing rate. But the absolute level of demand will pose a formidable challenge, especially in terms of economic feasibility. Particular problems relating to demand include a global imbalance in wealth and income distribution, changes in the age composition of domestic population, and changes in lifestyles and values.

Society appears technically and economically capable of producing quantities of goods and services demanded at reasonable prices. However, there will be serious adjustment problems as sources for such important supplies as energy shift from exhaustible to renewable resource bases. Moreover, the mirror image of imbalances in demand parameters is an imbalance in the global distribution of productive renewable natural resources. Particularly troublesome for the U.S. will be the extent to which we permit our renewable natural resource base to deteriorate to meet global demands and to help alleviate our own balance of trade deficits.

The greatest uncertainty is in energy because it is the key to the intensity with which goods and services will be demanded -- or can be supplied -- from our renewable natural resources.

But the real problems likely will not be with demand and supply per se but how society accepts and manages change. These include finding ways to (1) improve public and private processes for social management, especially in the allocation of renewable natural resources to competing uses; (2) improve educational programs to facilitate participatory democracy and acceptance of needed change by the public; and (3) bring about orderly change to global interdependence -- create an effective institutionalized world order.

A more complete synthesis of the workshop scenario development activity is presented in the full proceedings. Also, a contract has been signed for the preparation of alternative scenarios "with a futurist's bent".

To gain further insights into how their scenario efforts could be improved, workshop participants were involved in two stimulating simulations of world food and agricultural futures.

Under the leadership of Selwyn Enzer and Richard Drobnick, Center for Futures Research, University of Southern California at Los Angeles, participants were grouped into 10 teams representing the major food exporting and importing world regions. The teams simulated possible alternative actions of these regions in the world grain market -- by means of an interactive computer model -- to see how grain production and reserves, prices, capital investment, and so forth could be affected by their actions, in concert with

random weather factors, the energy situation, and other probabilistic events. Major insights gained from this activity were that the long-range future is composed of a series of shorter-run events and decisions, and that the U.S. does not make major agricultural decisions in isolation -- other countries are simultaneously managing their food and agricultural programs.

Then Patricia Strauch, Mihajlo Mesarovic, and Juan Huerta, Systems Application, Inc., Cleveland, Ohio, demonstrated world integrated scenario analysis -- again with an interactive computer model and large video screen display. Analysis of the soil/oil issue demonstrated that computerized global models are not only plausible but essential for comprehensive analysis of the larger emerging issues relating to renewable natural resources.

Results of the intensive scenario writing and world food simulation efforts generated a pervasive feeling of frustration and uneasiness as the workshop neared the wrap-up phase. Clearly, some alternative societal approaches to future challenges were needed. Thus, the timing was ideal for Peter Schwartz of Stanford Research Institute to provide a different perspective on humanistic changes that could affect social values and political systems. The implications of how such worldwide people-oriented changes could modify perceptions of the challenges facing renewable natural resources provided a much needed stimulus for the final effort: How could the results of the workshop be meaningfully applied to long-term stewardship of the planet Earth.

The final plenary session was a panel discussion devoted to follow-up approaches to incorporating workshop findings into USDA planning, moderated by Robert Buckman, Forest Service Deputy Chief for Research. Highlighted below are comments by C. W. Carlson, Agricultural Research, Science and Education Administration; J. Lamar Beasley, Resources Program and Assessment, Forest Service; John Okay, Program Evaluation, Soil Conservation Service; Melvin L. Cotner, Natural Resource Economics, Economics, Statistics, and Cooperatives Services; James Giltmier, Senate Committee on Agriculture, Nutrition, and Forestry, and Robert E. Wolf, Congressional Research Service.

Systematic study of the future is a means to more effectively manage our Nation's renewable natural resources for present and future Americans and all mankind.

Federal legislation mandates futures management in agriculture and forestry. The Renewable Resources Planning Act of 1974 (RPA), as amended, requires an assessment of the nation's forests and rangelands and a five-year renewable resources program for Forest Service activities. The Soil and Water Resources Conservation ACt of 1977 (RCA) directs the USDA to study soil, water, and related resources, and to develop a national program to assure the conservation of those resources to meet the long-term needs of the Nation. Title XIV of the Food and Agriculture Act of 1977 requires that all of the USDA's future research and extension programs be jointly planned and coordinated. The Renewable Resources Extension Act of 1978 (RREA) also contains a mandate for an expanded program in renewable resources extension, and requires that information from the RPA Assessment and the RCA Appraisal be used in formulating that program.

Although Congress has mandated these needs, it is up to the USDA, with its central focus, to provide the institutions, information, and programs to successfully develop, manage, and conserve our Nation's renewable natural resources.

The legislation, practical experience, and activities of the workshop confirm that although "we cannot predict the future, -- we must continue to study possible future relationships to help guide man's interaction with the physical resource base." This is a dynamic and adaptive process. Values and beliefs about resources, economic motives, and our economic system, as well as the laws, rules, and institutions to accomplish desired resource goals can be changed to shape a desirable future. Accordingly, physical, biological, and socioeconomic relationships are required in interdisciplinary study and decisions about future challenges.

Both our data bases and analytical systems need improvements. Monitoring programs are needed to collect information on physical, biological, social, and economic variables pertinent to renewable natural resources. Comprehensive interdisciplinary models should be emphasized to show not only social and economic but also physical and biological relationships in the future use of our natural resources in an increasingly interdependent world.

National programs in RPA, RCA, and research and extension planning will set the direction for USDA and thus our Nation's future management of renewable natural resources. This workshop has made us more cognizant of the environment in which resource programs will exist -- changing demographic growth and composition, changing beliefs and values -- and the interrelatedness of technical, economic, social, institutional, and global dimensions of future challenges.

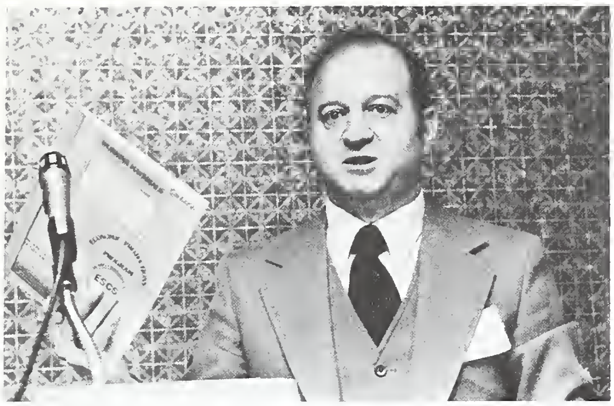
With work completed for the 1979 Forest and Rangeland Renewable Natural Resources Assessment and 1980 Program, the workshop and follow-up activities will not impact the RPA until the 1985 Program and 1989 Assessment. But the identification of issues and interdisciplinary dialogue begun in the workshop should provide a good starting point for future RPA work.

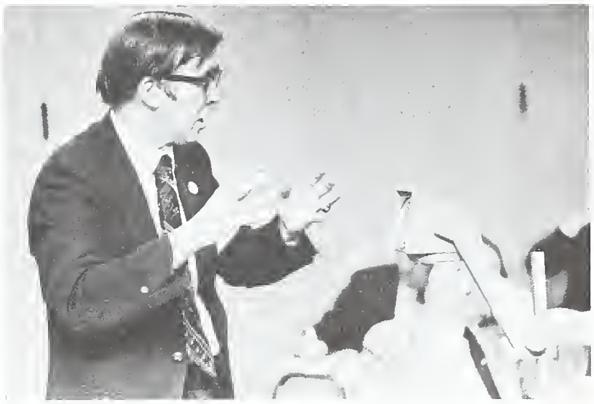
With respect to RCA, there is much to gain since we are at present working on the first draft appraisal and program reports due to Congress in January, 1980. The futures work sampled here offers new an innovative tools -- new ways of looking at past and current events -- that will open new thought patterns for considering the future, help us structure a systematic process for developing and analyzing alternative futures, and aid us in putting new planning ideas into action.

We also are now more aware of the limitations of futures research. We should not become trapped into thinking we can encompass all interrelationships in a comprehensive model, either formal or informal, that will generate estimates of all the secondary and tertiary impacts of resource decisions. Many questions will always remain unanswered, but our thinking will be challenged. The scenario can be used by those charged with developing alternative program strategies. The Resource Conservation Act program will address some of the key resource issues and opportunities identified in the workshop.

The workshop provided needed interdisciplinary interaction and broadened the horizons of USDA personnel. As one participant put it, "I am going away knowing that I don't know what I thought I knew about planning for the future -- but -- the new concepts I was exposed to will improve my understanding of the future."

In brief, the workshop brought together a complementary mixture of people, issues, and ideas emphasizing a systematic and forward-looking perspective for USDA programs in renewable natural resources. The seeds are sown for a renewed interdisciplinary team approach to long-range planning for U.S. agriculture in an interdependent world. It is now up to us to nurture and care for those seeds such that the future will not only be manageable in terms of adequate food, clothing, shelter, and amenities for a growing U.S. and world population, but also a future in which the U.S. Department of Agriculture will have persisted "in the service of agriculture for the public good."





Leroy Quance (left) and Dennis Little (right) described workshop philosophy and procedures before participants broke up into disciplinary-issue and interdisciplinary-scenario teams.

Introduction to the Workshop: Why and How

Leroy Quance[1]

Why

This workshop was developed from the notion that the several programs of the U. S. Department of Agriculture involving long-range resource assessments, research planning, and program evaluation need strengthening in at least three important dimensions.

First, we tend to be limited by disciplinary boundaries, whether we are conducting a long-range assessment of the supply and demand for food and fiber, a periodic assessment of our nation's forest and rangelands, a long-range appraisal of research needs in food and agriculture, or an emerging conservation needs assessment. This is not to say that there are no interdisciplinary considerations. Rather, the interdisciplinary considerations are predominately side conditions, constraints, or assumptions. Thus, independently derived commodity projections become fixed demand levels for supply-related research and extension needs, cropland availability estimates become fixed supply parameters in determining the future commodity supply capability, and so forth. Yet we know, for example, that public decisions about agricultural research and extension will affect future commodity supply potential and thus actual commodity production, and increasing commodity demand can bring about a larger supply of available cropland.

Excellent progress has been made in developing analytical tools for use in resource assessments. These include the Forest-Range Environmental Production Analytical System (FREPAS); the Iowa State University/Economics, Statistics, and Cooperatives Service (ESCS) linear programming model; and ESCS's National-Interregional Agricultural Projections (NIRAP) system. But we are increasingly realizing that marginal improvements in these basically intra-disciplinary systems and the assessment programs they support are not as important as making the major inter-disciplinary feed back loops. This need can be extended to viewing the U.S. food, agricultural, and forestry complex as part of an increasingly global system.

A second major dimension needing more attention relates to policy issues. Our long-range appraisals are usually conducted under general scenarios or sets of assumptions about growth in population, GNP, agricultural trade, and productivity. Although these variables will determine the broad environment in which food. agriculture, and forestry enterprises will adjust, such generalized projections do not provide specific enough "policy handles" for the executive and congressional branches of government in our democratic society to act upon. We need to disaggregate the broader determinants of supply and demand growth to more single-valued policy issues. For example, it is not enough to say that agricultural productivity growth is slowing, if it is, and that more public commitment to research and extension (R&E) programs is needed. We need to quantify the relationships between productiv-

[1]Economics, Statistics, and Cooperatives Service U.S. Department of Agriculture.

ity growth and its causal factors, including governmental expenditures on agricultural R&E programs, project productivity growth under scenarios differing with respect to R&E expenditures, calculate rates of return from public R&E expenditures for different technologies, and prioritize such alternatives according to social benefits and costs. Then limited public resources can be more optimally allocated between alternative food, agriculture, and forestry R&E programs and non-agricultural production alternatives such as environmental conservation, energy development, education, and health programs.

Better methods need to be developed to make our policy analyses more participatory: more people-oriented, such that the human dimension of future challenges receives the greatest consideration. After all, people are our most valuable resource.

The third major dimension of long-range assessments in food, agriculture, and forestry needing greater emphasis is strategic planning. Too often our disciplinary, or even interdisciplinary, studies of policy issues, however complete or incomplete in themselves, have not been an integral part of a comprehensive public planning process in food, agriculture, and forestry. To some extent, planning in a democratic society, where the principle of individual choice is so important, seems almost un-American. But in a shrinking world of increasingly interactive global systems, the long-range survival of our democracy may depend on successful national planning. What we need is not a planned society, but planning in our democratic society: a strategic national process that would guide programs to keep the broad parameters of change within ranges conducive to individual choice. The question is not whether we will have strategic planning that will determine the future course of spaceship earth, but what role our national government will play in that planning relative to the role of other countries and multinational corporations.

A continuing reactionary "brush fire" approach to national and global issues is an alternative. But is it the best one? The future is being shaped by decisions made each step of the way. And there is a growing realization that decisions based on analysis of historic or present phenomena may not be the best long-range strategy -- witness the result of the "future is now" philosophy of some football coaches. It may be that if we want to stay in the game, we should not just consider winning the next game or election, but consider today's game plan in the context of strategic, long-range planning.

This brings us to the role of the futurist. The futurist has a creed that says something to the effect that:

We cannot predict the future
because it doesn't exist.
But working together,
we can create a desirable future!

How

To the extent that we have studied disciplinary and interdisciplinary policy issues in our long-range assessments, we have too often projected the past and/or present to predict the future. The futurist turns this around and studies the future to better understand the past, better manage the present, and better plan for the future. Thus, a major characteristic of this workshop was the participation of several nationally and internationally recognized futurists. These people made formal presentations, participated in workshop team activities, and generally steered our conventional thinking toward the futurist's creed.

Figure 1 illustrates the intent of the workshop to bring an organized body of information of a disciplinary, policy issue, and strategic planning nature to bear on public decision needs with respect to the nation's renewable natural resources. To the extent that we were successful, these discipline, issue, and planning dimensions will become accurately focused to provide a clear picture of an issue-oriented scenario for change in the social management of our nation's renewable natural resources (as illustrated in figure 2).

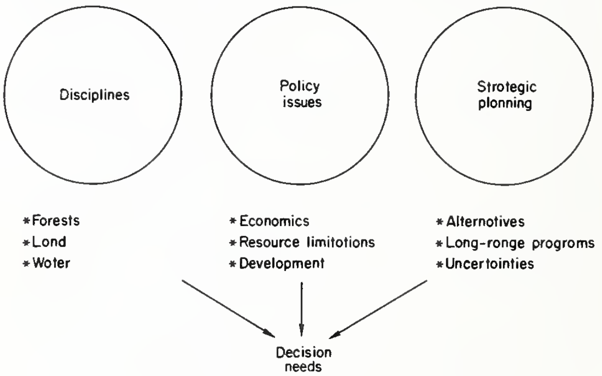


Fig. 1.-- Three major workshop dimensions.

Several major kinds of activities were planned to facilitate achieving our objective:

* Public charge,
* Delineation of issues,
* Selection of priority issues,
* Scenario development,
* Enrichment.

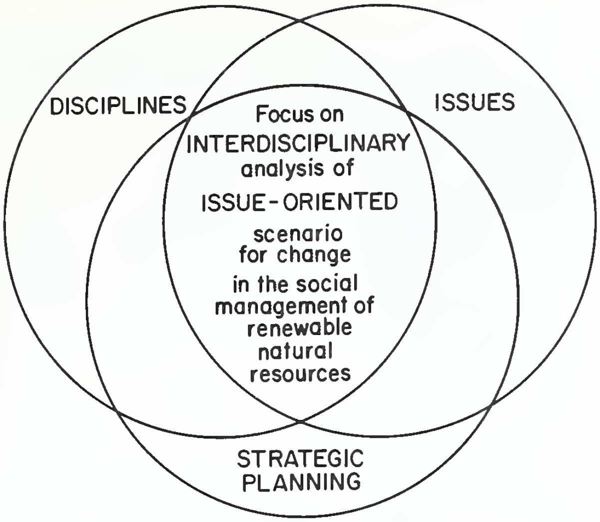


Fig. 2.-- The major workshop objective.

Public Charge: Secretary of Agriculture Bob Bergland and Senator John Melcher of Montana presented the workshop challenge. Secretary Bergland set the stage for a global perspective on challenges facing the future of renewable natural resources. In recounting the President's budget recommendations for FY 1980, Senator Melcher speculated that current budgeting priorities, resulting from many necessary compromises and trade-offs, probably do not adequately recognize future challenges and opportunities in renewable natural resources.

Delineation of Issues: Pre-conference work coordinated by Dennis Little, Congressional Research Service, provided summaries of over 200 probable issues. This document, entitled "Renewable Natural Resources: Some Emerging Issues" provided the background material for many of the working sessions. It will be published by the Senate Committee on Agriculture, Nutrition, and Forestry. The issues were organized according to six discipline areas:

* Fish, wildlife, and recreation;
* Energy;
* Forest and grasslands;
* Environment, land use, and land management;
* Air, water, and climate; and
* Research, technology, and education.

Selection of Priority Issues: No set procedure was set for selecting priority issues. Each work group, directed by the work group chairman, and with the rapporteur drafting a report, reviewed appropriate sections of "Renewable Natural Resources: Some Emerging Issues" and selected the top five issues in its respective area. Issues not covered in the pre-conference survey were also considered. The chairman then presented the work group reports on the top five discipline-related issues at a plenary session.

Scenario Development: The selection of priority issues provided the basic building blocks for developing scenarios for change in renewable natural resources. Workshop participants were divided into three interdisciplinary scenario development teams, each with a chairman and rapporteur. The three scenario teams were given the same challenge: using the statements of priority issues, workshop presentations, and other available information, develop an unfolding scenario of supply-demand management for the future development, use, and conservation of our nation's renewable natural resources in food, agriculture and forestry activities. But in developing such a manageable scenario, each team was to identify possible developments that, if not prevented or prepared for, would cause the future to diverge from the manageable scenario. Each team met in three successive working sessions to draft, discuss, and revise their scenario statements. Following the workshop, Leroy Quance, ESCS, U.S. Department of Agriculture, synthesized the three workshop-derived scenarios into a composite scenario for change in renewable natural resources. That composite scenario appears later in this proceedings.

Enrichment Activities: The successive priority issues selection and scenario development processes were divided by formal presentations and practical exercises presented or led by participating futurists and other researchers engaged in the development of improved methods and tools for studying the future. These enrichment activities were intended to guide the workshop participants toward a more interdisciplinary, global, and futures perspective on future challenges in renewable natural resources. All such enrichment activities are reported in these proceedings.

DISCIPLINARY ISSUES TEAMS

I. Fish, Wildlife, and Recreation

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John Coates
Carl Sullivan
Bob Smith
John Hallagin
Kevin McCarthy
John Gottschalk

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B. A. Stout, Rapporteur
Paul O'Connell
Charles Beer
Doug Leisz
Selwyn Enzer

III. Forest and Rangeland

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John H. Rich, Rapporteur
Rexford Resler
Lamar Beasley
Gerald Thomas
Charles Hewitt
Cuouhtemoc Cardenas
John Sullivan
R. J. Bourchier

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Ed Thor, Rapporteur
Norman A. Berg
Donald E. Crabill
Earl O. Heady
Sterling Brubaker
John C. Barber
Richard D. Lieberman
Hyde H. Murray
Neil Sampson
David G. Unger
C. W. Carlson
Donald E. McCormack

V. Air, Water, Weather, and Climate

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Robert McDermott, Rapporteur
Kenneth Hadeen
Gerald Seinwill
Ernie Todd
Bob Cashdollar
Keith Arnold

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Norman E. Borlaug
T. W. Edminster
John L. Okay
Richard Drobnick
Richard Marks
Robert Buckman

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John D. Sullivan
Robert McDermott
Norman Borlaug
Carl R. Sullivan
Kevin McCarthy
Douglas L. Leisz
Charles Hewitt
Gerald W. Thomas
R. Keith Arnold
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C. W. Carlson
David M. Ostermeier
T. W. Edminster

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Melvin L. Cotner
Robert Smith
John Gottschalk
B. A. Stout
Robert E. Wolf
R. J. Bourchier
Robert Buckman
David G. Unger
Ernest V. Todd
Robert Theobald
Neil Sampson

U.S. Department of Agriculture Expectations for the Workshop[1]

M. Rupert Cutler[2]

When Secretary Bergland opened this workshop last night, he referred to the uniqueness of this conference, the impressive credentials of the participants, and the challenging and very important nature of this three-day retreat.

The secretary's remarks focused on the need for creative thinking. Basically, he was urging us to go far beyond the traditional constraints that we often place on ourselves because of our day-to-day and year-to-year issues.

I am not entirely certain that I can say with profound wisdom or great vision specifically what the Department of Agriculture expects to receive from these plenary sessions and workshops.

From a broad perspective, however, you who are here may well begin an important new dialogue that results in critical examination of new and different concepts and alternatives in your respective subject areas.

The Department of Agriculture has major responsibilities for long-range planning and conservation of our Nation's natural resources. Having these authorities does not necessarily mean that we now possess the ability to ask all the right questions or develop solutions to all the difficult problems. That's where you come in.

This in no way reflects negatively on the ability of the USDA administrators, the researchers, or technicians present today, nor does it mean the futurists have not performed well. It is meant to reflect the difficulty in planning programs for conditions 70 years from now.

The Forest Service was given the first long-range planning authority in the last decade under the Forest and Rangeland Renewable Resources Planning Act (RPA). The first report to the Congress under this Act was in 1975. USDA's update of the national assessment and the national forest and rangelands conservation program is underway for presentation in 1980. Beyond this assessment, there remain dozens of issues.

We know that our country's annual use of forest products has been 11 to 13 billion cubic feet for 75 years. Yet, some projections indicate an increasing demand between now and the 21st century.

If commercial forests are producing timber at half their estimated capacity, if over half of U.S. forests are privately-owned, what can be done by the federal government to increase output within a well-articulated plan? Is it advisable for the government to undertake these kinds of actions? Are there ways to protect the amenity values that most private land owners want protected, yet increase the harvest? What incentives are needed to achieve effective management? Is our technical advice on the use of private land appropriate, or should it be changed? If so, how?

A second authority for protecting our natural resources is quite recent. The Soil and Water Resources Conservation Act of 1977 (RCA) provides the broad-based authority to make an appraisal of the soil, water, and related resources of this country in order to develop an improved national soil and water conservation program.

[1] Paper presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

[2] Assistant Secretary for Natural Resources and Environment, U.S. Department of Agriculture.

Our efforts in this area are closely linked with the Resources Planning Act authority, and this program is targeted for submission to the Congress in 1980.

I think we must ask the question: Are our assumptions about trends with respect to population, income, food, technology, and water valid enough bases from which to propose program changes? These trends will profoundly affect our future and should influence program design.

A short-term problem with long-term implications is: Should the owners of prime farmlands be required to preserve that land in a food and fiber-producing capacity? Should they comply with a mandatory conservation program? Or, can the government provide additional incentives? If so, what kind? Is cost sharing enough? How can Secretary Bergland's emphasis on "targeting" of our cost sharing programs to ameliorate the most flagrant private-land conservation needs best be implemented? If we recognize the legitimate need for housing and other urban development, should such development be confined to marginal farmland?

A third authority was provided in Title 14 of the Food and Agriculture Act of 1977. A fourth was in the Renewable Resources Extension Act of 1978.

Title 14 focuses on research. While phenomenal advances have been made because of research, trend lines on agricultural productivity indicate a much slower growth in the next 10 to 20 years than in the past. If true, should we be looking at new directions for research? If the answer is yes, where? How can innovative research be encouraged? What are the consequences if we abandon long-standing research projects and retrain scientists to consider issues which are not yet present?

The Renewable Resources Extension Act is an effort to strengthen the natural resources role of cooperative extension, on the basis of the RPA assessment and the RCA appraisal.

There is no question that our natural resource base is finite. Therefore, increases in our productivity must not erode that resource base.

In addition to these four specific authorities, the Department of Agriculture has a long-standing responsibility to provide the leadership in the federal government for food, fiber, and forest products. Our role includes planning, research, financial and technical assistance, and liaison with the states.

All of you have a copy of the document, "Renewable Natural Resources: Some Emerging Issues." The document provides an overwhelming list of issues -- all of which relate to the long-term efforts that I have described briefly. But, I'm sure it does not represent <u>all</u> issues or <u>all</u> questions. I hope that your work will go beyond this foundation to issues and questions which may be far more important.

Our discussions can lead to the initiation of multidisciplinary research which will give us that "crystal ball" to look with more certainty into the future. Above all, we must strive to pinpoint specific areas where a policy decision can help us avoid an irreversible event that would threaten our natural resources and our world.

We must be able to identify those assumptions about the future that may be entirely wrong. For instance:

We know energy costs are going to increase, but do we have any concept of what they will be in the year 2050? How will these costs affect our food-producing systems of that time? How much can we count on the research programs of today for alternative energy sources tomorrow?

There is increasing evidence of the depletion of ground water sources from irrigation. If permitted to continue unabated, what are the social costs? If ground water supplies are no longer enough to support crop production, what are the implications for agriculture and for rural communities?

If the work week of Americans should be 30 or 35 hours, what are the impacts on our forests and wilderness areas if people have more leisure time and a longer life span?

We have seen the initial impacts of environmental disasters on lakes and rivers, but do we know the long-term implications? Have we really seen the problems that may show up 50 or 70 years after a chemical spill?

Are there going to be significant shifts of climate that will affect our food-producing capability?

What are the effects of new communications technology on the demand for paper? Will the innovations we know about and others yet to be discovered make the printed word obsolete by the year 2050?

Are there better means for gaining broader public participation in the decisionmaking process, particularly concerning natural resources?

If these are some of the questions, how do we obtain answers and translate them into responsible leadership?

I feel we must be more concerned about our natural cycles, our ecosystems, so that we accurately consider the total impacts of our decisions. We must look for secondary impacts and beyond. Our "Spaceship Earth" is very interdependent, subject to shocks which appear minor, but which may be in fact catastrophic.

What happens if we lose certain endangered species? Can we afford to lose a plant or animal species? What about disease control or the symbiotic relationships with other species of plants and animals? Are we studying these potential issues soon enough or even in the right context?

Are we even working in the right areas to discover new plants or develop new plant varieties? If we are not doing enough, how can we stimulate this work?

The depth and diversity of our natural resource base and the strength of those who farm the land and manage our forests and rangelands have been major reasons for our unrivaled food, agriculture and forestry system. We have been extremely fortunate.

But the next 70 years may determine how well we have helped farmers, ranchers and forest owners, conserve, improve, and preserve these resources for the future.

You can help inspire research that leads to concrete actions for defending and wisely using our critically needed resources.

We cannot afford simplistic solutions to complex problems. Such solutions often tend to be anti-ecological.

Major breakthroughs are needed throughout our social and physical sciences--breakthroughs such as those we have made in biological pest control and conservation tillage.

I hope that these discussions can lead to greater use of aquaculture, significant breakthroughs in protein sources, in shortening of the food chain, in remote sensing, in better measurement of our present conditions and trends.

I have great confidence in our present research system, in the partnership of USDA with Land-Grant and other universities and with private industry. The record that we have established is a good foundation, but we must go far beyond this for the future. We must be able to establish a better mechanism for private industry/government cooperation to expand multidisciplinary research, look at social and economic issues, and translate basic research into production of improved goods and services.

These meetings begin a process that may help ensure the future of our world. I congratulate John Gray on his development of this program and his choice of participants. I'm pleased that John McGuire, Mel Davis, Anson Bertrand and their key deputies are here in supportive roles; I trust they'll pass along to me the good ideas which flow from your deliberations. And I thank you all for your concern and your help.

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Congressional Expectations for the Workshop— The Senate[1]

James W. Giltmier[2]

Policy formation in this country is generally a random sort of thing. Generally it occurs in an evolutionary way, or as a result of some crisis.

Congress, although Constitutionally provided to be a policy-making body, is really an ad hoc outfit, responding to day-to-day pressures presented to its members by the public and by interest groups. Since it is reactive, and since it is made up of 535 individuals, representing vastly divergent points of view, it sometimes seems amazing that policy decisions get made at all, or that they are as good as they are.

Fortunately, the system forces Congress to come to conclusions -- when there is sufficient crisis. Often Congress consciously ducks issues which the members feel they can wait to deal with. All sides give a little and concensus is reached. The policies that are reached are those that are possible.

Senator Bellmon likes to say that if you like sausage or law, don't watch either of them being made. And he's right. The legislative or policy-making process often seems confused, and it certainly can be confusing.

The essential element in policy formation is compromise. And that, oddly enough, is what Americans like least about the political process. Compromise is often seen as dirty -- a sacrificing of principles -- when in fact without the sacrifice of a principle on this side and another on the other side, policy determinations cannot be reached. This is simply because one set of principles that may hold up for the East will not hold up in the West. What's good for farmers may not be good for grocers.

Because of the randomness of the policy formations process, issues are delivered to Congress in small, and hopefully saleable pieces. Today's piece may be price supports for farmers, tomorrow's piece might be the management of public lands, and on Friday the piece will display an element of national water policy.

Even the Executive branch agencies have tended to approach issues from the standpoint of programs they have in place to deal with them. Program structure in the renewable resources areas has sometimes even been more important than consideration of what total needs in conservation might be. Therefore, it is highly worthwhile that the Department of Agriculture, through the process provided for in the Soil and Water Resource Conservation Act, is doing serious zero-based planning, with an eye on changes in program structure that might be needed to deal with a total conservation program. Issues developed at this conference could play an important role in how the RCA is finally implemented.

Even though there has been some talk about transferring certain conservation programs from USDA, I don't think Congress will permit that to happen. Therefore, the two basic planning tools of the Department, the RCA and the Forest and Rangeland Renewable Resources Planning Act, will grow in importance.

Unless serious consideration is given to the emerging issues in renewable natural resources, it will obviously not be possible to plan activities in five and ten year increments, as required by law. Since a sizeable number of policy issues originate in the Department of Agriculture, and since it must now -- by law -- keep the broadest possible perspective on resource protection, management and development, obviously this conference is essential to the Department and to agencies in other Departments that have similar jurisdictional interests.

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[1] Paper presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

[2] Senior Professional Staff Member, Senate Committee on Agriculture, Nutrition and Forestry.

From the standpoint of Congress, it is somewhat less clear what the payoffs of this conference will be. As I said, policy issues tend to be dealt with by Congress in manageable or saleable chunks. Senators with as many as eight committee assignments seldom have time to explore the broad perspective of resource policy. For instance, the Endangered American Wilderness Act was passed without any consideration of its impact on the RPA Program of Work. Even though the Congressional Research Service and USDA did an excellent job of boiling the issues related to this conference down to their bare bones, the planning document is still of sufficient size to prohibit many members of Congress from reading it. Further, rural issues like agriculture and forestry tend not to be high priority items in the consciousness level of an urban Congress.

Notwithstanding these limitations, I think this conference will have a positive impact on the Congress. Congressional staff members will read the work of the conference. Interest groups that contact Congressmen will be influenced by the work that goes on here, and they will make their concerns known to the members.

Hopefully the conference will stimulate a continued dialogue over the proper role of the government with respect to renewable resources.

Finally, I hope the conference will stimulate a vigorous discussion of tradeoffs and compromises necessary in resource management, protection, and development.

A smart man once said, "Government cannot do one thing." What this man meant was that, by taking a single action, designed to accomplish one purpose, other constituencies and other policies tend to become affected by that one thing, just as dropping a pebble in a pond establishes a ripple effect.

Senator John Melcher of Montana discussed legislative implications of long-term planning during Monday evening's opening session.

Just as true as government cannot do one thing, resource managers cannot do one thing. Even actions they fail to take have an eventual impact on the resource base, for good, for evil, or for no consequence at all.

Perhaps by exploring the potentiality of the resource base in terms of national needs, we will finally begin to resolve -- at least in part -- the questions of what is good and what is evil with respect to our resources.

The Department of Agriculture was the environmental movement at one time. Now in many quarters it is seen as the enemy of the environment.

Perhaps the nation's values have changed and those of USDA have not. I don't know, but perhaps we will all know ourselves and our resources a little better once we have explored what our potentials and problems will be in the future. Perhaps we will also get some inkling of how Smokey has come to be perceived as a forest killer.

Congressional Expectations for the Workshop— The House[1]

Hyde H. Murray[2]

Introduction

Policy is made in Congress by politicians, and as observed by former Secretary Butz, "eternity in the House of Representatives is defined as two years; in the Senate, six years".

Congress itself recognizes that long-term policy cannot be tied to biennial elections and has, therefore, created long-range planning institutions and laws . . . Congressional Research Service, Forest Service, Soil Conservation Service, etc.

Basic Expectations

Naturally, we who are a part of the Congress expect this Workshop will produce responsible and practical solutions to renewable natural resource problems.

In approaching those solutions, however, we hope you will concentrate on reaching consensus on what the problems are. The facts, statistics, and scope of any problem must be identified before a diverse legislative body can begin to take any cohesive or effective action.

In approaching solutions, we also hope you will list alternative ways to solve commonly-agreed upon problems.

Interwoven into the fabrics of all our recommendations are the value systems we each have--property rights, our tenets of philosophy, and our political attitudes all mold our advocacy.

Thus, no one solution will strike many Congressional policy-makers as good. Better, then, prepare a set of choices consistent with solution of the agreed problem.

Competition of Other Expectations

No matter what the Workshop produces, there will be other competing expectations facing Congress.

There are four that are obvious in the natural resource area.

1) President's Budget. A $29 billion deficit for FY 1980 is symbolic of a trend toward fiscal restraint. All elements of the political spectrum are "big spenders". (Some would spend no more than raised by revenue, however.) The question, then, is what priority for spending should be emphasized--defense? welfare? agriculture?

The President's budget puts low emphasis on research and farm programs. This emphasis will probably be increased by Congress as the legislative Committees begin the Budget Process and report to the House and Senate Budget Committees by March 15, 1979.

2) Reorganization. Using a football analogy, the league management seems bent on trading Smokey Bear to the Woodsy Owls. Capitol Hill Bear fans are trying to defense that move.

The first defensive play will be to challenge the legal basis of the 1949 Reorganization Act as a device to create a new Department of Natural Resources. We Bear fans feel that the statute exempts from the reorganization procedure the creation of a new Department like this. Instead, the change, if made, should be done through legislation shared by the Agriculture and Interior Committees of Congress.

The six former Secretaries of Agriculture who have served since 1948 and the leadership of both House and Senate Agriculture Committees have taken positions in the defensive line to "Save the Bears".

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[1] Paper presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

[2] Counsel, House Committee on Agriculture.

Whatever the outcome, the energy and enthusiasm of the Congressional establishment will be devoted to this matter.

3) RARE II. RARE II reflects quite clearly the conflict of values that tug at us in coping with tomorrow's rather than yesterday's problems.

Again the agricultural community and the Agriculture Committees are seeking "part of the action" on how public land and the public who use or enjoy those lands will be treated in the future.

4) Disaster Assistance/Crop Insurance. The natural disaster-aid provisions of the 1977 omnibus farm/food bill expire next year. Also pending are proposals to liberalize the Federal Crop Insurance Program.

The disaster-aid provisions normally trigger outlays of $250 to $650 million per year. The expanded crop insurance program proposed by the President is estimated to be $98 million per year. Thus, it is questionable whether one program will be completely traded for the other.

Conclusion

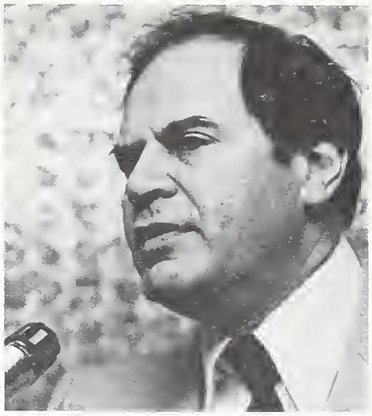
Think Big!

The Congress appreciates your effort and your expertise . . . and if you can identify (and agree upon) the main problems and then recommend several practical routes toward the solution of those problems, the Congress will, I'm sure, do its part to make a better tomorrow for us all.

The Future of Renewable Resources:

A Global Perspective[1]

Marvin J. Cetron and Audrey Clayton[2]



Abstract

This paper is based upon the tenet, established by the authors and other researchers, that Sweden can be regarded as a precursor to the United States in terms of societal experience. Consequently, the attitudes and actions of the Swedish population and government are examined to provide guidance in the formulation of policies, and the assessment of impacts, concerning resource conservation and related issues. Specific examples focus upon nuclear energy and protection of the environment.

Introduction

In recent years, and particularly since the oil crisis in the winter of 1973-74, the developed countries have become very conscious of our rate of consumption of resources of all types. Despite a reduction in the number of births, population levels continue to rise inexorably (although at a lesser rate than in the developing countries), while the supply of commodities essential to our well-being, or even to our survival, is limited and, in many instances, already seriously depleted. We are all well aware of this, and I repeat the obvious only by way of introduction to a new viewpoint, a different approach to the problems of planning and policy making relating to the resource crisis.

Consumption patterns are a consequence not only of basic needs but of life style and societal structure. Comprehensive programs for resource conservation must therefore take into consideration not only economic and technological factors, but also changing attitudes and values, and the total socio-political environment in which the programs must function. Predictions of this future environment are not amenable to traditional established forecasting techniques, which do very poorly when applied to societal factors. However, it is widely recognized that in many areas, and certainly in terms of development and implementation of public policy, there exist certain "bell-wether" jurisdictions consistently years ahead of all others. These leading jurisdictions vary with different times in history, and for different issues. Some of them are domestic, but in the domain of attitudinal and value changes it is of greater value to explore the experience of other nations, some of whom have proved to be decades ahead of the United States. Figure 1 shows a typical example of innovative diffusion where the vertical axis is some measure of activity in a given area -- such as number of acts passed per year relating to that topic; the horizontal axis is elapsed time(1). Sweden is a particularly consistent and striking example of such a "precursor" or adaptor nation.

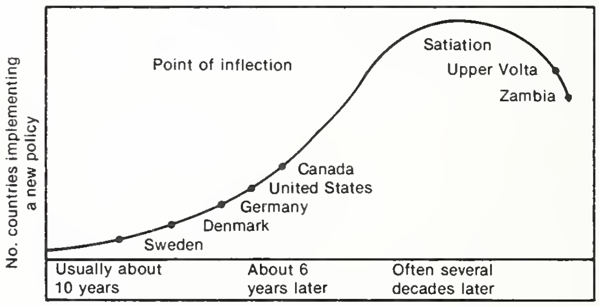


Figure 1.--Domestic and international precursors.

This does not imply that Sweden is the first to generate a new idea, but rather that it is faster in adapting the ideas of others to its own uses, and in implementing them appropriately. This results from many factors,

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[1]Presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.
[2]Forecasting International Ltd., Arlington, Virginia.

including its small size, relatively homogeneous population, centralized and stable government, and national modes of reaching consensus.

Examples of Swedish reaction to experiences elsewhere are numerous: seeing that the Japanese were having problems with mercury in fish, the sale of fish with high mercury levels was immediately banned in Sweden. They watched the United States develop unit pricing and self-service stores and adapted these ideas to their own uses, in each case taking the original notion much farther than we had. Other social advances such as social security and health insurance plans were copied from Germany and Great Britain. This is one reason why Sweden already has no-fault car insurance, no-fault divorce, compulsory arbitration for labor disputes, why it has the world's third most far reaching social security system (we stand 19th), and why it has had a viable feminist movement for 50 years. Once women were brought into the economy other changes followed: equal pay, day care centers, use of their own names, maternity leave and now paternity leave for the new fathers. Today, one-third of middle-management in Sweden is female(2).

Others have been aware of this phenomenon: throughout de Gaulle's period in office, the French five-year plan was built on the recognition of Sweden as a precursor. The practice was discontinued on his death, but this appears to have been a political decision rather than any breakdown of the theory. A recent study in Scandinavia(3) dealing with the food distribution system revealed that Norway, Finland, and Denmark also tend to use Sweden as an indicator of change, statistics showing that Sweden precedes them in the dissemination chain of innovations.

This does not imply that any one country can be taken as an absolute precursor to the U.S. or to any other nation: each is composed of a different population, with different needs and motivations. However, nations that share a similar culture -- the "advanced" or "post-industrial" countries such as the U.S., U.K., Japan, France, Sweden, Canada, F.R.G. etc. -- are very likely to accommodate to strain or circumstance in recognizably similar ways, and to develop similar or related solutions. This does not imply any deterministic theory of development, but merely that nations communicate with and observe each other; once started down a path of development, it is essentially impossible to "go back and start all over". Thus a group of nations of similar cultural background, which remain in social and economic contact, are very likely to come to share common features(4).

Retrospective analysis has demonstrated(5) a significant positive correlation, in well-defined social areas, between developments in Scandinavia (especially Sweden) and the U.S., and thus by reviewing Swedish policies and their implementation in areas of common concern, we can obtain a check list to assist our own assessment process, and a "test-bed" to enable us to observe the Swedish consequences of policies which might be analogous to those considered in the United States.

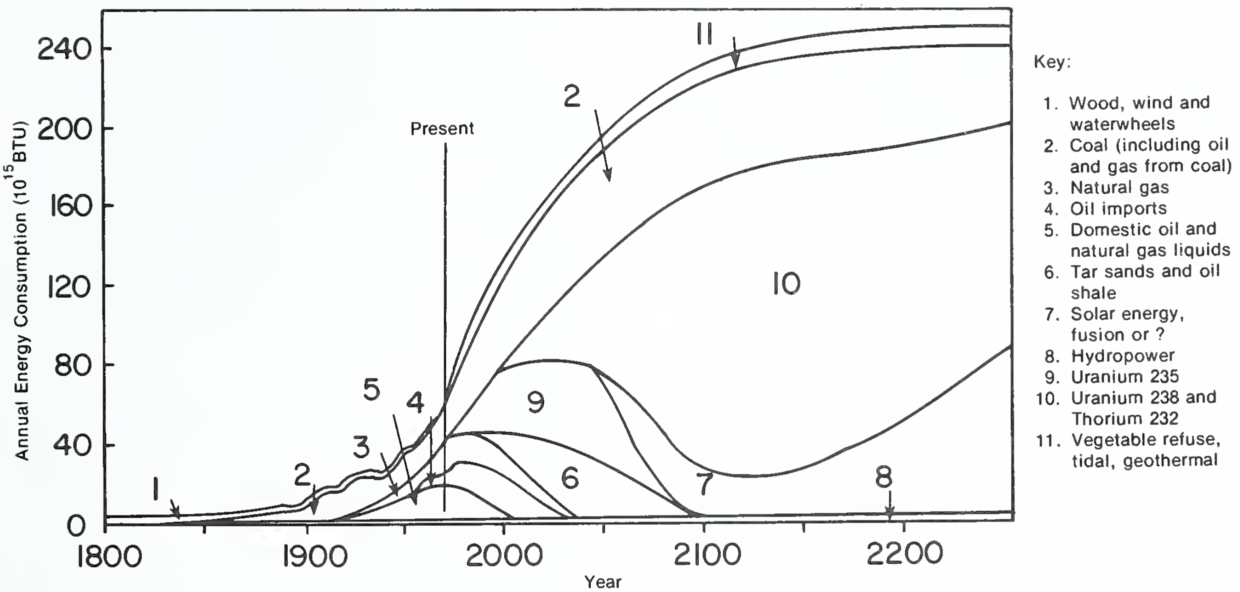

Figure 2.--A 1971 forecast of energy consumption in the U.S., by source. (Source: Cook, Earl, "Energy Sources for the Future," The Futurist, August 1972, p. 147.)

Nuclear and Fossil Energy

Even prior to the energy crisis, it was recognized that the United States must turn to nuclear power to meet its escalating energy requirements (see fig. 2), and by the mid-1960s it was determined that the economics of nuclear power were favorable, and the utilities felt secure in "going nuclear." A total of 30 reactors was operating by 1973(6), but the ready availability of cheap fossil fuels minimized the importance of developing this alternate resource, and the initial over-optimism was cooled by the reality of a still rapidly evolving technology. The situation was also complicated by the public's new sensitivity to environmental protection(7).

In terms of per capita consumption of energy, the United States ranked 10th of 214 nations in 1975, and was the only major industrial country to exceed 10,000 kg of coal equivalent per capita(8). Members of Congress, industrialists and economists alike have expressed fears that a decrease in energy consumption will seriously damage the economy. However, Sweden maintains roughly the same standard of living as the U.S., (6,178 kg) per capita consumption. Sweden's gross domestic product continued to grow, in real terms, at an average rate of 2.2% p.a. during the period 1970-76, compared to 2.9% for the U.S.(10).

The dominant sources of world energy, are coal, oil and natural gas which Sweden lacks (11); hydroelectric power is its only abundant energy source, and this is both localized and inadequate for future predicted needs. Consequently, Sweden has been forced to consider nuclear sources much more urgently than those nations possessing currently adequate supplies of fossil fuels. A Fuels Commission, established in 1951, had the avowed intention of overcoming by conservation measures a threatening overdependence on imported oil. By the time its final report was published in 1956, the recommendation was to improve supplies by resorting to nuclear power(12). Let us review briefly, therefore, the consequences of this decision, and the implications for us here in the U.S.

In retrospect, a series of decisions taken in Sweden between 1955 and 1965 made the shift to nuclear power inevitable. These included not only the voting of funds for R&D, but also the active promotion of electrically heated homes, and the brushing aside of alternatives to nuclear-based electric power, trends visible also in the U.S. Since 1965 the U.S. has also shown increased energy-intensity of the economy, energy usage having outstripped the growth in GNP(13). This trend was apparent earlier in Sweden, as shown in figure 3(14).

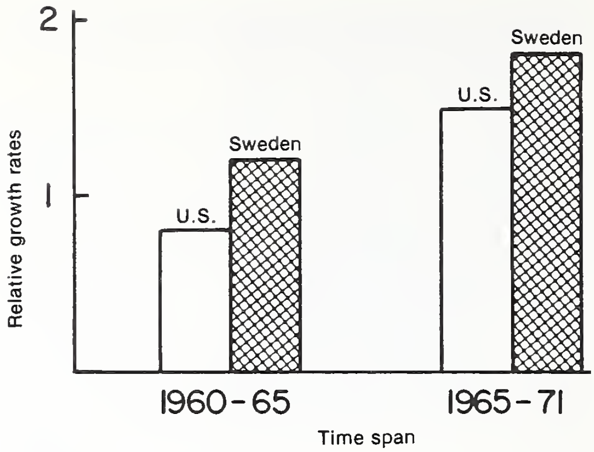

Figure 3.--Energy consumption growth relative to growth in GNP. (Vertical coordinate = Average annual percentage rate of change in energy consumption ÷ Average annual percentage rate of change in real GNP.) (Data Source: Energy Facts II. House Committee on Science and Technology (Washington, D.C.: Government Printing Office, 1975) p. 71.

A number of private and municipal power companies in Sweden joined in 1955 to create the AKK Atomic Power Group as a special corporation, and the first multi-purpose nuclear power station (Agesta) began delivery of heat and power at the beginning of 1964. The first commercial plant for electricity production was put into operation in 1972, and in 1975 nuclear sources accounted for 15% of domestically consumed electric power(15).

Responding not only to the oil shortage, but to growing concern about the pollution of the environment and increased international interdependency, the Swedish Parliament in 1975 took a decision on energy policy which was concerned with the management of energy resources up to 1985. A planned subsequent decision, in 1978, was to shape the design of energy supply to 1990. By 1978, despite schedule slippages, there were six operating reactors (16) with a combined potential capacity of 4490 Mwe(17).

The issue of nuclear power generation, however, was highly controversial in Sweden as in the U.S., and politically sensitive. The commitment to increasing nuclear capacity was essential for self-sufficiency, since uranium is the only fuel with which Sweden could possibly support itself, the uranium resources found in central Sweden being among the largest known to the world(18). (However, the ore content is relatively low, and recent finds in Northern Sweden are of unknown extent, so that most uranium needs will be filled by imports over the next ten years(19). The Democratic Socialist government under Olof Palme worked very diligently to convey the importance of the project to the people and established some 75,000 "people's working groups." These organizations or committees, distributed throughout Sweden, provided information from the central government concerning the current and future requirements for energy, the availability of various resources and the projected costs for those resources. It was believed by Mr. Palme at the time that the population had understood the problem and that there would be no major conflict during the election of 1976. Several other issues including the tax system and several irregularities in the taxing procedures had raised a great deal of concern among the populace just prior to the election. Nevertheless, a key factor influencing the electorate was the continuation of construction and placing into operation of the five new nuclear power plants previously authorized. The Social Democrats, who had been in power alone or in coalitions since 1932, were defeated, and a coalition government took over, under the leadership of Prime Minister Falldin of the agrarian or Center Party which had demanded a halt to the nuclear power buildup, and a closedown of existing plants(20).

The three parties which formed the new coalition proposed a Stipulation Act, adopted by the parliament in 1977, requiring that a utility demonstrate capability for "absolutely safe" waste disposal prior to new plant construction(21). This policy delayed scheduled completion of the Forsmark 3 plant until 1984(22). This government subsequently fell (because the parties could not agree on short-term construction levels), and the nuclear industry is once more gaining confidence (23). A new energy policy will shortly be presented to the parliament: if the nuclear power program continues without further hindrance, by 1985 uranium is expected to account for about 30% of the total Swedish energy supply.

The Swedes are a very pragmatic people, and as the cost for imported energy increases, so does their recognition of the value and significance of indigenous nuclear power generation facilities. Despite the protests and demonstations of concern in the U.S., it seems likely that a similar outcome can be anticipated here.

Environmental Pollutants

Another global problem that has been given much attention in recent years is preservation of the environment, certainly our most non-renewable resource. This is also an issue where the study by Forecasting International(24) found a consistent lead-lag relationship between comparable Swedish and U.S. experience. The list of events found to be strictly comparable is given in table 1, and the relative dates of occurrence are shown in figure 4.

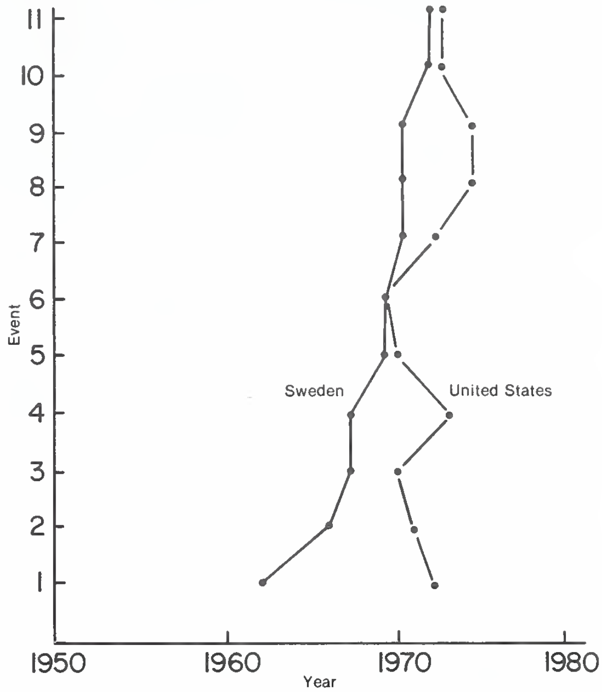

Figure 4.--Events related to environment/contaminants.

However, many actions have been taken in Sweden for which there are no comparable efforts at a national level in the U.S., and it is these which are of value for us to study in this context. Considerable attention for example has been paid to petroleum discharges from tankers in connection with cleaning of the tanks. Particularly in such a limited area as the Baltic, these discharges may have disastrous consequences, but it has become apparent that the Atlantic Ocean is also seriously affected(25). All dumping of oil or refuse (solids, liquids or gases) in Swedish territorial waters from vessels or other means of transportation, or from Swedish vessels in international waters, is prohibited by the Dumping Act of 1971(26).

The primary legislation in this area, however, consists of the Environment Protection Act of 1969, and the 1964 Nature Conservancy Act. As a consequence of the former, environmental investments in the period 1969-1974 amounted to about 1 billion Skr per annum, and the operational and capital costs of industry and local government authorities were estimated at 1.5-2 billion Skr per annum, or about .7% of the 1974 GNP(27). (In 1974, 1 Skr = U.S. $0.23).

In a situation of increasing competition for natural resources, the key feature of Swedish policy is advance planning at a national level. This requires that environmental aspects be considered at an early stage of all comprehensive planning and potential conflicts reconciled. The increasing demand for timber, for example, causes conflicts between nature conservation and forestry; questions of draining of bogs and other wetlands, felling for forests, fertilization and planting, development of so-called energy forest (biomass energy production), large scale peat harvesting, all require establishing a balance in accordance with established national goals(28).

Under the Nature Conservancy Act of 1964, the deposition of litter out of doors is absolutely prohibited (29). Land and water up to 100 meters (extendable to 300 meters) from a beach, lake shore or river bank may be designated as areas under bank protection, implying inter alia that no buildings may be erected or altered within the area without special permission. In all areas, permission is required for the erection of permanent outdoor advertisements, or for quarrying (except for the domestic requirements of the landowner). The Nature Conservancy Act epitomizes Swedish ecological concerns, but in comparison with the cost of environment protection, the costs of tending and mangement related to nature conservation have been insignificant, amounting to about 150 million Skr per annum(30).

A great deal of social overhead capital has been expended on the municipal waste problem. Sewage treatment plants are proliferating, with over one-third of them equipped with facilities for chemical or biochemical purification.

TABLE 1.--ENVIRONMENT-RELATED EVENTS COMMON TO SWEDEN AND U.S.

1. Pesticide labeling and registration of number on label.
2. Ban on mercury (in fish).
3. Establishment of Environmental Protection Agency.
4. SST Ban.
5. Environmental Protection Act.
6. Cyclamate Ban.
7. DDT Ban.
8. Aldrin Ban.
9. Dieldrin Ban.
10. Marine Dumping Act.
11. Lead Content (limitation in gasoline).

Most biocides (e.g. mercury, DDT, PCB), except for specified exceptions, are totally forbidden in Sweden. Even though mercury has been outlawed for most purposes since the mid-1960s, new lakes and streams are still being added to the blacklist: i.e., no fish may be taken from these waters and sold if they contain more than 1 mg of mercury per kg of flesh(31).

The Environment Protection Act, dating from 1969, deals with water and air pollution, noise and vibrations, unwanted light, and other disturbances. To facilitate its enforcement, the National Environment Protection Board undertakes extensive studies in partnership with industry's trade associations. Just how much should be done to protect the environment is judged in reference to what is technically feasible and economically reasonable. With such studies as its data base, the Board prepared guidelines for different factories, which are gradually tightened to reflect new technological developments. State subsidies are available to assist older manufacturing plants to meet guidelines for the treatment of air and water emissions, and for municipalities to install sewage treatment plants.

A key feature of the Environmental Protection Act is that it is relevant to situations where there is only a risk of environmental pollution or nuisance, so that it is not necessary to wait until damage has occurred: the emphasis is on prevention(32). One example of this, which at the same time contributes (by recycling potential) to the preservation of material resources, is the provision of subsidies for auto scrapping. Initiated by the Ministry of Agriculture, a fund was approved in 1975, supported by a tax on new cars, to provide an economic incentive to counter the trend toward junk heaps, abandoned autos and scrap autos which were littering the woodlands, lakes and roads. This debris not only disturbs man, animals and the biosphere, but deprives industrial civilization of a valuable source of scrap metal (and, increasingly, plastics). It was estimated that from 1945 on, approximately 10% of scrapped autos in Sweden were improperly disposed of (33).

Nominal (300 Skr) payments were authorized to be paid to the registered owner when a car was scrapped at an authorized facility. Local authorities were also provided with a subsidy for reclaiming abandoned automobiles. There is some concern that the intent of this measure will be defeated by the small size of the authorized payments.

An important characteristic of Swedish philosophy is the notion that education is a primary instrument for change; accordingly, this is an area of major emphasis in Sweden for attaining long-range goals of environmental protection and resource preservation. Elementary schools in Sweden have included nature studies since 1919, and today's students receive a thoroughgoing orientation to environmental problems and are trained from the first grade to help out in the fight against pollution. Curcicula at all levels warn of the dangers of exploitation of non-renewable natural resources, and the pupils make their own investigations of the environment in the local community, and make individual contacts with different concerned public institutions(34).

Agriculture/Arboriculture

In terms of agriculture in general, the Swedish policy has been very similar to that in the U.S., where the efforts of USDA and its extension services have been notably successful. The first initiative in creating an official Swedish "plant protection" service was taken in 1877 when the parliament made a grant for a plant physiologist. In 1897 a National Entomological Institute was established, and in 1907 subsumed into the Central Institute for Research in Agriculture. In 1932, the Botanical and Entomological departments were detached to form the present National Swedish Institute for Plant Protection, while the remaining departments were included in the newly founded Agricultural College of Sweden(35). The main focus of the Institute is to investigate diseases of crops, injuries caused by pests and appropriate (non-polluting) pesticides for control.

The major difference between the U.S. and Sweden in terms of food supply is really beyond the scope of this discussion, since it concerns the handling and marketing of processed foods. Swedish national policy is aimed at providing the consumer with maximum information, quality and economy, and encouraging an efficient distribution system with minimum wastes. The primary regulations in this area address food (content) labeling and open dating(36).

There is more for us to learn, however, by examining Swedish policies concerning arboriculture. Sweden's forests have historically constituted one of her major resources, and the subject is also of growing interest to the U.S., where the southern states are becoming a major factor in the long-term development of the global forest industry. While trees are technically a renewable resource, the "renewal" period in this instance is long: Swedish trees have an average growing cycle of about 85 years, compared to 25-30 years in the southern U.S.(37).

Lumber is a commodity of particular significance to the Swedish economy, Sweden's initial industrialization being built upon its forests, iron ore and hydroelectric power. Sweden's forests supply a highly developed sawmill, pulp, paper and finished wood product industry. Despite high domestic consumption, 40% of its forest products are exported(38). The fact that raw material for paper is in short supply is paradoxical, in view of the fact that half of the domestic refuse in Sweden consists of paper (see table 2). The problem is being tackled from two aspects: preservation/reafforestation, and the application of modern technology to achieve a more efficient use of the raw material resource. Recycling is a major factor in the conservation of any type of resource, and this aspect of the problem must also be considered in policy formulation.

Examples of the direct protection of the basic resource are provided in Sweden by a 1974 Act aimed at the preservation of beech woods, prohibiting the felling of beeches without special permission; and the Forest Conservation Act of 1948 which provides that valuable terrain is to be maintained and conserved, deciduous stands are to be kept up and increased by suitable felling and aftergrowth measures, etc. A 1974 Royal Ordinance also authorizes grants for various purposes including reafforestation measures, clearance, the drainage of waterlogged forest land, thinning, etc.(30).

Table 2.--Average contents of Swedish municipal solid waste.

	Percentage by weight
Paper	50
Food waste	20
Glass	8
Ferrous metal	5
Plastics	8
Metals	1
Textile, leather, rubber, wood, etc.	5
Miscellaneous (sand, ceramics, ashes, etc.)	3

Source: Permert, Eva-Lotta, The Flakt RRR-plant at Lovsta, Stockholm (Stockholm, Sweden: Flakt Engineering, July 1978), p. 5.

In terms of the general reclamation of waste products, the U.S. undoubtedly predominates. However, it is still of value to us to examine Swedish recycling practices, particularly their employment of developed technology to separate the material from refuse in a sufficiently pure form so that it can be used together with conventional raw materials in an economically viable manner.

Swedish municipal solid waste contains yearly more than one million tons of paper, as well as almost a quarter of a million tons each of glass and plastic, and more than one hundred thousand tons of iron, all this having a recycled value of $44 - $88 million U.S.(40). The paper constituent dominates in terms of value(41). The findings of a 1974-76 Stockholm experiment were that the use of recycled paper saves not only the basic material resource, but also energy. Significant energy differences exist in pulp production: defiberization of wood requires large amounts of energy compared with the use of old paper in which the fibers have already been separated (see table 3). The use of recycled fibers increased almost 40% from 1975 to 1976(41). Even if we consider just the energy viewpoint, incineration of one ton (.9 metric ton) of recycled paper yields the energy equivalent of about 86 gallons of oil(42).

TABLE 3.--TOTAL ENERGY CONSUMPTION IN GOE (LOE) IN THE MANUFACTURE OF ONE TON OF NEWSPAPER

		Raw material	
		Wood	Reclaimed paper
Energy supplied in material		115 (435)	13 (50)
Handling to factory		3 (10)	5 (20)
Chemicals		1.5 (5)	7 (25)
Defibration process		51.5 (195)	20 (75)
Paper manufacturing		71 (270)	71 (270)
Total	goe (loe)	242 (915)	116 (440)
Equivalent price 38¢ per goe* (10¢ per loe)**			Theoretical price value
Energy saving	goe (loe)	126 (475)	$47.88 ($47.50)
Energy content of PDF	goe (loe)	86 (325)	$32.68 ($32.50)

Source: Cederholm, "Paper Fiber Recovery System", op. cit.

*gallon of oil equivalent
**liter of oil equivalent

The implications of this type of experience are broader than the context of a paper shortage. The combined constraints imposed by diminishing supplies of raw materials, energy requirements and environmental pollution serve to emphasize the need for the recovery of materials as a part of a comprehensive program of resource conservation.

Summary

In this brief discussion we have been able to examine only one or two specific cases where assessment of Swedish experience may provide a valuable input to the process of U.S. policy formulation as it concerns renewable and non-renewable resources. It may appear surprising that we can profit from such comparisons: there are many differences between our countries, Sweden having a comparatively homogeneous population, a royal family, a Social Democratic party which until 1976 had been in power almost continuously since 1932, and enjoying 150 years of peace.

However, the same or similar problems are facing most of the post-industrial societies(43) in today's world, and we have many features in common; selected socio-economic data are presented for comparative purposes in table 4, for Sweden and the U.S. As we mentioned earlier in this paper, we are not alone in maintaining that it is of value to consider similarities in cross-cultural trends and attitudes. In one of a series on modern comparative politics(44). Dr. Hancock of the University of Texas has stated:

> As a microcosm of post industrial change, Sweden provides a model of potential transformation that is relevant for assessing the future of other industrial-urban states. The United States, Britain, West Germany, Norway and Denmark serve as a logical basis of comparison, for all of them display broadly similar attributes of modernity.

He proceeds to point out that, in comparative perspective, Sweden faces relatively fewer obstacles to coherent post-industrial change than other industrial-welfare states. Although Sweden lacks the resources to equal American investments in advanced scientific-technological research, Swedish technicians can borrow from "technetronic" discoveries in the U.S. and elsewhere to augment the nation's otherwise favorable inventory of system capabilities. Sweden takes pride in her rise to modernization, and in her ability and agility to adapt to changes. Both people and government try to maintain flexibility and to avoid archaic codes that do not apply to the changing character of society and its needs. Compared to other post-industrial nations, income is also more equitably distributed. This relative homogeneity of population and levels of affluence may well contribute to the nation's ability to explore new approaches on an experimental basis, and to discard those which prove ineffective. The Swedes also have a tendency

TABLE 4.--COMPARATIVE INDICES OF SOCIOECONOMIC MODERNITY[1]

	Sweden	United States
Productivity Index (1975)[2]	116	107
General Level of Employment (1976)[2]	109	112.5
Consumer Prices (1976)[2]	161.9	146.3
GDP (1976 U.S. Dollars, x 10^6)[3]	74,214	1,702,000
Annual Growth Rate, GDP (1976)[3]	2.2%	2.9%
National Income Per Capita (1976 U.S. $)[b]	8,043	6,996
Energy Consumption Per Capita (kg, 1975)[3]	6,178	10,999
% Population Literacy (1975-6)[3]	100%	99%
Persons Per Physician (1975)[4]	600	600
Expenditure for Education as % of GNP (1975)[4]	7.5	6.2

[1]Term coined by Hancock, op.cit., p. 271. Tabular information updated and extended as noted.
[2]1970 = 100. Year Book of Labor Statistics, 1976 (Geneva, Switzerland: International Labour Organization, 1976).
[3]The World in Figures (London, England: The Economist, 1978).
[4]Statistical Abstract of the United States, 1978 (Washington, D. C.: Government Printing Office, 1978).

to anticipate problems before they achieve a level of great urgency, and although they hold no monopoly on good ideas, but "brilliant ideas in the U.S. stay just that -- put into practice, if at all, spasmodically, partially and unsatisfactorily. In Sweden good ideas are rushed into application on as broad a scale as possible"(45).

For a variety of reasons, then, we believe it to be of considerable potential benefit to the United States to be constantly aware of Swedish policies, activities and attitudes in a variety of areas, not least as concerns the conservation of resources. This is not a difficult matter: Sweden is one of the world's most thoroughly documented nations(46), and displays no reluctance to communicate its experience to the U.S., in terms of both successes and failures.

In the preceding pages, we have sketched in broad outline Swedish experience and concerns relative to renewable and non-renewable resources as exemplified by their policies on nuclear energy, environmental protection and lumber conservation. The common theme which I would like to emphasize is the early recognition of the need for long-term planning and the reconciling of conflicting needs. Characteristic of Swedish philosophy is the combination of rapid reaction, prevention in preference to correction, and the recognition that permanent changes in attitudes and behavior can only be achieved through education, and specifically through the formal educational system.

In the particular context of this present discussion, I would like to stress the urgent necessity for establishing a cohesive and comprehensive identification of national goals, which would then form the basis for efficient and effective planning at all levels throughout the country. I believe that our citizens, as in Sweden, must and will come to realize the necessity for development of nuclear power, and that within the framework of a coordinated effort by Congress and the Executive Branch, we can accommodate both our needs for energy and our concern for the environment. I believe that Federal policy can reconcile the conflicts between societal and individual rights, industrial and social costs on the issue of pollution, by ensuring an adequate flow of information between all concerned parties. It is essential to incorporate these diverse interests early in the planning process, to ensure the maximum cooperation of all parties in optimizing our utilization and conservation of both renewable and non-renewable resoureces.

Accommodating Human Needs and Numbers to the Earth's Resources[1]

Lester R. Brown[2]

The French use a riddle[3] to teach schoolchildren the nature of exponential growth. A lily pond, so the riddle goes, contains a single leaf. Each day the number of leaves doubles--two leaves the second day, four the third, eight the fourth, and so on. "If the pond is full on the thirtieth day," the question goes, "at what point is it half full?" Answer: "On the twenty-ninth day."

The global lily pond in which four billion of us live may already be at least half full. Within the next generation, it could fill up entirely. Occasional clusters of lily leaves are already crowding against the edge, signaling the day when the pond will be completely filled. The great risk is that we will miss or misread the signals and fail to adjust our lifestyles and reproductive habits in the time available.

A careful reading of the signals indicates that pressures on the earth's principal biological systems and energy resources are mounting. Stress is evident in each of the four major biological systems--oceanic fisheries, grasslands, forests and croplands--that humanity depends on for food and industrial raw materials. Except for croplands, all are essentially natural systems, little modified by humans. In large areas of the world, the pressure of growing human demands on these systems has reached the point where it is impairing their productive capacities.

Discussions of long-term economic growth prospects in recent years have concentrated on nonrenewable resources, especially minerals and fossil fuels. They have been undergirded by the implicit assumption that because biological resources were renewable they were of little concern. In fact, both the nonrenewable and renewable resources bases have been shrinking. The earth's biological systems form the foundation of the global economic system. In addition to food, biological systems provide virtually all the raw materials for industry except minerals and petroleum-derived synthetics.

The oceanic food chain, yielding some 70 million tons of fish per year, is humanity's principal source of high-quality protein. Not only do fisheries provide animal protein for direct consumption, but the less palatable species are converted into fishmeal and fed to poultry that produce meat and eggs.

Forests provide not only lumber, still a universal building material, but for fully a third of humanity, firewood as well. They are the source of the newsprint for the daily newspaper and of other paper. In short, the housing, education and communications sectors depend heavily on forest for raw materials.

The earth's grasslands are a rich source of protein, from which comes most of the world's meat, milk, butter, and cheese. In addition they sustain the draft animals that till a third of the world's croplands. They are also the source of leather for the footwear and leather-goods industries, and of wool, one of the oldest and most highly prized fibers of the clothing industry.

Croplands produce an even greater range of products. They supply food, industrial raw materials such as rubber, and a variety of fibers, alcohols, starches, and vegetable oils. The contribution of cultivated crops to the global economy is far greater than the one-tenth of the earth's land surface that they occupy.

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[1] This presentation at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Va., was based on the first three chapters of Brown's new book, "The Twenty-Ninth Day".

[2] President, The Worldwatch Institute, Washington, D.C.

[3] I am indebted to Robert Lattes, who earlier shared this riddle with Donella H. Meadows et al., The Limits to Growth (New York: Universe Books, 1972).

Four billion human beings with rising aspirations exert great pressure on these biological systems, often exceeding nature's long-term carrying capacity. The productivity of scores of oceanic fisheries is falling as the catch exceeds their regenerative capacity. In a protein-hungry world, overfishing has recently become the rule, not the exception. Forests are shrinking before the onslaught of the firewood gatherer, the land-hungry farmer, and international timber interests.

As the number of cattle, water buffalo, sheep, goats, and camels increases apace with human populations, the earth's grasslands are being overtaxed. Denudation, soil erosion, and desert encroachment result. Croplands, too, are under pressure. The frontiers have largely disappeared. Fallow cycles everywhere are shortening, and farmers seeking land are being forced up steeply sloping hillsides and onto less fertile soils.

The deterioration of ecological systems through human abuse is not new. Overcutting and the subsequent decimation of forests by humans date back to the earliest civilizations in the Middle East. What is new today is the scale and speed at which biological resources are being impaired and destroyed.

Although these recent trends cannot long continue, how much time it will take to face up to the problem and to arrest the biological deterioration is unclear. Re-establishing a stable relationship between humanity and the natural systems that support human life will perforce preoccupy political leaders during the years and decades immediately ahead.

The adjustments we must now make in consumption patterns, in population policy, and in the economic system if we are to preserve the biological underpinnings of the global economy are profound; they will challenge fully both human ingenuity and the human capacity for behavioral change. Unfortunately, a second equally momentous change--namely, the shift from nonrenewable to renewable energy sources--will compound the difficulties of making the first.

With the projected downturn in oil production only ten to fifteen years away, there is little time in which to convert the economic system from oil to renewable energy sources. The conversion should have been launched decades ago, but the promise of nuclear power lured planners and political leaders down what now appears to be a blind alley.

The most immediate symptoms of ecological stress are physical--deteriorating grasslands, soil erosion, or climate modification. At the next level, the stresses manifest themselves in economic terms--scarcity, inflation, unemployment, and economic stagnation or decline. And finally, the stresses assume a social and political character--hunger, forced migration to the cities, deteriorating living standards, and political unrest.

The need to adapt human life simultaneously to the carrying capacity of the earth's biological systems and to the limits of renewable energy sources will require a new social ethic. The essence of this new ethic is accommodation--the accommodation of human numbers and aspirations to the earth's resources and capacities. This new ethic must above all arrest the deterioration of man's relationship to nature. If civilization as we know it is to survive, this ethic of accommodation must replace the prevailing growth ethic.

As disturbing as the discontinuities of the seventies are, the myopia of those officially charged with analyzing and preparing us for the future is even more unsettling. Biologists who see and understand the deterioration of the earth's biological systems were not able to link it to the performance of the economic system. Conversely, economic and political decision makers failed to grasp the relationship between biological and economic systems. Communications between economics and ecology are virtually nonexistent, in part because ecological principles and economic theory share so little common ground. Economists tend to think in terms of unlimited exponential growth and to place great faith in "technological fixes," while biologists tend to think in terms of closed systems, of natural cycles and of carrying capacities. Economists see specialization as a virtue and as a source of efficiency, while ecologists perceive it as a risk and a threat to the stability of systems.

The analytical breakdown is not confined to any particular area. Experts failed to anticipate the energy crisis, food shortages, double-digit global inflation, the abrupt alteration of the international political structure, the collapse of major fisheries, the astronomical climb in world wheat prices during the early seventies, and a global economic slump unmatched since the Great Depression.

We now confront the prospect that the complexities of the modern world might exceed our analytical capacities. We must now also ask whether existing political institutions can effectively manage deepening international interdependence. Perhaps more important, are we capable of creating and managing the political institutions we need?

The social changes that must be compressed into the next two decades promise to be profound as measured by any historical yardstick. Each of us will be affected. Arresting the deteriorating relationship between ourselves, now numbering four billion, and the earth's natural systems and resources will affect what we eat, how much we pay for housing, and how many children we have. Some will view the changes in prospect with alarm, even in doomsday terms. Others, including the author, believe that the problems are manageable but that managing them satisfactorily will require an exceptional exercise of political will and human ingenuity.

ECOLOGICAL STRESSES I: THE DIMENSIONS

The concept of carrying capacity is familiar to biologists, ranchers, and wildlife managers but not to economic advisers and political decision makers. Even the biologists who developed the concept usually apply it only locally. Curiously little attention has been paid to the carrying capacity of biological systems by national governments, and the subject has been almost entirely ignored at the global level. Only with the preparation of the documents for the 1977 UN Conference on Desertification did the term begin to creep into the vocabulary of UN officials.

The daily news frequently carries accounts of what happens when biological carrying capcities are exceeded. Extensive deforestation in the western Himalayas leads to record floods and destruction in Pakistan. An earthquake in the Peruvian Andes wrecks damages far greater than those suggested by the Richter scale reading, because extensive deforestation paved the way for massive earth and rock slides following the initial tremors. The price of soybeans multiplies as the global fish catch declines. A dust storm in northeastern Colorado closes schools for two days because the growing world demand for wheat led farmers to plow marginal lands that should have been left in grass.

These consequences of excessive pressure on biological systems are not intended. Nobody wanted the North Atlantic haddock fishery to collapse. The combined claims made by fishing nations simply overtaxed it. But, if the deterioration or outright destruction of local biological systems like this one continues, the number of humans the earth can ultimately "carry" will fall off sharply.

Carrying Capacity: The Concept

The carrying capacity of a natural biological system is determined by its maximum sustainable yield, and this in turn is the product of its size and regenerative powers. The latter varies widely. Grasslands and forests in humid areas have greater regenerative capacities and hence greater carrying capacities than those in semi-arid regions. The maximum sustainable yield of biological systems, which can be expressed as a percentage of stock, may vary from a few percent of growth to well over half; but it cannot be exceeded indefinitely without reducing the system's carrying capacity.

A natural grassland can support a set number of cattle or a somewhat larger number of sheep; a fishery will supply the protein needs of a certain number of people; and the forest surrounding a village will satisfy the firewood needs of a given population. If the number of livestock or of people dependent on these biological systems becomes excessive, then the biological system will slowly be destroyed. If the trees regularly removed from a forest exceed its regenerative capacity, then the forest will eventually disappear. If the offtake from a fishery exceeds its regenerative capacity, stocks will dwindle and it will eventually collapse. Where herds grow too large, livestock will decimate grazing lands; as erosion exacts its toll, these pastures will turn into barren wastelands.

Weather, disease, or other changing natural conditions can also reduce the carrying capacity of biological systems. Prudence suggests leaving a margin of safety; otherwise, a drought or outbreak of plant disease can spell disaster. Such was the case in the Sahelian Zone of Africa when nomadic tribes lost entire herds of cattle and goats during the prolonged drought.

Perhaps the most easily understood example of carrying capacity is that applied by ranchers. Ranchers know that if they carry too many cattle on their land, the range slowly deteriorates and the cattle become emaciated. Eventually, part of the herds may be lost through attrition or the forced selling of breeding stock for slaughter. Successful ranchers can peg rather precisely the carrying capacity of their land, and they allow a small margin of excess capacity so that their herds can survive the lean years. They understand the costs and risks of overstocking. Aside from being forced to sell breeding stock in poor years, they recognize that if they overstock for years on end they will slowly destroy their own grasslands and the carrying capacity of their ranches.

The concept of biological carrying capacity is of central importance: human existence itself depends on the output of fisheries, forests, grasslands, and croplands. The natural productivity of the first three is, for the most part, out of human hands. The productivity of the earth's vast semi-arid and arid grasslands can be raised, but the principal techniques for doing so require water and fertilizer and are energy-intensive. Any effort to convert natural systems to controlled systems invariably involves heavy expenditures of energy, something that will likely become prohibitively expensive as the earth's oil reserves run out. Occasional cases of successful tree or fish farming notwithstanding, no economical way of greatly enhancing the productivity of these systems on a global scale has yet been discovered.

The fourth biological system--croplands--is a natural system fundamentally modified to satisfy man's needs. From the beginning of agriculture until the present, humans have sought to improve both the genetic potential of the originally domesticated crops particularly cereals, and the techniques of cultivating them. The great growth in human numbers since agriculture began testifies to the success of these efforts. Of the four biological systems, the earth's croplands have by far the greatest potential for future growth in productivity.

The three biological systems that remain essentially in their natural state are being adversely affected by the pressure born of excessive demand. In some situations, the pressure put on a biological system can be controlled-witness the case of the individual rancher who owns and carefully tends a piece of land. But when resources are held in common (as are the woodlands surrounding a village), controlling the offtake may prove impossible. The shrinkage of carrying capacity is exacerbated by what has been called the "tragedy of the commons."

The Tragedy of the Commons

The inherent tragedy associated with the common use of common resources was first articulated by an English political economist, William Forster Lloyd, in 1883, in a pamphlet entitled "Two Lectures on the Checks to Population."[1] In his monograph, Lloyd considered the problem posed by the village green --perhaps relying on his observations of the very village green that still adjoins Oxford University, where he was then lecturing. He pointed out that a common grazing area worked well as long as the number of cattle did not overtax the land's carrying capacity, ruining the pasture and reducing the number of cattle it would sustain. According to Lloyd, the herdsmen using the green might agree that it would be in the interest of all to reduce the number of cattle to that which could be supported indefinitely. But the individuals had no incentive to remove their cattle. If a particular herdsman decided to cut down his herd to ease the pressures, others would not necessarily follow suit. Thus, the sum of individual decision to maximize gains would be to place far more cattle on the green than it could sustain.

Lloyd's pamphlet received little notice. His idea, however, has been called back into circulation as carrying capacities are exceeded in one way or another. In particular, Garrett Hardin applied it to the contemporary world in an article in Science in 1968 entitled "The Tragedy of the Commons."[2] Hardin contended that the commons today is nothing less than the earth itself. Since then, political scientist William Ophuls has taken the concept farther.[3] He points out that today the commons includes the earth's atmosphere, water, outer space, upper atmosphere, oceans, and biological cycles. On our global commons, the individual herdsmen may be whole nations, multinational corporations, or individuals.

In an increasingly interdependent world, local tragedies of the commons can have global consequences. As the demands for wood for use as fuel and for other purposes increase in developing countries as a result of population growth, deforestation spreads. As the effort required by villagers to reach the receding forest mounts, they are eventually forced to burn animal dung for fuel, reducing the amounts available for use as fertilizer. In turn, local food production falls off, and world food prices rise as ever more local shortages are offset with food imports.

The solution to the tragedy of the commons is to limit the collective claim on common resources to a sustainable level and to find a just and enforceable way to adjudicate claims. At the international level, conventions are needed to regulate the catch from oceanic fisheries. So too are regulations restricting the waste oil that ocean-going tankers can discharge. If the worldwide use of aerosols is not restricted or banned, the protective layer of ozone surrounding the earth may be irreversibly depleted. The energies of diplomats are consumed increasingly by efforts to cope with the tragedy of our earthly commons, to work out the regulations, the conventions, and the treaties that will protect and preserve it.

Overfishing: The Oceanic Commons

Throughout most of human history there were far more fish in the oceans than we could ever hope to catch. Indeed, the fish in the seas seemed as plentiful as those in the New Testament parable. But recently, as human numbers moved toward four billion, the global appetite for table-grade fish such as salmon and tuna approached and, in some cases, exceeded the regenerative capacity of fisheries. Overfishing led to shrinking stocks and declining catches.

Between 1950 and 1970, fish supplied more and more of the human diet as the technological capacity to exploit oceanic fisheries expanded. During this two-decade span, the catch more than tripled, climbing from 21 to 70 million tons.[4] At nearly 70 million tons in live weight, it averaged some 18 kilograms (1 kilogram equals 2.2 pounds) per person annually, well above the annual yield from the world's beef herds.

At least 90 percent of the world fish catch comes from the oceanic commons. The remainder is produced in fresh water, mainly in inland lakes and streams. Two-thirds or more of the catch is eaten directly by humans, while the remaining third is consumed indirectly in the form of fishmeal fed to poultry and hogs.[5]

The importance of fish in diets varies widely by country. Among the larger countries, fish figure most prominently in the diets of the Japanese and the Soviet people. As population pressure built up during the late nine-

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teenth and the twentieth centuries, the Japanese were forced to turn to the oceans for animal protein and to devote their limited land resources to rice production. As a result, they evolved a fish-and-rice diet with an annual fish consumption per person of thirty-two kilograms, the highest of any large country.[6]

The Soviet Union, hard pressed to expand its livestock industry adequately, began some two decades ago to mine the oceans for animal protein. It has invested heavily not only in fishing fleets but also in floating fish-processing factories and in sophisticated fishing technologies that enable its fleets to locate and take fish in all waters. Consequently, Soviet consumers now each eat an average of ten kilograms of fish a year, nearly double the American level.[7] In the United States fish compose an important part of the diet, but direct consumption averages only about six kilograms per capita (compared with about one hundred kilograms of meat and poultry).[8]

World fishing fleets have expanded enormously since World War II. Investment in fishing capacity multiplied severalfold as the industry adopted sophisticated fishing technologies such as sonar tracking. Between 1950 and 1970, the catch increased by an average of nearly 5 percent yearly, far outstripping population growth and sharply boosting per capita supplies of marine protein. But in 1970 the trend was abruptly and unexpectedly interrupted. Since then the catch has fluctuated between 65 and 70 million tons, clouding the prospects for an ever bigger catch (see Figure 1). Meanwhile, world population growth has led to an 11 percent decline in the per-capita catch and to rising prices for virtually every edible species. Many marine biologists feel that the global catch of table-grade species may be approaching the maximum sustainable limit. If the "tragedy of the commons" befalls more fisheries, the world catch will decrease even further.

Although some of the potential for extracting food from the sea remains untapped, dramatic growth in the world fish catch of the sort that occurred between 1950 and 1970 looks like a thing of the past. Fish farming has been practiced for thousands of years and has been widely discussed for the past decade, yet it still accounts for only a minute share of world fish consumption. Only by turning to unexploited species such as krill, the shrimp-like crustacean found in massive quantities off the coast of Antartica, will it be possible to markedly expand the world catch in the foreseeable future. Whether krill will ever become an important food source will be influenced by consumer acceptance and by the energy requirements of developing a food resource so distant from areas of consumption. As human populations expand further, per-capita supplies of preferred species will likely fall further. Higher prices and growing international competition for available supplies appear inevitable.

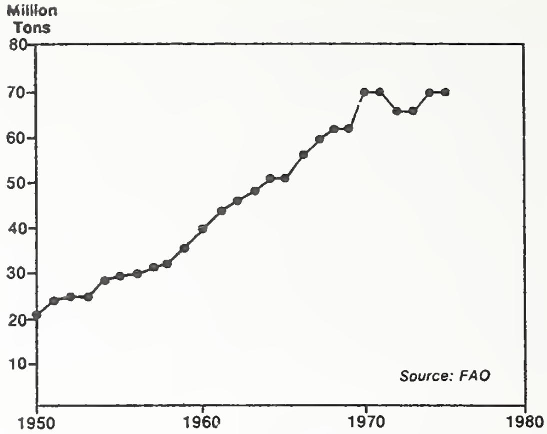

Figure 1. World Fish Catch, 1950-75

Overfishing, frequently discovered only when the catch begins to decline in a sustained fashion, has become a pervasive global problem. Catches of most of the thirty-odd leading species of table-grade fish may now exceed maximum sustainable levels; in other words, the

Secretary of Agriculture Bob Bergland had an opportunity to discuss mutual concerns with Cuouhtemoc Cardenas, Undersecretary of Agriculture for Forests and Animals, Mexico, during initial sessions Monday evening.

species' regenerative capacities cannot sustain even the levels of the present catch. As growth in the world catch slows and in some cases declines, the large Soviet and Japanese populations are especially vulnerable. Deprived of oceanic sources of protein, they will likely have to offset declines by importing more feedgrains and soybeans to expand indigenous poultry and livestock production. Taking such a tack will place additional pressures on exportable grain supplies, but the only alternative is belt-tightening.

The oceans have long been considered a major potential source of food, but the hope that humans could turn to the oceans for food as pressures on land-based food resources mounted is being shattered. Indeed, as the world fish catch levels off or drops, pressures on the land are intensifying.

Deforestation: Cutting Too Many Trees

Four billion people now depend on the earth's forests for firewood, lumber,newsprint, and a host of less essential products. Firewood is used primarily for cooking, but in mountainous communities such as Afghanistan or Bolivia, it may be the only means of fending off the cold.

Villagers in the poor countries where firewood is used for cooking are decimating local forests. The average villager requires between one and two tons of firewood each year, and expanding village populations are raising firewood demands so fast that the regenerative capacities of many forests are being surpassed. Under the population onslaught, forests recede farther and farther from the villages until entire regions and countries are eventually deforested.

While firewood is a principal energy source only in developing countries, wood is a primary building material everywhere. Vast tracts of forests are cut to secure the lumber used to build houses, schools, churches, offices, shops, bridges, railroads, factories, and storage facilities. But even though the forests are being decimated, most of humanity are poorly housed: the need to house some 64 million new inhabitants each year, coupled with the need to replace existing housing, is raising total claims on many remaining forests to an unsustainable level.

A third major pressure on the earth's woodlands comes from the demand for paper. It is the feedstock of modern industrial societies, in which more people are employed in offices than in factories and on farms. In a bureaucratic, nonindustrial city like Washington it is the principal raw material. It is the common medium of both mass and interpersonal communication everywhere. As the share of humanity that is literate expands, the demand for newsprint expands even more rapidly than population. The pressures of these rising demands are further aggravated by a lack of paper recycling facilities in principal consuming countries.

Forests have proved to be one of humanity's most valuable economic resources and in consequence one of the most heavily exploited. If cutting is excessive, forests shrink, and their capacity to satisfy human needs diminishes. Most of the Middle East and North Africa and much of continental Asia, Central America, and the Andean regions of South American are now virtually treeless. In the denuded areas, wood and wood products are scarce and expensive. What is worse, the remaining forested area in all these regions except eastern Asia is shrinking.

Almost every country undergoing rapid population growth is being rapidly deforested. Forests that once covered a third of the total land area of Morocco, Tunisia, and Algeria, for example had been reduced to scarcely a tenth of their original area by the mid-twentieth century. Despite the major reforestation programs that are under way throughout North Africa, the net loss continues unabated. At least a third of the grassy savannah in sub-Saharan Africa was once forest. Successive aerial surveys of the ivory Coast's dense rain forest show a reduction in forested area of 30 percent between 1956 and 1966.[9] In Nigeria, the shrinkage of the forests prompted one forester to talk about "timber famine before the end of the century."[10]

Deforestation threatens all ecological systems and undermines the fertility and stability of soils. Over the past generation the Indian subcontinent has been progressively deforested; as a result the soil's ability to absorb and hold water has diminished, and flooding has become more frequent and more severe.

A review of the state of the world's forests provides no grounds for optimism. In the landmark work on land degradation, Losing Ground, Erik Eckholm notes that Western Europe has "achieved a reasonable balance between the ecological need for forests and other land uses, but it is a balance maintained in part by large imports of wood and wood products," principally from Scandinavia, the Soviet Union, and tropical Africa. Similarly, Japan "is now protecting its steeper slopes from deforestation," but doing so means importing timber from Southeast Asia and elsewhere.[11] Only North America, Scandinavia, and the Soviet Union appear to have both relatively satisfactory forest-management programs and sufficient forest resources to cover domestic needs.

Although deforestation jeopardizes future supplies of firewood, lumber, and newsprint as it contributes to soil erosion, flooding, and silting, little is being done to reverse existing trends. A United Nations study reports that only 10 percent of the area destroyed by slash-and-burn agriculture in Brazil has been reforested. In Colombia, only 1 percent of the land deforested each year is replanted.[12]

Wood shortages and the ecological problems deforestation causes have led many governments to resolve to reforest their lands. Unfortuntely, as Eckholm points out, "the annals of the past few decades are littered with ambitious national forestry plans unfulfilled by governments either unwilling or incapable of backing their schemes with sufficient money and political commitment.[13]

Overgrazing: Eroding the Protein Base

On every continent the area in grass exceeds that planted to crops. The products grown on the 2.5 billion hectares of grassland play an important role in the food, energy, and industrial sectors of the global economy. Grasslands supply protein in a variety of forms, energy in several forms, and numerous raw materials for industry. The ruminants supported by grasslands--beef and dairy cattle, water buffalo, camels, goats and sheep--supply most of the world's meat and milk. As humanity's demand for protein has risen in step with population and affluence over the past generation, pressures on grasslands have increased markedly.

Besides supplying protein for human consumption, grasslands are a source of energy for agriculture. Just as the firewood from forests provides cooking fuel for close to one-third of humanity, so the roughage from grasslands provides the fuel for cultivating that one-third or more of the world's cropland that is tilled by draft animals. In addition, the world's grasslands indirectly supply leather for footwear and other goods. They are the source of wool, a staple fiber of the world's textile and clothing industries, and of the tallow rendered by the meat packing industry and used in various industrial products and processes.

Endowed with complex four-stomach digestive systems, ruminants can efficiently convert grass and other types of forage into products humans can use. Each of these species, most of which eat roughage rather than grain or other feed concentrates, provides some of the vast quantities of meat and milk humanity consumes. According to livestock specialist Harlow Hodgson, even in the United States where vast tonnages of grain are fed to livestock, roughage still accounts for 63 percent of the feed units fed to dairy animals and 73 percent of those fed to beef. Elsewhere, of course, these figures are far higher.

The one-fifth of the earth's land surface on which forage for ruminants and other animals is produced is a cornerstone of the global economy. Integral parts of both the world food and the world energy economies, these grasslands and the 2.7 billion domesticated ruminants they support--1.2 billion cattle, 1 billion sheep, 400 million goats and 130 million water buffalo--also represent an essential source of raw materials for industry.[15] Their production potential and their condition directly influence the prospect of feeding our still-expanding population and of further expanding the global economy.

The amount of range vegetation that can be removed by cattle each year varies widely. Where rainfall is heavy and the species are hardy, well over half of the annual growth can be removed, but where it is exceedingly light only a small fraction of the grass or other vegetative matter can be safely removed without damaging the stand. If more than this is removed year after year, the grass slowly dies out and leaves the bare earth exposed to the elements. A rancher can occasionally alter and substantially improve the productivity of grasslands by seeding them with non-indigenous grasses or, where moisture is abundant, by fertilizing them. But the maximum number of cattle that the land can carry is determined by natural factors usually beyond the rancher's control--by soil fertility, temperature, and the amount and seasonal distribution of rainfall.

Together, population growth and rising affluence are taxing the world's grasslands at a time when overgrazing is already commonplace. Because the best grasslands are gradually being converted into croplands, most remaining grasslands are either concentrated in arid or semi-arid regions or are located on land that is too steeply sloping to be farmed. As ecosystems, semi-arid and steeply sloping grasslands are among the most fragile, capable of surviving only if grazing is carefully controlled.

Even in agriculturally advanced regions, overgrazing is widespread. Recent analyses of the conditions of U.S. grazing lands leave no room for complacency. Reporting in 1975 on the sixty-six million hectares of range it manages, the Bureau of Land Management (BLM) found half the area to be in only "fair" condition--meaning that the more valuable forage species had been depleted and had been replaced by less palatable plants or by bare ground. Another 28 percent was in "poor" condition; stripped of much of its topsoil and vegetative cover, it produced only a fraction of its forage potential. Five percent of the BLM-controlled land was deemed in "bad" condition: with most of its topsoil gone, it could support only a sporadic array of plants of little worth. The twenty million hectares of land in "poor" or "bad" condition, an area equal to that of the state of Utah, was damaged primarily by overgrazing.[16]

Over time, climatic changes and the ecological stresses that lead to denudation may be reinforcing each other with devastating effect. Unless the desertification process is reversed, Africa, which has the highest birth rate of all the continents, may lose a part of its food-producing capacity. Meanwhile, the vastness of the Sahel and the delicate social problems involved in getting the proud nomadic inhabitants to alter their living habits pose formidable obstacles.

The role of grazing lands in supplying food, principally livestock products, is well understood. What is less widely understood is that grasslands or woodlands used for grazing also provide fuel for tillage in the form of forage for draft animals. In most developing countries precious cropland cannot be devoted to the production of grain for draft animals, so these animals must survive largely on foraged roughage.

In many communities in many countries, forage for livestock grows scarcer by the day. If agriculture were modernized and mechanized in these countries, the pressure on grazing areas would abate somewhat. Indeed, when U.S. agriculture was mechanized a generation ago, some twelve to sixteen million hectares of cropland once used to produce feed for horses was converted to the production of food.[17] But, with petroleum supplies dwindling and fuel prices climbing, the prospect for even limited small-scale mechanization is dimming perceptibly unless fuel can be diverted from less essential uses such as private automobiles.

In some areas supporting draft animals has become well-nigh impossible, and draft animals too emaciated to draw plows are becoming common sights. Now that the hope of replacing water buffalo or bullocks with tractors has been deferred in many poor countries because of rising fuel costs, overgrazing both directly threatens the supply of livestock products and indirectly threatens the supply of livestock products and indirectly threatens food production by imperiling draft animals.

Overgrazing is not new, but it is now in evidence to some degree on every continent. Deterioration that once took centuries is now being compressed into years by population growth. Populations are, in effect, outgrowing the biological systems that sustain them.

Overplowing: Moving onto Marginal Land

As world population gradually expanded after the development of agriculture, farming spread from valley to valley and from continent to continent until by the mid-twentieth century the frontiers had virtually disappeared. Even while the amount of new land awaiting the plow shrank, the growth in demand for food was expanding at a record pace. Coupled with the uneven distribution of land in many countries, these trends gave birth to a land hunger that is driving millions of farmers onto soils of marginal quality--lands subject to low and unreliable rainfall, lands with inherently low fertility, and lands too steep to sustain cultivation.

Over the millennia, farmers have devised special techniques for farming land that could not otherwise sustain cultivation. In mountainous regions, the use of terrace agriculture stabilizes soils and protects them from erosion. Centuries of laborious effort have gone into the construction of elaborate systems of terraces that work quite well in older settled countries such as Japan, China, and Nepal and in the Andean regions once inhabited by the Incas. But over the past generation explosive Third World population growth has forced farmers onto steeply sloping areas, and there has not been sufficient time to construct terraces. Where mountainous land is not terraced, it erodes severely and soil accumulates in the valleys in streams, irrigation canals, and reservoirs. As the erosion progresses, such land must be abandoned. Gradually, the productive capacity of both the mountainsides and the valleys is impaired.

In the vast semi-arid regions in which rainfall and moisture are inadequate to sustain continuous cultivation, systems of alternate-year cropping have evolved. Under these systems, land lies fallow in alternate years to accumulate moisture; all vegetative cover is destroyed during the fallow year, and the land is left covered with dust mulch that curbs the evaporation of soil moisture. The crop produced the subsequent year can draw on two years of accumulated moisture. This practice would lead to serious wind-erosion if strip cropping were not practiced simultaneously; the alternate strips planted to crops each year serve as windbreaks for the fallow strips.

In low-rainfall areas, continuous cropping would be catastrophic. Indeed, it proved so in the U.S. Great Plains during the Dust Bowl era of the thirties and in the Virgin Lands of the Soviet Union during the sixties. Except where land can be irrigated, the basic natural constraints on cultivation under low-rainfall conditions cannot be altered substantially. Where rains are light, the use of strip cropping has permitted farmers to crop land that otherwise would not sustain cultivation.

In the tropics, fallowing is used to restore fertility. Stripped of their dense vegetative cover, soils in the humid tropics quickly lose their fertility. In response to these conditions, shifting cultivation has evolved. Farmers who practice shifting cultivation clear and crop land for two, three, or possibly four years and systematically abandon it as its fertility falls; they then move on to fresh terrain and repeat the process. These cultivators return to the starting point after 15 to 20 years, by which time the soil fertility has regenerated sufficiently to again support crop production for a few years.

Over time, shifting cultivation, stripcropping, and terracing have enabled farmers slowly to expand agriculture into areas where conventional agriculture would not survive. Without these specialized techniques, the earth's capacity to support humans would be far lower than it is. Although these practices have withstood the test of time, in some areas they are now beginning to break down under population pressure.

Taking agriculture uphill is often a losing proposition. As a UN study of Latin American agriculture indicates, land with slopes up to 30 degrees is being cultivated, and the consequences of such acts of desperation are harrowing: "Throughout the Andes acute examples of gullying and sheet erosion are commonplace sights and frequently cropping occurs right up to the edge of rapidly advancing gullies."

The Nepalese government estimates that the country's rivers now annually carry 240 million cubic meters of soil to India.[18]

The mantle of topsoil covering the earth ranges in depth from a few inches to a few hundred feet. Over much of the earth's surface it is only inches deep, usually less than a foot. Nature produces new soil very slowly, much more slowly than the rate at which humans are now removing it. Thus, once topsoil is lost, a vital capacity to sustain life is diminished. With soil as with many other resources, humanity is beginning to ask more of the earth than it can give.

Pollution: Overloading the Ecosystem

The burden of excessive human claims on the earth's biological systems is being aggravated by yet another human excess, the generation of waste. Just as felling too many trees can overtax the regenerative capacity of forests, creating too much waste can overtax the earth's waste-absorptive capacity. The absorption is an important natural function of the earth's ecosystem. Indeed, in the complex web of plant and animal life, one organism's waste is another's sustenance. But when waste is excessive, it becomes pollution.

Pollution is more than a mere nuisance. It can impair and even destroy the productivity of local biological systems. It can ruin forests, crops and fisheries; eutrophy fresh water lakes and streams; destroy whole species of plants and animals;' impair human health; break up the ozone layer; impede the exchange of oxygen and carbon dioxide between the oceans and the atmosphere; and even damage clothing, buildings, and statues. Pollution increases along with global economics activity--national efforts to curb it notwithstanding.

Among pollution's many origins are the burning of fossil fuels, the discharge of industrial waste, and the use of agricultural chemicals. The synthesis of new chemical compounds that are not readily biodegradable and the introduction into the ecosystem of heavy metals extracted from beneath the earth's surface pose special threats. The current scale of pollution, the long-lived nature of synthetic chemicals and radioactive waste, and the indestructibility of heavy metals make it an international problem, an expansion of the "village commons" problem to the global level.

Hundreds of new synthetic compounds that cannot readily be broken down by microorganisms are being brought into use each year without a thorough investigation of their environmental impact. As Dr. John Wood, Director of the Fresh Water Biology Institute, notes, "the further the chemists get from natural chemicals the greater the danger" of environmental disruption becomes.[19] Among the long-lived synthetic chemicals that are life threatening are chlorinated hydrocarbons (including pesticides such as DDT). In 1962 Rachel Carson drew public attention to twelve pesticides that might be potentially hazardous to animals and humans--DDT, malathion, parathion, dieldrin, aldrin, endrin, chlordane, heptachlor, toxaphene, lindane, benzene hexachloride and 2,4-D. Since then the use of each has been regulated, and some have been phased out.[20]

The threat of this family of compounds to the survival of numerous species of birds and fish and to human health has been well established. But another newer group of long lived synthetic chemicals, the polychlorinated biphenyls (PCBs) may pose an even greater threat to humans. An outbreak of a disfiguring skin disease affecting more than a thousand Japanese was traced to batch of rice oil heavily contaminated with PCBs. Monkeys exposed to the compound have experienced a sharp increase in miscarriages and have borne sickly infants. Rats have developed liver cancer after sustained exposure to PCB, a laboratory finding that has prompted Dr. Renata D. Kimbrough of the Center of Disease Control in Atlanta to warn "that PCBs may be a low-grade carcinogenic agent to man.

The heavy metals that are mined and used for various industrial purposes (including lead, mercury, arsenic, cadmium) are often part of natural systems, but they occur in very minute quantities. It is only when the amount becomes excessive that various animal and plant species are threatened. One of the first hints of the extreme toxicity of heavy metals came in the early fifties in the small Japanese coastal town of Minimata. Mercury poisoning resulting from the discharge of effluent wastes by local industry spread from fish to fishermen and their families. Hundreds of people were poisoned. A few years later Swedish ornithologists observed that some species of birds were fast disappearing. Mercury from pulp and paper mills was responsible.[22]

While scientists have long recognized the effects of pollutants on rivers, lakes, and the oceans, the effect of pollutants on the upper atmosphere is only beginning to be understood. ProfessorMichael B. McElroy, Director of Harvard's Center for Earth and Planetary Sciences has joined a swelling body of scientists who believes that "atmospheric ozone is threatened by certain air pollutants" and that this is leading to an increase in solar ultraviolet radiation. According to McElroy, the challenge "is to clarify the exact biological consequences of serious ozone depletion, and to figure out how to prevent such an environmental disaster.[23] If the ozone layer is being progressively depleted, it could affect all biological processes and all forms of plant and animal life.

Pollution has many dimensions and many consequences. Air pollution is now so concentrated in many industrial countries that it affects crop production. According to a recent U.S. Congressional study, "The impact of air pollutants on crop productivity is becoming increasingly apparent. A 1974 field experiment in Riverside, California, for example, found that yields of crops exposed to pollution were markedly reduced when compared to those of the control crops." The experiment provided precise but disturbing data. "For alfalfa there was a 38 percent decline in production;for black-eyed beans, 32 percent; lettuce, 42 percent; sweet corn, a phenomenal 72 percent; and for radishes a 38 percent reduction." In California alone, air pollutants cause an estimated 25 milion dollars worth of crop damage yearly.[24]

The impact of industrial air pollution on agriculture can be felt and measured far from the fields adjacent to industrial plants. Grape production in upper New York State is threatened by polluted air carried eastward from factories and automobiles in heavily populated industrial regions in northern Ohio and Indiana. Dr. Trenholm D. Jordan, an agricultural specialist in Chautauqua County, reported that yields of the Ives variety of grapes used in red wines had fallen from four or five tons per acre to two tons. Both the yield and sugar content of wine and table grapes are reduced by air pollution. Dr. Jordan reported that Concord grapes were "seriously affected all over the East."

Even proverbially durable trees are vulnerable to air pollution. Pollution-related damage to forests has been reported in such dissimilar climates as those of southern California and western Poland. One report indicates that "A comparison of annual ring growth in similarly aged groups of ponderosa pines in the San Bernardino mountains of California during the relatively unpolluted 30 year period between 1910 and 1940 and the more polluted years between 1944 and 1974 showed that after adjusting for climate variability, 20 board feet of merchantable wood was produced per tree between 1910 and 1940, where as only five board feet were produced between 1944 and 1974.[26]

The term "acid rain" is rapidly becoming a part of our daily vocabulary. When sulfur-bearing fossil fuels are burned, sulfur dioxide is formed. Some of it further oxidizes to form sulfur trioxide. As the hot fumes from electrical power plants move up the stacks and into the atmosphere, the sulfur trioxide reacts with atmospheric moisture to form sulfuric acid. This then returns to earth as acid rain, the effects of which on plant and paint, corrode metal, erode marble statues, and deteriorate boat canvas and clothing.[27]

Fresh-water lakes are particularly vulnerable to acid rain. In literally thousands of lakes in Scandinavia, the northeastern United States, and southeastern Canada, some species of fish have disappeared entirely. A 1976 Cornell University survey of 217 lakes in the Adirondack Mountains of New York State showed 51 percent of these lakes to be highly acidic. A generation ago virtually all were alive with fish, but, the survey showed, 90 percent are now barren.[28]

At least one industrial country, the United Kingdom, has managed to visibly improve its environment. Blessed with a stable population and a slow rate of industrial growth, it has reversed the process of environmental deterioration. While air quality continues to deteriorate in Washington, D.C., where pollution alerts sometimes remain in force for several days, the air in London is now far cleaner than at any time in recent history. Eighty percent more sunshine reaches London now than in 1955--the year the first Clean Air Act was passed. While the Rhine gets dirtier and less fit for fish year by year, the once filthy Thames is undergoing a remarkable rebirth. Leonard Santorelli reports that "some 83 species of fish have now been identified in the Thames estuary and its first salmon in 141 years was caught in 1975." Although a small measure of Great Britain's progress may be Scandinavia's sorrow (progress may be due to tall smokestacks that release pollutants into atmosheric air currents), this encouraging effort does indicate that environmental deterioration can be arrested.

Relationships between pollution and the productivity of biological systems need further study. Gaps in knowledge exist because pollution has reached destructive levels so recently that neither the time nor the resources needed to examine pollution's immediate impact, much less its longer-term effects, has been mustered.

The earth's waste-absorptive capacity is a prime economic resource. It is also a finite resource. When the amount or nature of waste generated exceeds the amount that the natural system can handle, the system cannot function properly. Overburdening the earth's waste-absorptive capacity, all but inviting malfunctioning, involves far-reaching and perhaps even incomprehensible costs.

Ecological Stresses I: The Dimensions

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ECOLOGICAL STRESSES II: THE CONSEQUENCES

The consequences of overtaxing the earth's carrying capacity are invariably negative, destructive, and costly. They range from the loss of cropland to the inadvertent modification of climate. Virtually all such ecological stresses are likely to intensify as human numbers and aspirations increase further. Only some of the more obvious physical consequences of exceeding nature's thresholds are dealt with in this chapter.

The Loss of Cropland

Three of the excesses described in the preceding chapter--deforestation, overgrazing and overplowing--all contribute to one of the most serious ecological stresses--soil erosion and the loss of cropland. All countries, rich and poor, suffer some soil erosion. The loss of cropland, wherever it occurs, affects the world food outlook.

Roughly one-tenth of the earth's thirteen billion hectares of land surface is cropland. On this land the indigenous forest or grass cover has been replaced with the selected plant species that best serve human needs. The human prospect is closely tied to the size and condition of this cropland base, which is the foundation not only of agriculture but of civilization itself. Thus, both the outright loss and abandonment of cropland--through either severe erosion or conversion to nonagricultural uses--and the deterioration of soil fertility through erosion deserve careful attention.

Each year some of the world's cropland goes out of production. It is paved over, strip-mined, eroded, and left to dry out when irrigation water is diverted to other purposes. Deserts and cities encroaching on cropland on every continent are claiming uncounted millions of hectares each year.

Canada, the second ranking exporter of cereals after the United States, is losing large chunks of its best cropland to urban sprawl and other nonfarm uses. According to the Science Council of Canada, "Between 1966 and 1971, four hundred thousand hectares, or almost one-tenth of the improved farmland in southern Ontario, was lost to agriculture."[1] Canada's total harvested area remains constant only because the loss of prime agricultural land is being offset by the addition of marginal land in lower-rainfall areas. This substitution helps explain why grain yields in Canada no longer seem to be increasing. The Science Council found that "an estimated one-half of the farmland lost to urban expansion is coming from the best one-twentieth of our farmland. The farmland which normally might be considered to replace this loss is almost invariably in regions with poorer soil and a less favorable climate."[2] Another study concludes that the agricultural land requirements associated with a doubling of Canada's population will reduce the area of premium farmland by one-third, putting "urbanization in direct confrontation with agriculture."[3]

The United States shares the problems of land loss with its neighbor to the north. In the United States, the production base is shrinking because the area of agricultural land being lost exceeds that of the new land being brought under the plow. As David Pimentel and his colleagues reported in Science, "Each year more than one million hectares of arable cropland are lost to highways, urbanization and other special uses." They go on to note that this "loss is partially offset by the addition (primarily through irrigation and drainage projects) of five hundred thousand hectares of newly developed cropland per year."[4] These trends do not suggest that the United States and Canada will themselves experience food shortages, but they do suggest that the world's ever-growing dependence on the North American export surplus is risky.

Apart from the loss of cropland, soil erosion on remaining cropland is undermining land productivity. A natural process, soil erosion as such is neither new nor necessarily alarming. Soil is continuously being formed by the weathering of rocks, and it is continuously eroding. Indeed, geologists sometimes casually refer to soil as "rocks on their way to the sea." But when erosion outpaces the formation of new soil (something like one hundred years is required to form an inch of topsoil), inherent soil fertility declines.

It is the rate of soil erosion that distinguishes the current era. In vast areas the topsoil being lost through erosion exceeds that being formed by nature. Soil scientists analyzing the relationship between soil loss and formation calculate the T-factor (or tolerable rate of soil loss), which ordinarily varies from 1 to 5 tons per acre. In a survey of Wisconsin soils, 70 percent were found to have a soil loss greater than the tolerable level. On these soils with a T-factor of 3.6 tons, the actual loss of 8.4 tons, more than double the tolerable rate.[5] The annual loss of agricultural topsoil in the United States has been estimated by Pimentel at thirty tons per hectare or some three billion tons per year. Three independent studies help put this loss into perspective: they indicate that, other things being equal, U.S. corn yields have declined by an average of "four bushels per acre for each inch of topsoil lost from a base of 12 inches of topsoil or less." [6]

Thus far efforts to step up the productivity of the world's cropland base by applying more fertilizer, expanding irrigation, adopting new technologies, and investing in land improvement still more than offset the loss and degradation of cropland, so world food production continues to grow. But in some individual countries, the negative forces now nearly equal or even exceed efforts to expand food supplies. Per-hectare grain yields in Nigeria and Nepal have declined steadily for more than a decade as agriculture has moved onto marginal land and as soil erosion has worsened.[7] The growing dependence of scores of countries on North American food shipments reflects in part the deterioration of local food systems.

The disturbing trends emerging in the world food economy during the seventies indicate the national governments may have to take much stronger action than heretofore to preserve food scarcity and food price inflation. The urgent need for such action is heightened by the rising cost of "land substitutes" such as energy and fertilizer, and by the scarcity of water.

Oceans: The Ultimate Sink

The oceans that cover two-thirds of the earth's surface are the common heritage of all. They constitute an integral part of humanity's life-support system--supplying hoth food and oxygen. The long oceanic food chain, with microscopic plants at the bottom and choice table grade fish at the top, supplies humanity with vitally needed high-quality protein. Thus, pollution jeopardizes human nutrition as well as marine life.

Long too vast for humans to fathom, oceans were also long thought to be too vast for humans to harm. But the scale of human activity is now such that it can damage the seas irrevocably. While it is not in humankind's interest to discharge more waste than the oceans can absorb, the benefits to the individual polluter (whether a country or a corporation) so outweigh the costs that there is little or no incentive to exercise restraint. The tragedy of the commons is now the tragedy of the world's oceans.

A major source of human food, the oceans have become the planet's ultimate waste receptacle, the passive recipient of staggering amounts of industrial, agricultural, and municipal wastes. Thousands of waste products--some highly toxic--are polluting the oceans from which life first sprang. Oil, chemical effluents, lethal gases, radioactive wastes, junk metal, trace elements, organic wastes from humans and animals, automobile exhaust products, pesticides, detergents, and other wastes are routinely dumped into the sea. Hydrocarbon pollution--the legacy of offshore drilling, routine oil-tanker operations and the growing number of wrecked oil tankers--is getting out of hand. Over ten thousand oil spills in U.S. navigable waters were reported by the U.S. Coast Guard in 1975 alone.

In July of 1976, a huge fish kill covering over a thousand square miles was found off the New Jersey coast. Microbiologist Pat Yanaton reported the the ocean "was completely dead--starfish, eels, lobsters, all sizes of crab--everything was dead."[9] Apparently, decomposing sewage sludge from New York and other adjoining municipalities was responsible.

Such disasters should not come as a surprise. An article in the Marine Pollution Bulletin in 1973 reported that concentrations of chromium, copper, lead, nickel, and zinc were "10 to 100 times greater near waste disposal areas" than in other waters in the Atlantic Ocean off New York. Robert S. Dyer, an oceanographer with the U.S. Environmental Protection Agency, reported finding traces of plutonium off both the Atlantic and Pacific coasts of the United States. The plutonium had leaked from some of the 114,500 barrels of radioactive waste materials dumped into the oceans by the U.S. government between 1946 and 1970.[10]

Fish have virtually disappeared from some of the more defiled rivers and coastal zones of the industrial countries. The once-rich oyster beds of Raritan Bay, New Jersey, have been almost obliterated. The shrimp harvest of Galveston Bay in the Gulf of Mexico shrank by more than half between 1962 and 1966. The shad catch in Chesapeake Bay, estimated at fourteen million pounds in 1890, has averaged only three million pounds in recent years.[11] In the United States, over half the human population and 40 percent of all manufacturing plants are clustered next to estuaries and coastal waters. City sewage, little of which is treated, is the major pollutant, followed by industrial effluents and agricultural chemicals.

Before long, humanity must choose between preserving the oceans as a food source and using them as a waste receptacle. Over the longer term they simply cannot be both. Clearly, oceanic pollution is worsening, and the oceans are bound to deteriorate further before existing trends can be reversed.

Endangered Species

The creation of new forms of life and the extinction of old ones is the essence of evolution. Over the two billion years or so since life first emerged on earth, more species have evolved than have disappeared. Accordingly, the web of plant and animal life has grown incredibly complex and interlinked. Although not all species have been identified and catalogued, biologists estimate that as many as ten million plant and animal species may coexist in the world today.

Climate and other natural forces have always influenced evolution, but during the modern era humans have become an evolutionary force. Unfortunately, the human contribution is negative, furthering the extinction of species. In recent decades, more plant and animal species have been destroyed than have evolved. The number of extant species is now declining, and the diversity of life is diminishing apace.

The more nostalgic dimensions of this problem usually capture public attention. The loss of a large and visible species of wildlife is heart-rending, but it is cause for another kind of concern. If too many species are lost, the complex biological web could begin to unravel. The extinction of any species of fauna or flora can become a tear in the whole cloth of life. No species exists in isolation: all animals depend directly or indirectly on plants for food, and plants depend on soil micro-organisms to cycle nutrients. Each species, whether found in only one river or on every continent, serves a particular function. All land and marine plant species, for example, employ photosynthesis to convert solar energy into chemically bound energy that humans and other animals need.

All life forms support other life forms. Micro-organisms aid in the decomposition of organic matter. Some birds feed on insects whose numbers could otherwise become excessive. Ruminants concentrate plant materials into forms that humans can eat, but ruminants cannot perform this task unaided. They depend upon the micro-organisms that live in their complex series of stomachs. Micro-organisms also break down crude organic material in the soil, returning its carbon to the atmosphere as the carbon dioxide that plants need. Thus, numerous species of micro-organisms turn the carbon cycle on which all life depends.

The threats of extinction take three forms. One is by contact with artificially made or artificially concentrated compounds that interfere with life processes. For those micro-organisms in the soil that cannot tolerate an acidic environment, the change in soil chemistry resulting from "acid rain" can be lethal. Similarly, the release into the atmosphere of carbon from coal and oil alters the composition of the air we breathe. Oceanic pollution endangers both fish, a major protein source, and the marine micro-organisms that supply atmospheric oxygen.

A second threat to the survival of species is the physical destruction of natural habitats. Destroying the homes of such animals as the Bengal tiger, the Ceylonese elephant, or the Indonesian orangutan could turn these species into zoological rarities. At worst, it could lead to their extinction. The hunting of wild animals poses yet another threat--whether they be leopards for pelts or whales for food.

Preserving a particular form of life is seldom merely a matter of instituting a ban or quota on the killing of certain forms of wildlife prized by hunters, tailors, or furriers. Rather, the issue strikes at the heart of modern materialism and at human reproductive habits. Increasingly, ecologists hold that efforts to preserve endangered species are futile unless they are combined with efforts to preserve entire ecosystems. "The principal destructive process at work now," ecologist Norman Myers notes, "is modification or loss of species' habitats, which arises for the most part from economic development of natural environments."[12] To adopt this view is perforce to question present-day population policies and the pursuit of material wealth by those whose basic needs have been met.

Others, Thomas Lovejoy among them, believe that common sense now argues against trying to save all forms of threatened life and that humans ought to concentrate on helping the fittest survive. Since saving everything is impossible, the reasoning goes, net losses would be minimized if the species whose prospects look bleakest were left to die. Once this decision is made, concentrating all available energies and resources on the most important (ecologically and economically) of those that remain might pay off. According to Lovejoy, the result of growing pressures on ecosystems is "impoverishment of the biota of the planet, a reduction of its ability to support man and other forms of life." The problem of endangered species, says Lovejoy, is "not, therefore, a hypothetical one as many may wishfully believe; biotic impoverishment is an irreversible process that has profound consequences for the future of man."[13] These analyses underline the urgency of the need to address this problem systematically at the international level, preferably within the United Nations.

Inadvertent Climate Change

Climate and climate changes have always affected humans, but only recently have humans acquired the means to influence climate. As a 1975 study by the national Academy of Sciences reports, "While the natural variations of climate have been larger than those that may have been induced by human activities during the past century, the rapidity with which human impacts threaten to grow in the future, and increasingly to disturb the natural course of events is a matter of concern." The Academy study went on to note that "these impacts include man's change of the atmospheric composition and his direct interference with factors controlling the all-important heat balance."

The earth's heat budget equals the amount of energy it receives from the sun minus the amount reflected or radiated into space. If this delicate balance is altered so that the earth receives more or less heat than it has in the past, the earth's climate will change. If it receives much less, a new ice age will begin. If it receives or retains a great deal more, the polar ice caps will melt--raising the oceans and submerging vast tracts of land and coastal cities.

The earth's absorption and reflection of heat can be altered in many ways. At the local level, the shift from forest to field altered this capacity, as did that from field to desert. The deforestation of vast areas, either as a result of clearing land for agriculture or of cutting firewood, can influence local climates measurably. Conducted on a large enough scale, deforestation could change the global climate as well.

The chief worry emerging among the meteorologists and geophysicists who study the earth's heat balance is that increases in the amount of carbon dioxide in the atmosphere will promote a "greenhouse effect." Carbon dioxide does not reduce incoming solar radiation, but it does absorb some of the heat that is reradiated. Thus, any rise in the CO_2 in the atmosphere would cause the atmospheric temperature to increase.

At present, vast tonnages of carbon that have been sealed under the earth in fossil fuels for long geological epochs are being released into the atmosphere. Since the beginning of the Industrial Revolution the burning of fossil fuels has raised CO_2 levels in the atmosphere by an estimated 13 percent, and, as a 1977 study by the National Academy of Sciences projects, a four-to eightfold increase in atmospheric CO_2 can be expected within the next two centuries if heavy reliance on fossil fuels, principally coal, continues. According to the Academy study, "Our best understanding of the relation between an increase in carbon dioxide in the atmosphere and change in global temperature suggests a corresponding increase in average world temperature of six degrees Centigrade or more with polar temperature increases as much as three times this figure."[15]

This increase in average temperature of 6 degrees Centigrade (or 11 degrees Fahrenheit) would be accompanied by an increase in humidity and in precipitation. If the temperature rise led to even a five-degree warming of the upper 1,000 meters of ocean water, simple expansion would raise the sea level by about one meter. In the preface to the Academy study, co-directors Philip H. Abelson and Thomas F. Malone, indicate in the study's principal conclusion, that "the primary limiting factor on energy production from fossil fuels over the next few centuries may turn out to be the climatic effects of the release of carbon dioxide." In relating the findings of their study to public policy, they report that averting a wholesale warming of the earth "will require a carefully planned international program and a fine sense of timing on the part of decision makers."[16]

The carbon dioxide factor, coupled with the air pollution that is also associated with the burning of fossil fuels, may accelerate the global shift to solar energy sources. The direct use of sunlight, wind power, and water power do not raise atmospheric CO_2 levels. Nor does the burning of wood, unless it contributes to deforestation.

Another source of climatic change is thermal pollution, as weather forecasts for major cities remind us daily. Temperatures within the inner city commonly range from a few to several degrees higher than those of the adjacent countryside. So far, the clearly measurable thermal effects remain largely localized, but the continuing growth in fossil-fuel use could eventually lead to global temperature increases. A 1977 Ford Foundation-sponsored study, Nuclear Power: Issues and Choices, reports that electric power generation can both directly and indirectly contribute to a warming of the earth. "The most serious potential environmental impacts from greatly increased power generation are changes in global climate. The thermal output of both coal and nuclear power plants contributes directly to the long-term heating of the atmosphere. A much more immediate atmospheric heating problem, however, results from the carbon dioxide produced when coal is burned."[17]

The number of deer that a given area can support can be calculated rather precisely. So too can the number of lions that can coexist in an East African game reserve. But calculating the number of people that the earth can safely sustain is a far more complex undertaking. While all deer of the same size consume similar amounts of forage, material consumption among humans varies widely. National averages may vary by a factor of twenty or more, and individual consumption levels may vary by a hundredfold. Although the earth can support far more people with simple lifestyles than people with affluent ones, poor people almost always aspire to live as the rich do.

Calculating the earth's population-sustaining capacity is made even more complicated when technological advances are taken into account. Prior to the development of agriculture, the earth supported an estimated ten million people, no more than the number living in London or Afghanistan today. The 400-fold increase in world population since agriculture evolved was made possible by technological and social progress. But just as mankind has ingeniously enhanced the productive capacity of the natural system, so too people can impair or destroy it, either out of greed or out of ignorance. Examples of human overreaching have already made history. The population of the Fertile Crescent of the Tigris-Euphrates was probably far greater a few thousand years ago than it is today. North Africa, once the granary of the Roman Empire, can no longer even feed itself.

The human excesses recited thus far reflect both the growth in human numbers and in individual consumption. A global population that grows at 2 percent multiplies seven times per century. If the demands generated by rising affluence during the postwar period are added to those associated with population growth, the growth in global consumption from 1950 through the early seventies comes to nearly 4 percent per year. If such a rate is sustained for a century, it leads to an increase of fiftyfold. The earth's biological systems cannot handle growth of such proportions. Nor can human ingenuity and technology fully compensate for the collapse of natural systems.

Biologists have long been aware of this incontrovertible fact. In their analyses of biological systems, they often refer to an S-shaped growth curve that describes various long-term biological growth processes including, among others, the growth of various animal populations introduced into new environments and the gains in productivity of a corn field as new technologies are applied (see Figure 2). The S-curve usually measures time on the horizontal axis and population size or yield on the vertical one. It generally shows growth increasing slowly at first, then more rapidly until the trend becomes almost vertical. At some point it then begins to slow and bend to the right as various constraints cause it to level off. The point at which progressive acceleration halts and progressive deceleration begins is called "the point of inflection."

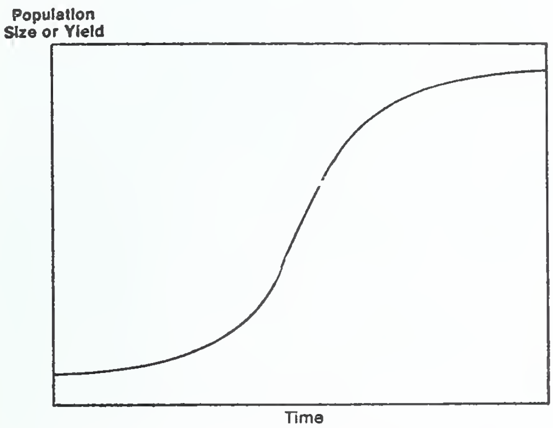

Figure 2. The S-Shaped Biological Growth Curve

It is tempting to assume that the human species is, after all, different from other species and that its size may not be governed by the same rules to which lower forms are subject. But is it? In the long run the growth curve of the human population may not be very different from that of the fruit flies in the laboratory jar, or most other biological organisms in a finite environment. The principal difference may be that human ingenuity has postponed the horizontal flattening of the curve. In the case of humans, feedback from the social environment to the organism may take the form of rising unemployment, of UN projections of growing food deficits in densely populated countries, or of warnings such as those sounded by the Club of Rome's studies. The recent slowing of human population growth suggests that the inflection point on the world population growth curve was passed several years ago. If so, it may mean that our accommodation to the earth's limited capacities and resources has already begun.

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Why Effective Decision-Making Is Currently Impossible[1]

Robert Theobald[2]

I have obviously chosen a highly provocative title for this speech. It is therefore up to me to prove the validity of the thesis and to show why effective decision making is indeed presently impossible.

I am going to argue that disagreements about societal goals, personal motivations, and methods of achieving change are now so great that effective policy-making is impossible. I am going to argue, further, that until we sort out these deeply conflicting positions we shall continue to end up with highly unsatisfactory compromises. Indeed, these will often be so flawed by internal contradictions that today's processes of legislation and executive decision-making can often make problems worse and possibilities more difficult to grasp after the policy-making process is completed than before.

Let me provide examples from outside the renewable resources area as these may, paradoxically, be the easiest for this group to grasp. Let us look at economic policy:

-- the dominant view behind existing policy-making is that we must preserve full employment and that it will be possible to meet societal needs for both stable prices and jobs for all. This leads to pressures for high levels of economic growth and productivity increase, for the first will raise incomes and the second will cut into rates of inflation: the Humphrey-Hawkins bill emerged from this perception of reality. Evidence that socioeconomic conditions have changed so fundamentally that a new economic theory is required was totally ignored.

What other fundamentally different views exist about appropriate economic directions? One increasingly significant and vocal group believes that we cannot expect rapid, world-wide economic growth in the future because of energy and conservation constraints. Many people in this group are beginning to argue against high rates of productivity increase because this reduces job availability and thus condemns certain people to a life of idleness and inadequate incomes.

A third group goes still further. It accepts the argument that rapid world-wide economic growth is now infeasible. It argues that it will be necessary to ensure that the poor countries grow faster in the future than those now rich. It then shows that if this is true the central theses of the neo-Keynesian model, which requires that we provide jobs for all, is the source of many of our most serious problems at the present time. This group also argues that the movement toward multiple job-holding in most families is infeasible, undesirable and disruptive of the social fabric over the long-haul. (Incidentally, this group claims that the writing of John Maynard Keynes shows that he too would repudiate his disciples if he were still alive.)

Because there are partisans of all of these views active in the intellectual and political fields, most pieces of legislation result from a confused mix of goals. This situation will continue unless there is very significant change for our current political and intellectual process has very little opportunity for resolution of disagreement about goals. In effect, we continue to assume that there is an agreed goal, despite the

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[1]Paper presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

[2]Futures Conditional, Wickenburg, Arizona.

evidence to the contrary, and almost all effort goes to discovering the means by which this goal can be achieved. Those people who feel left out of the process because they do not share the goal, look for ways to sabotage the means-decision-making-process because they believe that they have been excluded from participation.

It is this reality which has moved so much of the "political" process into the law courts. So many groups feel that their legitimate goals are not being considered that they feel a right to block the decision-making and activity patterns in any way they can. Indeed, society accepts this and permits an ever-lengthening process of administrative and legal review which raises costs, creates uncertainty, and makes almost all important decisions reversible.

At the beginning of this process, it was those who supported new patterns of thinking--or paradigms--who felt that they had been excluded from the political process and tried to go around it--first through demonstrations and later through legal action. Now the supporters of the original points of view feel that their legitimate interests are being subverted, and they too are moving into extra-political styles and patterns. Thus the confusion grows.

I have now sketched one of the reasons why I believe we are unable to make effective decisions. People feel so strongly about different views of the future that they see others who hold different views as wrong-headed, dangerous, and, often, dishonest. They therefore feel a right to block the actions of other groups in any way they can because the stakes are so high it would be totally wrong to let inappropriate policies develop.

This difference in societal goals, however, is not the end of our difficulties. In addition to disagreements about social purposes, there is no common position about the way in which people can be motivated to change their behavior. Thus, for example, we find in recent energy legislation an odd and confused mix of policy between: A) Compulsion: it is assumed that people will only change if forced to do so by rationing, regulations, or law. B) Price signals: it is assumed that people will change their behavior if relative costs change: those who advance this thesis worry to greatly differing degrees about the equity issues caused by differing income levels, particularly the problems of the poor. C) Information: it is assumed that people will change voluntarily if they gain a new understanding of reality; or to put it differently, they see their self-interest in a different light.

Just as there is no effective forum for discussing differing goals, we have very few opportunities to consider when and where to use compulsion, price signals, or information as our primary tool for change in particular situations.

Why have I chosen to use economic and energy examples? These are fields that I know better than natural resources - and anyway there are fewer experts in the room who can contradict me! In addition, and obviously, it is possible for each of you to see, without difficulty, the parallels in the renewable resources area. Just to give one example, the limited work I have done on water policy issues in Arizona shows that decision-making systems here are affected by the same sort of problems.

Critical Issues

Before moving on to consider how difficult it will be to break out of these dilemmas, I must allude briefly to two other critical issues which lie behind the natural resources questions. First, we need to look at the issue of land itself. For those of you who have examined the history of economic theory, you may remember that the great economist Ricardo argued at one time that eventually all of the wealth of the society would be in the hands of the landlords as population growth increased the scarcity of land.

Certain analysts of our present inflationary situation place far greater weight than is common among conventional economists on the impact of land scarcity on overall prices--and, specifically, of course, on the price of housing. This problem can only worsen, and one is forced to ask to what degree we are going to be required to rethink the methods by which land uses are determined. We use an uncomfortable mix of compulsion through planning and zoning and price changes for this determination at the present time--what changes are we going to be forced to make?

Local, state, and national groups are finding it exceptionally difficult to come to grips with this issue. I am increasingly inclined to believe that the essential problem comes from the fact that we have accepted a way of thinking about land which makes effective decision-making impossible. Most cultures have seen the land and what grows on it as sacred and needing to be preserved for future generations: typically those who worked with it only had the right to use it for purposes that were seen as beneficial. They did not "own" it with the right to do anything which pleased them whatever the consequences.

As we learn that everything is connected to everything else, our culture has been forced to modify the old absolute right of ownership. I have already talked about planning and zoning, which is a major limitation on absolute rights of ownership. Increasingly, there are rules set up in terms of management of agricultural and forest land which impose what is seen as "good practice" on those who use the land. We are in the middle of a revolution in our perceptions of "land rights", but we are not discussing the subject in a way which enables most people to be aware of what is going on.

Now let me turn to the economic issue which underlies almost all natural resources discussions. Most natural resources are sold in "perfect markets" where free market forces are responsible for setting prices and each individual producer has to accept these market prices. Price-setting agreements and cartels have usually been unsuccessful--there are still great arguments about the long-run impact of OPEC: is it going to so increase the availability of energy resources that there will be a glut in the eighties, or do we face a continuing shortage and possibly acute scarcities?

There is no doubt, therefore, that natural resources sell at lower prices compared to "value" than those goods which are sold in "imperfect markets" and where prices can be forced up through segmentation of the market, effective advertising, etc. This difference in pricing is one of the primary complaints, for obvious reasons, of those who produce natural resources, both nationally and internationally.

The strategy adopted to deal with this issue at the present time is to try to discover how to enable natural resources to gain the advantages available to those goods and services which are sold in imperfect markets. In today's new conditions, however, it may well be that we are asking the wrong question. Perhaps we should be asking how it would be possible to rethink the economic system so that the imperfections of the market could be eliminated to the maximum possible extent.

Why might this approach be useful now, if it never was in the past? Most of the justifications for market imperfections come because they are likely to increase the rate of economic growth and provide jobs. If these are not going to be the most important goals in the future, then we need to rethink as rapidly as possible whether practices which violate "free market" principles should be permitted to continue. In other words, those concerned with natural resources would turn their minds away from getting natural resource producers to share in the gains created by the existence of imperfect markets to a strategy which would permit them to sell on the same terms as others in far more perfect markets.

I have now talked about some issues which will heavily affect the patterns of our interactions in natural resources areas. I now want to examine briefly some of the other driving trends in our world culture which will have impacts on which way we move in the coming decades. Obviously, each of the subjects that I shall tackle could be considered at far greater length--indeed, each of them has been and deserves to be the subject of full conferences. All that I can hope to do here is to remind you of a few of the major aspects of each issue.

Rich-poor country tensions. It is clear that the tensions between the rich and the poor countries will continue throughout any time period about which we can reasonably be concerned. There is no way that the gap between the income levels in the rich and the poor countries can be closed in the near future. Indeed, Iran reminds us that availability of oil wealth does not resolve the problems of "future shock" but may instead aggravate it by increasing the speed and the dimensions of the revolution of rising expectations.

It has been argued by some writers that it is possible to cut off North America from the rest of the world. Apart from the question of the Mexican border, which poses acute problems in itself, the development of modern technologies makes terrorism and major destruction impossible to control without total control over all aspects of life: indeed, this would probably be insufficient. Thus, any scenario must accept this set of problems as an unalterable fact of life.

*Interconnectedness and votility of all systems.*Our nineteenth century patterns of knowledge and our nineteenth century styles of action make it possible to act as though there were only limited connections between various groups and systems. The situation is quite different today, where the whole world is tied together by an essentially instantaneous communications web. For example, Sadat is said to have stated in the early seventies that he had put off the date of a war with Israel because everybody was too busy to pay attention. We hear much talk about the planned media event: we often fail to realize that all major activities are now inevitably media events, and that the group that does not accept and cope with this reality will inevitably end up with the short end of the stick.

The consequence of this reality is that tightly controlled planning has become impossible. All that can be hoped for is a management style which will be able to cope with the large-scale changes in perceived and real conditions which will occur with increasing frequency in coming periods. The essential effect of this change is that we must move away from planning and toward "management of uncertainty."

Obsolescence of social science theory and particularly economics. This reality follows directly from the previous point. Our social science theory is based on static mechanical principles derived from Newton. Thus it is assumed that one event does not affect another, that risk and uncertainty can be safely ignored, etc.

We need a new set of social science theories which are derived from the teachings of Heisenberg, Einstein, Bohr, and other twentieth century scientists. They are slowly being created but they have, as yet, had little impact on the styles of teaching, and indeed practice, of most social scientists. As a result, there is a great gap between theoretical ideas and the real world these theories are meant to explain.

Why is this serious? John Maynard Keynes said it best, perhaps: "All politicians are slaves of some defunct scribler." We all structure the world according to certain principles: if these are inaccurate or inadequate, we shall inevitably make poor decisions.

Theories of learning. A special, but critically important, area of the science/social science problem is that we have no adequate theories of learning at any level. We do not know how the brain stores knowledge nor how people learn effectively. Indeed, all too often, we do not even make a distinction between training--the acquisition of a given body of knowledge without understanding its principles--and education, which is the process of understanding a subject so that one can make a contribution to its development.

If it is true, as is argued in this paper that it is critical that people should re-learn about the world, we are only going to be able to do this on the basis of a new theory of learning, which indeed presupposes a new theory of knowledge. This is, in fact, also coming into existence but little attention is being paid to its implications.

Changing patterns of energy. It is clear that a movement away from fossil fuels must take place in the foreseeable future. There are profoundly different views about the difficulties which will be associated with the shift.

Some people argue that we must find ways to cut back energy usage. There are at least two causes for this position. The first is that we shall be unable to invest substitutes for the energy sources available in the requisite abundance. There are others who claim that the problems of pollution, heat gain, CO_2 increase, exhaustion of natural resources, etc. will constrain any attempt to keep energy use growing on an exponential basis for any considerable period of time.

Those arrayed on the other side are the technological optimists. They claim that human beings have overcome similar problems in the part and there is no reason to assume the difficulties will be insoluble at this point.

It should be noted that the disagreements extend to short-run trends also. Some people anticipate that the eighties--regardless of possible short-run difficulties with Iran--will be critically energy short, while others assume the high price will bring new and unexpected supplies on line as well as see significant conservation.

Finally, it should be noted that, as in so many fields, the statistical bases are so bad it is almost impossible to tell what is happening, let alone what is going to happen.

Population patterns and shifts. Leaving aside the population problems of the developing countries, which form a large part of the reason why it is impossible to hope that the gap between the rich the the poor countries will close down within any reasonable planning period, it is also important to note the major implications of population patterns in the United States.

First, we need to be aware of the possibility of a baby boom echo over the next decade. While present desires for children do not suggest a very large increase in births is likely to occur, it is certain that the annual population cohorts will be considerably larger in the eighties than in the seventies with significant consequences for school districts which are now lcosing their schools. If, in addition, some quite possible forces might develop, the rise in the number of children born could be so large as to produce real problems.

Second, while the size of future population cohorts is necessarily unknowable, and has totally fooled the census bureau more times than they like to think about, the consequences of the late fifties peak in births are essentially inevitable. They have been compared to the effect which follows when a snake eats an animal so large that one can see it moving down the snake. Just as there were a whole range of difficulties associated with the large number of teenagers, the high concentration of people at increasing age levels will cause major consequences. It is possible to see these as good and bad: one's balancing of possible effects at this point is largely personal and ideosyncratic.

Third, there is the move into the Sun Belt. This move continues, and the costs seem to be increasingly serious while the benefits are less and less certain. Indeed, I have argued that rapid growth is no longer in the interest of any part of the country in this period of rapidly increasing costs; intelligent policy-making would consider how people could be encouraged to stay where they are rather than increasing the burden on already overloaded growth areas. It should be noted that I am not arguing for controls, but for better information movement.

Fourth, this movement into the Sun Belt is complicated by the movement into the rural areas, which is continuing to gain strength and which is overwhelming many county areas. The movement into the rural areas is partly based on "pull factors"--people desire to be in the

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rural areas and have wanted to be there for a long time, but have not seen the ways to achieve their goal. It is also based on "push factors"--people hope the country will be cheaper, and that the web of laws and regulations will bind them less tightly than they do in the city.

Moral structures. All of these factors have combined to break down the trust that people have in their leaders and their institutions. There has been a catastrophic drop in the public's level of confidence in the honesty and reliability of people and institutions over recent years.

It is not necessary to detail the highly dangerous consequences of such a situation. The governability of any country is directly related to the confidence people have in their leaders. If this should decay, it becomes almost impossible for the "leader" to lead, for he will no longer have any followers. More and more analysts fear that all the countries of the world are moving in this direction, and point to the situation in Lebanon as one of the possible end results of present trends.

One of the most critical indicators of our dangers is the rise of single-issue politics. People are willing to elect or defeat a candidate on the basis of his stand on a single issue, and to forget all the other characteristics which determine whether or not he or she will make a good decision-maker and leader. Another element here is the rise of the fundamentalist sects, which tend to discourage imaginative and creative thought.

High technology. Finally, let us look at the potential of high technology to change the ways in which the world presently works. There has been a decline in recent years both in the confidence of the average citizen in the capacity of high technology to resolve problems, and the willingness of those with resources to fund the development of high technology which might resolve problems.

It is therefore uncertain what patterns will eventually develop. For example, it has now been shown, on a laboratory scale, that fusion is a feasible technology although the scaling-up process will be lengthy and immensely costly. Will we be willing to put aside the resources to capture the potential of fusion? The energy picture will inevitably look quite different depending on the choice we make here.

One new high technology, however, is coming into existence now and is almost certain to continue. This is the development of microelectronics. More and more "brain power" will be provided by computers with extraordinary consequences for society which we have hardly begun to examine. It does seem certain, for example, that the societal commitment to full employment will be even more difficult to maintain than in the past.

If any of us are to have any chance of understanding the range of options in the future, we must keep all of these driving forces and others in mind. It is for this reason that these thoughts are relevant, although they may at times have seemed far afield from a talk

During a break, Theobald hooked up a terminal to a data base through a pay telephone to help illustrate his concepts of trends in electronic communications.

on the future of renewable natural resources. Indeed, our critical problem, with which we must grapple, is the right way to think about the future of natural resources and the frameworks in which we can effectively conduct our analysis.

If we accept a particular starting point for our analysis it will lead us, through incremental, logical steps to a particular answer. If we accept a different starting point, it will lead us to a different, and probably contradictory, conclusion.

The need of our time is to examine the validity of the various starting points used for suggesting policy conclusions rather than to quarrel about the policy prescriptions that follow inevitably from these assumptions. The next section of the speech will therefore look at the primary models currently being used for thinking about the future.

Our thinking about decision-making, and particularly about political science, emerged as already stated from the Newtonian mechanical model. It assumes essentially static conditions and the possibility of equilibrium. Most decision-making therefore starts by assuming the existence of a desirable previous state of affairs, and then tries to restore that state through the development of new policies.

As I have already suggested, the theoretical justification for this model has worn thin in recent years. Few people today consciously support such a model, but the evidence shows we have not really moved beyond it when making policy.

For example, I have been lucky enough to work recently with the Office of Technology Assessment of the U.S. Congress, first on the problem of residential energy conservation and now on the potentials of biomass. The first major lesson I have learned is that our idea that we can be wise enough to understand the specific directions in which the society will move in advance of developments is naive, at least with the present state of the art. Indeed, I do not personally believe it will be possible for us ever to anticipate sufficiently well to manage the type of socioeconomic system which now exists.

I compare our present ways of thinking to running a car on a mountainous road at such speeds that from time to time two wheels go over the edge and we wrench it back because of the speed at which we are going, and a good measure of luck. Everybody in the car is painfully aware of the dangers involved, but we fear that the process of slowing the car down may be the very factor which causes the car to crash.

We cannot continue in this way. I am convinced we must rebuild flexibility into our society so that we do not have to try to react on an emergency basis to every change in conditions, but rather leave the society and the economic system with space to respond through self-corrections: governments then only become involved when it is clear that the need for correction is beyond the automatic mechanisms. (This is similar to the automatic pilot on a ship. It will not deal with the stormiest weather and any changes of course must be set by the captain or the pilot. Interestingly, of course, the skills of automatic pilots continue to increase.)

Our need is to steer between two dangers:

The first is the one that has beset us for the past 20 years, where the answer to every problem has been the passage of a new piece of legislation. We are only now beginning to perceive the consequences of this pattern.

The second is the belief that the "government is best which governs least." This, of course, is the model out of which our present excessive patterns of intervention grew.

What then is the best government? It is the government which has the skill and knowledge to know just when to intervene in ways that have maximum impact in absolutely required directions. One can make a parallel with the good doctor who concentrates on helping his patient to stay healthy but is, nevertheless, perfectly aware there will be times when intervention, whether through drugs or surgery, is essential. The twin dangers of excessive intervention and benign neglect exist for human beings and for societies.

Obviously, the problem with this style of management is that it calls for judgment and has little place for consistent rules. Each case must be judged on its merits. "It all depends" becomes a profound statement and "knowing what it all depends on" becomes the basis of knowledge.

This is a different model from those most commonly used in decision-making at the present time. I want to set those existing models out briefly so we become aware that different people in this room will be starting from very different premises, and that we shall have to look at these premises and paradigms if we are to have a chance of creating true learning out of this National Workshop.

Decision-Making Models

Post-war trends will continue. The dominant public and political rhetoric of our time is still that of a continuation of the post-war trends. Most people use this model automatically most of the time without ever looking for a justification for its use. It is ingrained and "natural".

Those who justify the approach argue along the following lines: There have indeed been some significant breaks in growth and productivity trends in recent years, and the recent rates of growth, inflation, and unemployment have been unfavorable. We have, however, now identified the causes of these breaks in trend, and we shall be able to cope with them in the future. Thus we can expect to return to a situation in which the vast majority of the population gains a continuing increase in its standard of living every year and in which we return to reasonably stable prices.

The issues in natural resources which appear to come to the fore under these circumstances are:

1) How will it be possible to ensure that the rate of growth in the production of natural resources keeps up with the increasing demand for them in a world of rapid growth? Where are the increases in needed production to be achieved in the face of growing stabilization of yields about which Lester Brown told us?

2) What policies should be followed to ensure that producers of natural resources get a fair shake in terms of prices? What is the relevance of the concept of parity? Is it achievable? What policies should be followed in exporting--should the United States use its strong position to raise prices for foreign sales?

Slow transition. This first model is, of course, highly vulnerable to both because of the present land-use situation in the world where resources are already strained, coupled with the impacts of exponential growth taught by the first Club of Rome report.

Many futurists who see essentially a continuation of present trends for a significant period into the future have now moved to new ground. They argue that we are now passing through the inflexion point of an S-shaped curve--that we are moving through the time when the rate of growth has been increasing to a time when the rate of growth will be decreasing. They expect, however, that the shift will be gradual as in an "idealized" S-shaped curve, and that it will occur without great stress or difficulty.

Thus the questions asked by this group vary little from those raised by the first group, although their theoretical stance is significantly different. Indeed, as they are technological optimists, for the most part, there is a feeling that the solutions to present problems will probably fall into place without too great difficulty. This slow transition model is certainly the most optimistic of the visions presently available to us.

Collapse. The slow transition model is challenged, however, by those who believe that the stresses and strains that now exist throughout the world society, both internally and internationally, are so serious that a miracle will be needed to avoid collapse.

There are a large variety of collapse theorists, and a total description of them is beyond the scope of this speech. Indeed, except for the starting point that major changes have to be made if collapse is to be avoided, these groups share little common ground.

Some groups argue that a collapse is inevitable and that we must wait for it, see what is left, and then pick up the pieces. Others argue we should prepare for the collapse by beginning to isolate ourselves from the poor countries that are overloading the world's system and that are going to suffer from mass starvation.

Still others argue that draconian measures should be encouraged/forced on populations at the present time so that collapse can be avoided. For example, there are many who believe the urgency of population control is so great that it must be achieved at all costs.

It is clear there will be different priorities for different groups who share the perception that collapse is probable/certain.

Management Theories

Management theories for the future start, usually, from a belief that collapse is indeed inevitable <u>unless</u> substantial changes are made. It is assumed, in addition, that the necessary changes cannot be made unless our methods of decision-making are fundamentally altered. This speech is given from a management point of view.

It is argued, specifically, that the world is now so complex that if a major collapse should occur, the costs would almost certainly be so high that present societal systems would be destroyed and there would be an appalling loss of life. The interconnections now existing throughout the world are so tight that it is impossible to imagine a collapse not having massive impacts.

Management theories therefore are designed to change the direction of the world system before collapse occurs. Too little work has yet been done using this model for there to be an agreed body of knowledge, but certain factors are agreed:

It is impossible to push any society--whether "democratic" or "dictatorial"--beyond certain points, otherwise social breakdown or revolt becomes inevitable. The government of India, for example, decided that birth control was critical. Its efforts to push this approach were so unacceptable within existing cultural norms that the government was brought down.

If it is true that we are in need of immediate and pervasive change, it follows that one of the primary issues which confronts us as a society is how change in thinking is brought about. This subject could take a paper in itself, and all I can state is the conclusion I have reached after working in this area for many years: People will only consider issues which they see as affecting their self-interest, and they will only change their views if this change is also seen as being in their self-interest. This means that, if we need to change the public's perception of the natural resources area, which I believe we must, we must somehow find ways to structure the discussions in ways which grab their interest and then find methods to permit them to discover new perceptions which meet both societal needs and their own.

There are two critical issues, then, in a management strategy. First is the provision of information which those involved can understand. The central difficulty today is that the various points of view are so confused--for reasons that have been stated earlier--that a great number of people have given up trying to make sense of the world in which they live. They have opted out, and decided the political process is simply irrelevant to any hope of an improvement in the quality of their lives. This was made obvious in the dynamics of the 1978 election.

Some of us have been developing a new form of document, entitled a Problem/Possibility Focuser, which aims to deal with this problem. It is set out so that it states the agreements which exist in a given field, the disagreements and the reasons for them, the scenarios which follow from different sets of policy choices, and the resources available to people who may want to study the subject further. In a sense, then, this meeting is about the creation of a problem/possibility focuser, for we hope to clarify for ourselves and others what the critical problems and possibilities may be at the present time.

The primary pattern which gets in the way of creating a problem/possiblity focuser is the belief that it is reasonable to hope for agreement at this time. As already stated, there are such different views about the present and the future that we cannot hope to agree at this point. We can reasonably hope, however, to sort out <u>why</u> we disagree and to state the types of data, information, knowledge, and wisdom which might enable us to move beyond our present disagreements.

The second step in a management structure is for people to gain the skills to operate in an uncertain, risky world. As I have already suggested, this requires different patterns from the present time. Today, we search for enough information through research to know what the right step is. Unfortunately, the pace of change is so great we can never arrive at this point. We need to learn the quite different set of skills which enable us to act <u>despite</u> inadequate information.

Conclusions

Obviously, all of this set of ideas reflects immediately on our own procedures here. A lot of people have given up time and other resources to spend three full days in thinking through a highly complex and difficult question which I have only been able to touch upon--particularly as I feel that the question period is more important than the speech.

If my decision-making thesis is right, it is extremely probable that we shall fail to use the time to the best advantage. We shall try for agreement when it is not feasible rather than accepting the inevitability of profound disagreement and recognize that sorting out the causes of this disagreement would bring new understandings, not only to us here but other people throughout the country who have lost any sense of understanding of these questions.

What will determine whether or not we succeed? I believe that the answer to this question is whether we see ourselves as self-guiding or cybernetic--whether we expect a small group of planners of this conference to understand all the dynamics and to make good decisions without our impact. Nobody here is clever enough to know how to cope with the immense difficulties of creating styles that will be more effective in knowledge-creating and decision-making. It is just possible that all of us, taken as a team, could be effective.

It is my belief that this might be possible which has brought me here. I would be delighted if we could prove that the title of my speech is wrong.

An Overview of Related Studies in Food and Agriculture[1]

Leroy Quance[2]

Historically, we have had a feast-or-famine attitude about the world food situation. With emerging regularity, some analysts have swung between the extreme views that agriculture has a chronic, built-in capacity for overproduction, and that it has an equally durable characteristic for underproduction leading to food scarcity. For convincing evidence supporting the chronic overproduction thesis, see The Roots of the Farm Problem (4) and The Overproduction Trap in U.S. Agriculture (7). For the scarcity theme, read almost any of the current popular literature on global food production, especially Lester Brown's By Bread Alone (3). And for a nearly complete swing from feast to famine, read Brown's Seeds of Change (2) before you read By Bread Alone.

The feast-or-famine scenarios recognize increasing demand for food from population and income growth, but emphasize supply as the positive or negative force in the world food balance. To complete the picture, we must give demand and supply equal weight in a four-quadrant supply-demand adjustment plane (fig. 1). Although fig. 1 emphasizes food production, it can reasonably represent the total supply of, and demand for, services of renewable natural resources[3].

[1] Paper presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

[2] Agricultural Economist, ESCS, USDA, Wash., D.C.

[3] Jean Johnson, National Science Foundation, developed the original supply-demand possibility concept used here while she was with Forecasting International, Ltd. (8).

Malthus originated the quadrant III disaster world in which only starvation is effective in holding population in check and balancing food supplies with needs. In An Enquiry Into The Human Prospect, Robert Heilbroner is a modern-day Malthus (5). He laments the human prospect resulting from our inability to act in time to stop horrifying

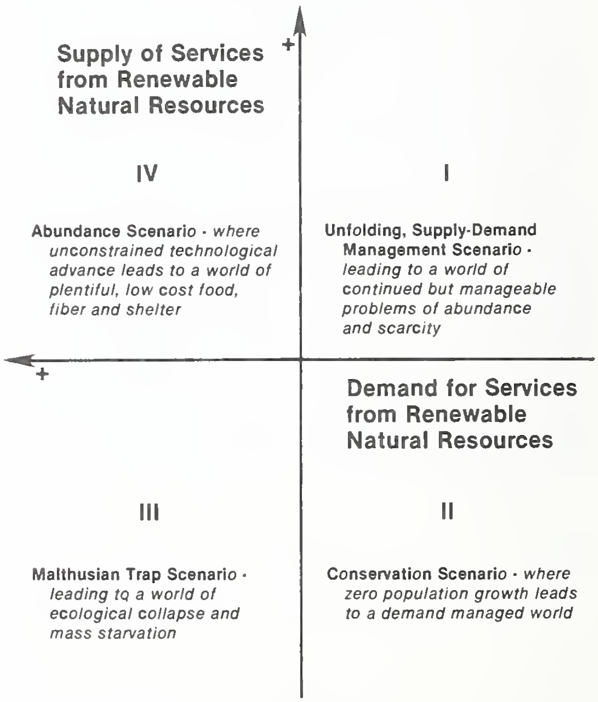

Fig. 1.-- The future of man and his relationship to renewable natural resources.

population growth that will lead to catastrophic starvation and disease throughout a large portion of the developing world; and he believes that unrestricted industrial growth will eventually bring environmental collapse.

Advocates of the technology-induced abundance world of quadrant IV view unchecked population growth and other rising demand aspects as an alarm for greater technical research in food and agriculture. Michigan State University's Sylvan Wittwer, coordinator of the National Academy of Science's food and nutrition study, advocates a "Manhattan project" in food that would rival the atomic bomb effort (11).

Hans Linneman, A Dutch economist and leader of the Club of Rome's project on how to feed a doubled world population by year 2000, is convinced that food constraints need not limit population growth in the foreseeable future. And so is Herman Kahn (9).

The conservation futurists in quadrant II ignore the possibilities for increasing conventional food supplies, placing emphasis on regulating population growth and conserving limited resource and food supplies. In his book, In the Human Interest, Brown advocates a population control strategy leading to a stable world population of 5.8 billion by year 2015 (1). This compares with uncontrolled world population projections ranging from 10 to 16 billion in the same time scope.

Teamed with population control advocates are those who emphasize conservation of our limited resources. In Lewis Mumford's Pentagon of Power--The Myth of the Machine, energy is forcing us to adapt civilization to the machine (10). Mumford advocates that we all "plant, work, and eat."

USDA studies have thus far indicated an unfolding world of supply-demand management illustrated in quadrant I, where man succeeds in controlling himself and his environment, a world in which both technologies and human values change. A balanced future is sought in which both quantity and quality of human existence are valued. Rather than rejecting the machine, having blind faith in science, or giving up in despair, those in quadrant I have faith in a future where science and man get on with the job of rational analysis and positive action.

Before we look at current food and agricultural projections, it is important to recognize that the unfolding supply-demand management scenario has dominated USDA thinking primarily because of the Department's historical concern for the long-term future. Through decentralized programs of resource development and management, research, and extension, the USDA has periodically updated long-range appraisals in food, agriculture, and forestry, and planned and implemented appropriate action programs. For example, Secretary of Agriculture Henry C. Wallace's concern for the next three or four decades resulted in a report "The Utilization of Our Lands for Crops, Pasture, and Forests," in the 1923 Yearbook of Agriculture. A report "Looking Ahead on Agricultural Policy" was presented at the Annual Outlook Conference in 1936. This report analyzed the question: "What adjustments in agriculture would seem to be necessary...from the standpoint of domestic consumption, foreign demand, soil conservation, and the economic and social well-being of agricultural producers?" And more recently, former Secretary of Agriculture Orville Freeman sponsored a series of reports entitled "Agriculture 2000" which brought together projects of population, land use, technologies, and standards of living.

There have also been other, more conventional programs emerging, such as the U.S. Water Resources Council's OBERS Projections of Economic Activity in the U.S. (17), and the Resource Planning Act and Resource Conservation Act programs. For an inventory of other such studies, see Jane Porter's Agriculture The Third Century: Historical Perspective on Demand and Supply Projections in the USDA (12).

Current Projections for Food and Agriculture

The Scenarios

Our scenarios are concerned with uncertainties related to both the supply and demand for food and agriculture.[4] Within an adjustment range that we call supply-demand management, we define two scenarios: a high demand-low supply scenario and a low demand-high supply scenario. The baseline provides the boundary between these two scenarios. Still within what we think would be a manageable supply-demand situation, but with much higher demand and much lower supply attributes, we define the boundary to a third scenario that we call toward scarcity. Conversely, as we decrease the demand attributes away from baseline assumptions, we reach the boundary to the fourth scenario, toward abundance.

Our expectations for supply attributes to be so low, and demand attributes so high, as to push food and agriculture into the

[4] For a more complete description of these scenarios and resulting projections, see Quance, et. al. (13).

toward scarcity scenario range are quite small--.3 for 1976-1990 and .12 for 1991-2000. The probabilities of supply and demand attributes pushing food and agriculture into the toward abundance scenario are also small--.12 for 1976-1990 but a somewhat larger .15 for 1991-2000. Supply and demand attributes of the two supply-demand management range scenarios have the greatest probability of occurrence. Within this range, the probabilities are slightly higher (.39 in 1976-1990 and .35 in 1991-2000 compared to .36 and .35) that food and agriculture will experience high demand/low supply conditions rather than low demand/high supply conditions. Both of these supply/demand management scenarios, as well as the toward scarcity scenario, lose some of their likelihood in favor of the toward abundance scenario as we move from 1976-1990 to the 1991-2000 period.

Aggregate Impacts of the Projected Supply-Demand Shifts

Baseline--Agriculture will maintain a fairly favorable position under the baseline assumptions. Demand will increase slightly faster than supply. Net farm income (before inventory adjustment) in 1974 dollars will be higher than the 1975-1977 average of $18.2 billion at $25.9 billion for 1990 and $31.6 billion for 2000 (table 1). The ratio of prices received to prices paid is 111 for 1990 and 116 for 2000, higher than the 94 for 1975-77 (1976=100). The projected situation is not as favorable, however, as 1973 when net farm income reached $32.8 billion (in 1974 dollars).

Output will increase about 20 percent by 1990 and productivity about 10 percent from the 1975-77 average, which indicates higher input use. By 2000, output increases about 40 percent and productivity 22 percent. An increase of about 14 percent in input use results. As resource use and output increases, real production expenses (in 1974 dollars) increase about 12 percent by 1990 and 38 percent by 2000. Exports are projected to increase 39 percent from the 1975-77 average to 1990 and 72 percent by 2000. The percent of real per capita disposable income spent on food increases only slightly because, although the total cost of food and fiber at the farm gate increases 18 percent by 1990 and 45 percent by 2000, per capita

Table 1.--Projected economic indicators for the farm production sector at the scenario bounds for 1990 and 2000.

Item	Units	Actual 1975-77 Average	1990 (1) HD-LS	1990 (2) MD-MS	1990 (3) LD-HS	2000 (1) HD-LS	2000 (2) MD-MS	2000 (3) LD-HS
Prices Received	1967=100	185	478	344	221	985	592	280
Prices Paid	1967=100	197	407	311	235	805	510	314
Price Ratio	Percent	94	117	111	94	122	116	89
Output	1967=100	117	146	141	128	168	165	142
Exports	1967=100	169	248	235	170	286	291	188
Inputs	1967=100	102	117	110	97	122	116	93
Productivity	1967=100	116	125	128	132	137	142	152
Gross Farm Income:	Billion $							
Current		102.1	326.9	227.8	132.8	772.6	456.2	185.9
1974 dollars		88.4	112.8	104.4	81.0	135.5	128.3	84.5
Production Costs:	Billion $							
Current		81.1	244.7	171.2	103.1	581.6	343.9	146.1
1974 dollars		70.1	84.4	78.5	62.8	102.0	96.6	66.4
Net Farm Income:	Billion $							
Current		21.0	82.2	56.6	29.7	191.0	112.3	39.7
1974 dollars		18.3	28.4	25.9	18.2	33.5	31.6	18.1
Inflation Index	1974=100	116	290	218	164	570	356	220
Percent of Disposable Income Spent on Food	Percent	16.8	17.8	17.2	16.2	18.1	17.6	16.3

disposable personal income increases 33 percent by 1990 and 69 percent by 2000. Overall, this represents a favorable position for agriculture, with only a small increase in the consumer burden.

High Demand-Low Supply--At this scenario bound, producers' income is very favorable. Although there is poor weather, low productivity, and high inflation, net farm income in 1990 at $28.4 billion (1974 dollars) is very close to the high 1973 net farm income of $32.8 billion. The ratio of prices received to prices paid of 117 is close to the 120 of 1973. By 2000, the price ratio reaches 122 and real net farm income goes to $33.5 billion.

Because of low productivity growth and high output due to a strong demand pull, input use increases about 15 percent by 1990 over the 1975-77 average and 20 percent by 2000. Production costs (in 1974 dollars) increase 20 percent by 1990 and 46 percent by 2000 with higher output and greater input use. Input use in 2000 is about 5 percent above the baseline, as productivity falls from 142 to 137 and output is slightly higher. Net farm income is about $2 billion higher than the baseline, even though production expenses are about 6 percent higher. Exports are projected to increase 47 percent from the 1975-77 average to 1990, but by 2000 the higher prices under this scenario hold the increase to 69 percent, less than the 72 percent change under the baseline.

While this scenario is favorable for the producer, the consumer would be in a more adverse position. The percent of real per capita disposable income spent on food increases to 17.8 by 1990 and 18.1 by 2000, compared with a 16.8 average in 1975-77.

Low Demand-High Supply--In contrast to the above high demand-low supply scenario bound, producers here are in an unfavorable position as real net farm income holds at the low 1975-77 level of $18.2 billion for 1990 and $18.1 billion for 2000. The consumer, on the other hand, is only spending about 16.2 percent of his disposable income on food, somewhat below the 16.8 average for 1975-77.

Prices received by farmers drop 36 percent while prices paid drop only 24 percent below the baseline in 1990 (due to a lower assumed inflation rate) resulting in a price ratio of 94, equal to the 1975-77 average. By 2000, prices received are 53 percent and prices paid 38 percent below the baseline, resulting in a price ratio of only 89. The 1975-77 period was one of surplus production and relatively low prices received by farmers as inflation escalated prices paid. Similar conditions prevail under this scenario, except that the inflation rate is maintained at a low 3 percent. The low demand for farm commodities combined with high supply keeps prices received low. Even though commodity prices are low, exports remain at about the present level because of the assumption that world conditions will not be conducive to increases in world agricultural trade. Even by 2000, exports are only 11 percent above the 1975-77 average, and only 6 percent above the index of 177 for 1977.

Summary--Despite the relatively short supplies and high commodity prices of the early 1970's, and publicly expressed concerns about the future of food and agriculture, the current situation is one of overproduction and surpluses. Stocks of wheat, corn, and rice have increased, with soybean disappearance adequate to hold stocks at relatively low levels.

Our projections indicate a high probability that the U.S. food and agricultural complex will adjust within a manageable range of supply and demand conditions through 2000. In contrast to the high probability of a manageable food future, there is a low probability of supply conditions so high and demand conditions so low as to push food and agriculture into a toward abundance future with excess supply pressure. Also, there is a small chance that food and agriculture will experience a future moving toward food scarcity.

Within the supply-demand management range, demand increasing more than supply will cause real prices and net farm income and food prices to increase modestly. But with the projected growth in the general economy and our productive farm sector, consumers will continue to enjoy food prosperity, spending about 17 percent of their real per capita disposable income on food.

If the high demand-low supply conditions were to prevail, then real net farm income would increase substantially and consumers would spend up to 18.1 percent of their disposable income on food. Under the low demand-high supply conditions, farm income would drop and consumers would spend only about 16.2 percent of their disposable income on food.

Growth in agricultural productivity appears to be slowing slightly, but with good public support for agricultural research and extension programs, such a slowdown will not be alarming unless there is a long period of adverse weather.

This analysis is of a long-run normalized nature. No attempt is made to project annual variations due to weather, input supply problems, stock adjustments, or changes in world trade. The price and other annual changes due to such short-run phenomena can easily be larger than some of the normalized long-run changes projected in this analysis.

In short, there are no alarming long-run growth patterns emerging for food and agriculture in the planning horizon to 2000. Long-range problems of agricultural research, resource conservation and development around the world must continue to receive a reasonable amount of emphasis if this prognosis is to materialize. But growth in food and agriculture should be of such a manageable nature as to permit public policymakers and private decisionmakers to concentrate on short-run supply and demand management mechanisms to reduce year-to-year uncertainty, while still providing for long-term growth.

Some Interdisciplinary Concerns

Just as the above appraisal points to a future of manageable dimensions for U.S. food and agriculture, other studies reach similar conclusions for other major sectors of the food, agricultural, and forestry complex.

In a recent study Alternative Futures for World Food in 1985 (14), the ESCS concluded that the world has sufficient capacity, both technical and economic, to meet the food needs of an expanding, more affluent world population at real price levels somewhat above 1970 levels. However, if the scenario of slower productivity growth and deteriorating climate were to persist, the result could be serious pressure on resources and increases in prices of grains imported by food-deficit countries. Further pressure on food supplies will also result from rising demand for meat and livestock products.

The second U.S. National Water Assessment (16) concludes that, although there are major water problems in most of the nation's 21 major water resource regions, the nation's water supplies appear generally sufficient to meet projected water needs for all beneficial purposes through the year 2000.

The assessment of the forest and rangeland situation in the United States, now being finalized by the Forest Service, concludes that improved management of our nation's forest and range lands is the key to meeting the expected increases in demands for forest and rangeland products and services (15).

Thus, every major USDA long-range assessment indicates that, although there will be continued problems, the future appears manageable. But there is one characteristic of these studies that should be emphasized: Each was a quasi-independent study, without simultaneous study of the other major sectors of food, agriculture, and forestry. In other words, there may have been important interactions or feedback loops between populations, food, forestry and fiber production, natural resources, and the environment that were not fully considered.

Our recent experience with the "Global 2000 Study" directed by the U.S. Council on Environmental Quality (CEQ) provides an excellent example of this problem of inadequate feedback loops. This study, requested by President Carter in his 1977 environmental message, and planned for publication in the fall of 1979, is a global assessment of trends in population, environment, and resources. In coordinating the study, the CEQ asked several agencies to provide projections of important variables in their respective areas under three scenarios differing with respect to population projections made by the U.S. Bureau of the Census and gross national product (GNP) projections made by the World Bank. In addition to population and economics (GNP), projections were generated for such important areas as food, fisheries, energy, water, minerals, and the environment.

In compiling the total report, the CEQ staff discovered that, although most of the projections and analyses had been made with great care and good subject matter expertise, the projections were not mutually consistent. This inconsistency resulted from attention being paid to each major sector in unrealistic independence of other sectors. The impacts of other variables on the particular projections, such as population, energy, agriculture, etc., were inadequately treated, especially in the areas of feedback effects. For example, assumption of high economic growth for a particular region was not perhaps consistent with high oil imports and high balance of payment deficits.

To assess the importance of the above inconsistency, the Global 2000 Study director asked Case Western Reserve University and Systems Application Incorporated to analyze the impact of closing such feedback loops in the context of their World Integrated Model (WIM). WIM is a general world economic model with seven sectors and 13 geographic regions, with 27 possible subsectors. It is supported by five submodels for population, food, energy, raw materials, and international trade. The feedback loops in WIM were first cut to validate the Global 2000 agency projections. Then the loops linking the various sectors were closed to assess the impact. Some of the important feedback loops analyzed were (1) balance of payment restrictions on imports, (2) the impact of energy deficits on economic growth,

(3) fertility as a function of income, and (4) the impact of calorie and protein availability on mortality (6).

We do not have time here to examine the impacts of closing the principal interdependence loops in the Global 2000 Study, but closing such loops generally had significant impacts. For example, in the closed loop analysis, there is less capital for agricultural investments and production inputs. This causes world grain production to fall considerably short of the growth rate projected in either the WIM open loops scenario or the Global 2000 median projection.

It is my feeling that although we need further improvements in all our long-range assessment capabilities, marginal improvements in our basically intra-disciplinary assessment capabilities are not as important as closing the major inter-disciplinary feedback loops. This need should be extended to viewing the U.S. food, agricultural, and forestry complex as part of an increasingly global system.

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Emerging Priority Issues Facing Renewable Natural Resources:

Disciplinary-Issue Team Reports

Group I: Fish, Wildlife, and Recreation

Robert Dils, Chairman
John Garrett, Rapporteur

The general feeling of Group I was that issues in the "green book" were too specific or too narrow in scope to have a chance for making the top ten. The group, therefore, spent some time in attempting to group or combine the various issues into broader categories for consideration.

These categories are:

1. Changing demands for fish, wildlife, and recreation resources.
2. Protection of fish, wildlife, and recreation environments.
3. Enhancement of fish, wildlife, and recreation environments.
4. Changing values (benefits) of fish, wildlife, and recreation.
5. Management and funding responsibilities.

Issue I: Changing Demands

Issue Statement

"What will be the nature of future changes in the demand for recreation services, and how will policymakers identify and respond to those changes?"

The demand for recreation, fish, and wildlife services continues to increase, and demand patterns evolve as a byproduct of ongoing population, economic, and living style changes. During the next 50 years, land managers must be able to respond to this demand effectively. This task will require managers to estimate the size and characteristics of those demand changes, and develop a coordinated management strategy to deal with them. Hence, the critical issue listed above.

Visibility of the Issue

If past experience is any guide, the current demographic, economic, and living style changes underway in the U.S. will produce significant changes in the size and composition of consumer demand for recreational services. Indeed, this trend is already apparent in the recent revival of population growth in non-metropolitan areas--a revival which has been led by rural recreation areas. Future economic trends, including shorter and more flexible work schedules, increased income levels, and an increasing tendency for individuals to choose amenities over wages, suggest that individuals will have increased time, money, and inclination to enjoy those services.

Anticipated Public Pressure

Pressure will continue to increase for more and varied types of recreational activities and different uses of fish and wildlife, particularly near urban centers.

Policy to Prevent Related Problems

If management does not have firm estimates of future demand patterns, adequate long range plans cannot be made in the near and distant future to cope with this demand. As a consequence, the demand may have a detrimental impact on the natural environment and eventually destroy the very environment that recreationists seek to enjoy. In addition, managers may not be able to resolve demands and conflicts among recreational and non-recreational activities for the same resource.

Policy

Promote better understanding of future demand and associated management options to meet demand.

Issue 2: Protection of Fish, Wildlife, and Recreation Environments

Issue Statement

The future protection of fish, wildlife, and recreation environments will depend on the accurate identification and maintenance of remaining critical environments. The loss of fish and wildlife habitats for development should be avoided. Once environment is altered, it is very difficult to recover.

Fish, wildlife, and recreation environments have come under increasing pressure from development for living space, agriculture, and energy production. Since sound habitat is the key to fish and wildlife abundance, protection of remaining habitat areas is critical. Of particular importance is the maintenance of complete, stable ecosystem units. The maintenance of these units does not preclude multiple use of the land involved; forestry, hunting, fishing, and back-packing may all be conducted on forest land. Fish, wildlife, and recreation environments are not mutually exclusive. Technological advances have allowed previously unprofitable development of certain uses to become economically feasible.

It is assumed that the public will desire to continue to participate heavily in outdoor activities involving fish and wildlife habitat. Future policy by implementing agencies should reflect this desire. The fact the public believes wildlife preservation is desirable has been demonstrated by recent public sentiment on issues such as endangered species, better project development, and national park and wildlife refuge establishment.

Department of Agriculture programs should be reviewed and revised to encourage identification and protection of fish, wildlife, and recreation environments rather than fund programs which contribute to their loss. The great loss of bottomland hardwoods environment in the lower Mississippi Valley is an example of such destructive programs. The government cannot buy all the lands needed to protect environments, so agricultural programs must assist in the way they are funded. The solution could be as simple as agriculture not funding destruction of fish, wildlife, and recreation environments as with the old case of the Soil Conservation Service paying to drain areas while the Fish and Wildlife Service paid to protect or acquire wetlands.

Issue 3: Enhancement of Fish, Wildlife, and Recreation Resources

Issue Statement

Given the assumption that fish, wildlife, and recreation values accrue directly to specific segments of society, but that society as a whole benefits indirectly from these resources and/or opportunities, should federal efforts be increased to enhance fish, wildlife, and recreation environments?

If we assume demands for the use of land for all purposes will continue to increase for the foreseeable future, then lands and water resources dedicated to recreation and fish and wildlife uses must be much more intensively managed. Similarly, land whose primary use may be for food or fiber production can, at the same time, be enhanced for fish, wildlife, and recreation. Enhancement will most likely also include some land acquisition, some land trade, some specific water rights purchase, and developments.

Fish habitat enhancement will include the protection of low flows, and water quality improvements as gained through soil erosion prevention. Riparian zones important to the maintenance of fish habitat will be given added protection and intensive care. Stream improvement measures will be liberally applied on critical areas.

Wildlife habitat improvements will include intensive management, as well as protection, of key areas such as winter range, calving areas, migration routes, and nesting sites. Forest harvesting will be conditioned by the needs of wildlife for nesting, for food supply, and for escape cover.

Recreation resources will be enhanced through protection of highly visible, high-use areas. Waterside zones particularly will be strictly managed. Forest cutting, roads, and structures of all types will be controlled in most high-value recreation areas by esthetic, historic, and anthropologic considerations.

The relationship between enhancement on public and private lands will need special consideration.

Increased coordination will be required, especially in fish and wildlife management (e.g., wildlife belong to State, but inhabit private and federal lands). Opportunities for involvement of private landowners in recreation, fish, and wildlife will increase. Resource enhancement and development can be anticipated.

If we are to provide favorable habitat for some of our threatened and endangered species, enhancement is a must. Similarly, coordination among Federal, State, and Private agencies and land owners will be a requirement.

Issue 4: Changing Values

Issue Statement

Within the next 50 years, the value attached to recreation, fish, and wildlife will change dramatically, and the change is most likely to occur in the direction of placing greater importance on protecting, preserving, and leaving these resources accessible.

Primary driving forces toward change include:

1. Increasing stress on individuals = demands for recreational outlets.
2. Decrease in time spent at work.
3. As the older population becomes more vigorous, recreational use and recreational employment become viable options.
4. Fish, and potentially wildlife, become increasingly important food sources.

Conflicts are probably between segments of society regarding the desirability of certain types of recreation, and enjoyment of fish and wildlife. Primary stress segments are: old vs. young, snowbelt vs. sunbelt, fishing by food importing vs. food exporting countries, urban vs. rural, environmentalists vs. commercial fisheries, recreationalists, developers, and State vs. State.

Major events which will negatively impact the trends include reserve energy shortage and prolonged recession.

The amount of pressure brought to bear on the federal government will be a residual after other basic needs of older people are met. Younger people will be much less powerful and their particular needs will not be dealt with as a primary issue.

Management of the coastal zones for recreational and fishing use will also be impacted by energy development (drilling, extracting, and processing oil and gas). Most segments of society, but particularly older people, will probably support energy extraction more than the need for increased recreational facilities.

Policy options:

Create specialized recreational areas, based on regional composition of population. Extend coastal boundaries. Support (set aside) areas for agriculture. Create facilities at recreational sites designed to attract particular segments of the population. Determine fish resource of the U.S.

Issue 5: Management and Funding

Issue Statement

Who shall be responsible for the management and funding of fish, widlife, and recreational resources?

Fish & Wildlife (Inland) -- The animals themselves: Historically, the management of fish and wildlife resources in the U.S. has been the responsibility of State governments, with the cost of management born by the hunter/fisherman user groups. The entire emphasis has been on the so-called "sport" species. In all likelihood, the future will see much greater emphasis on nongame species. Some of the questions to be answered are:

Who shall pay for management of nongame species, i.e., users or general public?

How can we best manage highly mobile species that disregard state boundaries?

What should be the goal of management--optimum harvest, maximum abundance, maximum diversity, maximum economic benefit, etc.?

What is the role of government in stimulating aquaculture?

Fish & Wildlife (Inland) Habitat: The management of habitat has always been the responsibility of the landowner, whether public or private. Some questions are:

Should governments mandate or offer incentives for enlightened management of habitat on private lands?

Should governments attempt to mitigate historic habitat losses by habitat enhancement on government and perhaps even on private land?

How can fish and wildlife values receive greater consideration in government agency policies, particularly in times of surplus?

Fish & Wildlife (Coastal) : The management of fish and wildlife resources beyond 3 miles is the responsibility of the federal government. What should be their management goal--optimum or maximum yield? How shall the harvest be apportioned to commercial fishermen, sport fishermen, and foreign countries, and who should pay the management costs? What is the role of limited entry, and what protection, if any, should be provided for the inefficient operator?

Recreation : Recreational opportunities on public land have traditionally been the responsibility of the owning governmental unit, with costs paid from general revenues. Should this situation persist, or should a "user pays" policy be adopted? On private land, the recreational opportunities are privately funded. Should governments offer incentives to stimulate private initiative and investment, and what would be the coordinating role for governments in helping groups of private interests combine to provide recreational opportunities? In addition, how far should governments go in purchasing or otherwise securing recreational easements on private land? What federal policies should be adopted to stimulate State or local government programs? How much emphasis should be placed on bringing natural reserve (fish, wildlife, recreation) enjoyment opportunities to urban areas?

Group II: Energy

Walter Hahn, Chairman
B. A. Stout, Rapporteur

Group II felt the following factors constrained its selection of five issues:

1. Breaking out a finite number of issues did not permit holistic, systematic developments of interrelationships actually present in the discussion or choices.

2. Any such selection process tends to bias the chosen issues toward short-range action and impacts. Also, the domestic connotations dominate, in spite of an explicit attempt to keep the global context in mind.

3. External uncontrollable events (nuclear war, famine, natural disasters . . .) were deliberately omitted.

4. Although the "green book" for the workshop on page 4 calls for "beginning assessments of impacts . . ." of the issues, time precluded doing so.

Issue 1: Public Acceptance of Limited Energy Use (or Flexibility of Using Alternative Energy Sources)

With cheap energy over the last 50 years, the U.S. economy has developed dependence on a few limited sources, primarily oil and natural gas. There has been an apparent assumption at the higher policy levels in this country that we must consume energy from these sources at the same or increasing levels to maintain and improve our standard of living. Answers to two questions may make this premise invalid. Would people be willing to shift to alternative sources of energy even though they may be less convenient, and to what extent are people willing to use less energy? Some alternative supplies are coal, wood, solar energy, and agricultural residues. To what extent would conservation practices be acceptable, and would they have a detrimental effect on our quality of life? Socioeconomic studies are needed to determine how flexible U.S. citizens are.

Issue 2: Socioeconomic and Institutional Barriers

We believe that socioeconomic and institutional barriers to change need priority consideration. In other words, we believe that, even after there have been changes in individual perceptions, values and goals, their effectiveness may be limited by socioeconomic and institutional barriers which developed when conditions were quite different. (This point affects all areas, not just energy.) Several examples can be identified:

- Building and safety and health codes which limit new uses of energy.
- Management systems which were designed for periods of relative stability rather than massive change.

Workshop participants struggled intensely to select and refine issues, but were hesitant to characterize specific scenarios.

- o Work and job patterns and styles designed from periods when economic growth was the only priority.

Work in this area must be accomplished at several levels:

- o The effects of codes, laws and regulations must be carefully examined to see whether they block needed new directions.
- o Fundamental socioeconomic systems must be reconsidered to see whether they serve the best interests of Americans, internally and internationally.
- o Management systems must be reexamined at all levels to determine ways in which greater flexibility can be built into them to cope with expected and unexpectd change.

Issue 3: Efficient Systematic Farming and Forestry Operations Which Provide for Limited Demands on Non-renewable Energy Resources.

We must consider the possibility that non-renewable energy sources may be limited in availability or completely unavailable. Thus research and development (demonstrations) of systems of farming and forest production which produce food, fiber, and forest products in adequate quantities at reasonable economic costs with minimum amounts (or no use) of non-renewable energy is of prime importance.

We should also consider development and use of intermediate renewable resources which would substitute for non-renewable energy sources in such farming and forestry operations. This would include studies on the location of the production activities so as to minimize transportation of products to ultimate users.

Issue 4A: Energy from Agriculture, and Oceans

Photosynthesis production of biomass is one of the world's greatest sources of renewable energy. The energetics and economics of biomass production, collection, conversion, and utilization are uncertain, however. Alternative uses of biomass and of the land and water resources required to produce it must be recognized (e.g., food, feed, fertilizer, soil organic matter, structural materials, etc.). The value of domestically produced biomass in offsetting imported oil must be considered. Some other items to be considered:

- -- direct and indirect impact of biomass use for fuel or commodity prices, food etc.
- --selection of new or exotic species
- --plant feeding to insure biomass yield
- --new conversion technology (e.g. new processes for making fuel alcohol less expensive, gasifiers, etc.)

Issue 4B: Energy from Forests

Forest biomass offers promise of enough energy to warrant fuel research, development, and systematic application. Forest biomass production is feasible in all regions of the U.S. There is substantial biomass available in the cultural management of forest stands, unutilized material left at harvesting, and in the manufacturing process.

Energy plantations are a new possibility. Utilization of fast-growing species on a short-rotation management approach looks favorable on appropriate sites.

Producers of forest biomass could often be the consumer at the local level. Equipment already available and in use in farming and forestry offers promise for collection of biomass.

Issue 5: Synthetic Food and Fiber

Developments in synthetic food and fiber production, such as single-cell protein, could significantly decrease the demand for renewable resources in the future. In addition, the ability to produce such resources in a controlled factory-like environment would reduce the fluctuations in the supply side of current agriculturally produced materials. For example, single-cell protein is currently produced and used commercially as feed for cattle in many parts of the world. These plants use petroleum as the feed stock, but the possibility of producing synthetic food and materials from feed stocks such as natural gas and coal should not be overlooked.

Success of these developments could have an enormous impact on renewable resource demand, and hence our ability to meet this demand.

Group III: Forest and Rangeland

Robert E. Wolf, Chairman
John H. Rich, Rapporteur

Assumption

The basic assumption is that world demands for renewable resources from forests, grasslands, and agricultural lands, and the need for protection of those vital ecosystems, will grow with world population changes and gradual exhaustion of fossil energy resources. The restoration of depleted vegetative ecosystems and the identification, retention, and intensive management of prime agricultural, forest, and rangelands is fundamental to effective social, economic, and political systems throughout the world. It is assumed that those nations with the most productive soils, climate, and technology will work toward meeting the broad goals of producing renewable resources through intensive management without impairment of natural ecosystems.

Issue 1: Relation Between Public-Private Sector (Ownership-Management)

Statement of Issue

The forests and rangelands of U.S. amount to approximately 1.6 billion acres. Of this, 72 percent is rangeland. Although the percentages vary in other countries, there is a mix of public-private ownership.

The way in which policies and management systems are implemented on public lands greatly influence the management and use of privately owned lands. More recently, the issue of what role public lands should play in the production of goods and services has been raised, along with the opportunities for producing these goods and services from the private lands.

Numerous questions have been raised concerning the level of investments and the production of commodity products from public lands. Such questions include the effects of pricing of goods on outputs from private lands; the role of range grazing versus concentrated feeding of livestock; and the effect on private landowners' investments. The role of the public lands in meeting more of the demands for noncommodity outputs is being discussed. The question of whether there should be more extensive management of the land for such activities as outdoor recreation, fishing, hunting, nonconsumptive uses of wildlife and wilderness is being discussed. There has been virtually no increase in recent years in the amount of public land and small nonindustrial ownership, with some increase in industry ownership.

The questions are:

1. What should be the role of public lands versus private lands in the production of commodity and noncommodity goods and services?
2. What levels of investments should be made on public lands versus private lands?

Technical, Economic, and Social Visibility

The social and economic visibility could be great, depending on how the relationship is defined. For example, many local users are dependent on market outputs from public lands. Policy changes could disrupt local economies and households, causing relocation, shifts to other types of employment, or unemployment. The economic base could be revamped to take advantage of those activities related to production of noncommodity outputs.

Public Pressures

There would be local pressures to continue the present role of public lands, with more regional and national pressure to change the role. There are exceptions to local pressure where private landowners view some competition from the market outputs from public lands.

Present and Future Role of Agriculture

The present role is to manage public lands for multiple uses with reasonable tradeoffs. Should this role change, Agriculture should take an aggressive step in lessening local social and economic impacts.

Issue 2: Resource Decision Systems

Statement of Issue

A wide variety of management and use decisions impact on forest and rangeland resources.

Technical, Economic, and Social Visibility

Conflict exists between short- and long-term economic objectives in the use of land. Public attempts to intervene in the private decision system are, and will continue to be, controversial. Land resource decisions may well conflict between forest, range, and wildlife values. The usual economic values, either short-term or long-term are not

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Gerald Thomas (left), Richard Drobnick, and Norman Borlaug brought a unique combination of talents to bear on analyzing issues to be faced in the long-term management of renewable natural resources.

sufficiently descriptive of all the values that accrue to a resource management goal. In addition, the public is not prepared to accept paying for incentives to help landowners achieve economic and noneconomic objectives.

Public Pressures

Private intervention in resource decisions is becoming commonly expressed through the courts, and decisions are decided in an adversary environment that does not lend itself to compromise. Public thrusts in recent years are directed strongly at single-use for resource units that are neither economic nor related to a wise or efficient use. Single-purpose public interest groups become progressively better organized and are able to place progressively more force on the ballot box; this places great stress on the political process and, ultimately, on resource decisions.

Present and Future Role of USDA in Agriculture

The Department should seek to be the lead public agency to provide food, fiber, and forest products to the public at reasonable cost and at acceptable levels of impact on the environment. It must insure both the existence and the effectiveness of the land base to achieve the objectives from public and private lands.

Issue 3: Resource Management Systems

Statement of Issue

We need to develop and select management systems to meet requirements for varying intensities of resource management, and decisions on resource use.

Visibility

The issue will be readily perceived as important from the standpoint of technical consideration. Questions of long-term ecosystem viability will be the critical point. The social implication will be less readily apparent, but the long-term efforts in terms of employment patterns, deurbanization, and population movements will be significant. Similarly, the long-term economic effects can be large in terms of costs and benefits.

Public Pressure

The issue is likely to generate strong public pressures. A significant portion of the public will be opposed to more intensive management of public lands. On the other hand, moves to foster management on private land will generate diverse public response because of strongly held views related to an individual's perceived rights to use his land for his own purposes.

Present and Future Role of USDA

A 3-fold role can be seen: (a) development of management systems that recognize the imperative of ecosystem viability; (b) implementation of systems on public lands; (c) design of institutional means to foster management on private lands.

Issue 4: Regional Shifts in Resource Use

Statement of Issue

The history of resource use in the United States has been one of expanding "frontiers" and marked shifts in the regional location of resource harvesting and processing. In forest production, timber harvest was first concentrated in the northeast, next the Lake States and Rocky Mountains, and then the Northwest. Recently, dwindling supplies of old-growth timber in the Northwest have caused the industry to move to the Southeast. New investment decisions being contemplated now would see major expansions of the timber industry into the Northeast, effectively closing a cycle of migration around the country. Trends in agriculture have followed similar shifts from region to region.

Movements in the concentration of forest and agricultural production cause substantial social and economic dislocation. A region with declining production loses the underpinnings of its rural economy. Unemployment, loss of income, social upheaval, and even community abandonment often results. The region facing increasing production fares much better economically. Nevertheless, land management capabilities in such a region may be temporarily exceeded, and social changes associated with rapid growth may be traumatic. Should the USDA seek to stabilize production of forest and agricultural crops in a dispersed pattern around the country?

Technical, Economic, and Social Visibility

Technical, economic, and social visibility of this issue are all expected to increase. The development of processing facilities to manufacture reconstituted materials such as particleboards, fiberboards, and composite 2 x 4's has preceded an increasing scarcity of mature softwood sawn timber. The ablity to harvest and chip whole trees efficiently has increased the supply of reasonably priced raw materials for manufacturing reconstituted boards. Combined, these capabilities have attracted the attention of land managers and conservationists in the Southeast and Northeast, the two regions at the threshold of dramatic growth in fiber processing. Similarly, the social and economic costs of abandoned sawmills and declining manufacturing on the West Coast have attracted much public and political attention. Concern by the general public over these problems is likely to continue to grow during the next two decades. Regional shifts in agricultural production are slower and have attracted less attention.

Public Pressure

Pressure by the public has been intense concerning this issue though it is seldom phrased in these terms. In the Northwest, for example, the timber industry criticizes the USDA for not releasing more public timber, while the environmentalists demand additional wilderness areas. In the Northeast, the conservation community is hotly debating the directions in which whole-tree chipping will lead land management, materials fabrication, and energy production.

Present and Future Role of USDA

The USDA currently manages large tracts of public lands throughout the country, as well as provides a lead role in conducting research and educational programs aimed at improving resource use. Its role in minimizing regional dislocations resulting from shifting resource production areas, however, has been passive. Should the USDA assume a more active role in minimizing such regional shifts and stabilizing rural economics?

Issue 5: Knowledge Needed and How to Get It

Additional research should be a high priority on both range and forest land. This research should be designed to:

1. Understand ecosystems and man's impacts at any given time
   a. Energy flow thru the system--both photosynthetic energy capture and dissipation or delivery to the consumer, as well as energy subsidies (cultural energy) required to deliver the consumer product
   b. Nutrient cycles (N, P, K, etc.)
   c. Water cycles and watershed management.
   d. Where and how should man tap the system?

2. Understand vegetation change through time--succession--regression patterns and manipulation of the vegetation complex by:
   a. Control of biological populations, including grazing animals;
   b. Chemical and mechanical control;
   c. Other techniques for vegetation management.
3. Improvise technology to better utilize the existing vegetation complex--possibilities for increased efficiency of use and/or changes in the methods of harvest and utilization, depending upon society's specific purpose.
4. More knowledge to determine priorities of land uses (multiple use versus limited use).

Group IV: Environment, Land Use, and Land Management

Richard Deusterhaus, Chairman
Ed Thor, Rapporteur

Issue 1: Basic Information/Data Base

A great many kinds of questions will be asked and must be answered in the future relative to the use and management of our renewable natural resources. To be most confident that the answers will meet objectives judged to be important at the time they are asked, it is essential that an extensive data base be assembled that will permit the answering of complex "What if" questions.

We cannot know exactly when the questions will be asked, who will ask them, what the questions will be, or how widely they and their answers will be expected to apply—but it is absolutely certain that a wide range of resource questions will be asked, and that finding the proper answers will require extensive data. The objective should be to have on hand in easily accessible form as much of the required resource data as possible as soon as we can.

Hasty judgments about the use and management of renewable natural resources will not be eliminated by the proposed data base, but they should be minimized. Proper use of the data will help managers analyze multiple impacts and complex interactions quickly so they can accurately conceptualize consequences.

Issue 2: Shall Degradation of Natural Resources be Allowed?

Public concern that the U.S. lacks the understanding and capability to manage our natural resources in a way that will provide sustained quality of life appears to be justified. The intensive systems involving large equipment, pesticides, fertilizers, and monoculture cropping are responsible for increased soil erosion, decreasing organic matter, and a deterioration of soil physical properties. The degradation of our agricultural soils not only results in the farmer using more fuel and agricultural chemicals, but also accounts for declining yields of some crops and a leveling off of the yields of others. The question is, How can future federal natural resource programs impact on the soil degradation problem?

Issue 3: Environment, Land Use, and Land Management

Over some range of practices and methods of resource use, maintenance and conservation of these resources benefit production of other commodities. On highly erosive soils, for example, conservative tillage and cropping practices can also result in greater crop yields. However, at some level and combination of cropping systems and tillage practices designed to reduce soil loss and conserve resources, the tight restraints used can cause crop yields or total production to decline. National studies have shown the nature of these tradeoffs between soil protection and crop production. The tradeoffs are positive over some range of soil protection. For further progress in soil protection, small sacrifices are necessary in the efficiency of crop production. However, extreme levels of soil protection can be attained only at the expense of crop production levels and efficiency of production. Hence, from a complementary range where greater soil protection results in greater crop production efficiency, more intensive protection will tend to decrease crop production efficiency.

It is important to establish the levels of these tradeoffs between soil protection and crop production efficiency, over both their complementary and competitive ranges. These tradeoffs then can be compared with the values society places on preservation of natural resources and on food products. Optimal combinations of resource preservation and food production then can be specified.

Issue 4: The Allocation of Land

The contest over who shall determine land use and by what principles promises to be an enduring one. Historically our society has held that land is private property and the owner can dispose of it as he will; presumably the social welfare is served in the process. Increasingly, however, this market paradigm does not describe our land allocation system, and neither does it accommodate all that needs to be done.

Where the physical and/or economic attributes of land dictate a clearly preferred use, there is little problem, and where compatible multiple uses are possible, the problem is not severe. In many instances, however, mutually exclusive uses are feasible on the same parcel. Society has an interest in the outcome. Its interest is to promote a currently efficient allocation of land among uses, and to protect those without ownership interest or those remote in time and place from the allocation decision. This applies both to private and public lands.

Public intervention in land-use decisions appears to be increasing. On public lands it takes the form of more active management that must be responsive to a wider range of interests. Private lands are subjected to direct restrictions on use in response to such social objectives as minimizing externalities, providing public goods, or reducing the cost of public services. They also may be restricted by competing private holders who manipulate the public power to their own ends without discernible public purpose.

A host of regulations and investments at all levels of government, although not aimed directly at land use, nonetheless powerfully affect it. And while the interests of outsiders are defended by such devices as wilderness designation, protection of historic sites, or court attacks on exclusionary zoning, the public generally cannot halt the destructive use of private lands or prevent their irreversible conversion to less essential uses.

Apart from the issue of which land use decisions are properly left in private hands and which belong in the public sphere, there is a difficult question of what jurisdiction should exercise public control. Public land managers must be sensitive to local concerns. Such seemingly local issues as exclusionary zoning may conflict with broader social objectives or with the rights of citizens to mobility. Is Iowa farmland a state resource or a national resource? Why does federal law require the expensive restoration of low-value stripmined land, but not require the protection of high-value cropland?

The drive for comprehensive national land-use planning and controls has receded, but piecemeal efforts will continue to affect the public lands, and special land categories such as prime lands, coastal zones, and wetlands. Land use controls at the state and local level are apt to proliferate. The issue will be highly visible. To the extent that rural lands, public lands, or the rural/urban interface are involved, the USDA will need to prepare its posture on how far and for what purposes it would alter traditional methods of land allocation.

Issue 5: How Do We Link Through People to Resources

Fifty-eight percent of America's land is held in private ownership. From this land flows virtually all of the Nation's food, much of its timber products, and most of the new wealth generated. Degradation or depletion of this land resource base is not in the public interest, but prevention of this damage lies in the hands of private managers who have many other values, including economic survival, to consider as they make land management decisions. How does the public goal of proper resource management reach these people--in a way that they accept as consistent with American values, property rights, and social mores--and influence their behavior so that acceptable levels of land management and resource conservation result?

Some factors involved are:

1. The use of public incentive programs
2. Tax and subsidy programs
3. Education and persuasion
4. Regulation, control, and penalties
5. Technical assistance
6. Development of new land ethic through public policy leadership.

Current visibility of the issue is low, but visibility will rise rapidly if government gets alarmed at resource depletion, and passes laws that do not adequately recognize the need to work through people in an acceptable way.

Potential for controversy is high, because people are very sensitive to government incursions on ownership rights.

Related problems include land use and allocation, and achievement of environmental quality goals.

The USDA has long trod the fine line between leading and pushing people on these issues. It has not always been successful, but must build on success rather than start over anew.

Group V: Air, Water, Weather, and Climate

Melvin Cotner, Chairman
Robert McDermott, Rapporteur

Priority issues identified by Group V were:

1. Air quality impact on continued productivity of renewable resources
   a. acid rain
   b. ozone
   c. toxic metals
2. Water allocation and supplies
   a. competing uses
   b. groundwater depletion
   c. conjunctive uses
   d. desalinization
   e. weather modification
3. Water quality
4. Water resources management
   a. water saving technology
   b. water reuse
   c. conservation of energy
5. Climatic change and variability

Issue 1: Air Quality

The use, distribution, and quality of our Nation's air supply may be the major issue faced by this country during the remainder of the century. While air is a renewable resource, there is no substitute available. Current failure of numerous air quality regions to attain ambient air quality standards presents a challenge and danger. Nonattainment poses a danger to health and welfare of the Nation's population, and its ability to produce food and fiber. Conversion to coal is likely to intensify the deterioration of air, severely challenge State air quality implementation plans, and curtail freedom of location and expansion of industry.

The Clean Air Act emphasizes ambient air quality standards and limitation of emissions from pollution sources; however, the long-range transfer of unregulated transformation products (e.g. sulfates) has been responsible for environmental damage far removed from emission sources. Thus, transformation pollution not only threatens local air quality, but also harms forest and agricultural products by acid rain and tropospheric ozone.

Further research on and monitoring of carbon dioxide is absolutely necessary. Current rates of fossil fuel consumption, deforestation, and desertification are causing atmospheric carbon dioxide to reach critical levels that may affect global climate. Various industrial processes, smelting, incinerating, and combustion of fossil fuels--especially coal--emit toxic metals that must be included in air quality standards.

Issue 2: Water Allocation and Supplies

Water has become a scarce resource. While renewable on a broad scale, the water available for use in a region or a locale is limited. Rights to the use of this water must be allocated in some, hopefully rational, manner.

Allocation of water is presently the jealously guarded realm of state law. The use of water is widely held as a property right, and is exceeded in its lore, mysticism, and myth only by the coveted rights of private ownership of land.

The Federal government ducked the allocation issue in the 1978 water policy review, and also tends to distort economic allocation of water by its pricing policy of water from federal reservoirs. As the competing demands for the same water supply increase (a new energy development, for instance, in an area of fully allocated supply) we must find better methods, political or economic, to allocate available supply to its best use. In all cases, the maintenance of instream flows must be considered a competing water use.

Included within this issue are the impacts of groundwater depletion and contamination, the potential of conjunctively managing ground and surface waters, and the possibilities of augmenting present supplies through desalination and weather modification.

Adequate pricing of water could preclude the need for radical change in our water allocation infrastructure, but could have significant impacts on agricultural water users.

Issue 3: Water Quality

Water pollution comes from point and nonpoint dispersed sources, and affects both surface and subsurface water supplies. Point-source pollution is still caused largely by the direct and indirect discharges of municipal and industrial wastes. Nonpoint or dispersed source pollution stems from runoff from urbanized, agricultural, forested, and mining areas. The EPA National Residuals Discharge Inventory shows that about 33 percent of the oxygen-demanding loads, 66 percent of the phosphorus, and 75 percent of the nitrogen discharged into streams comes from dispersed agricultural sources.

Accelerated storm runoff from urban areas is a significant source of sediment, nutrients, heavy metals, and biological contamination.

Runoff from agricultural cropland may deliver sediment, nutrients, pesticides, toxic heavy metals, and organic materials to surface waters.

In the United States, groundwater supplies approximately 25 percent of all fresh water used; 95 percent of the total domestic, agricultural, and industrial needs of the rural population; and 50 percent of all water used for agriculture. Severe quality problems are facing groundwater users throughout the country. Much more understanding is needed about the aquifer systems and their ability to improve water quality.

The quality of coastal waters for all uses has been a severe problem that must be addressed in the future.

Water quality has become a national concern, and will continue to receive much atention. No longer can we use our streams, rivers, and lakes as dumping grounds for waste. The maintaining of water quality must be a major factor in future uses of our renewable resources.

Issue 4: Water Resources Management

A great deal of technology (ditch lining, for example) is available and can be further developed if applied within an allocation or total water management framework where specific values can be placed on specific volumes and qualities of water. The large volume of water currently used for irrigation and the projected increases with ongoing technology are largely inefficient uses of water. At issue are the volumes and rates of application, which are far in excess of need for successful production of crops.

Irrigation and other uses of water are not only in excess of actual need, but there is a minimal reuse or closed cycling of water to the extent that large volumes are displaced for single or limited use that could be successfully incorporated in other uses within some regional management framework.

Agricultural uses of water include the corollary matter of energy consumption by complex pumping equipment. Energy consumption could be reduced through more efficient uses of water and the integration of reuse systems.

Issue 5: Climatic change and Variability

Climate is not a fixed element of the natural environment. Indeed, important advances in climate research and the study of former climates confirm that past climates of the Earth have changed on virtually all resolvable time scales. This characteristic suggests that (1) there is no reason to assume the favorable climatic regime of the last several decades is permanent, and (2) climate change and variability must be recognized and dealt with as a fundamental property of climate.

Climatic changes and variability could result in major economic, social, and political consequences. Modern society, with its new, highly specialized crop varieties matched to the narrow spectrum of temperatures and precipitation conditions that have prevailed in the last several decades, and its increasing dependence on energy-intensive services, has heightened its sensitivity to climatic variability. Global food and energy-supply crises could be sharply intensified by short-term changes in climate--whether naturally occurring or resulting from man's activities--with widespread positive or adverse impact on (1) food and fiber production; (2) energy consumption, and to a lesser degree, supply and distribution; (3) air, water, and land transportation; (4) water supply and control; (5) construction standards and design; and (6) fiscal and budgetary planning at the Federal, State, and municipal levels.

Carbon dioxide in the atmosphere poses a special dimension to this problem because of man's use of fossil fuels for combustion.

In the 100 years since about 1860, the concentration of carbon dioxide increased about 12%, but because of the exponential nature of the consumption of energy and the burning of fossil fuels, the next 12% increase could take only 20 years and the next 12% increase beyond that only about 10 years. In this connection, it is the amount of carbon dioxide remaining in the atmosphere that is most important. Since the carbon dioxide accumulating in the atmosphere is about half the total released by fossil fuels, it is assumed that the ocean and both the land and marine biospheres serve as additional sinks for carbon dioxide. The fate of the missing 50% is still a matter of active debate, and the problem is further complicated by a series of current appraisals that suggest the terrestrial biomass may be an additional source of carbon dioxide as large or larger than the fossil fuel source. A better understanding of the roles of both the biosphere and the oceans in the carbon dioxide cycle would seem necessary.

What climatic changes might result from increased atmospheric carbon dioxide? The most complete, though still imperfect, climatic models suggest that a doubling of the current amount of carbon dioxide in the atmosphere would increase the average annual temperature of the lower atmosphere at middle latitudes by about 2.4°C to 2.9°C (4.3° to 5.2°F).

What would be the consequences of such climatic warming for human societies and for the natural environment? Would such a warming influence the extent of ice and snow at the polar ice caps, or alter the level of the world ocean? How and where would such a warming benefit or disrupt present patterns of agriculture and forestry?

Policy implications this problem poses:

--Greater need for research in adopting agricultural and forest plant species to changed weather conditions, with particular attention to genetics.

--More attention to land-use planning, as related to species and varieties with ability to move north or south, or up or down to meet changing climate.

--Better prediction of endangered species existing at limit of climatic adaptability.

--Expanded research in CO_2 - O_2 balance, sources, sinks, dynamics, and effects of increase in CO_2.

The Workshop provided an unprecedented opportunity for people from various backgrounds and disciplines to exchange philosophies on possible futures of renewable natural resources.

Group VI: Research, Technology, and Education

Keith Shea, Chairman
David Ostermeier, Rapporteur

Issue 1: Management of the Renewable Natural Resource Base - Resource Stewardship

Protection of soil, water, air, and the plant and animal species dependent on them is a fundamental responsibility of this and all future generations. Science and education have an indispensable role to play in identifying the interactions among these components of the environment, and in formulation of methods by which the resources can be used without impairment.

We have every reason to believe that protection of the resource base will be an important public issue in the 21st century, probably even more than it is today. Because of their complexities, problems will be best recognized by technical experts. Economic visibility may be brought about by increasing product prices over time, but only a small segment of the general population will be aware of this issue. Increasing population and greater purchasing power, especially in the developing nations, will increase pressures for the products of renewable resources.

Educational efforts will need to be increasingly focused on non-traditional clientele. We've been talking to ourselves for too long. We must reach a wider audience with the message that we see serious losses of productive capacity and declines in water quality due to soil loss; adverse long-range effects from failure to safeguard germ plasms; and irreversible conversion of renewable natural resources to other uses. We need to revitalize the conservation ethic to foster a greater commitment to research and technology to the natural resource base.

What does this mean for science programs in agriculture? It means that we must devise measurement and long-term monitoring systems for these basic resources. It means that we must be able to forecast the consequences of soil loss, or degradation of air and water quality. Above all, science must develop methods that will permit the use of renewable resources without diminishing their ability to produce goods and services in the future.

Issue 2: Provision of High-Quality and Safe Food and Fiber Products

High-quality and safe food and fiber products are perceived by many to be essential to human welfare. Future quality of food and fiber products may be influenced by a number of factors such as: (1) rising production costs, (2) use or nonuse of pesticides, (3) inadequate post-harvest technology, (4) insufficient basic research to provide new mechanisms for crop improvement, or adaptation to varying growing conditions, and (5) limitations imposed by the present technological base.

In some countries, public pressure (consumer interests) may be for enough food just to stay alive; in others, quality (eye appeal) may have greater significance. In all countries, food safety will receive increased emphasis. Thus, public pressures for food quality and safety will have a definite impact on food supply and on the research and development essential to sustain adequate quantities of high-quality, safe, food and fiber.

Agricultural research institutions worldwide should strengthen their basic research programs to develop new breakthroughs in (1) plant gene mechanisms, (2) biological nitrogen fixations, (3) disease- and insect-resistant varieties, (4) integrated pest management, (5) crops adapted to varied environments, and (6) photosynthetic efficiency. All these programs should be designed to reduce dependence on petrochemicals.

Issue 3: Improve Animal and Plant Production, Protection, and Processing

Recognizing the forthcoming growth in demand for food and fiber products and the possible shrinkage in the land and water production base, it is necessary to improve potential yield, improve cultural practices, and reduce post-harvest losses. This must be done by developing technologies, economic incentives, and management systems that are appropriate to the various socio-economic systems that exist throughout the world. These advancements must be developed in an interdisciplinary manner that accomplishes the following:

1. Improvements in the efficiency of the production system through improved cultural practices, improved nutrition and improved genetic yield.
2. Improvements in stability of production through development of plant and animal varieties with

greater resistance to diseases and adverse ecological conditions (drought resistance, frost resistance) as well as being more suitable to integrated pest control programs.

3. Reductions in current severe post-harvest losses through research in storage and processing.

Issue 4: Provide Adequate Basic and Applied Agricultural Research Both Nationally and Internationally

If we accept the premise that the current reserve of technological information to meet projected food and fiber needs of the future world population has rapidly become depleted, it is essential that we provide adequate financial, manpower, and facility support to agricultural research institutions to replenish and strengthen this technology reserve.

This research will be increasingly complex as solutions must be found to meet growing environmental constraints, reduced energy resources, increased production efficiency, and increased regulatory constraints. These complexities dictate the need for an increased research base that has full continuity and flexibility to adjust to the changing needs and impacts of physical and social change. The support must be both national and international to assure a capability to coping with world food and fiber requirements before the time of actual need.

Such support of agricultural research must be recognized as an investment in the future, rather than as a budgetary cost. Further, it must be recognized as a precursor of social and economic change and development as it more adequately provides for the world's population needs. Such research must include full technology assessment to assure safe and effective integration into related social, economic, and technical systems as they develop.

Current national and international agricultural research institutions and systems can, with minor modifications, be charged with the responsibility of carrying out this intensified research program.

Issue 5: Renewable Natural Resource Education for the Public and Resource Professionals and Scientists

Transferring renewable natural resource management information to the general public calls for an assessment of the managemnt alternatives and consequences, both to the resource base and the environment. Interwoven into any education program is a call for the assessment of current and future needs, and types and magnitude of necessary government and private participation, including adequate funding to assure continued technology transfer. Effective legislation and appropriations for the management of the natural resource base depends on public support and involvement.

Continuing education is a critical component in the productive life of renewable natural resource scientists. The practical field experience of these professionals at various stages of their career can be augmented by exposure to new bodies of scientific knowledge. Future natural resource managers and scientists must be adequately trained to communicate their ideas with one another and with professionals in allied areas.

If the number of agricultural scientists continues to decrease, the annual production of advanced degrees will be below current replacement levels. Given the anticipated demands on agricultural research, the potential for an inadequate number of scientists seems significant. In addition, the types of training that scientists are now receiving may be inadequate due to differences in expertise needed in the future.

Accordingly, current renewable natural resource educational efforts--directed at the public, and at professional managers and scientists--seems inadequate both in content and strength.

A Scenario For Change In Renewable Natural Resources

Leroy Quance[1]

Although traveling the same basic unfolding and manageable journey through time, the three scenario teams saw some quite different problems along the way. They also responded to Robert Theobald's earlier challenge to use their limited time to best advantage, to resist trying for agreement when disagreement is inevitable, and to expand the concepts of the workshop beyond the initial structure conceived by the planners. They feared that framing broad scenarios of a 50-year-distant future on the basis of brief group interactions could lead eager planners around the world to simplistic decisions based on misplaced confidence in the report of a select group. Participants did attempt to frame scenarios, but with the disclaimer that they would not be published as written. One composite scenario, based on workshop efforts, was to be compiled after the workshop. That scenario follows. Because teams decided not to attempt to rank problems in terms of probability of occurrence, or to weight them in more than general terms of importance or magnitude of impacts, this synthesis may reflect some of my personal biases. Hopefully, however, this composite scenario closely approximates what would have resulted had the workshop participants had the time to combine their efforts in a "second round" scenario refinement.

Although we will undoubtedly continue to hear prophets of doom, peddlers of a technology fix, and advocates of extreme conservation, the global prospect is for neither feast or famine, but an unfolding supply-demand managed future. This does not mean we can go our merry ways as though we had unlimited natural resources, or that solutions to emerging problems will automatically appear without costly effort. A manageable future does not imply an invisible hand guiding the actions of individuals seeking individual gain such that the utility of the whole is maximized, or even maintained at an acceptable level. Rather, a manageable future means that, if we get on with rational analysis and reasonable anticipatory action, alternatives will be available that can keep the supply of goods and services from our renewable natural resources in reasonable balance with demands growing at reasonable rates -- a future in which both the quality and quantity of human existence is valued.

Most future attributes of concern to us here can be categorized as being related to either the demand for, or supply of, goods and services from renewable natural resources. But if there is a dominant concern about the future of renewable natural resources, it is energy. Energy considerations impact on both supply and demand attributes.

The long-range demand for goods and services from renewable natural resources, driven by population and income growth, has probably passed an inflection point, shifting from increasing at an increasing rate to increasing at a decreasing rate. With present

Intense discussions characterized breaks between formal workshop presentations. Left to right: Gerald Thomas, "Mike" Mesarovic, Juan Huerta, Patricia Strauch, Robert Theobald.

[1]Economics, Statistics, and Cooperatives Services, U.S. Department of Agriculture, Washington, D. C.

birth rates, domestic population will reach a maximum early in the next century. Also, several countries with a recent history of explosive population growth are making significant progress toward more manageable growth.

Domestically, real income growth, although expected to continue, will not excessively increase the demand for conventional goods and services from our renewable natural resources. World-wide, real income growth is a more significant source of increasing demand, but within manageable limits when converted to export demands for U.S. goods and services. But the absolute level of demand will pose a formidable challenge, especially in terms of economic feasibility. Particular problems relating to demand include a global imbalance in wealth, economic growth, and income distribution, changes in age composition of the domestic population, and changes in lifestyles and values.

Developed and developing countries close to the take-off point will be able to produce or commercially import natural-resource-based commodities to meet their needs. But more seriously disadvantaged countries will require massive technical and economic aid. In addition to food aid, such countries will need capital for investment in agriculture and forestry, and technical assistance for population management, resource discovery and development, increasing agricultural and forestry productivity, and education.

The long-range consequences of not providing such needs of poor countries would be very serious. Populations in less-developing countries are growing faster and are younger than in developed countries. Coupled with evidences of a widening economic gap between the developed and developing countries, this will increase international polarization and tension. The important questions for the U.S. are: (1) How much aid will we supply? (2) What will be the right balance between exporting the productivity of our natural resources via aid and commercial exports vs. providing financial and technical assistance to develop food, fiber, and forestry production capability in other parts of the world?

Deforestation is also a serious and increasing concern on the global scene. Commercial developments in South America and China could dramatically alter world trade in forest products.

At home, the age structure and lifestyle of our population is changing. The Post World War II baby boom caused an age-group bulge now entering its most productive period of age 30 to 60. This age group will be the most educated and wealthiest in our history. Coupled with smaller family size and more two-wage-earner families, increases in real per capita income will provide a potentially huge demand for enterprises based on renewable natural resources. But since the demand for food does not increase significantly as income increases above a moderate income level, this demand will likely take the form of pressure on our land, forest and water resources for rural living, second homes, investment opportunities, outdoor recreation, fishing, hunting, etc.

There will be continued movement of people from the snowbelt to the sunbelt and from urban to rural areas. There will be fewer children, smaller growth in the labor force, more illegal immigration, more mid-life career changes, earlier retirement, shorter work weeks, more leisure, more national and international travel, more flexible working arrangements, a smaller percent of the work force needed to produce goods and services, more concern for environmental quality, increased yearning for individual participation in community affairs, more enjoyable urban environments, and improved management of natural resources in urban areas for amenity and recreational uses.

There will be greater acceptance of a conserver society -- eating lower on the food chain and more recycling. And there will be more intensive and multiple use of public facilities such as schools, churches, and recreation facilities -- all day, everyday, all year.

The above tend to be gradient changes from current conditions. But the prospect is for some fundamental changes in some dimensions of the demand for renewable natural resources. Most such changes will be related to energy.

Renewable natural resources will play an important role in the search for alternative energy sources. Costs of production, as reflected in relative prices, will undoubtedly favor conventional fossil energy sources for the next 5 to 20 years. But energy from renewable natural resources such as biomass will begin to reduce the upward pressure on energy prices around the turn of the century. Significant adjustments toward biomass production would have important implications for the grain-livestock mix, crop mix (cereals vs. legumes), regional production patterns, irrigation vs. dryland farming, fresh vs. processed food consumption patterns, and protein from cereals. Underutilized pasture and rangeland could be improved by intensive management for biomass production. Biomass removal could have negative impacts on wildlife habitat, and increase soil erosion and sedimentation, but could improve forest productivity.

Gasohol is another potential energy source from renewable nature resources. The conventional approach is to mix alcohol fermented from grain with gasoline to provide a gasohol blend. Another potential is to derive alcohol from greenhouse-produced algae across the Southwest.

The energy question is key to the intensity with which goods and services are demanded from our renewable natural resources. Development of a cheap energy source such as fusion would relieve pressure on renewable natural resources as an energy source. Conventional food production could then become even more energy intensive and less land extensive than might otherwise be the case, permitting greater use of renewable natural resources for amenity values. If no such cheap energy source is developed, there will be increasing pressure on renewable natural resources as alternative or supplemental energy sources, but the demand for recreation and second-home purposes may decline as these uses require much energy for transportation. Also, under the scarce-energy scenario, food production may become less energy intensive and more land extensive, although there may not be much of a net energy savings in such an adjustment.

Regardless of the energy solution, there will be greatly increased competition for goods and services from our renewable natural resources for some time to come. There will be conflict between producing more food for the export market to help feed a growing world population and offset our balance of payments difficulties on the one hand, versus such things as increasing forestry production, urban sprawl, protecting fish and wildlife habitat, more ski resorts, dams to provide water for agricultural and industrial uses, energy production, second homes, and travel across back country in off-road vehicles.

The potential supply of goods and services from our renewable natural resources is encouraging but not unlimited. There will be a natural tendency to continue increasing food production beyond our domestic needs to maintain a viable farm production sector and to play an increasingly larger role in meeting world food needs -- both to aid needy countries and to provide export earnings to offset our oil and other trade deficits. A major national strategy is needed to define the extent to which we will permit the degradation of our renewable natural resources to obtain the advantages of increasing agricultural exports.

Although our agricultural and forestry supply capability is based on renewable natural resources, food production processes are dependent on energy intensive inputs -- fuel, electricity, fertilizers, and chemicals. The need for improved energy efficiency will continue to intensify. Thus, energy will be one major dimension of an overall need to improve research and education programs in agriculture and forestry.

It is important to match energy forms with the end use. For example, solar energy provides heat, but with current technology it is less practical as a source of mechanical power. Wind is a good source of stationary mechanical power, but that power is difficult to store. Biomass can be burned to produce heat directly, or it can be converted to liquid or gaseous forms and thus serve as a mobile fuel. Thus, greater research attention is needed on flexibility in future energy use.

Dennis Little, Robert Dils, R. J. Bourchier, and Gerald Thomas pondered strategy Latin America might use during a world food simulation exercise.

The energy transportation linkage is also paramount. An energy breakthrough allowing continued expansion of a transportation system providing for rapid and low cost transportation of people and materials would greatly intensify the demands on renewable natural resources. Conversely, increasing "real" energy costs may not only reverse this domestic mobility trend, but could significantly dampen the trend toward global interdependence.

Other research areas needing more attention in agriculture and forestry include gene splicing and recombinant DNA, photosynthesis enhancement, bioregulators in crop production, twinning in beef cattle, and controlled-environment agriculture.

With our agricultural and forestry complex becoming increasingly part of a globally interdependent system, a problem in one part of the world system can have serious repercussions throughout the world. Thus, it is becoming increasingly important to research and make operational, a long-run "genesis strategy" to overcome potential breakdowns or supply-demand gaps, much like our grain reserves provide for the short-run. For food production, such a strategy could include a backlog of completed research in genetics and agricultural technologies that could be brought on stream and adapted within one to two years to reverse any alarming divergence in global trends. For forestry, such a long-range genesis strategy could include an "on the stump" fiber reserve for flexibility in international trade.

Fifty years hence, it is possible that our food and fiber could be predominantly produced from synthetic sources. This would make our renewable natural resources generally available for amenity uses. Conversely, with the large absolute increase in demand we will face, if food and fiber are still predominantly produced from renewable natural resources, tremendous pressure will be placed on our productive capacity, resulting in low prioritv for amenity uses. Either direction requires new research and education efforts to attain new knowledge and to better disseminate and use current knowledge.

We are seeing the beginning of an information revolution. Knowledge is becoming increasingly important as a resource. With this resource, however, there is no evidence of the typical tendency of limits to growth found with more conventional resources. The increasing ability to transfer information will quicken the pace of change in rural America. Here, as in most technological change, the small firm is at a disadvantage.

A potential development in the information revolution is the substitution of cathode ray tubes and other electronic devices for paper in the storage and transmittal of information. This could dramatically reduce the demand on forests.

Future research needs also include study of the long-term impact of residue removal from forests, ranges, and wetlands. We need research on biomass production and management, public acceptance, and social and economic benefits and costs. Large scale biomass conversion may not be feasible in the West due to limited water supplies. Again with respect to forestry, the availability of hardwoods dictates their substitution for softwoods. This will require new technology and new capital investment.

Implications for the USDA relate to growing public demands for participatory democracy and accountability in the face of increasing global interdependence and greater pressure on almost all ecological, technical, physical, and socio-economic systems. Our phenomenal history of success in research and education programs and the resultant increase in agricultural productivity may be creating a belief that science can solve any and all problems in a relatively short time. This assumption may cause the general public to expect more and quicker results than are reasonably obtainable. This means that those responsible for social management must get their act together -- and there is no more important dimension of social management than the development, conservation, and use of our renewable natural resources so as to provide adequate food, clothing, shelter, environment, and amenities for present and future generations through the programs of the U.S. Department of Agriculture.

The growing interdependence of national and international technical and economic systems leads to increased vulnerability in the sense that a breakdown in any major component can cause the entire system to fail. Further, other trends toward reduced public acceptance of centralized leadership and clamors for participatory democracy mean that special interest groups can almost single handedly cause national and international crises. On the globabl scale, this potential is even more serious due to the lack of any "real" institutionalized international order.

But we cannot let pragmatic realism drag us into viewing the future as hopeless. We must be willing to abstract systematically from endless detail, define the dominant issues, develop policy mechanisms to control the main causal relationships, analyze alternatives, and make rational choices in anticipatory social management.

Regardless of the specific organization and program content of the USDA, its functional programs and policy responsibilities will be increasingly linked to other federal and state agency or department functions and responsibilities. Thus, there is a need for more interagency, interdisciplinary analysis and decisionmaking. And we must find ways to bring about not a planned society, but more planning in a democratic society.

These, then, are the future challenges in renewable natural resources. And while we cannot predict the future, both the history of the U.S. Department of Agriculture and its current resolve points to a continued dedication to work within the framework of a strong, participatory, and anticipatory democracy "in the service of agriculture for the public good"

Neither Feast Nor Famine: World Food 20 Years On

Selwyn Enzer, Richard Drobnick, and Steven Alter[2]

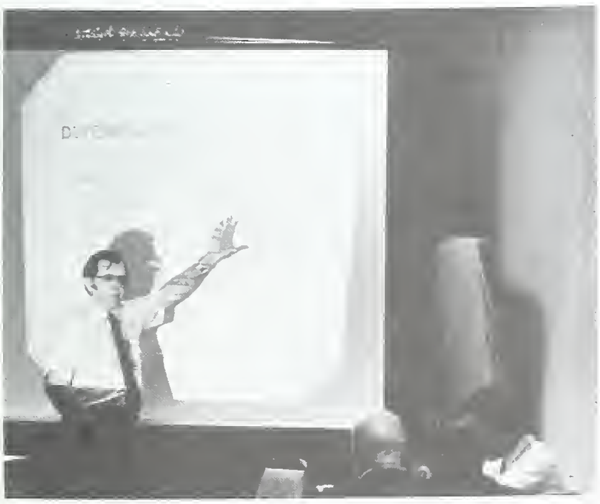
The authors summarize the results of a modelling exercise designed to examine future problems in the world food system. The alternatives resulting from the interactive analysis are presented and the impact of some of these alternatives on American business and society are discussed. Their conclusions include the likelihood that world food conditions in the next 20 years will not follow the trends of the last 20 years; that the rising level of food imports of poor regions will not be sustained; that self-reliance holds the key to a stable future; that food reserves are essential and US policy on them needs to be reassessed; and that the measures needed in poor countries could conflict with the present concern of the US government for human rights.

Little positive action has resulted from the recently increased awareness of food and agricultural problems. A consensus appears to have been reached about the critical nature of the food/population balance, the need for improved food production around the world, and the need for food reserves to protect all nations from the prospects of a crop failure. But the bumper crop of 1976 and its expected encore in 1977 appear to have effectively defused the concerns which flourished in the World Food Conference in Rome in 1974. This is particularly disturbing since virtually all analytical research into world food prospects has confirmed the critical nature of the long-term food/population balance and regarded the prospects for massive famines as quite high--notwithstanding the fact that bumper crops would occasionally occur.

Our research was begun in 1975 and our concern was not that future alternatives had not been evaluated but rather that virtually all of the alternatives led to undesirable outcomes. These alternatives all indicated that population growth was continuing without prospects for control; that much of the accessible fertile land was in the cultivation cycle; that food production growth in the future would require large capital investments; that new acreage would probably be less productive than current acreage; that in the poor nations of the world, urban-populations dependent upon low-cost food to avoid immediate starvation would continue to grow at alarming rates; and so on. The general view was that the poor world was involved in a grotesque race between people and food production. Largely as spectators, inhabitants of the wealthy world were warned that people seemed to be winning the race. Constrained to existing trends, extrapolative research came up with the right

[1] This paper, reprinted with permission from Food Policy, Feb. 1978, provides the basic background presented by Dr. Enzer prior to the world food simulation exercise discussed in the following paper.

[2] Center for Futures Research, Graduate School of Business Administration, University of Southern California, Los Angeles, CA 90007.



Selwyn Enzer introduces workshop participants to the fine points of futures modeling.

answers to the wrong question. Extrapolative projections only indicate the rate at which regional food deficits are increasing. The key question is not to determine when and where mass famines will take place, but rather to figure out how to make the image of a race inappropriate by more effective management of the food/population balance. If Malthus is not to prevail, what are the key alternatives and what are the consequences of these alternatives for both the poor and rich people of the world?

Research Approach

We began a systematic study of the changing forces that are interacting to determine the future with the basic assumption that the future was not preordained by extrapolations of the past. Rather, the future would be determined by the interaction of the three types of components shown in Figure 1.

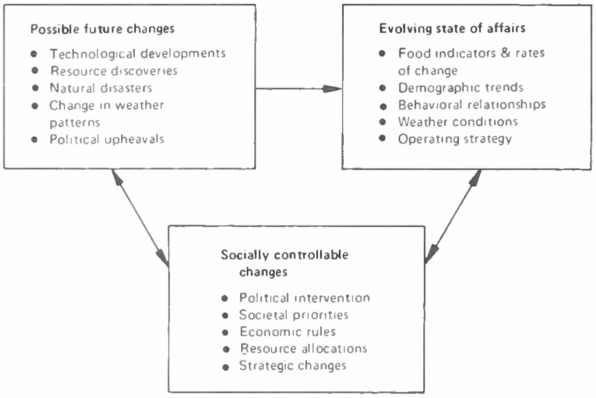


Figure 1. Determinants of the Future.

Any methodology based totally on the extrapolation of the past will ultimately focus on 'when the race would end' rather than on the important question of 'how its course might be diverted'. Since the future invariably contains technical, political, social and resource changes that are never fully anticipated by historical trends, we believe that the future is not as constrained by the past as a totally historical model might suggest. Therefore, one of our principal tasks was to create an analytical procedure that could be used to forecast alternative future changes as well.

But what were these changes and how might they come about? Although the literature contained discussions of many technical, environmental and policy changes which might affect or even shape these futures, many other changes may not have been identified. It seemed important to develop a methodology that could help in identifying some of these changes, especially since the inclusion of these changes might reveal desirable evolutionary paths regarding world food.

Our approach to this problem was to design a creative exploration process necessary to anticipate possible future changes whose occurrence could reverse the worsening food/population trends, and to analyze the degree to which society could bring these changes about. The vehicle developed for this purpose is called interactive cross-impact analysis. In such an analysis, the deliberations of people are combined with projections from simulation models to produce alternative future scenarios. The analytical simulation models describe the trends, and probabilistically describe the uncertain forces of weather, technical change, resource discoveries, outbreaks of agricultural blights, etc. These models simulate alternative futures using conventional techniques, except that they have been programmed to forecast only one year at a time. The results of each annual forecast are then presented to the people who are simulating societal decision makers before the analysis is continued.

In order to make these interactive analyses realistic, considerable research had to be conducted. A good systems model had to be developed which faithfully described trends. Not only did this model have to be capable of projecting key food and population trends based on historical data and contingent societal policies, but it also had to be able to adjust its forecasts to reflect both the impact of the occurrence of future events and the new policies which interactive participants might wish to introduce. Forecasts of future developments in food production, storage and distribution had to be made, and the impacts of these developments on the food systems model had to be estimated. These data had to be integrated into a computer programme that supported and facilitated the deliberations of the interactors.

The forecasting system that was produced described the elements of change in a manner shown in Figure 2. As can be seen, two analytic models were produced, a food systems model and a cross-impact model. The development of these models drew upon inputs from the literature, the research team, and from a Delphi study. The Delphi study was designed expressly to explore and quantify scientific judgments about the key foreseeable changes that might affect world food conditions and the impacts of these changes on those conditions.

Background

What is the food problem? We list below a series of statements that might represent differing opinions about the nature of the problem.

- There is no shortage of food and none is likely within the next 20 years. The current situation simply involves too many poor people who cannot afford to pay for the food they would like to consume. If economic conditions could be improved, the farmers of the world would have no difficulty producing enough food to meet the demand.
- The food problem is really a population problem. Food production is increasing steadily, but it cannot keep pace with population growth.
- Food reserves are low because the rich nations gave their surpluses to the poor countries.
- The Russians created the food problem with their grain deals.
- OPEC caused the food problem by increasing the cost of energy.
- The food problem is a transient phenomenon caused by several bad harvests which depelted US grain reserves.
- The food problem is a result of the domestic policies of developing nations. By controlling food prices at unreasonably low levels, they have inhibited the use of additional resources and advanced technological methods that could increase their food production.
- The affluent nations caused the food problem by over-consumption and by wasting enormous amounts of fertilizer, land, and water on lawns and golf courses.
- The world food problem is a result of neglect of the domestic agricultural sector by many populus/poor nations. Had they invested a greater proportion of their wealth in agriculture rather than in tourist hotels and imported luxury items, there would be no shortage of food

Although each of these relates to some aspect of what has happened or is happening,

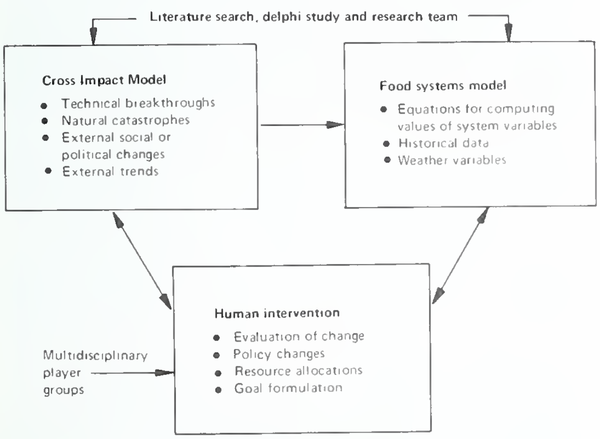


Figure 2. Process of change.

very few are wholly true and none captures the totality of the food problem.

Our research leads us to conclude that the real issue is management--the management of a food/population balance in a world that includes a wide variety of technical, social, political and economic agendas. From this perspective, the above statements represent series of criticisms or challenges to the manner in which food related activities are being or have been managed by society. It is societal management of food production and consumption that has determined the nature of the food problem. Our questions concern the manner in which societal choices in this area could achieve 'a better future'.

In order to recognize a better future, it is necessary to define food goals; for this effort we used the following:

- The ability to provide an adequate quantity of food for all people (including the distribution mechanisms).
- To provide protection from periodic shortages inherent in agricultural production.

Food problems arise when either or both of these goals are not being met.

The analytic model described earlier can be used in three different ways: deterministic, probabilistic and interactive.

Deterministic projections

When the food model is run in a deterministic mode, the effects of all sources of uncertainty are eliminated. These sources of uncertainty are weather, technological and environmental developments, and policy interventions. Although weather fluctuations do have year-to-year effects on consumption, reserves and trade, which ultimately cause the results of deterministic runs to differ from the average of the probabilistic runs, deterministic runs are useful in studying the impact of policy choices such as production and consumption growth rates, trade arrangements and pre-specified contingency plans.

A large number of deterministic runs were completed. To emphasize the main points that emerged from the analysis, we will discuss the consequences of two sets of regional production growth policies--'historic' and 'optimistic'. Historic production growth is simply an extrapolation of regional trends over the last 15 years. Optimistic production growth rates were estimated by the Delphi panel as the maximum growth rates that can practically be sustained over 20 years if major commitments to increasing agricultural production are made.

Figure 3 projects per capita grain production for three types of regions: poor importers (the Third World), rich importers

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(West Europe, East Europe, Japan and the Middle East), and exporters (North America and Australia).[3]

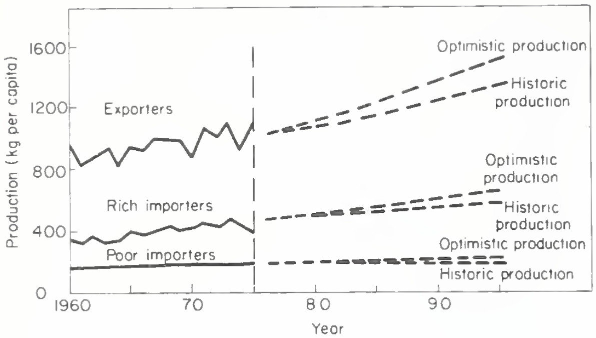

Figure 3. Per Capita Grain Production. Source: Calculated from data in USDA, Foreign Agricultural Service, Reference Tables on wheat, corn and coarse grains and rise, and projections computed from Center for Futures Research world food model.

The projections in Figure 3 lead to three important conclusions:

1. It is possible to maintain a steady increase in per capita production in all regions if historic patterns of population and food production growth can be maintained.
2. An increase from historic to optimistic rates of production growth by the importers results in only a small improvement in per capita productivity. This reflects the fact that recent historic maximum sustainable rates have been very high and are close to the maximum sustainable rates estimated by the Delphi panel.
3. Although the absolute rate of production growth increases faster for the poor importers than for the rich importers,[4] poor importers obtain smaller per capita gains as a result of their greater population growth.

Feasibility

Maintaining historic production growth trends will be more difficult in the next two decades than it was in the past. All of the easily accessible fertile land is now in production. Additional land will either be of poorer quality or will require extensive investment (clearing forests, draining swamps, developing irrigation, etc). Such development cannot practically be accomplished at a rate comparable to that at which land was added to the cultivation cycle in the past, even if cost were not an overwhelming problem. Thus, if historic food production growth rates are to be maintained or exceeded, the increases will have to come largely from increases in yield per acre.

Current constraints on yield increases are not nearly as binding as the constraints posed by the limited amount of high quality farm land. Continued yield increases are within the current state of the art even for the high yield producers. The issue is not one of feasibility but of political choice, priorities, economics and technology transfer. The growth in production realized in the poor regions in the past decade was in large part stimulated by the green revolution. The diffusion of this technology appears to have slowed down. Whether or not it will increase in the future is uncertain. Very poor nations have as yet placed a high priority on food production. Also, the recent inflation in fertilizer and international food prices makes the outlook for sustained productivity improvements bleak for the poor regions.

Impact on Trade

Although the range of improvement in per capita productivity in Figure 3 appears to be small, it has an enormous impact on the amount of grain traded on the international market if stable consumption trends are to be maintained. Figure 4 presents projections of the quantity of grain traded on the world market (assuming historic per capita consumption growth trends are maintained) with the two productions growth trends presented in Figure 3.

If the importers maintain historic domestic production in growth rates, grain imports increase dramatically particularly in the poor regions. This scenario is highly unlikely, not only because weather and other variables are held constant, but because the poor importers could not possibly afford such food imports (47% of world imports).

On the other hand, if the importing regions could achieve the optimistic growth rates in their domestic production, a far more realistic situation obtains on the international grain market. With just the modest per capita production gains shown in Figure 3, the poor importers are able to reduce their import demand considerably. By the mid-1990s they are almost self-sufficient in food. Quite to the contrary, the rich importers

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[3] For this research project the world was divided into 10 regions which are almost identical to the ones used by Mesarovic and Pestel in Mankind At The Turning Point, 1974.

[4] When each group follows optimistic production patterns, absolute production is increasing by a compound growth rate of 2.9% per year for the rich imorters and 3.5% per year for the poor importers.

continue to increase their demand for grain on the international market.

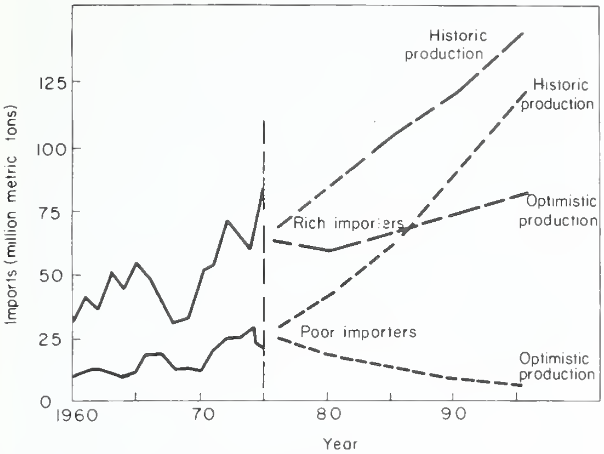

Figure 4. Grain imports using the deterministic Model (historic consumption growth). Source: Calculated from data in USDA, Foreign Agricultural Service, Reference Tables on wheat, corn and coarse grains and rice, and projections computed from Center for Futures Research world food model.

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Probabilistic Projections

Coupling the probabilistic components--weather variables and the possible future events in the cross-impact model--to the food systems model provides additional insights that are not available from the deterministic analyses. When run probabilistically, actual grain production does not necessarily equal planned production. On the contrary, actual production is almost always somewhat higher or lower than target. This variability creates the need for food reserves. In the deterministic runs, reserves are irrelevant, since production always equals target. Furthermore, the fact that production is variable means that the model must contain a set of operational guidelines (representing regional policies) which it can use to decide what course of action to follow for each combination of outcomes that may occur. These guidelines are used to determine actual regional consumption levels and subsequent food production targets based on computed production (regional and world), regional consumption, regional reserves, regional wealth, etc.[5] Finally the uncertainty inherent in the potential occurrence of technical developments and changes in environmental conditions adds another level of richness and complexity. Some of the more important forecasts of these developments by the Delphi panel are given in Table 1.

Table 1. Selected forecasts of the Delphi panel

Development	Probability of occurence by 1996	Repeatable events [a]
Nitrogen fixing grains are developed which reduce the need for nitrogenous fertilizer by 10%	0·40	
Widespread grain disease occurs —15% of the crop in the affected area is lost.		0·02/reg/yr [b]
Genetic breakthrough occurs which allows the average yield of non-irrigated grains to increase by 25%.		0·05/yr [b]
Development of improved grain storage techniques which reduce potential losses by 10%.		0·02/yr [b]
Breakthroughs in integrated pest control techniques which lead to 25% reduction in crop production losses in areas where it is applied.		0·02/yr [b]
The beefalo is successfully raised and marketed.	0·05	
Development of beef twinning techniques that lead to an increase in the average calving rate of 30%.	0·70	
Development of a forage grass which will grow in arid areas with 50% of normal water requirements; thus allowing these areas to support twice as many cattle as currently.	0·30	
Breakthrough in unconventional feed production makes it commercially feasible to permit a 10+% reduction in the amount of grain consumed by livestock.		0·04/yr
Simple and inexpensive solar cookers are developed and utilized by significant numbers of peasant families	0·15	

[a] *These events may occur more than once in the next two decades. The values shown are their probabilities of occurring in any single year.*

[b] *These events are also repeatable, but only affect one of the ten regions when they occur. The values shown are their probabilities of occurring in any region in any year.*

Figures 5 and 6 present a 'typical' scenario[6] generated by the combination of the food systems model (with the weather variable operating probabilistically in each of the 10 regions) and the cross-impact model. This scenario assumes that historic production and con-

[5] For example, in the deterministic runs, planned imports always equal actual imports and the cost of these imports are always the same as budgeted costs. When the model is run probabilistically, planned levels do not equal actual levels. Hence, it is possible for an importing region to exceed its production target while the world in general has had enough bad weather that the price of food on the world market is higher than expected. Under this combination of circumstances the hypothetical importer may purchase less food than its original import target, but still spend more due to the increased price of food.

sumption trends are being maintained. As can be seen, year-to-year variations are substantial.

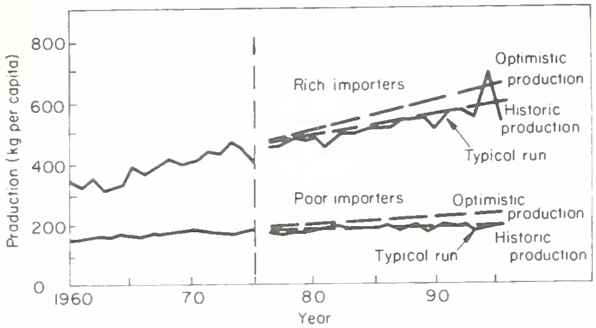

Figure 5. Per capita grain production scenario using the food systems model and cross-impact model.
Source: Calculated from data in USDA, Foreign Agricultural Service, Reference Tables on wheat, corn and coarse grains and rice, and projections computed from Center for Futures Research world food model.

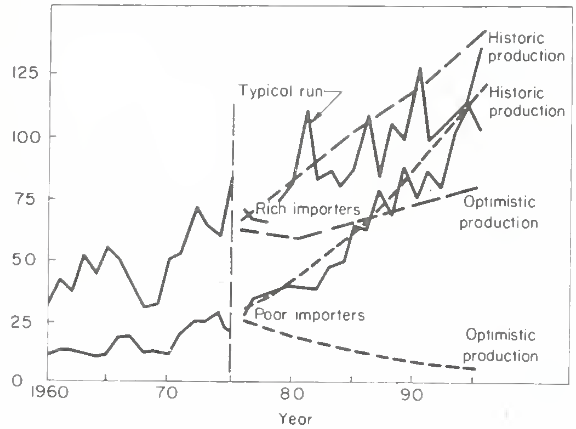

Figure 6. Grain imports with probabilistic weather (historic consumption growth).
Source: Calculated from data in USDA, Foreign Agricultural Service, Reference Tables on wheat, corn and coarse grains and rice, and projections computed from Center for Futures Research world food model.

[6] These variations may lead one to question whether this particular scenario is really 'typical' given the probability distribution of the regional weather variables and the events. In the scenarios presented in Figures 5 and 6 regional weather patterns did not exhibit any extreme sequences of abnormally good or bad weather. Similarly, the mix of events which occurred was not abnormally favourable nor unfavourable to agricultural production. The scenario presented in these figures appears quite similar to most of the others generated by the model in that the policies and problems it suggests are repeated in many runs.

The typical scenario contains periods of high and low production by the importers, with corresponding periods of low and high demand for grain in the world markets. The ability to follow the production and consumption trend projections obtained in the deterministic analyses depends upon regional maintenance of agricultural policies that are consistent with the long-term goal of steady expansion in consumption. Such policies include two components. First, the continual expansion of production even during periods of surplus (bountiful weather), and secondly, the storage of excess food production to cover periods of shortfall (as opposed to withdrawing land from production and over-consuming during periods of surplus.

The production uncertainties produced by weather fluctuations, pests, etc. pose a more serious threat to the poor regions than they pose to the rich regions. Because of extremely low levels of per capita consumption, failure to meet food supply targets means reduced consumption levels and ultimately starvation.[7] Consequently, when a poor region is confronted with a cyclic food shortage that it cannot cover from its reserve stocks, the acquisition of additional food from international sources becomes an urgent problem. If the region cannot obtain food aid or credit, it must divert scarce foreign exchange from productive investment projects to cover food imports. In such cases, the immediate pressures of short-term survival take precedence over long-term development goals. Viewed from this perspective, a poor region which must periodically rely on others to maintain food consumption is in a one-sided dependency relationship with the exporters. To the food exporters, a poor region confronted with a food shortfall is an unwelcome customer during periods of 'tight' supply.

Interactive Analysis

Interactive analyses use the probabilistic model in conjunction with a group of people who act as regional decision makers and attempt to guide the food conditions in each of the regions and for the world. The probabilistic models are used in the single scenario mode, ie, the model pauses after each simulated year. It reports results for that year, indicates the nominal targets for the coming year (assuming no change in strategy), and awaits inputs from the interactors.

The interactors evaluate the interim results to develop a more complete sense of the food conditions in each region than is contained in the quantitative food data. They

[7] Neither the possibility of such shortfalls nor their potential magnitudes are obtainable from the deterministic analyses.

also discuss the consequences--political, social, and economic--that they think are likely to accompany these conditions.[8] After completing their deliberations on the state of food conditions, a policy analysis is conducted. As a result of this analysis, the interactors may change any component of their regional food policy--their production or consumption targets, their domestic research and development programmes, etc. They may also negotiate with representatives of other regions for long-term food purchases, aid, or the establishment of international (world) food programmes. The changes they decide upon are then used to modify the policies included in the analytic models before the next year is simulated. At their option, the model can project more than one year at a time without reporting back to them.

Performing a probabilistic analysis in an interactive mode greatly increases the degree of flexibility and reality that can be built into each simulation. Consider, for example, the different behavior of the USA in response to the Indian food shortages in 1966-67 and in 1972. At the onset of the Indian drought of 1966-67 the USA had large grain reserves and the international price of wheat was only $60 per ton. The 'opportunity cost' to the USA of shipping 20 M metric tons of wheat as food aid to India was low. However, during India's monsoon failure in 1972, most exportable stocks had been tied up by the Soviet Union. In this situation, the USA could not make food aid available without either reducing domestic grain consumption or abrogating other long-term commitments. Many of the policy changes that enter into regional food decisions (such as those which influenced US policy toward India) are captured in an interactive analysis.

The flexibility acquired by introducing regional decision makers into the analytic modelling structure makes it possible to anticipate future contingencies and policy developments. This cannot be done so successfully by more conventional modelling techniques which replace societal decision makers with 'built-in' sets of contingent policy guidelines. The shortcoming of conventional approaches is that it is impossible to develop a 'complete' set of contingent policy guidelines. There are two reasons for this. First, if the contingent guidelines are solely based on historical policy behavior, they will be inadequate determinants of future policy. Secondly, even if the model builders include all of the non-historically based policy guidelines which they think may occur in the future, they may not have included many choices that decision makers will 'invent' when faced with particular problems in the future.

[8] To aid in these deliberations all of the data projected by the model is available to them. This includes the current status of each cross-impact event and trend, as well as a time series of all previous values calculated by the food systems model. For example, if the simulation has just completed projecting 1985 they may request a region by region print-out of production growth trends for all of the years from 1975-1985. They may also ask for the amount of foreign exchange used for food purchases, the levels of food reserves, population growth, etc.

Conclusions

Change in trends.

World food conditions in the next twenty years are not likely to follow the trends seen in the past two decades. The rising level of food imports by the poor regions will not be sustained. Food conditions will worsen for the poor importing nations unless they readjust their priorities to increase domestic food production growth rates and to reverse the trend toward increased dependency on imported food. This is not to say that these regions have not been expanding domestic food production in the past--they have been expanding production rapidly. However, this production expansion has barely outpaced the rapid population growth in many of these regions. Consequently, per capita food consumption has advanced at only modest rates. Furthermore, in the recent past an increasing portion of the food consumption growth in these regions has come from food imports. For instance, food imports for South Asia have risen from 5-6% in 1960 to 8-9% of total consumption by 1975. At 1975 population levels, this meant that approximately 100 M South Asians relied on imported food to sustain a near subsistance level of food consumption. An extrapolation of historic production and consumption trends to 1985 show that their level of import dependency will double to 17-18%. It is doubtful if a poor region such as South Asia will be able to afford this level of imports. Although the exporting regions have the growth potential to meet continuing global growth in import demand, they will not produce this quantity of food unless they expect profitable commercial markets to exist. How can the poor nations of the world be viewed as commercial markets for massive food imports? How can the poor nations offset their growing food deficits?

Self-help by the poor.

The obvious conclusion is that the poor nations cannot afford to finance large food deficits. Therefore, if food consumption trends in the poor nations of the world are to be sustained, these nations must increase domestic production growth rates above and beyond their already high historic rates and must control their populations to end spiraling growth in food consumption.

Self-reliance in food.

Nothing that the affluent regions (both exporters and importers) can do unilaterally will improve food conditions in the poor, populous nations. First and foremost, the poor importers must recognize that their highest priority must be to achieve self-reliance in food, i.e. they must achieve a condition whereby they can either produce or purchase the amount of food they plan to consume, without relying on massive food-aid programmes from surplus producers.[9] They must be ready to take whatever steps are necessary to accomplish that end. If the poor importers adopt the goal of self-reliance in food, then there is a great deal that the affluent world can do to help them achieve that goal. The affluent nations can provide the technology, the long-term and short-term capital required to accelerate agricultural development, the educational programmes, etc.

Diffusion of existing technology.

The road will not be an easy one. There are no miraculous technological developments on the horizon which will dramatically reverse current food trends. On the contrary, most of the advanced technology that can be effectively used already exists. The problem involves such practical issues as quickly tailoring existing knowledge and technology for use in the labour abundant, capital scarce tropical countries of the world, the establishment of institutions and incentive structures that will motivate the rapid adoption of this technology, etc. In short, these are not the usual kinds of scientific problems that the modern world has been solving (or even thinking about) over the past century. Hence, the difficulties will be great for both the affluent and the poor nations.

Food trade growth-less than extrapolations suggest.

As a result of current trends it is likely that food production areas and population centers will be increasingly separated in the future. Consequently, international food trade will grow. However, since trade will be increasingly concentrated among affluent nations, current trade projections, which include large imports by the poor nations, will not be realized.

[9] Self-reliance as used here is not a utopian state of affairs. 'Planned' consumption levels imply 'acceptable', not necessarily 'desirable' levels.

Self-sufficiency and self-reliance.

This research does not suggest that self-sufficiency in basic foodstuffs is either necessary or desirable for all nations. Rather, it suggests that self-reliance in food is essential for a stable form of interdependence to be developed among members of the world community. Food self-reliance is the ability of a nation to produce or purchase the food it plans to consume. When self-reliant nations enter into an interdependent relationship--even for an essential commodity such as food--both importers and exporters are self-motivated to fulfill their commitments. Since the poor importers have little to offer in trade, for them self-reliance equates to self-sufficiency.

Continuing challenges in a self-reliant world.

Even in a self-reliant world, the future contains many problems regarding food production. Driven by population and affluence, food consumption will continue to increase. Technological progress and investment in production increases will continue to be important. Food prices will continue to increase as less productive land is put into production and as the costs of agricultural inputs increase. Reserves will become increasingly important for offsetting periodic production shortfalls. The threat of diseases which can destroy crops throughout an entire region will increase as fewer types of new hybrid grains are cultivated. Thus, even if self-reliance is attained, proper management of the world food situation will remain a major challenge.

Population control.

Clearly, there is no long-term solution to the world food problem that does not include population control. World population simply cannot grow indefinitely in a finite world. Even if population control becomes accepted as a world goal, it does not become operationally viable until it is adopted and enforced at the national level. The goal of self-reliance in food requires population to be limited to a level that is domestically affordable. In the poor, populous nations this implies population control. Without the adoption of self-reliance in food at the national level, population control is likely to remain a goal without a policy maker. It is only through the adoption of self-reliance as a national goal that population control is likely to gain any political importance. In short, if a nation can only afford to have a population it can feed--either through food production or purchases--the goal of self-reliance contains a population control goal which takes on national political significance.

Self-reliance--the only stable future.

There are no alternative futures that do not move toward national self-reliance in food as an end condition. There are, however, many paths which may be taken in achieving self-reliance. These include a balance of growth in food production and commerce such as has been achieved in Taiwan, as well as the isolationist self-survival path adopted by the People's Republic of China. Both of these nations are self-reliant or are moving toward self-reliance in food. Both are also moving toward long-term population control. The issues facing the world and the individual nations of the world are the willingness to accept the importance of self-reliance and the choice of the path to follow in reaching self-reliance.

Impacts on American business and society.

The impacts of future world food conditions on the USA are numerous and varied. As the world's largest surplus food producer, the USA will be torn between conflicting humanitarian, economic and political considerations in a search for appropriate national plicies. Problems of this type are of course, not new to the USA. What is different with food is that the USA has only indirect control over the course of events surrounding food conditions.

As a surplus food producer the USA is dependent upon the food import policies adopted by its customers. These policies determine the demand for food imports and hence the rate at which US productive capacity should be expanded. Food productive capacities involve long-term investments which can only be justified on the basis of stable long-term markets. Long-term international purchase agreements tend to be quite fragile, particularly in periods of high economic turbulence. When domestic surpluses exceed international demands, the USA faces acute domestic problems concerning farm income supports, storage (or disposal) or surplus food, etc.

Reinforcing these political uncertainties are basic uncertainties inherent in agricultural production. Notwithstanding modern technological improvements, weather and pests still cause vast fluctuations between production targets and actual outputs. These fluctuations exacerbate the fragility of long-term international food purchase agreements. Short-term economic realities make it difficult for a food importer to justify high-priced food imports at a time when domestic harvests have been bountiful. Yet such purchases are essential in order to provide a basis for a steady expansion of US production capacity.

Food reserves. One development which can alleviate this condition is the establishment of a large food reserve. A large food reserve can be of immense value to the USA as well as to the world. For the USA it would stabilize demand and for the world it would provide much needed protection against periodic shortages. Reserves have traditionally been a domestic response to the problem of balancing fluctuations in food production with stable consumption demands. But even domestic reserves create complex political problems. Consumers invariably want food prices to drop during periods of abundance. The farmers seek the opposite. Fortunately, the US government has had the authority and the perspective to see that in the long-term both the food producers and consumers benefit from stability. As a result, the USA has maintained a policy that attempted to keep supply (productive capacity) in balance with demand by a combination of farm price supports, reserves and idled crop-land. However, as the share of US food production earmarked for export markets grows the domestic tradeoffs which guided US farm policy are no longer adequate.

It is important to note that the need for food reserves is strictly a result of fluctuations in food production and an unwillingness to accept corresponding fluctuations in consumption. The amount of food that should be held in reserve therefore depends upon the magnitude of the production deviations that can be expected and the degree to which consumption is permitted to vary. The proper size of a food reserve for protecting domestic US consumption is smaller than one which would be needed if the US reserves were also to protect importing nations from their production fluctuations. A world food reserve would have to be correspondingly larger. The issue of who should be responsible for the maintenance and cost of a world food reserve is far from resolved.

The most frequently mentioned obstacle to the establishment of food reserves is their cost. This preoccupation with cost stems from America's historical experience of accumulating reserves as an unwanted side effect of farm price support programmes. However, currently (and for the foreseeable future) the USA is exporting about 35% of its annual grain production. The foreign exchange earnings resulting from these exports are very important to the US balance of payments, hence food reserve policies should be examined from a broader perspective than in the recent past when operating costs were of overriding concern. In the present environment it is important for America to use reserve policies to accomplish a broad range of goals, including:

- Protection of its export markets by guaranteeing reliability of supply.
- Protection of its farmers' income from short-term shifts (i.e., weather-induced shifts) in foreign demand.

- Protection of the welfare of its consumers from unstable prices and supplies.

These considerations appear to have been overlooked in the development of current US reserve policy.

A positive approach to the use of food reserves would not only avoid these negative conditions, but could also be used to stabilize US food production growth to levels that are consistent with national interests. This would happen because, in addition to affecting world food prices, US reserve policies also affect the size and distribution of world food production growth rates. To the extent that the USA wants to maintain constant food production growth rates, a large food reserve can provide the needed clout. The cost of such reserves is a moot question since these costs would be borne by the consumers regardless of who holds the reserve. Since the USA is the only nation capable of building a reserve large enough to satisfy the multi-faceted criteria dictated by world needs, and since it is in the national interest to have such a reserve, US policy toward food reserves should be re-evaluated.

U.S. economic conditions. Agricultural exports have become an important component of US trade in recent years. US grain exports have largely offset growing US oil imports, thereby protecting the purchasing power of the dollar and limiting inflation. Because of the cyclical nature of agricultural exports, however, they cannot be counted on to regularly offset oil imports. Thus, it is important for the USA to stabilize its agricultural exports with long-term sales agreement with importers and/or be able to maintain a substantial fraction of its surplus production in a reserve. This would reduce economic disruptions caused by frequent and large swings in the US balance of trade.

Any increase in priority for US agricultural exports may conflict with a move toward self-reliance in food among the third world nations. In an effort to become more self-sufficient in food, these nations will seek aid from the USA. These requests will emphasize production technology and education as opposed to food for immediate consumption. This may pose a conflict in priorities for US agricultural interests. If the USA is trying to maximize food export sales, it may appear that such technology transfers act against American self-intersts. US policy must avoid this trap. Improvement of food production in poor third world nations would not affect food sales, since these nations can not afford to pay for their food needs. If they become self-reliant, they may need less imported food, but they will be able to pay for their food purchases.

U.S. human rights policy. In the pursuit of self-reliance many third world governments will have to impose harsh measures affecting freedom of choice in procreation, purchases of non-essential goods, demographic mobility, land-use patterns, etc. Such measures invariably compromise human rights. Viewed from a purist perspective these measures will appear to conflict with US policies which deny aid to nations which violate the human rights of their citizens. What could be more inhumane than denying aid to poor/populous nations on the grounds that measures essential to their survival violate the human rights of their citizens?

However, since every tyrannical dictator will claim that his repressive measures are necessary in the pursuit of national survival, US policy makers will not find it easy to decide which nations warrant US aid and which do not. Nevertheless, the food population imbalances of the last few generations will not be tolerated for the next few generations. If the world does not take firm action to bring food and population into balance, Malthus will do it from the grave. Even this, however, does not herald the end of the world, it is just another path to self-reliance. One way or another, the nations of the world will become self-reliant--the choice of how this occurs belongs to all of us.

Simulation of World Food Futures[1]

Selwyn Enzer and Richard Drobnick[2]

As part of a 20-year forecast project concerning future world food conditions, the Center for Futures Research developed an interactive, probabilistic model of world grain production, trade, and consumption. This model was used to engage the conference participants in an interactive simulation. The goals of this activity were: 1) to promote a better understanding of the complexity of long-range planning for systems which are inherently uncertain and which are influenced by different interest groups, and 2) to demonstrate a new process for analyzing such systems in a long-range holistic context.

The interactive simulation process involves a combined man/computer analysis which produces typical future scenarios. The computer program contains models of grain production, trade and consumption; population growth; possible future technical developments and natural phenomena; and weather fluctuations in a world subdivided into 10 regions. Participants in such a simulation, acting as decision makers, evaluate the projections of the model and adjust regional agricultural policies in efforts to improve their evolving food conditions.

For the demonstration at this conference the analytic models were engaged through the use of a computer terminal and a telephone link, with a computer at the University of Southern California. Before the simulation activity began, a presentation was given on the overall food research project for which the simulation model was developed. Most of the background material presented to the conferees is contained in the February 1978 Food Policy article entitled "Neither Feast Nor Famine," which precedes this paper in these proceedings.

Figure 1. World Regions

Source: Map adapted from M. Mesarovic & E. Pestel, Mankind at the Turning Point (New York: E.P. Dutton & Company, 1974).

Initial Phase of the Simulation

This discussion of the simulation describes only the particular food future developed at the conference.[3] The 40 persons in the audience were divided into 10 policy groups representing agricultural decision makers for each of the regions contained in the model. These are shown in Figure 1. Each of the groups was provided with historic data on key grain trends, information on budgetary and policy constraints, and a set of nominal projections of the grain trends for the upcoming 1979/80 crop year. An example of the

Dick Drobnick explains world grain market simulation techniques to the "Australia" team, Messrs. Cardenas, French, O'Connell, and Berg.

[1] A demonstration of the C.F.R. World Food Model at the national workshop on Future Challenges in Renewable Natural Resources, January 22-25, 1979, Rossyln, Virginia.

[2] Center for Futures Research, Graduate School of Business Administration, University of Southern California, University Park, Los Angeles, CA, 90007.

[3] Even though the time alloted for this demonstration was generous in terms of the conference agenda, it proved to be too brief to fully develop an interactive policy simulation.

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trend information for one of the ten regions (North America) is provided in Figure 2, and the nominal projections for 1978/79 are shown in Table 1.

Policy Changes for 1970-80

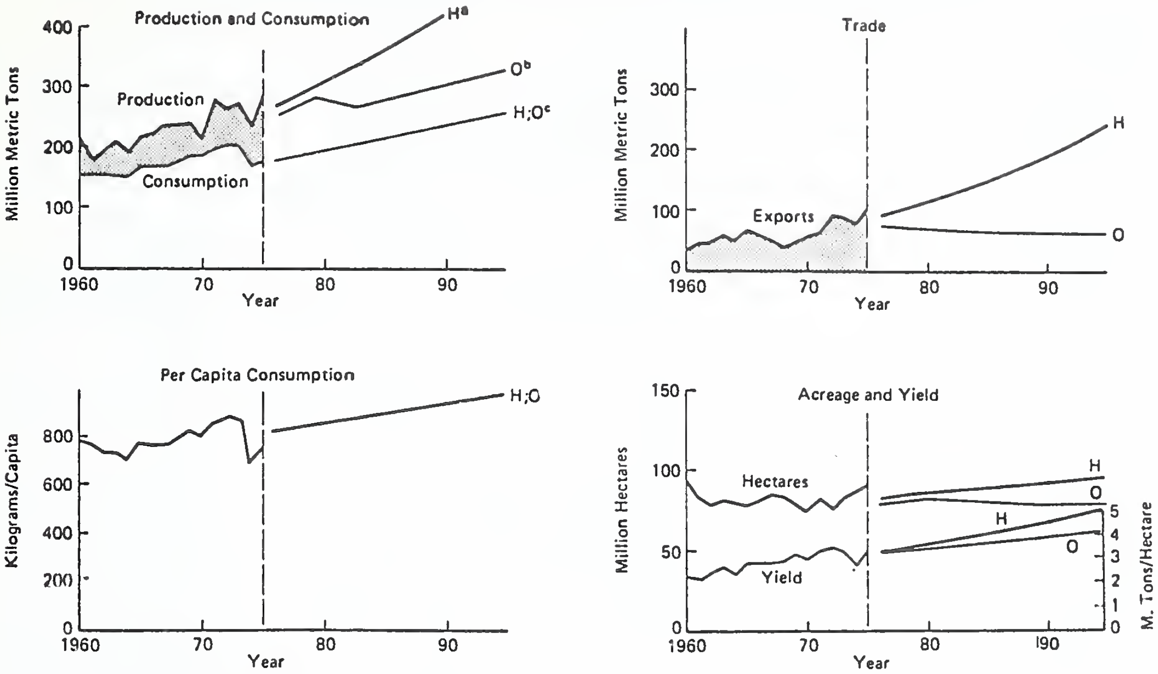
The regional policy groups evaluated the nominal projections and developed some new

Table 1. Nominal Projections of Key Food System Variables for 1979/80*

Code:	Trend Title	World Value	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8	Region 9	Region 10
7	EXPECTED PC CONSUMPTION	0.3159	0.7721	0.4948	0.2941	0.3455	0.8148	0.2362	0.2462	0.0940	0.1704	0.2373
11	TOTAL EXPECTED CONSUMPTI	1357.75M	188.64M	205.99M	34.17M	18.67M	307.12M	85.93M	43.68M	31.10M	214.13M	228.33M
20	EXPECTED PRODUCTION --	1358.75M	290.32M	184.06M	12.18M	30.06M	293.20M	82.91M	27.85M	27.33M	185.70M	225.14M
23	POTENTIAL SURPLUS	28.31M	126.25M	-21.93M	-21.99M	14.14M	-13.92M	-3.02M	-15.83M	-3.77M	-28.43M	-3.20M
24	EXPECTED IMPORTS	113.07M	0.00M	21.93M	21.99M	0.00M	13.92M	3.02M	16.83M	3.77M	28.43M	3.20M
26	EXPECTED EXPORTS	113.07M	101.68M	0.00M	0.00M	11.39M	0.00M	0.00M	0.00M	0.00M	0.00M	0.00M
37	EXP F EXCH SPENT/EARNED	22614.97M	10168.43M	2192.86M	2198.66M	1139.06M	1391.70M	301.88M	1682.59M	377.01M	2343.10M	319.69M
48	RESERVE GOAL	234.16M	67.20M	34.25M	5.26M	10.64M	35.01M	9.80M	13.28M	1.77M	40.68M	16.27M
49	BEGINNING RESERVES	140.00M	61.89M	21.15M	3.35M	9.35M	13.52M	4.63M	4.56M	1.00M	14.28M	6.26M
51	PLANNED CH. IN RESERVES	1.00M	0.00M	0.00M	0.00M	0.00M	0.00M	0.00M	1.00M	0.00M	0.00M	0.00M
59	ACREAGE (in Hectares)	692.72M	82.95M	57.50M	2.76M	19.25M	141.80M	57.18M	22.70M	31.42M	152.51M	124.66M
63	EXPECTED YIELD	1.9615	3.4999	3.2011	4.4206	1.5615	2.0677	1.4499	1.2270	0.8700	1.2177	1.8060

*Most variables are expressed in terms of millions of metric tons; an important exception is Expected Per Capita Consumption which is stated in terms of metric tons per person.

Figure 2 NORTH AMERICA



Source: Calculated from data presented in U.S.D.A. "Reference Tables on Wheat, Corn, and Coarse Grains and Rice," FG 9-76 and FR 1-76. Projections computed from Center for Futures Research world food model.

[a]Projection based on historic production growth rates. [b]Projection based on optimistic production growth rates. [c]Projection is the same for either historic or optimistic production growth rates.

Historic Consumption Growth		1.8%/yr	Historic Production Growth		3.3%/yr
Per Capita	1.0%/yr		Acreage	.8%/yr	
Population	.8%/yr		Yield	2.5%/yr	
Population (Mid-year 1975)		237 million	Optimistic Production Growth		3.3%/yr
			Acreage	.8%/yr	
Grain Reserve		45 M.M.T.	Yield	2.5%/yr	

policies that they thought would improve their conditions. Because the conferees were unfamiliar with the model, their policy choices were limited to that of only changing target growth rates of production or changing reserve levels.[4] Furthermore, the participants were asked to try to make policy choices that would keep them within assigned annual foreign exchange budgets and debt limits.[5]

[4] In order to facilitate this demonstration, the participants were not allowed to change such things as consumption policies, reserve release rules, supply and demand elasticities, likelihood of technological changes, etc., all of which are variable in the model.

[5] These budgets and debt limits were based on the expected cost of the 1978 regional grain import targets.

In order to focus on the passive position of exporters in the short run (i.e., exporters can only sell what importers want to buy), only the importers were allowed to make policy changes in the first planning phase. In general, the conferees chose to invest most of their budgets to increase regional production growth and to use the balance of their funds to build up reserves. The specific policies introduced by the various regions are outlined in Table 2.

After the policy changes had been made, the nominal projections for 1979/80 (Table 1) were revised to reflect the expected consequences. The Revised Nominal Projections are shown in Table 3. One of the important consequences of the policy changes was a reduction of about 2% in the expected demand for North American grain exports. Another consequence of the policy changes was that a worldwide increase of 1.6 mmt in reserves was

Table 2. Policy Changes Introduced at 1979/80 Planning Stage

Region	Changes in Production Growth Rate Targets	Changes in Reserve Levels
1. North America	None	None
2. Western Europe	Reduced from 2½% to 2% per year	1 million metric tons (mmt) per year draw down
3. Japan	None	1 mmt/yr. build-up
4. Australia	None	None
5. Eastern Europe	Increased from 3.1% to 3.55% per year	0.6 mmt/yr. build-up
6. Latin America	Increased from 3.5% to 4.0% per year	None
7. Middle East	None	None
8. Tropical Africa	Increased from 1.5% to 4.0% per year	None
9. Southeast Asia	Increased from 3.2% to 4.0% per year	1 mmt/yr. build-up
10. China	Increased from 3.4% to 3.7% per year	None

expected.[6] A detailed analysis of the expected consequences of the policy changes can be made by comparing the Nominal Projections of Table 1 with those of Table 3. Even though it may be desirable to make further policy changes in response to the revised projections, no further interventions were allowed at this time. Instead these policies were adjusted and the model simulated weather and technology conditions and computed the actual trend values for 1979/80.

Summary results of this simulation of 1979/80 are presented in Table 4. By comparing these results with the projected values of Table 3, it can be seen that in the aggregate, weather conditions had almost no effect on projection in this year (total actual production was only slightly less than expected). However, the regional distribution of weather was such that North American production was about 4% below target and East European production about 3% above target. In terms of the stability of the price index and consumption levels, this distribution of bad and good weather was balanced, i.e., the principal exporter had a bad crop year when a major importer had a good one. However, in terms of expected foreign exchange earnings and expenditures, there were losers and winners, e.g., North America earned $1.6 billion less than it had expected while Eastern Europe was able to spend $800 million less than it had expected for food imports.

The technological developments that occurred in 1979/80 were improvements in plant genetics and the successful development of integrated pest control techniques. Both of these developments will cause gradual increases in expected yield levels over time.

[6] When more time has been available, analysts have often gone through an iterative policy-making process. This usually occurs because an examintion of the revised projections (Table 3) shows them that their potential opportunities have unexpectedly changed as a result of policy choices made by other regions.

Table 3. Revised Nominal Projections of Key Food System Variables

No.	Variable	Total					
7	EXPECTED PC CONSUMPTION	0.3159					
			0.7721	0.4948	0.2941	0.3455	0.8148
			0.2362	0.2462	0.0940	0.1704	0.2373
11	TOTAL EXPECTED CONSUMPTI	1357.75M					
			188.64M	205.99M	34.17M	18.67M	307.12M
			85.93M	43.68M	31.10M	214.13M	228.33M
20	EXPECTED PRODUCTION	1360.35M					
			288.50M	183.16M	12.18M	29.85M	294.52M
			83.33M	27.85M	28.02M	187.13M	225.79M
23	POTENTIAL SURPLUS	31.94M					
			126.25M	-22.83M	-21.99M	14.14M	-12.60M
			-2.59M	-15.83M	-3.09M	-27.00M	-2.54M
24	EXPECTED IMPORTS	111.05M					
			0.00M	21.83M	22.99M	0.00M	13.20M
			2.59M	16.83M	3.09M	28.00M	2.54M
26	EXPECTED EXPORTS	111.05M					
			99.87M	0.00M	0.00M	11.19M	0.00M
			0.00M	0.00M	0.00M	0.00M	0.00M
37	EXP F EXCH SPENT/EARNED	22210.41M					
			9986.52M	2182.64M	2298.66M	1118.68M	1319.76M
			259.14M	1682.59M	308.61M	2799.71M	254.09M
48	RESERVE GOAL	234.16M					
			67.20M	34.25M	5.26M	10.64M	35.01M
			9.80M	13.28M	1.77M	40.68M	16.27M
49	BEGINNING RESERVES	140.00M					
			61.89M	21.15M	3.35M	9.35M	13.52M
			4.63M	4.56M	1.00M	14.28M	6.26M
51	PLANNED CH. IN RESERVES	2.60M					
			0.00M	-1.00M	1.00M	0.00M	0.60M
			0.00M	1.00M	0.00M	1.00M	0.00M
59	ACREAGE (in Hectares)	693.50M					
			82.47M	57.50M	2.76M	19.12M	142.44M
			57.18M	22.70M	31.57M	153.11M	124.66M
63	EXPECTED YIELD	1.9616					
			3.4984	3.1854	4.4206	1.5615	2.0677
			1.4574	1.2270	0.8874	1.2222	1.8112

After computing these actual results, the model would normally make a set of nominal projections for the next year, and then wait for any new policy interventions. However, during this demonstration there was not enough time for another round of policy revisions, so we let the model simulate an additional ten years while maintaining the policies that were introduced during the 1979/80 planning period.

Summary of Results

In order to briefly evaluate the consequences of a simulation in which policies were held constant, the particular technology and weather conditions which prevailed are summarized below. In general, the events which occurred were favorable to increasing grain production while having little effect on grain demand. A list of these events is presented in Table 5. The weather conditions which prevailed in this scenario began with three pretty good years, and then were followed by five years of below normal conditions. After this the weather varied moderately until the last year (1988) when there was a drastic 5% production shortfall. While keeping this particular weather, technology and policy scenario in mind, a brief description of the behavior of some of the key trends is presented below. Some of the "unreasonable" consequences of continuous use of the policies which were introduced in 1979/80 are also noted.

Table 4. Expected Versus Actual Results 1979/80

11	TOTAL EXPECTED CONSUMPTI			1357.75M			
		188.64M	205.99M	34.17M	18.67M	307.12M	
		85.93M	43.68M	31.10M	214.13M	228.33M	
12	TOTAL ACTUAL CONSUMPTION			1357.75M			
		188.64M	205.99M	34.17M	18.67M	307.12M	
		85.93M	43.68M	31.10M	214.13M	228.33M	
71	PCT DEV IN CONSUMPTION			0.00			
		0.00	0.00	0.00	0.00	0.00	
		0.00	0.00	0.00	0.00	0.00	
20	EXPECTED PRODUCTION			1360.35M			
		288.50M	183.16M	12.18M	29.85M	294.52M	
		83.33M	27.85M	28.02M	187.13M	225.79M	
21	ACTUAL PRODUCTION			1359.18M			
		276.14M	181.76M	11.95M	31.56M	303.02M	
		80.66M	27.95M	28.15M	189.65M	228.37M	
22	WEATHER MULTIPLIER			0.9991			
		0.9571	0.9923	0.9806	1.0571	1.0289	
		0.9679	1.0034	1.0046	1.0134	1.0114	
24	EXPECTED IMPORTS			111.05M			
		0.00M	21.83M	22.99M	0.00M	13.20M	
		2.59M	16.83M	3.09M	28.00M	2.54M	
25	ACTUAL IMPORTS			98.50M			
		0.00M	21.95M	22.99M	0.00M	5.03M	
		2.81M	17.05M	3.05M	25.62M	0.00M	
26	EXPECTED EXPORTS			111.05M			
		99.87M	0.00M	0.00M	11.19M	0.00M	
		0.00M	0.00M	0.00M	0.00M	0.00M	
27	ACTUAL EXPORTS			98.50M			
		86.18M	0.00M	0.00M	12.32M	0.00M	
		0.00M	0.00M	0.00M	0.00M	0.00M	
38	ACT F EXCH SPENT/EARNED			19057.06M			
		8336.76M	2123.25M	2223.60M	1191.78M	486.85M	
		272.28M	1649.18M	295.00M	2478.37M	0.00M	
66	DEV FROM F. EXCH PLAN			0.00M			
		-1649.77M	-59.39M	-75.06M	73.10M	-832.91M	
		13.14M	-33.42M	-13.61M	-321.34M	-254.09M	
28	ACTUALSHORTFALL			-3.15M			
		-1.32M	-0.12M	0.00M	-0.57M	-0.34M	
		-0.22M	-0.32M	-0.09M	-0.14M	-0.03M	
50	ENDING RESERVES			124.18M			
		57.02M	16.85M	3.73M	8.99M	13.08M	
		1.25M	4.87M	0.89M	12.46M	5.05M	
57	ACTUAL UNPL CH RESERVES			-1.17M			
		1.32M	-1.28M	-0.24M	0.57M	0.34M	
		-2.45M	0.32M	0.09M	0.14M	0.03M	

Table 6. Nominal Projections for 1989/90

7	EXPECTED PC CONSUMPTION			0.3354		
		0.8109	0.5483	0.3441	0.3495	0.9558
		0.2602	0.2858	0.0940	0.1767	0.2836
11	TOTAL EXPECTED CONSUMPTI			1764.83M		
		215.58M	245.76M	43.34M	23.65M	391.36M
		128.28M	69.71M	41.69M	295.28M	310.18M
20	EXPECTED PRODUCTION			1798.87M		
		297.91M	232.30M	12.38M	31.61M	419.06M
		132.03M	36.51M	42.58M	277.10M	317.40M
23	POTENTIAL SURPLUS			111.64M		
		147.24M	-13.46M	-30.96M	14.25M	27.70M
		3.75M	-33.20M	1.59M	-18.18M	12.91M
24	EXPECTED IMPORTS			98.40M		
		0.00M	12.46M	31.96M	0.00M	0.60M
		0.00M	34.20M	0.00M	19.18M	0.00M
26	EXPECTED EXPORTS			98.40M		
		82.32M	0.00M	0.00M	7.97M	0.00M
		0.00M	0.00M	0.89M	0.00M	7.22M
37	EXP F EXCH SPENT/EARNED			19679.68M		
		8232.38M	1245.77M	3196.34M	796.53M	60.00M
		0.00M	3420.14M	89.04M	1917.59M	721.90M
48	RESERVE GOAL			298.82M		
		76.80M	40.86M	6.67M	13.48M	44.62M
		14.62M	21.19M	2.38M	56.10M	22.10M
49	BEGINNING RESERVES			29.83M		
		0.00M	0.00M	5.93M	0.00M	0.00M
		4.96M	3.76M	1.78M	0.00M	13.40M
51	PLANNED CH. IN RESERVES			34.05M		
		0.00M	-1.00M	1.00M	0.00M	28.30M
		3.75M	1.00M	0.00M	1.00M	0.00M
59	ACREAGE (in Hectares)			745.22M		
		74.57M	57.79M	2.24M	17.63M	148.38M
		74.63M	22.93M	37.26M	182.17M	127.61M
63	EXPECTED YIELD			2.4139		
		3.9948	4.0199	5.5242	1.7930	2.8242
		1.7691	1.5923	1.1426	1.5211	2.4872

Table 5. Event Occurrences 1979-1988

Event	Year of Occurrence
Integrated pest control	1979
Improvement in plant genetics	1979
Controlled release fertilizer	1980
Whale extinction	1980
Aquaculture breakthrough	1980
Grain disease in Australia	1981
Synthetic gas recovery	1986
Unconventional feed sources	1987
Methane cookers	1988

1. Foreign Exchange Budgets

Although the exporters earned less than expected during good weather years, their profits earned during bad weather years greatly exceeded those losses. Except for Eastern Europe and South Asia, the importers kept within their foreign exchange budgets and debt limits. When the East Europeans experienced bad weather in 1980 and again in 1981, they incurred large debts as they tried to maintain their consumption trends.

2. Actual Per Capita Consumption

Except for the bad weather years of 1981 and 1988, per capita consumption rose steadily in most regions. However, maintaining rapid production growth in tropical Africa without increasing per capita consumption goals eventually led to the incongruous situation of African exports and slightly declining consumption when bad weather struck. Another unrealistic consequence of maintaining the 1979/80 policies was that of Eastern Europe where grain consumption rose from 780 kilograms per person per year to 920 by 1988. If consumption trends had been stabilized at a lower level, then Eastern Europe would have become an important exporter.

3. *World Grain Trade*

Interregional grain exports fluctuated around 100 mmt per year.[7] This projection which is a reversal of recent trends was a result of the policies introduced by the conferees in 1979 which caused most of the importing regions to become more self-sufficient. These policies led to a reduction in the overall market and made it possible for China to become an exporter near the end of the period. These two factors caused American exports to decline slightly. As noted above, if the East Europeans had chosen to reduce their consumption trends, there would have been another region vying for a share of the export market.

4. *Grain Reserves*

Total grain reserves declined from high levels of 10% of annual consumption in the first four years to less than 2% by 1988.

5. *Acreage and Yield*

The total areas devoted to grain production rose by almost 60 million hectares (9%) and expected world yield rose from 1.9 to 2.4 metric tons/hectare. However, for North America and Australia grain acreage declined by about 16% from their initial 1975/76 levels. This decline occurred primarily as a result of the continuous growth in land productivity and the stagnant level of international demand.

6. *Nominal Projections for 1979-90.*

The expected values of the key variables for 1989 are presented in Table 6.

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[7] This refers to interregional grain trade which is only about two-thirds as great as the actual amounts traded across national borders.

Conclusions

The primary purposes of this exercise—to promote a better understanding of complex long-term changes in renewable resource systems and to demonstrate a new procedure for evaluating such changes in a holistic context—were at least partially fulfilled notwithstanding the brevity of the demonstration and the simplifying constraints imposed to facilitate the exercise. The grain production system is sufficiently similar to natural resource systems in general so that the considerations that arise in studying alternative futures for each are quite similar. Hence parallels could easily be drawn between these two systems with regard to interdependence. Just as grain exporting regions are affected by the independent policies of grain importers so are the various sectors of the renewable resources system affected by domestic and international policies in many sectors. Clearly, an appropriate approach to managing renewable resources in this country must incorporate these uncertainties and interdependencies.

To a lesser extent, the demonstration also indicated how external future changes—technological developments, natural phenomena, discoveries of nonrenewable resources, etc.—could affect renewable resource management strategies. However, the impact of external changes generally take more than one year to appreciate. And, since the participants in this demonstration were given only one opportunity to adjust policies, they did not experience seeing how an external development could (over time) dramatically affect their policies. Additionally, technological developments in grain production are not likely to change the basic nature of the world food problem over the next two decades. This is primarily due to the fact that there are many existing technologies which are currently underutilized in those parts of the world where they can have the greatest impact.

Since the key constraints in introducing new agricultural technologies are of a social, political, and economic nature, more technology per se, would face the same problems of underutilization. As a consequence, alternative food futures are dominated by policy choices. Because renewable resource futures will be similarly dominated by policy choices, the issue is not one of "forecasting" the future as much as it is one of "understanding" the possiblities. For this purpose, methods which analyze policy options in the presence of uncertainty such as the one demonstrated in this session should prove to be invaluable.

Long-Range Analysis of United States Land Use Options[1]

Patricia Strauch, Mihajlo Mesarovic,
and Juan Huerta[2]

The Soil/Oil Issue

The United States faces a significant dilemma over the next several decades which focuses on its land use patterns. This dilemma results from the simultaneous convergence of two top priority demands for land, a resource that appears to be in abundance.

On the one hand, the demand for land for people usage grows with increases in population size and real income per capita. This being the case, land is withdrawn from cultivation and forests with increasing frequency to be used for home building, recreation, and transportation purposes. The other side of this dilemma is that the United States, over the past several years, has experienced a severe and increasing disparity between the dollars it can earn from exports and the dollars it has to pay for imports. In particular, the pre-1973 reliance on earnings from agricultural exports to cover import expenditures has dissipated in the face of the growth in costs and demands for oil imports. This can best be seen by comparing the value of U.S. agricultural exports in years prior to 1973, the year of the oil embargo, which was about eight billion dollars, with the cost of importing oil, about five billion dollars, which was covered about four times by agricultural exports. Beginning in 1973 and continuing to the present the picture has reversed. U.S. agricultural export earnings have climbed to a net 12 billion dollars, while the cost of oil imports has skyrocketed to more than 44 billion dollars. Projections for the next several decades show an increasing gap between earnings for the export of agricultural products and the cost of oil imports.

Herein lies the dilemma. The United States needs export revenues; therefore a feasible policy is to cultivate its land base to the maximum feasible extent in order to produce the agricultural supply needed for export earnings. At the same time, the increase in population and in real income per capita generate demands for living space--the more disposable real income per capita, the greater the demand for quality housing, transportation networks, recreational facilities.[3] Additionally, the greater the public awareness of the benefits of improved environmental quality, the greater the demands for natural settings, low density housing, and "back to nature" living. Evidence is the recent increase in farm land purchases by city dwellers. The conflict between the domestic demands for improved living space and the international necessity to balance trade, relying to a large extent on agricultural exports, comes to a head in the soil/oil issue. Thus the query: how much land can the United States afford to protect for the quality of living of its people and how much land must be kept in agricultural production? Essentially, what is the soil/oil balance to be? To initiate long-range, multinational discussion on this issue, the AGWIM simulation model was used.

AGWIM

AGWIM is the agricultural version of the world integrated model, WIM,[4] which is a large scale simulation model representing full con-

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[1] Paper presented at the National Workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

[2] Systems Application, Inc., Shaker Heights, Ohio.

[3] USDA, Forest Service, The Nation's Renewable Resources - An Assessment, 1975.

[4] Strauch, Patricia, "Description of World Integrated Model," Systems Applications Company, Inc., Cleveland, Ohio, 1978.

Pat Strauch presented a detailed run-through of AGWIM, the Agricultural version of the World Integrated Model, using a combination of slides, overheads, and a display screen linked through a computer terminal to a data base in Cleveland.

figurations of energy, agriculture, population, economics, and trade. AGWIM includes two USDA models; NIRAP, the national integrated regional agricultural production model, and GOL, the world grain, oilseed, livestock model. The combination of these three models, AGWIM, is the basis for analysis presented in this paper.

In this model the world is represented by thirteen regions. They are the United States, Canada, Western Europe, Pacific Developed, Rest of Developed, Eastern Europe, Latin America, Middle East Oil Producing, Middle East Non-oil Producing, Africa, South Asia, Southeast Asia, and China (fig. 1). The model cycles annually and covers the years from 1980 to 2000.

The Land-Use Representation

The total land base of the United States is 2.32 billion acres or 916 million hectares. Seventy percent of this is forests or range land; forty-six percent of that seventy percent is in range and non-commercial forest and twenty-four percent is in commercial forest. Twenty percent of the total land base is crop land and ten percent is urbanized.[5] Using information from the Department of Agriculture,[6] five land usage categories were established.

The first of these categories is miscellaneous land; that is, land that cannot be usefully developed, such as swamps, mountains, deserts. This land comprises 122 million hectares. The second category is crop land. This includes all land which is used for planting crops and does not include crop land which is grazed. The sum of this category is 154 million hectares. The third category which totals 348 million hectares is pasture; it includes open pasture, forest land pasture and grazed crop land. The fourth category with 218 million hectares is forest land which does not include any pastured forest land. The final category, which totals 74 million hectares, is designated as urban land but includes in addition to land in urban areas, transportation land such as highways and airports, parks, federal industrial land and farm lands. This is the category of people support land and the one most directly impacted by population and income growth.

[5]Smith, Guys-Harold, ed., Conservation of Natural Resources, Wiley, 1963.
McClellan, Grant, ed., Land Use in the United States, H.W. Wilson Co., 1971.

[6]USDA, Austin Fox description of NIRAP output.

Scenario I

Two scenarios have been prepared to analyze the soil/oil tradeoff. Under the first scenario it is assumed that Carter's energy plan is enacted. In other words, it is assumed that the U.S. will decrease its dependence on oil as a fuel source and will substitute with an increase in its consumption of gas, coal and nuclear fuel. Under this scenario, the annual consumption of oil will vary little from year to year during this 20 year time period, staying in the range of 6.5 to 7.5 billion barrels of oil a year. However, consumption of gas will increase from 4.5 billion barrels to nearly 8 billion barrels of oil equivalent by the end of the century. Coal consumption will increase from somewhat over 3 billion barrels to 10 billion barrels of oil equivalent and nuclear consumption will increase from its present level to nearly 3 billion barrels of oil equivalent by the turn of the century (fig. 2).

In this scenario, the U.S. population growth rate remains well under 1% a year and an economic growth rate, in real terms, of about 4% a year is obtained for each year of this 20 year period.

The next set of assumptions concern land use projections. The first of these is that

Fig. 1.--Regionalization of the World System

land will be converted to population support purposes--urban, industrial, transportation--at the same per capita rate that obtains in 1975 and that for each $1,000 increase in real income per capita the 1975 urban land-person ratio will be increased by 5%. (Under this assumption, it would take a $20,000 increase in real income per capita to double the per person land base support required.)

Finally, under this first scenario, USDA's models have been used to make projections on grain yield, crop land usage and production. The USDA estimates that grain yield increases to the turn of the century will be in the range of 25% over the 1975 values. They also estimate that crop land and crop land pasture, which is the total of our second category and a portion of our third category, will increase from 467 million acres or 189 million hectares in 1974 to 485 million acres or 196 million hectares in the year 2000. Both of these projections are part of the assumptions which underlie this scenario.

We can now describe the results of Scenario I. Under this scenario, the world economic product in constant 1975 dollars increases from 7.2 trillion dollars in 1980 to 15.8 trillion dollars by the turn of the century, more than doubling over the time period. World population increases from 4.3 billion persons to slightly over 6 billion persons by the end of the century. This is a very moderate projection of population growth and is based upon the assumption that some degree of birth control is possible in this time frame throughout the world. Average world income per capita is initially 1,650 dollars, increasing to 2,600 dollars by the end of the run. The price of oil doubles during this time frame. It begins at slightly over $12.00 a barrel and holds within that range until about 1990 when the impact of increasing production and decreasing reserves has its effect; the price of oil then begins to rise rapidly and is nearly 26 dollars a barrel by the turn of the century (fig. 3).

SCENARIO 1

	CONS OIL USA	CONS GAS USA	CONS COAL USA	CONS HYDRO USA	CONS NUC USA
1980	6.52305	4.79880	3.3615	0.203580	0.36071
1981	6.60517	4.97617	3.5444	0.206429	0.45756
1982	6.68764	5.10947	3.8011	0.209056	0.54450
1983	6.78318	5.24626	4.0034	0.211728	0.61582
1984	6.90072	5.38741	4.2143	0.214496	0.69564
1985	7.04202	5.53171	4.4328	0.217324	0.78163
1986	7.19518	5.67969	4.6597	0.220252	0.87244
1987	7.33772	5.83283	4.8963	0.223364	0.96719
1988	7.46644	5.99030	5.1505	0.226664	1.06649
1989	7.59134	6.15001	5.4429	0.230123	1.17111
1990	7.25861	6.31306	5.7777	0.233838	1.28277
1991	6.99263	6.46748	6.1477	0.237414	1.40075
1992	6.85592	6.63065	6.5678	0.241102	1.53078
1993	6.80608	6.80505	7.0076	0.243977	1.67094
1994	6.81832	6.98821	7.4483	0.246859	1.81918
1995	6.86686	7.17707	7.8917	0.249719	1.97496
1996	6.94653	7.36752	8.3431	0.252547	2.13943
1997	6.86564	7.56137	8.8171	0.255209	2.31504
1998	6.81104	7.74944	9.3223	0.257731	2.50411
1999	6.75118	7.84659	9.8724	0.260280	2.70558
2000	6.69026	7.92778	10.4794	0.262856	2.91786

Fig. 2.--CONS - Energy consumption, billions of barrels of oil equivalent.

SCENARIO 1

	YTOT	POPTOT	YPCTOT	PRO
1980	7252.8	4382.99	1.65475	12.2864
1981	7553.1	4461.57	1.69291	12.7138
1982	7906.9	4540.64	1.74135	13.0002
1983	8301.3	4620.20	1.79674	13.0780
1984	8662.2	4700.38	1.84286	12.9260
1985	9064.6	4781.20	1.89589	12.6559
1986	9438.6	4862.78	1.94098	12.5096
1987	9819.1	4945.02	1.98565	12.4639
1988	10210.9	5027.98	2.03081	12.4033
1989	10619.0	5111.71	2.07739	12.5399
1990	11044.9	5196.26	2.12555	12.8943
1991	11327.2	5281.68	2.14463	13.9030
1992	11564.5	5367.99	2.15435	15.3576
1993	11913.6	5455.27	2.18387	17.0161
1994	12362.2	5543.42	2.23007	18.6829
1995	12943.0	5632.43	2.29795	20.2168
1996	13594.1	5722.36	2.37560	21.5446
1997	14288.6	5813.18	2.45797	22.6209
1998	14858.1	5904.78	2.51629	23.7299
1999	15385.0	5997.07	2.56542	24.8573
2000	15889.4	6090.00	2.60910	25.9981

Fig. 3.--

YTOT - World economic product, billions of 1975 dollars;
POPTOT - World population total, millions of persons;
YPCTOT - Average world income per capita, thousands of 1975 dollars;
PRO - Price of a barrel of oil, 1975 dollars.

Population in the United States grows from 221 million persons to 246 million persons, with a population growth rate of .7% initially, decreasing to about half that by the end of the century. Demand for agricultural products in other parts of the world grows with population and income per capita, but is restrained by a fifty percent increase in food prices, a doubling of oil prices, and balance of payments problems. Despite this, world demand for agricultural products grows and the U.S. still enjoys a substantial export market to which to respond (fig. 4).

The gross national product in the United States in 1980 is 1.7 trillion dollars and climbs to nearly 4 trillion dollars by the year 2000. Income per capita, initially 8 thousand dollars, is well over 15 thousand dollars by the turn of the century. Forty-five billion dollars are spent to import oil in 1980; in 1996, 68 billion dollars are spent for the same purpose, but, given the effective implementation of Carter's plan, that level is maintained until the turn of the century. Ten billion dollars are earned in 1980 from exporting agricultural goods. By 1990, this item increases slowly to only 15 billion dollars, but, as the price of oil increases, food prices are impacted and food export dollars increases to 25 billion dollars annually by the turn of the century. This is based upon the USDA's models projected grain price increase, in real terms, of about 50% over the 1975 price.

Let's now turn attention to the land use patterns that evolve under these conditions.

First of all, assuming the USDA projection of crop land and pasture land changes, these categories remain almost constant during the time frame, increasing by approximately 5 million hectares from 1980 till 2000. Of course, the land that is maintained under crop and pasture use is not maintained cost free. Maintenance dollars have been put into this land in order to secure its effective capacity. The amount of land which is added to population support grows dramatically both because of the increase in population and the doubling in real income per capita. Initially 78 million hectares are used for this purpose; by the turn of the century, 52 million hectares have been added for a total of 130 million hectares. With the encrouchment of population needs on land and the slight increase in crop land and pasture land, it is obvious that forest land must be decreased. In this scenario, forest land declines from 214 million hectares to 157 million hectares (fig. 5).

The significance of these redistributions can best be viewed in per capita terms in order to give more meaning to these numbers. Urban land per capita, initially 35% of a hectare, or 68% of an acre per person, increases by the end of the century to 53% of a hectare or about one and a quarter acres per person. This occurs because of the doubling of income per capita and the fact that richer people use more land. Forest land per capita, initially 96% of a hectare, or well over 2 acres per person, has by the end of the run, decreased to 64% of a hectare or about 1 1/2 acres per person. The question to be addressed by other analysts, given these results, is whether or not forest product yield can be increased sufficiently to maintain production demanded by a growing and ever more affluent population.

SCENARIO 1

	POP USA	POPR USA	Y USA	YPC USA	OD USA	FD USA
1980	221.577	0.0072733	1786.67	8.0634	-45.1873	10.4704
1981	223.188	0.0072250	1854.05	8.3071	-47.7722	10.3542
1982	224.801	0.0071170	1933.84	8.6025	-49.6991	10.4935
1983	226.401	0.0069465	2020.19	8.9231	-50.8573	11.0319
1984	227.973	0.0067167	2100.48	9.2137	-51.2616	11.8142
1985	229.505	0.0064400	2184.36	9.5177	-51.3499	12.0409
1986	230.983	0.0061365	2272.06	9.8365	-51.9551	12.5253
1987	232.400	0.0058286	2362.93	10.1675	-52.7505	12.9700
1988	233.755	0.0055349	2456.40	10.5085	-53.2414	13.5443
1989	235.049	0.0052676	2553.04	10.8617	-54.4888	14.2331
1990	236.287	0.0050319	2658.42	11.2508	-50.7730	15.0195
1991	237.475	0.0048252	2764.23	11.6401	-49.9833	15.8557
1992	238.621	0.0046382	2869.87	12.0269	-51.9264	16.4934
1993	239.728	0.0044533	2977.84	12.4217	-55.3717	17.3806
1994	240.795	0.0042537	3091.32	12.8380	-59.5965	18.6862
1995	241.820	0.0040427	3209.87	13.2738	-63.9555	19.8135
1996	242.798	0.0038418	3334.32	13.7329	-68.3024	20.9936
1997	243.730	0.0036686	3467.03	14.2249	-68.2958	22.0651
1998	244.624	0.0035269	3603.56	14.7310	-68.7556	23.0989
1999	245.487	0.0034079	3746.89	15.2631	-68.9541	24.1845
2000	246.323	0.0032966	3896.50	15.8186	-68.9848	25.1515

Fig. 4.--

POP - U.S. population, millions of persons;
POPR - U.S. population growth rate, percentage;
Y - U.S. gross national product, billions of 1975 dollars;
YPC - U.S. income per capita, thousands of 1975 dollars;
OD - U.S. dollars spent on oil imports, billions of 1975 dollars;
FD - U.S. dollars earned from agricultural exports, billions of 1975 dollars.

SCENARIO 1

	CROPLD	PASTUR	URLD	FOREST	URLDPC	FORPC
1980	154.939	346.186	78.351	214.524	0.353606	0.968170
1981	155.029	346.363	79.412	213.196	0.355805	0.955228
1982	155.142	346.516	80.650	211.692	0.358763	0.941685
1983	155.259	346.706	82.015	210.020	0.362254	0.927647
1984	155.349	346.828	83.367	208.456	0.365689	0.914387
1985	155.454	346.943	84.843	206.760	0.369678	0.900896
1986	155.554	347.131	86.446	204.869	0.374253	0.886944
1987	155.643	347.265	88.187	202.905	0.379462	0.873085
1988	155.748	347.438	90.079	200.734	0.385358	0.858740
1989	155.842	347.622	92.137	198.399	0.391990	0.844078
1990	155.936	347.793	94.374	195.896	0.399406	0.829062
1991	156.033	347.979	96.806	193.183	0.407645	0.813486
1992	156.118	348.154	99.451	190.277	0.416773	0.797400
1993	156.202	348.322	102.328	187.148	0.426851	0.780669
1994	156.286	348.478	105.453	183.783	0.437937	0.763231
1995	156.373	348.647	108.843	180.137	0.450098	0.744921
1996	156.453	348.839	112.490	176.218	0.463308	0.725783
1997	156.532	349.005	116.450	172.013	0.477782	0.705754
1998	156.615	349.195	120.737	167.453	0.493563	0.684532
1999	156.685	349.374	125.375	162.566	0.510720	0.662217
2000	156.758	349.535	130.383	157.324	0.529315	0.638689

Fig. 5.--

CROPLD - Cropland, millions of hectares;
PASTUR - Pasture land, millions of hectares;
URLD - Urban, people-support land, millions of hectares;
FOREST - Forest land, millions of hectares;
URLDPC - Urban, people-support land per capita, fraction of a hectare;
FORPC - Forest land per capita, fraction of a hectare.

We can view the issue from another perspective. We can look at the economic soil/oil gap that would develop under this scenario. First of all we can view the gap in trade dollars, that is, the excess money spent to import oil over the amount of money earned by exporting agricultural products. Initially this gap is in the range of 34 billion dollars. Under the assumptions in this scenario it peaks in 1996 at 47 billion dollars, and, given an increase in food exports and nearly constant annual oil imports from that time on, we see a decline in the size of the gap to 43 billion dollars at the turn of the century.

Now let us assume that an attempt is made, over this 20 year time period beginning in 1980, to close that gap through increased agricultural export earnings. There are a number of ways this can be done. Let us consider two of these: More land can be cultivated, more yield produced per hectare. What would be a sufficient increase in cultivated land to fill this 43 billion dollar trade gap by the year 2000, assuming the projected USDA yield increases and price changes? The answer is that by the turn of the century it would require 37 million hectares being added to cultivation. This is approximately a 25% increase in the land that is presently under cultivation. The question then becomes, from what category is this withdrawn? Is it withdrawn from pasture land? If so, what will happen to our meat production? Is it withdrawn from land that would otherwise go to people support? If that is the case, what kind of area and economic constraints are U.S. citizens going to have to recognize and accept? Or is it going to be withdrawn from forest land? That being the case, what is going to be the impact on forest products, on recreational opportunities, and on environmental considerations?

Assuming that it is deemed possible to develop this additional land base to fill the soil/oil gap, what would the price tag be? Cost of land development, initially 1,200 dollars per hectare, more than doubles over the 20 years because of the increasing scarcity of land to be developed. Taking that land development cost figure, the additional amount of investment in land development necessary to fill the gap would be 104 billion dollars by the year 2000. Obviously this is an unsupportable decision since this is more than twice the dollar gap that we are attempting to bridge and is approximately 8 times the amount projected by the model for investment in land development in the year 2000 (fig. 6).

Having explored that alternative, let us attempt to fill the 43 billion dollar gap through an increase in the yield per hectare, maintaining the cultivated land base at the size projected by the Department of Agriculture. Under this option, U.S. farmers would have to produce, by the year 2000, an additional 2.34 metric tons per hectare. This is 50% per hectare more than the USDA projections. Assuming that it is an acceptable possibility, this yield increase, at costs projected over the 20 year time frame, would require an additional amount of investment in agriculture in the range of 13.5 billion dollars, which is about a third of the gap that we are attempting to fill and about double the projected investment for yield increases.

Finally, let's assume that one or another of the alternatives would be acceptable and make an extrapolation to 2025, without benefit of the model, from the trends that the model has projected up to the year 2000. Under this extrapolation the oil agricultural gap reaches 55 billion dollars in 2025. The amount of cultivated land that would be necessary to close this gap is 67 million hectares, well over 40% of what is currently under cultivation. The amount of additional yield per hectare necessary to close the gap is about 4.5 metric tons per hectare. If the increase in cultivated land were pursued, it would cost 210 billion dollars, 4 times the gap itself; if an increase in yield were pursued, investment required would be 26 billion dollars, approximately half of the gap itself (fig. 7).

SCENARIO 1

	AGOGAP	LNDGAP	YLGAP	IALGAP	IAGAP
1980	-34.7169	11.4128	0.56772	15.714	2.5492
1981	-37.4180	14.2038	0.71766	20.319	3.2623
1982	-39.2056	16.6653	0.85492	24.740	3.9488
1983	-39.8255	18.5618	0.96660	28.660	4.5364
1984	-39.4473	19.8339	1.04852	31.903	4.9707
1985	-39.3090	21.0929	1.13160	35.142	5.4191
1986	-39.4298	22.4647	1.22269	38.837	5.9177
1987	-39.7805	23.8148	1.31397	42.782	6.4303
1988	-39.6981	24.8649	1.39025	46.240	6.8818
1989	-40.2558	26.2304	1.48519	50.659	7.4406
1990	-35.7536	24.1388	1.38355	48.333	7.0174
1991	-34.1276	23.7880	1.37950	49.358	7.0854
1992	-35.4330	25.4268	1.49127	54.709	7.7516
1993	-37.9911	28.0205	1.66144	62.402	8.7380
1994	-40.9104	30.8903	1.85038	71.178	9.8516
1995	-44.1420	34.0426	2.05896	81.115	11.1027
1996	-47.3089	37.2813	2.27615	91.917	12.4371
1997	-46.2307	37.1196	2.28655	94.656	12.6648
1998	-45.6567	37.3327	2.31949	98.320	13.0233
1999	-44.7697	37.2352	2.33255	101.439	13.2768
2000	-43.8334	37.0359	2.33842	104.145	13.4938

Fig. 6.--

AGOGAP - Agriculture/oil trade gap, billions of 1975 dollars;
LNDGAP - AGOGAP translated to land gap, millions of hectares;
YLGAP - AGOGAP translated to yield gap, metric tons per hectare;
IALGAP - LNDGAP translated to billions of 1975 dollars;
LAGAP - YLGAP translated to billions of 1975 dollars.

SCENARIO 1

	AOGAPR	LDGAPR	YLGAPR	IALGPR	IAGAPR
1980	-34.7000	11.4100	0.56700	15.710	2.5500
1985	-39.3000	21.0900	1.13200	35.140	5.4200
1990	-35.8000	24.1400	1.38400	48.330	7.0200
1995	-44.1000	34.0400	2.05900	81.120	11.1000
2000	-43.8000	37.0400	2.33800	104.140	13.4900
2005	-46.0856	43.4440	2.78040	126.248	16.2260
2010	-48.3713	49.8480	3.22280	148.356	18.9620
2015	-50.6570	56.2520	3.66520	170.464	21.6980
2020	-52.9426	62.6560	4.10760	192.572	24.4340
2025	-55.2283	69.0600	4.55000	214.680	27.1700

Fig. 7.--

AOGAPR - Agriculture/oil trade gap extrapolated to 2025, billions of 1975 dollars;
LDGAPR - AOGAPR translated to land gap, millions of hectares;
YLGAPR - AOGAPR translated to yield gap, metric tons per hectare;
IALGPR - LDGAPR translated to billions of 1975 dollars;
IAGAPR - YLGAPR translated to billions of 1975 dollars.

Scenario II

A second scenario was run in which the assumptions used in the first scenario are maintained with one exception. Here it is assumed that Carter's plan is not enacted, that we respond to, and don't anticipate, energy problems. Under this scenario the U.S. continues to attempt to use oil as its primary energy source. It is only forced to reduce oil consumption as relative fuel prices dictate and not because of a policy which anticipates prohibitive prices and scarcity.

Under this scenario the price of oil peaks at 31.8 dollars a barrel in 2000, U.S. income per capita grows to 15 thousand dollars in that year. Earnings from agricultural exports in 2000 is 23 billion dollars, 2 billion less than in the first scenario and the cost of importing oil is over 176 billion dollars in that year. U.S. consumption of oil steadily grows to 9.5 billion barrels annually in 2000, coal to 8 billion barrels of oil equivalent, gas to 7.4 and nuclear to under 1 billion barrels of oil equivalent. Despite the increase in oil prices, it is still the main energy source in the U.S. in the year 2000 (fig. 8).

The soil/oil gap in this scenario reaches 153 billion dollars by the end of this run. The land that would be required to fill this gap is 140 million hectares, about 95% of the land under cultivation in 1975. That means nearly a doubling of the cultivated land base. This additional 140 million hectares would have to come from other land uses and would cost an additional 271 billion dollars in land investment. If we chose to fill this gap through an increase in yield per hectare, it would require an additional 8.2 metric tons of yield per hectare at a cost of 35 billion dollars per year in investment by the turn of the century. This 35 billion dollars is well in excess of the projected total agricultural investment in 2000 (fig. 9).

Conclusions

Under the first scenario a 48% annual increase in investment in agriculture would be required to fill the 43 billion dollar gap at the turn of the century; under the second scenario the increase would be over 1.8 times the projected agricultural investment. If cultivated land was to be increased under the first scenario, the investment in land required would be 7.5 times the projected investment in land; under the second scenario, it would be 29 times the base projection of investment in land development. The land required under the first scenario would be approximately 35% more than the Department of Agriculture projections; under the second scenario, it would be 1.3 times the projection. If yield increases were sought, the yield increase required under the first scenario would be 50% increase over what is projected by the Department of Agriculture;

SCENARIO 2

	AGOGAP	LNDGAP	YLGAP	IALGAP	IAGAP
1980	-34.740	11.417	0.56792	15.720	2.5501
1981	-39.204	14.875	0.75180	21.277	3.3806
1982	-43.179	18.352	0.94132	26.981	4.2745
1983	-46.106	21.507	1.11894	32.746	5.0858
1984	-48.577	24.467	1.29007	38.284	5.8613
1985	-50.962	27.508	1.46871	44.112	6.6734
1986	-53.290	30.591	1.65245	50.391	7.5117
1987	-55.994	33.902	1.85120	57.172	8.4192
1988	-60.318	38.335	2.11425	66.093	9.6195
1989	-62.219	41.287	2.29822	72.740	10.4546
1990	-57.788	39.891	2.23957	71.648	10.1833
1991	-59.695	42.727	2.41872	78.136	10.8452
1992	-66.690	49.405	2.81801	90.742	12.2675
1993	-76.578	58.739	3.36743	106.976	14.4735
1994	-88.641	70.128	4.03262	128.826	17.3615
1995	-102.073	83.105	4.79271	154.573	20.8278
1996	-117.709	98.378	5.69142	185.430	24.9543
1997	-125.920	107.981	6.26969	206.345	27.6681
1998	-134.364	117.850	6.87029	227.990	30.1203
1999	-143.177	128.427	7.51480	248.559	32.6222
2000	-152.852	140.082	8.22001	271.432	35.3095

Fig. 9.--

AGOGAP - Agricultural/oil trade gap, billions of 1975 dollars;
LNDGAP - AGOGAP translated into land gap, millions of hectares;
YLGAP - AGOGAP translated into yield gap, metric tons per hectare;
IALGAP - LNDGAP translated to billions of 1975 dollars;
IAGAP - YLGAP translated to billions of 1975 dollars.

SCENARIO 2

	PRO	YPC USA	OD USA	FD USA	CONS USA OIL	CONS USA GAS	CONS USA COAL	CONS USA HYDRO	CONS USA NUC
1980	12.2864	8.0633	-45.187	10.4470	6.52306	4.79881	3.36151	0.203580	0.360713
1981	12.7137	8.3015	-49.526	10.3221	6.74313	4.98194	3.48416	0.206668	0.429374
1982	13.0460	8.6339	-53.617	10.4384	6.97454	5.12273	3.61258	0.209616	0.444476
1983	13.2093	8.9127	-57.241	11.1358	7.22783	5.26985	3.71280	0.212749	0.464730
1984	13.1797	9.1984	-60.304	11.7267	7.51044	5.42133	3.81588	0.216023	0.487751
1985	13.0065	9.4919	-62.974	12.0125	7.82640	5.57572	3.92081	0.219421	0.512465
1986	12.8133	9.7995	-65.730	12.4403	8.17177	5.73250	4.04814	0.222974	0.538271
1987	12.6848	10.1201	-68.866	12.8724	8.53451	5.89221	4.20417	0.226777	0.564742
1988	12.8843	10.4487	-73.750	13.4311	8.89793	6.05581	4.39226	0.230965	0.591644
1989	13.3585	10.8022	-76.301	14.0829	8.95792	6.22556	4.60780	0.234324	0.618873
1990	14.0843	11.1973	-72.581	14.7934	8.47431	6.39713	4.82705	0.237177	0.645670
1991	15.5420	11.4232	-75.239	15.5438	8.23850	6.56769	5.03556	0.239955	0.671423
1992	17.5257	11.4522	-82.785	16.0953	8.19841	6.75357	5.24905	0.242781	0.697592
1993	19.7467	11.6590	-93.526	16.9482	8.28828	6.94515	5.46825	0.245363	0.723185
1994	21.9682	12.0329	-106.638	17.9969	8.48260	7.13812	5.70116	0.247792	0.728346
1995	24.0189	12.5293	-121.284	19.2102	8.75290	7.33242	5.95372	0.250240	0.736555
1996	25.8121	13.0639	-137.740	20.0316	9.11253	7.53398	6.22382	0.252718	0.748259
1997	27.2950	13.6507	-146.790	20.8697	9.22439	7.74274	6.50202	0.255215	0.770611
1998	28.7758	14.1008	-156.057	21.6937	9.33682	7.89394	6.78888	0.257736	0.807652
1999	30.3035	14.5408	-165.801	22.6238	9.44852	7.98252	7.09150	0.260288	0.861279
2000	31.8834	15.0042	-176.321	23.4690	9.56699	8.05760	7.41470	0.262867	0.915463

Fig. 8.--

PRO - Price of a barrel of oil, 1975 dollar;
YPC - Income per capita, thousands of 1975 dollars;
OD - Billions of dollars spent to import oil;
FD - Billions of dollars earned from exporting agricultural products;
CONS - Energy consumption in billions of barrels of oil equivalent.

under the second scenario, it would be 1.8 times greater than USDA projections (fig. 10).

The most important insight highlighted by this analysis is that the U.S. can no longer rely upon agricultural exports to offset oil import costs. Even assuming the effective implementation of Carter's energy plan, the cost of maintaining our standard of living with a healthy economy based on high energy use exceeds even the most optimistic projections of earnings gained from exporting food. This obviously has a large set of consequences. It may mean that other U.S. products must become more competitive on the world market. It may mean that we must become more conservative in our use of oil. What it certainly means is that we must recognize the boundaries of agricultural exports as a foreign trade balancer.

Finally the finiteness of our land resources must be recognized. While land may be a renewable resource it is not an expandable one. There are 794 million hectares of land in the United States and projected demands indicate a strong necessity for conscious and conscientious planning of land use programs. Even as this paper is being written, events in far-away Iran have rippled to our shores in the form of rapidly increasing oil prices, an open-market price of $20 a barrel. President Carter is meeting with President Portillo in Mexico to discuss the issues of migration, trade, and oil. The US projects a $55 billion oil import bill next year in the face of these new events. All of these events put pressure on the U.S. balance of trade situation, emphasizing the role of land use programs, especially in the several categories discussed in this paper.

Mike Mesarovic gave a thought-provoking analysis of what food simulation models can -- and cannot -- do.

	SCENARIO 1 AND 2				SCENARIO 1 AND 2			
	YLGRR	YLGR1	LDGRR	LDGR1	IAGRR	IAGR1	IALGRR	IALGR1
1980	0.151200	0.15200	0.109072	0.10917	0.151425	0.15143	2.19108	2.1955
1981	0.188451	0.19685	0.135652	0.14213	0.188113	0.19708	2.74224	2.8992
1982	0.220361	0.24289	0.159141	0.17525	0.220112	0.24275	3.21299	3.5500
1983	0.245431	0.28426	0.177049	0.20527	0.245538	0.28468	3.58250	4.2149
1984	0.262000	0.32331	0.189019	0.23347	0.261717	0.32322	3.85732	4.8090
1985	0.278133	0.36386	0.200915	0.26230	0.278091	0.36289	4.10514	5.4123
1986	0.296126	0.40342	0.213925	0.29169	0.296000	0.40355	4.38870	6.0638
1987	0.313604	0.44686	0.226546	0.32320	0.313200	C.44692	4.67541	6.7259
1988	0.327059	0.50358	0.236442	0.36536	0.326686	0.50473	4.87763	7.6493
1989	0.344548	0.54762	0.249264	0.39350	0.344285	0.54342	5.17467	8.2378
1990	0.316705	0.52582	0.229250	0.38012	0.316644	0.52501	4.77098	8.0145
1991	0.311512	0.56279	0.225797	0.40715	0.311923	0.56224	4.70869	8.7307
1992	0.332589	0.65127	0.241203	0.47088	0.332761	0.65093	5.06105	10.2300
1993	0.366446	0.77471	0.265643	0.56023	0.366611	0.77338	5.58640	11.9531
1994	0.403930	0.92220	0.292685	0.66899	0.403689	0.92340	6.17346	14.3144
1995	0.444708	1.09589	0.322348	0.79286	0.444356	1.09401	6.81109	16.9114
1996	0.486538	1.29545	0.352830	0.93865	0.486508	1.29409	7.48534	19.9817
1997	0.484534	1.42177	0.351149	1.03025	0.483760	1.42043	7.47119	22.0695
1998	0.486373	1.55079	0.352969	1.12442	0.486365	1.55018	7.52257	24.3840
1999	0.484823	1.68764	0.351824	1.22583	0.484848	1.69015	7.51964	26.5555
2000	0.482062	1.84305	0.349896	1.33741	0.481785	1.84386	7.49208	29.0922

Fig. 10.--

YLGRR - Ratio of yield per hectare gap in scenario 1 to USDA reference projection
YLGR1 - Ratio of yield per hectare gap in scenario 2 to USDA reference projection
LDGRR - Ratio of land gap in scenario 1 to USDA cropland projection
LDGR1 - Ratio of land gap in scenario 2 to USDA cropland projection
IAGRR - Ratio of dollar cost of closing yield gap in scenario 1 to investment in yield increase investment projection
IAGR1 - Ratio of dollar cost of closing yield gap in scenario 2 to investment in yield increase investment projection
IALGRR - Ratio of dollar cost of closing land gap in scenario 1 to USDA cropland projection
IALGR1 - Ratio of dollar cost of closing land gap in scenario 2 to USDA cropland projection

Changing Values and the Environment[1]

Peter Schwartz[2]

Introduction

The primary foci of this paper are two related issues: 1) the basis for the values which shape our attitudes toward the natural environment, and 2) the likelihood for those values to change significantly in the years ahead. Part I suggests a framework for considering those issues. This framework is followed by a substantive discussion of:

- a historical perspective
- foundations of basic beliefs
- the women's revolution
- the meaning of the concept of nature
- alternative perspectives on the meaning of nature
- distribution of values in the population
- implications for policy

Levels of Analysis

A useful framework for analyzing fundamental change may be found in a medical analogy (Table 1).

One kind of diagnosis of illness is descriptive, focusing on symptoms. The relevant symptoms are such things as the patient's temperature, a runny nose, a broken bone, or a cough. Treatment focuses on relieving those symptoms. The second level of diagnosis attempts to find a pattern to those symptoms, called a disease syndrome. This leads to a search for some causative agents (e.g., a bacterial infection of some sort). The deeper interpretation of those symptoms leads to a different treatment (e.g., an antibiotic). There may lie a pattern beneath that disease syndrome. Perhaps the immune system of the body has, in some way, broken down. Something may be needed to restore the system, (e.g., changing the diet). Deeper still is the question of why it is that the immune system has broken down. This leads us to look at things like a person's life style, psychosomatic causes, basic beliefs that they have about themselves, and the way in which they live. Then the whole pattern of their lives may be the issue. In this paper the attempt is to focus attention on this deepest level.

Table 1

EXPLANATIONS OF ILLNESS

- Descriptive—symptoms
- Disease syndrome—causative agents
- Immunity systems breakdown
- Psychosomatic

A great many of the natural resources conflicts that appear intractable are because the participants are focusing on different levels; amenity value for resources for the forests is an example. Amenity value or efficiency are concepts which make sense at one level but are nonsense at another level. They are concepts that some people simply wouldn't even find meaningful because their whole basic belief system, their diagnosis, is going on at the most fundamental level instead of at a higher level.

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[1] Presented at the national workshop on Future Challenges in Renewable Natural Resources, Jan. 22-25, 1979, Rosslyn, Virginia.

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Historical Perspective[3]

The French historian, F. Braudel, in his introduction to THE MEDITERRANEAN, explains that in treating the Mediterranean world in the age of Philip II he had to write three histories. First is a history at the level of events--accessions to power, revolutions, treaties, laws, wars. As he says, "We must learn to distrust this history" because of the illusion that actions cause events, rather than both being manifestations of a deeper flow. The second history is at the level of institutions and institutional change. But this too fails to deal with all the forces present, so Braudel writes a third history, at the level of those enduring factors and patterns--climate, geography, basic cultural characteristics--which change only very slowly through the centuries, but nonetheless shape the changes at more rapidly varying levels.

Probably wide agreement could be reached that at that level of glacial movement one occurrence in the past millenium stands out in formative importance. That is the embarking of, first Western Europe and eventually practically all the world, on the journey which Robert Heilbroner termed "the Great Ascent"--the path of industrialization, modernization, economic development.

Table 2

MODERNIZATION TREND

- Secularization
- Industrialization
- Economic rationalization
- "Scientification" of knowledge

The first component of that trend is the secularization of values. Sociologists have used the term "secularization" to describe the predominant characteristic of this path toward modernity, secularization, as the tendency for society's activities and institutions to become rationally organized around impersonal, utilitarian values rather than shaped by traditional cultural and religious values. Accompanying secularization or deriving from it were other characteristics, including the industrialization of production, the development of modern science and technology, and the incorporation of an increasing fraction of human activity in the primary economic sector.

Lewis Mumford reminds us how dramatic was the values shift involved; "All but one of the seven deadly sins, sloth, was transformed into a positive virtue. Greed, avarice, envy, gluttony, luxury, and price were the driving forces of the new economy." That led to the dominance of industrial and economic values.

"Industrialization" of production involves breaking down the necessary operations into more and more elemental (and intrinsically meaningless) bits, and organizing and managing the performance of these bits so as to optimize with regard to such technical and economic criteria as efficiency and labor productivity. The modernization trend had led to industrialization of, first, production of goods and then on to services and thence to more and more of human activity.

Along with the industrialization of more and more of human activity is a parallel tendency of our economic accounting methods to force that activity into the primary economic sector. Exchanges which once were performed in the household and community (e.g., much food and clothing production, care of the aged) become commodities served out by large impersonal corporations. Other exchanges which remain in the household aren't counted in economic indicators (like the GNP)--and hence eventually seem psychologically to "not count." Thus, the housewife feels a pressure to "get a job," partly so her activities in the society will be counted.

Even more important in some ways is the steady encroachment of economic rationality into all aspects of societal decision making. Basic sociopolitical decisions at whatever level community or national involve noneconomic factors and often, explicitly or (usually) implicitly, basic metaphysical issues. Yet as the long-term trend has evolved, more and more of these fundamental philosophical concerns have been overwhelmed by the apparent power of economic rationality. We have been persuaded that the most rational and politically satisfactory decision rationale involved incorporating as faithfully as possible all relevant factors into an economic framework. Awareness of the extent to which this process distorts and corrupts human values has come to be largely suppressed. The question, "How much is a human life worth in dollars" has come to seem to be a meaningful question.

The fourth component of the trend is the "scientification" of knowledge. A brief reminder will serve to recall well-known characteristics of the dominant scientific paradigm. The primary emphasis is on observing the objective world through empirical measurement, and on quantitative data. Explanations tend to be reductionistic (explaining broad happenings in terms of elemental phenomena) and models to be deterministic. Science is basically value-inattentive, although it is dominated by the prediction-and-control values of the industrializing society in which it evolved.

[3] Most of the following discussion on the modernization trend is drawn from the work of Willis W. Harman.

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Technical and economic values play a commanding role in setting research priorities.

There has always been another kind of knowledge, of course, represented in the humanities and religions. This emphasizes human subjective experience. Here the concern is more with accurate representation of the qualitative, rather than on what can be quantified. Explanations tend to be holistic, and models teleological rather than deterministic. (For example, organisms are considered as wholes and their motivations and purposes are considered to be relevant data.) This knowledge is value-focused on what is wholesome for human and societal growth and development. As the prestige of positivistic science increased, this second kind of knowledge tended to be considered of secondary importance, or explained away in terms of the first. (Remember the "warfare" between science and religion, which science presumably won?)

The present value crisis--the crisis over what values and goals should guide our fabulously powerful manipulative capabilities--has its roots here. Every stable society that has ever existed on the globe, ancient or modern, Eastern or Western, has derived its basic value commitments from this area of subjective experience which our Western scientific/technological zeal has tended to downgrade if not debunk. As positivistic science eroded the transcendental base for Judeo-Christian values (or, more accurately, for the perennial wisdom of all the world's religious traditions), we tended to be left like a ship with powerful engines but no chart or compass.

Both within the scientific community and in the broader culture, these two kinds of knowledge are coming more and more to be recognized as complementary, as shedding different kinds of light on the totality of human experience. Scientific explorations into subjective phenomena--e.g., unconscious process, hypnosis, psychosomatic illness, biofeedback training--are being supplemented with new discoveries in such areas as consciousness research and psychic phenomena. Whenever the nature of man has been probed deeply, whether in the context of ancient esoteric or modern scientific endeavors, the predominant fact emerging is the duality of his experience. He is found to be both physical and spiritual, with neither explainable in terms of the other. Thus, scientific (physicalistic) and religious (transcendental) metaphors are complementary. Neither contradicts the other; both are needed to deal with man's wholeness.

To the extent that the "scientification" of knowledge has led to the erosion of knowledge about values and their origins, this aspect of the modernization trend is being questioned. Whether the boundaries of what we call "science" are to be explained, or two different names come to be used for the two complementary endeavors, a more evenhanded consideration of the two complementary aspects of knowledge appears to be part of our future.

The modernization trend may now be undergoing a fundamental shift.

Table 3

MODERNIZATION OUTCOMES

Abundance	→	Scarcity
Problem solving	→	Problem generating
Unintended benefits	→	Unintended detriments
Freeing	→	Enslaving
Democracy supporting	→	Democracy threatening

The advanced industrial nations make up the wealthiest society that the world has ever known. We live a bit like Louis XIV, the Sun King. We have applied economic and scientific power to solve some of the most awesome problems that any civilization has ever encountered. Along the way many kinds of unintended benfits resulted. The process has been liberating in most important ways. People have much greater freedom today than they every had before. Modernization has also permitted the kind of democratic revolutions that have characterized the last couple of hundred years.

The very same forces that have created abundance, problem solving, liberation, and democracy may now be counterproductive. Abundance is leading increasingly toward scarcity as we consume an ever greater fraction of the earth's resources. The economic and technological activities that helped us solve problems now lead to the generation of new problems. Increasingly, the problems that we face are problems of our own making, not problems of the world as we found it. The CO_2 problem, for example, is a problem of our own creation. The problems of the decaying urban areas, environmental degradation, disarmament; all the major problems facing society today are not the problems of nature; they're the problems of the world we have created. Modernization now seems to lead as often to unintended detriments as to benefits. More and more people seem to be constrained rather than freed. In that sense, democracy may be increasingly threatened. Democracy entails people having a sense that their lives are in their own hands; that they have some real influence over the course of their own lives. Increasingly people seem to have the sense that they have less control over their own lives. Social, political, and economic forces appear to determine the choices that they have.

Various historical and anthropological studies have uncovered the indicators of revolutionary change in the past. Table 4 shows those indicators of change. The currency of that list is further indication that the modernization trend may be breaking. It may be that we are seeing a similar indication of fundamental change. There are several other historic forces at work as well. They must be considered as a pattern because when some fundamental changes occur in society, the whole system has to rearrange itself in some important ways. If we examine some of the basic foundations of society, we find that there have been some important changes in progress at a fundamental level. The most obvious one is energy. Every time a civilization changes its energy source, it changes in many other ways as well. We moved first from a nomadic society to agricultural, changing our energy source as a result. Then we moved from an agricultural society and the burning of wood to a fossil-based society. Now the fossil era is clearly ending. Whether it's twenty years or fifty years, somewhere over the next half century or so, we're going to be shifting our basic energy source. That, in itself, represents a fundamental shift that will lead to other kinds of changes.

Table 4

REVOLUTIONARY CHANGE IN THE PAST
HAS BEEN PRECEDED BY INCREASE IN:

- Alienation
- Rate of mental illness
- Rate of violent crime
- Incidence of social disruption
- Tolerance of sexual hedonism
- Religious cultism
- Economic inflation

Our civilization is more vast and complex than any in human history. It isn't surprising that we have an overwhelming problem of trying to manage some of the larger governmental bureaucracies. It is doubtful that anyone understands HEW. The system has gotten so large and so complex that it may be beyond anyone's management.

The scale of our technological power has increased as well. We can do things today that we never could before. We can do things which are constructive, or destructive at a scale beyond anything in human history. The clearest example is our capacity to sterilize the planet with nuclear weapons. There are more people than we have ever had on the planet before. Finally, almost every stable era in human history has been characterized by an internally consistent view of the world; a fundamental metaphysic which made sense to people as was internally consistent. It was found in religion or science providing a consistent foundation of belief. Today, no such foundation exists. It's been fractured in the scientific and spiritual revolutions of the Twentieth Century. There is no shared basic belief system that organizes our world and there hasn't been one in this century.

As a result of these fundamental shifts in energy sources, in the scale of complexity, in the technological power available to us, the number of people, the basic structure of the world view, our future is uncertain. The outcome of this pattern of change is unpredictable. There are a number of basic changes in values that are in progress that are indicative of the outcome of that shift. A final indicator of this shift is the whole pattern of social movements, shown in Table 5. Rather than observing social movements as isolated and disconnected phenomena, insight can be gained by observing the whole pattern. All of those movements are arising simultaneously, and each is based on a changing view of basic beliefs and shifts in values.

Table 5

CONTEMPORARY SOCIAL MOVEMENTS

- Voluntary Simplicity, conserver society
- Environmentalism, ecological ethic
- Technology assessment, appropriate technology
- Decentralization, reruralization
- "Soft" energy, anti-nuclear
- Disarmament
- Person liberation, feminist
- Human potential, holistic health
- Transpersonal psychology, "new transcendentalism"

Foundations of Basic Beliefs

One of the points that was mentioned was the lack of a consistent fundamental view of nature. Most times in history, we've had such a world view. The Aristotelian view saw our world as much like nature; the processes of the world were like the seed, from which a tree grows. There was a higher transcendent order and a lower human order.

The Newtonian and Copernican revolutions changed that significantly. The Enlightenment changed it still further creating a new and relatively seamless world view. It served as the basic foundation for organizing social, individual and cultural values for several hundred years. Indeed, it was the foundation of the creation of the United States.

Beginning somewhere toward the end of the last century and moving rapidly into this century, that world view was fundamentally challenged. The heart of that challenge was evolution in biology and quantum and relativity theory in physics. What hasn't happened yet is the creation of a new and coherent world view. There are many different, disparate interpretations of the nature of reality. There isn't a single, seamless view that is likely to endure for several hundred years. There may be one in the process of emerging, the form of which is not clear yet.

There is an important epistemological change here that leads to a change in values. Science, in a sense, led to scientific metaphysics. It claimed that science could tell us everything we needed to know about the world. If there was anything worth knowing, we could find it out by the scientific method whether it was about people, nature, physics, chemistry or whatever. Eventually, it was supposed to lead us to a seamless and complete picture of the web of the world. Current research suggests that we may never be able to put together such a seamless picture of the world--that mystery may be a fundamental characteristic of life itself. In part that occurs because we've finally recognized that we're part of the game. What we do and how we interact with the world changes that world. Predicting the future is impossible because, in fact, we help create the future. As we move into a domain where uncertainty and mystery become fundamental characteristics of values and beliefs, science may move out of the metaphysical role that is has played for the last several hundred years. Science remains a tool and an informer, but not the basis of a new metaphysics. Perhaps a revitalized religious and spiritual base will form the foundations of a basic belief structure.

The Women's Revolution

Another emergent force shaping values is the growing impact of the women's revolution. A useful analogy can be drawn to the civil rights movement. The civil rights movement in the Fifties was, by and large, a leadership-oriented, elitist movement. It was relatively small in scale, and its primary goal was getting Blacks accepted into white society. The goal was a place for Blacks in white communities, white factories, white offices, and white voting booths. That didn't really work. What happened instead was that the movement changed characteristics. The real effect of the civil rights movement was to awaken a consciousness about their status in society in a whole generation of Blacks, young and old. When that occurred, the movement shifted goals. It's goal became getting whites to accept Blacks as Blacks. Hence, we say the rise of black power--black is beautiful--concepts that suggest that Blacks didn't have to change to fit in, rather that the society had to change to accept them. It was an important shift in consciousness.

The Women's Movement appears to be following a similar pattern. The Women's Movement began as a leadership-oriented, elitist movement of a relatively small number of women whose major goal was to get into a male-dominated society. Women wanted to get into the schools, jobs, the political process and soon; to fit into male roles. To some extent that's happening. However, the real effect of the Women's Movement is to do exactly what the Black Movement of the Fifties did for Blacks--that is to awaken the consciousness of women all over the country--young and old--to their status in society and to the fact that the basic social order and economic order arises from male values. That's important because men have made a logical mistake. Identity and equality are not the same. Two things can be equal without being identical. A woman and a man can be equal, but they don't have to be the same. Men had the image that they were going to unplug a male module and plug in a female module, and nothing was going to change as a result. All we had to do was unplug a number of men and, through equal opportunity we were going to plug in an equal number of women, the whole system remaining roughly stable. The obvious fact is that women are different from men.

As women and their own beliefs and values come increasingly to the fore, men are going to have to go through a great deal of change to accommodate them. Natural resources is one of the places where that force is likely to be felt earliest. It's not surprising that we have always talked about Mother Nature, not about Father Nature. Our extant environmental and natural ethic grows out of male views of reality rather than feminine view of reality. An example may help; my wife is a mountain climber. Because there aren't many women mountain climbers she climbs mainly with men. They want to get to the top; that's part of the thrill of climbing the mountain, but the goal of being on the mountain, of being receptive to the power of the mountain, or experiencing the mountain in an intimate way is why she's on the cliff face. It isn't to get to the top ahead of somebody else. There are no illusions about her having conquered the mountain. She knows who's in charge. The men who get to the top think they've conquered the mountain. Ask the mountain a thousand years later. The concept here is one of nurturance and receptivity when women look at nature.

In the document that was prepared for this meeting a quote from the Bible was in the front, "Man, the master of all life upon the earth and in the skies and in the seas." It's interesting that it's man and he's the master. That's not surprising. Western religious tradition has separated the body and the soul. It's a masculine religious tradition. It's other-worldly. William Blake suggested that man has no body distinct from his soul. The woman's view of the nature of religious experience is more like Blake's. Wendell Berry put it this way in his recent book, THE UNSETTLING OF AMERICA. "Contempt for the body is invariably manifested in contempt for other bodies: bodies of slaves, laborers, women, animals, plants, and the earth itself." Women, psychologically, tend to identify with the body, men with the mind. Women, in a sense, are of the body. Men are of the head, and, in that sense, the body is a metaphor for the earth. Caring for the body, metaphorically, becomes caring for the earth. It's not surprising that most gardening at home, tending of the earth around the house, is done by women, not by men. Our vegetable garden at home wasn't my doing. It was my wife's. She provided the food on our table. That shift in perspective of the meaning of nature in itself from a masculine to a feminine view is fundamental because women are coming, increasingly, into our society and are going to play new kinds of roles.

The Concert of Nature

One temptation is to suggest that we're going back to a kind of 19th century romaticism--that is, the view of nature held by Thoreau and Emerson. Though there are some people that do hold that view, James Ogilvy suggests a different pattern. Naive romanticism holds that nature is always good. No such notion could have arisen before the industrial era. People in the 17th century didn't say, "these are the good old days before industrialization destroys the natural environment." Romanticism became a perspective after the era of industrialization. Nature, obviously, isn't always good. Hurricanes, plagues, earthquakes are all natural disasters. Part of the task of technology has been to isolate us from the worst effects of nature. "If anything is natural to humanity, it would seem to be this ambivalent relation to nature, this love-hate struggle in which life is an oscillation between what is merely given and what's achieved by dint of transcending our origins." (Ogilvy) In other words, our origin is not our destiny. All of us have struggled with leaving our parents, often forcefully, to wander in a world which we have made. We leave our natural origins, our family, to go out into a world that we've helped create.

Furthermore, nature is no longer untouched by human hands. There isn't a place on the planet that we haven't, in some way or other altered so that mythical notion of nature is just that, a historical myth; it's gone forever. Ogilvy points out that nature once meant the alien environment, not an enemy, just the other, anything outside us, those things which are not subservient to our will. Once that meant sabre-toothed tigers, mammoths, hurricanes, floods, etc. Coping with an often hostile technological environment is much more what we do in our daily lives than dealing with mammoths and sabre-toothed tigers. Technology and the technological society begin to play some of the roles that nature once played in other civilizations. Technology, like nature, is, in some ways, beyond our control. Our tools, in some ways, have become disobedient. We aren't always able to control their effects. Our relationship to Mother Nature is ambivalent, so we may have a similar ambivalence to "stepmother" technology and the combination of an organic and technological nature. As with organic nature, Ogilvy's "neo-nature" is not amenable to total conquest. We always pay the price of trying.

Alternative Perspectives

As a result of these shifts in fundamental structures, belief systems, the scientific world view, the women's revolution, and a broadened concept of the meaning of nature itself, we can see two very different perspectives on nature and the natural environment. Table 6 shows this as a shift in perspective from Perspective I toward Perspective II.

Table 6

THE EMERGENT NATURAL PERSPECTIVE

A SHIFT FROM	TOWARD
I	II
Nature as a Resource	Nature as Sacred
Partition from Nature	Wholeness
Dominance over Nature	Nurture
Understandable	Mysterious
Management and Control	Unpredictable
Efficient Use	Caring
Technology Dominant	Technology Included in "Neo-Nature"
Symbols of Wealth	Real Wealth

Perspective I has been historically dominant. Nature is seen as primarily a resource, something for our use. The emergent Perspective II views that organic system, to some extent, as sacred, with the natural as symbolic of the divine. Perspective I holds that man is separate from nature. The alternative concept is wholeness; man as a part of nature. We too are natural. We cannot be separated from that thing which we study. Nature has an effect on us, we affect it, and that whole system must be considered together. Perspective I saw man as dominant over nature. Man is the master. Perspective II focuses on nurturance of the system of which we are a part. Science, according to Perspective I would lead to an understanding of how the whole system worked. More and more, we've learned that in nature unpredictable things happen. Nature behaves in surprising ways. Despite the advances of scientific knowledge, the mysteries of nature remain mysterious and wonderful. It is only an act of hubris to believe that man's science has mastered nature. We've a long way to go in terms of understanding the nature of nature. This lack of a firm foundation belies the goal of managing and controlling nature at the heart of Perspective I. Perspective II says that nature is unpredictable and hence unmanageable. Efficiency is a meaningful goal of management. Perspective II holds that because we aren't able to understand the whole system yet we have to carefully tend it. Perspective I says that technology is dominant. Our own capabilities can control it. We're able to create a technology that's able to manipulate and control nature. Perspective II now says that technology itself must become a part of the natural environment. We have to consider technology in its relationship to the natural environment and ourselves in relationship to both. Finally, Perspective I focuses on the symbols of wealth--dollars, gold, diamonds. These measures represent an abstract concept of wealth. Perspective II focuses on the sources of wealth--land, air, health, life, music, art, the basic things which constitute wealth itself, not the symbols of wealth. Conflicts in natural resource policy often arise because of the presence of these differing perspectives on nature. They are fundamental beliefs and not amenable to compromise as interests are.

Distribution of Values

At SRI we've being trying to understand the nature of human values and how they change with time. Arnold Mitchell, Director of our Values and Lifestyles Program, has developed a hierarchical model based on the work of Abraham Maslow and others. That model of values suggests that people, in their lives at various times in various ways, have patterns of values. Those patterns can be structured, leading to a typology of people-people whose sets of values, on the whole, conform to a pattern. Any one person has all values manifested in greater or lesser degrees. At any one moment in their lives, one particular set of values tend to dominate. The VALS typology is shown in Table 7. In recent months the VALS Program has linked our model with the data base of the National Opinion Research Center (NORC) in Chicago. We've been able to correlate the VALS model with the NORC data base arriving at a distribution in society.

Table 7

VALS GROUP DISTRIBUTION

Group	Percentage of Population Aged 18 or Over	Actual Number of People
Need-Driven	12%	19 million
Survivors	4%	7 million
Sustainers	8%	12 million
Outer-Directed	71%	109 million
Belongers	38%	58 million
Emulators	9%	14 million
Achievers	24%	37 million
Inner-Directed	17%	26 million

The first category of people is those people whose major motives have to do with meeting basic needs--survival and sustaining their survival capacities. These are mainly poor people and others low on the economic ladder. Roughly 12 percent of U.S. adults or 19 million people are in this group. Most of society fits into the second category, which we call outer-directed. Their values are socially derived. They are values which have to do with belonging--that is fitting in; values that have to do with emulation--that is adopting a pattern that other people have; finally, values that have to do with achievement. Achievers are the motors of this world. They're the executives, the scientists, the drivers for the most part. Outer-directed people comprise 71 percent of the population of 109 million people. The last category is inner-directed. They are people who look for their sources of meaning and basic drives in life within themselves. Seventeen percent or 26 million people altogether are inner-directed.

Our work indicated that the need-driven group is shrinking slightly. In the outer-directed group, belongers and emulators are remaining roughly constant. The biggest change is a shrinking in the number of achievers and a growth in the inner-directed. Year by year, that trend appears to be growing. Referring back to the two different perspectives noted earlier, we hypothesize that Perspective II is associated with the inner-directed and that Perspective I is associated with the outer-directed. Perspective II appears to be the one that is growing in force. That's not to suggest that the whole great number of middle

America--72 million people--have gone away. They're still there and they're remaining a relatively large and stable group.

As we look ahead this emergent pattern of values suggests that some of the historic relationships that have shaped our society may be in for change. For example, the relationship of economic growth to energy consumption may be increasingly decoupled. One of the consequences of an inner direction is that they are people who have the "luxury of frugality." By and large, they are people who have been wealthy, had adequate incomes, have lived reasonably well, and can afford to consume less and/or consume a higher quality but lower quantity. What that means is that we can produce an ever higher level of economic product without a higher level of energy consumption, without a higher level of resource degradation and lower levels of environmental impact. A study SRI is completing for the State of California shows that, in the long run California can have a population approximately twice what it is today, twice as wealthy in real terms, with no increase in energy consumption and almost no increase in environmental impact. Conversely, the same study suggests that if we're wrong about this increase in inner-directedness and the old pattern obtained, that by 2050 California would have roughly twice the population, three times the wealth, three times the energy consumption, and roughly twice as much environmental impact. Change in belief systems has a very fundamental long-term effect on the level of consumption of goods and the consequent consumption of energy and environmental impact.

Policy Implications

Mediating access to natural resources is the purpose of policy, but different kinds of people want different kinds of access. Table 8 shows some of those different people. There's a large group of people that, for the most part can be characterized by Perspective I. Among them are tourists. They are people who come to nature in order to see it. Loggers are people who want to use the forest. Consumers are people who use the products of the natural environment. In that same vein there are farmers, fishermen, and so on. People who have to manage land, people who own land, people who have to study nature are a hybrid between the two perspectives. An owner of land has a very different kind of perspective in the long run than somebody who simply wants to use it. Owners want to sustain and nurture it as well. Finally, there's a third group which has a kind of naive view of nature. Their major goal is to commune with the natural environment, to live lightly on the land and some people wanting to go back to living on the land. This group is becoming increasingly more sophisticated. They recognize that the naive romanticism of the early part of the decade is a thing of the past. Their view of nature is broadening.

Table 8

COMPETING GROUPS

Perspective I	Moving Toward II
Tourists Loggers Consumers Farmers Fishermen, etc.	
Perspective I/II	Little Change
Managers Landowners Scientists	
Perspective II	Broadening II
Communion Living lightly on the earth Back to the land	

It's important to understand in this analysis, the difference between political rhetoric and basic values. The political process involves asking for as much as can possibly be gotten in the hope that something will be won. It's not surprising that the political rhetoric is extremely polarized, nor is there any sign that rhetoric will change much. The basis for compromise in the short run, however, may be more plausible as the two perspectives shift more toward a harmony between them, simply in the growing recognition and acceptance of difference.

A fundamental change in basic beliefs and values is in progress. The evidence of that shift lies at the roots of our civilization itself. The forces for change attack our basic belief system and our relationship to the environment, involving both a greater reverence for and a broader concept of nature. The consequence is to make natural resource policy formulation increasingly more difficult because both divergent perspectives are still present and will be for some time. One can't be ignored to foster the other. They are very real and they are fundamentally different. The uncertainty as to which is likely to be dominant in the long run isn't going to be settled in five or ten or fifteen years. That's a fifty-year issue. The problem of that uncertainty in basic beliefs and values underlying resource projections and the policy decisions on the immediate horizon isn't going to go away tomorrow, and won't be resolved by a better forecasting model, or by a survey. That uncertainty is going to be with policy makers for a very long time to come.

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Panel Discussion:

Follow-Up Approaches to Incorporation of Workshop Ideas

Robert E. Buckman, Moderator[1]

LAMAR BEASLEY
Director, Resources Program and Assessment Staff, Forest Service

The Renewable Resources Planning Act of 1974, as amended, commonly referred to as RPA, requires the Secretary of Agriculture to prepare an assessment of the renewable resources program for Forest Service activities. Both the Assessment and Program are to cover four decades. The first Assessment was prepared in 1975, will be updated this year, 1979, and then every 10 years thereafter. The Program was prepared in 1975, and is also currently being updated. Both reports will be transmitted to Congress in early 1980. The drafts of both the Assessment and Program will be available for review in March of this year.

I don't intend to lay out all of the requirements that are to be met in preparing the Assessment and Program, but I will highlight a few of them so you can see how this workshop relates to the RPA planning effort.

The Assessment requires (1) an inventory of the renewable resources, (2) an analysis of the supply of and demand for the resources, including identification of program opportunities, (3) a description of Forest Service responsibilities, and (4) a discussion of policies, laws, and regulations that could affect the forests and rangelands. The Program includes alternatives for Forest Service activities, based on the Assessment, with an analysis of the costs and benefits.

In both the 1975 Assessment and the draft for 1979, we have used one scenario from which we have made our demand and supply projections. This is essentially the same scenario we have worked on for the past two days. In addition to the analysis built around the one scenario, we have done a limited amount of sensitivity

[1] Deputy Chief for Research, Forest Service, U.S. Department of Agriculture, Washington, D.C.

Participating in the panel were (left to right): James Giltmier, Melvin Cotner, Lamar Beasley, John Okay, Carl Carlson, Robert Buckman, and Robert Wolf.

analysis by varying some of the basic determinants, such as GNP, which could represent some part of a different scenario.

Because of the status of our current Assessment and Program, it will be difficult for us to incorporate very much of the efforts from this workshop in the 1979 Assessment and 1980 Program. With additional followup on the work which has been done, however, I see a need and an opportunity for using this work in the 1985 Program and 1989 Assessment.

Since the policy issues to be discussed in the Assessment include those that affect the Nation's forest and rangelands, it is important that they be identified by a wide range of disciplines and interests. The beginning of this identification of issues, even though they were not endorsed by this group, does provide us with a starting point. With further work and review, they could emerge as some of the issues which should be discussed in the next Assessment.

I was hopeful that some alternative scenario could be developed. We need to make projections under alternative scenarios, and we also need to look at alternative programs under different scenarios. The efforts of this workshop will contribute to the additional work we must do in defining the scenarios we will use.

In summary, I see three points in the RPA planning process where the workshop findings can be incorporated:

-- Look for opportunities to discuss some of the policy issues identified in the workshop in the 1979 Assessment.

-- With additional followup, begin developing the issues to be used in the 1989 Assessment, and

-- With further work, develop alternative scenarios for use in making different projections in the 1989 Assessment and to analyze alternative programs under these scenarios for the 1985 Program effort.

I personally have benefited from the workshop. What influence this will have in our future planning efforts is yet to be determined, but this type of interaction and discussion keeps our horizons wider.

CARL W. CARLSON
Acting Assistant Administrator, Agricultural Research, Science and Education Administration

Most of us in this room have spent a considerable portion of our careers on exercises concerned with developing long-range plans of varying types. The one thing all of these efforts had in common was a disappointment on my part, because I have seen little evidence that these plans were ever put to use. My observations have been that my efforts in planning programs for small groups, locations, laboratories, or specific subject matter areas have been more successful.

Title XIV of Public Law 95-113, National Agricultural Research, Extension, and Teaching Policy Act of 1977, specifically states that all of the Department's future research and extension programs will be jointly planned and coordinated. The major objective of the SEA reorganization in 1978 was to organize in such a way that we could improve the planning and coordination of food and agriculture programs in the Department. This increased emphasis on planning will be built on the current and past planning that have been part of Agricultural Research, Cooperative Research, and Extension Service.

Additional staff, which are also part of the new organization, are to provide assistance to the program coordination efforts within SEA. These staffs include the Program Development and Coordination Staff, Current and Future Priorities Staff, and the Evaluation and Impact Staff. In addition, another unit in SEA called Program Management has the responsibility for facilitating planning of selected complex programs of high priority. The tasks of these staffs, which are just forming, will be to integrate the planning of all SEA programs into one national program. We are in the process of developing the missions for these working groups, and developing procedures and mechanisms that will assure a cooperative effort.

A word or two about incorporation of the workshop findings into my future efforts. I am not sure how many things I changed my mind about during my three days here. I am going away "knowing that I don't know what I thought I knew" about planning for the future. However, I am satisfied that the new concepts I was exposed to will improve my understanding of the future.

My past efforts directed to getting everything tidy and neat will be directed in the future to sharpening my skills in communicating "what the problem really is." Although I am willing to accept observations and testimonies about a problem, I prefer to develop a hypothesis for the solution of the problem based on documented data.

I am going from the workshop more convinced than ever that my experience and skills should be directed to developing plans for researching such problems as improving water use efficiency, understanding the soil erosion process from the field site into and down the stream, understanding the factors responsible for declining productivity of our better soils, and better methods for providing the chemicals needed for good plant nutrition. I would hope to have these plans available on short notice.

JOHN L. OKAY
Director, Program Evaluation Division,
Soil Conservation Service

I wish to address the relationship of this workshop to current and future analysis and planning activities of the Soil Conservation Service. Let me say first that this has been an exciting and stimulating experience. We who have shared in the discussions, dinner, exercises, luncheons, debates, and coffee breaks will carry away the full flavor of a session like this. The workshop proceedings to be published later will certainly be a valuable reference for many workers in the field of renewable natural resources. But only those of us here can fully appreciate the expanded view of the future we now share.

Within the Soil Conservation Service (SCS), the focal point for long-range resource analysis and planning is the Soil and Water Resources Conservation Act of 1977; we call it the RCA. This Act directs the Secretary of Agriculture to study existing soil, water, and related resources, and to develop a national program to assure the conservation of those resources to meet the long-term needs of the Nation.

Authority for RCA has been delegated to the Soil Conservation Service; but it is truly a USDA program. An RCA Coordinating Committee has been established by Secretary Bergland to oversee the process of resource appraisal and program development. Eight USDA agencies are represented on the Committee, as well as OMB and CEQ. Mr. David G. Unger, Deputy Assistant Secretary for Conservation, Research and Education is the chairman. It is significant that Mr. Unger and three RCA Coordinating members -- Mr. Donald Crabill, Mr. Norman Berg, and Dr. Melvin Cotner--have participated in this workshop. Mr. Ernest Todd, RCA Manager, who is responsible for directing day-to-day staff activities for RCA, has also taken part.

The Resources Conservation Act establishes a process for a continuing appraisal of the status and condition of soil, water, and related resources. This is to include an analysis of the capability of those resources to meet current and projected demands for food, fiber, and environmental values. The national soil and water conservation program is to be based on the appraisal. The national program will set the direction for future USDA soil and water conservation efforts, including those of SCS.

The RCA is a companion to the Forest Service RPA. Through these two laws, USDA has been charged with the analysis of the Nation's renewable natural resources, and with the preparation of program strategies for their future conservation.

The first RCA appraisal and program reports to Congress are due in January 1980. Since the next reports are due in 1985, a focal point of the current process is the 1980 to 1985 period. Yet we must also address the longer run impacts of decisions made and actions taken during that 5-year period.

People, institutions, resources, and natural ecosystems will be affected, possibly far into the future, by things that are done--or not done--as a result of that national program. So it is most appropriate that some of those involved in RCA have participated in this workshop. We have gained much for ourselves and have much to share with our collegues who are right now at work on the RCA appraisal and program. We have wrestled with how to go about planning for the future. We have shared perceptions about the ways numerous issues may affect renewable natural resources in the future. We have both general and specific products to incorporate in the RCA process.

In general, futures research offers new and innovative tools for resource planning. Most of all, it seems to provide new ways to look at past and current events and to open up new thought patterns for consideration of the future. Futurists can help structure a systematic process for developing and analyzing alternative futures. And they can help put these new planning ideas into action.

We have also been made aware of the limitations of futures research. Robert Theobald counseled that we not become trapped into thinking we really can encompass all interrelationships in a comprehensive model and generate estimates of all the secondary and tertiary impacts of resource decisions.

The message from the exercise with Selwyn Enzer and Richard Drobnick was similar. Even their seemingly complex model left many questions unanswered, while at the same time challenging our thinking.

The work of the three scenario teams will have immediate direct use in RCA. We are not too far along in the process for the 1980 reports to incorporate some new perceptions of the various resource issues. Data, assumptions, and projections now in the appraisal should be reexamined in light of expert opinion summarized by each team. The scenarios could be reviewed by those charged with developing alternative program strategies. The national conservation program will address key resource issues and opportunities identified here. For example, the continuing and increasing need for USDA resource inventories, research and development, education, and technical and financial assistance was mentioned in a number of individual issue statements. The RCA national program should include appropriate levels of such activities. At the same time, an important message from this workshop is to be open to entirely new approaches. More of the same programs may not be adequate to deal with many of the issues reviewed in the scenarios. Now is the time to take a zero-based approach to developing policy and program strategies for the future.

Looking past the 1980 RCA reports, there are fascinating opportunities for using the results of this workshop. In this regard, one of the key results is the dialogue established between futurists and natural resource specialists. We hope to build on this as we prepare for the 1985 appraisal and program. Even before the 1980 RCA process was firmly established, SCS had formed an ad hoc study group to brainstorm ways of preparing for 1985. The proceedings of this workshop, and the personal message we carry back to that study group, will ensure continuing payoffs from our work this week.

We want to continue the dialogue with all of you participants. We want to explore opportunities for sharpening some of the futurists' tools and adapting them more specifically to the RCA context. Now that we have a link between our two camps, let us maintain and strengthen it. We have much binding us together besides our association here.

On Tuesday, Mr. Giltmier said that agriculturalists and foresters were the first environmentalists. One could also argue that resource conservationists were the first futurists. Conservation has a direct future orientation. The concept of stewardship is tied to the desire to turn over unimpaired resources to future generations. National Forests were established by men with a vision for the future. Soil conservationists shared that vision. USDA water resource planning and development programs also have reflected a concern for the future. Research programs have always involved a commitment of current efforts with the prospect of future payoffs. But just as we were overshadowed to some extent by the new environmental movement of the 1960's, our ideas about planning for the future may seem to have been left behind by a new wave of futurists. Perhaps we have been talking to ourselves too long on this score, just as we may have done on environmental issues. In any case, this week we have opened the windows and let in some fresh and exhilarating air. We cannot afford to close them again.

MELVIN L. COTNER
Director, Natural Resource Economics Division,
Economics, Statistics, and Cooperatives Service

My responsibility within the Department of Agriculture is to provide leadership to a social science research program. The role of my organization is to develop and provide information useful to policy and program officials about natural resource issues. In addition, research and related information is provided the general public and individual decisionmakers. In our work we draw on the skills of economists, geographers, sociologists, attorneys, psychologists, systems analysts, political scientists, etc.

My work and training as an economist causes me to bring a social science perspective to this workshop. My view is that soil, land, air, and water do not exist in a vacuum. These qualities in our universe have value and pertinence only to the extent that man and his institutions interact with them to make them resources. In my view, the workshop has reaffirmed the importance of the interaction of man and natural resources. Accordingly, physical, biological, and socio-economic relationships are, and will be, important in decisions about the future of renewable resources.

The sociology of natural resource use is extremely important in understanding and predicting resource demands, availability, investments, and use. As we heard this morning from Peter Schwartz, beliefs and values are important determinants of individual and group actions. Travel in other countries vividly illustrates different land ethics. Urban sprawl does not exist in many countries, indicating a different regard for land. A conservation ethic also prevails among some land users and not others.

In a similar manner, economics and economic institutions play a major role in the use and conservation of resources. Monday evening, Senator Melcher said that if wheat prices were high enough, Montana farmers and ranchers will make conservation investments. His comments were in response to a comment by Neil Sampson that the all-out production and high prices of the early 1970's resulted in greater conservation problems. Additional information is needed concerning this apparent contradiction; regardless, our market-oriented economy and the profit motive do influence resource use. In fact, our competitive economic system is the driving mechanism in our use of resources; the important question concerns the needed intervention in this mechanism to achieve desired ends.

Political science is also important. Various laws, rules, regulations, and individual rights have considerable bearing on how resources can be used. Laws that determine ownership, control, and distribution of benefits from resource use dictate how resources are impacted.

In summary, man's interaction with physical nature is a dynamic and adaptive process. Man can change values and beliefs about resources, he can change his economic motives and his economic system, and he can change the laws, rules, and institutions to accomplish desired resource use goals. These social dynamics make life difficult for those who try to perceive the future. As Mr. Theobold said earlier in the conference. . . "we cannot predict the future". Nevertheless, we must continue to study "possible" future relationships to help guide man's interaction with the physical resource base.

The workshop has reinforced my social science perspective. Three actions are suggested:

- o Expand social science research programs: Sociology, with emphasis on attitudes, values, goals, motives, and ownership as related to resource use. Economics, including studies on the effects of the market system and the role of incentives on resource availability and use. Political science, examine impacts of land and water laws, study intergovernmental and individual rights on resource use decisions.
- o Broaden data monitoring programs: Design systems and implement expanded monitoring programs to collect information on physical, biological, social, and economic variables pertinent to natural resources.
- o Improve evaluation and analytic systems: Build on and refine existing modeling capabilities, i.e., World Integrated Model, NIRAP, National Water Assessment Model, OBERS, etc. Emphasis is needed on comprehensive interdisciplinary models to show not only social and economic relationships, but physical and biologic effects as well.

Overall, the meeting has been useful. The workshop helps broaden our perspective. I am sure that our future work will benefit.

JAMES W. GILTMIER
Professional Staff Member, Committee on Agriculture, Nutrition, and Forestry
United States Senate

All of the Federal agencies and programs represented at this conference were generated or regenerated during the administrations of the two Roosevelts, Theodore and Franklin. These were the glory programs of the government. They were where the action was. The best minds in the country were drawn to them.

Following their original impetus, the overlaps and contradictions built into these programs became more and more evident. They began to compete for budget dollars.

The Forest Service argued with the Soil Conservation Service over watershed and range jurisdiction. SCS vied with the conservation programs of the Extension Service and ASCS.

On the budget front, the Forest Service began to sell its budget based on the timber and other receipts it brought to the government, arguing that program outlays ought to be as large as the income brought in.

The research programs sold their budgets on the basis that, as a result of their work, crop yields increased annually; therefore, research had practical pay-offs.

The SCS pointed to its backlogs of sponsors for watersheds and to individuals who wanted Great Plains Conservation Program contracts.

Those reasons for granting increases in budgets are simply no longer valid. And that fact raises the question of how to deal with planning and budgeting for renewable resources.

The strength of the Department of Agriculture is its greatest weakness, both with respect to developing a constituency and with respect to keeping renewable resource planning and action as close to ground level as possible. In this system there has been little accountability or evaluation at the Washington level with regard to what went on in the field. Professional scientists and resource managers were permitted to do "their thing", in accordance with local priorities and sound resource management principles.

To deal with the need for long-term renewable resource planning; to deal with the problem of budgeting on a rational basis; and to provide evaluation of the impacts of resource decisions made on the ground; Congress developed the Forest and Rangeland Renewable Resources Planning Act of 1974, the Soil and Water Resource Conservation Action of 1977, and Title XIV of the 1977 farm bill.

These legislative provisions are unique because their thrust is not to create new programs, but rather to establish devices for setting resource policy. They are themselves devices on which policy decisions can be hung.

As far as I know, there are no similar laws anywhere else in the government. RPA got off to a bad start, but it is heartening that both SCS and the Forest Service are including Mr. Don Crabill and others from OMB, in the development of the appraisals and the programs that will come forth. Unless Presidents can feel that they own these recommended program initiatives in some way, the RCA, RPA, and Title XIV can never be successful.

John A. Baker, a former Assistant Secretary of Agriculture, is a wise old friend of mine. Some years ago, John showed me that, in the evolution of any institution, there comes a time in its growth cycle when some new protein must be injected lest the institution begin a serious decline. The RPA, RCA, and Title XIV are that new protein. They will strengthen and make more relevant the USDA resource and research efforts so that attempts to break them up or reorganize them will be defeated. Further, these new policy formation tools will give impetus to those in Congress who wish to give more logic to the overall resource development issue by legislatively adding to USDA new functions which are now in other departments.

The RPA, RCA, and Title XIV will force us to look forward to the future in a more analytical manner. That is good. But I have always found it helpful, in dealing with issues of the present and the future, to remember the past. The Department of Agriculture has been essential to food security and consumer protection. The Department of Agriculture has been essential in the conservation fight to protect our land and water resources on both public and private lands.

Outside factors such as population growth or energy shortages may force us to change the way we deal with these questions. They may, but in the end, the basic missions will remain the same, and it will be up to us to provide the planning necessary to carry out those missions in the "Brave New World", in whatever form that world might take.

ROBERT E. WOLF
Congressional Research Service
Library of Congress

Congress does not have a central focus mechanism like the Executive Branch does. Thus, diffused desires and expectations are the rule in Congress. But Congress sets policy, both by action and by inaction. Its presence assures an influence.

It is important to USDA personnel to realize that in the 1974 Resource Planning Act and 1977 Resource Conservation Act it has two excellent models for proposing policy. USDA does not require new laws to adapt these systems to its wide array of issues.

The core philosophy of the Resource Planning Act is that our knowledge of what the future will be will never be perfect or clear. But the future will come as long as day follows night. We plan for the future by:

1. Assessing the situation as it now exists.

2. Reaching a judgement as to where we want to go.

3. Devising a policy and program to get there.

4. Adopting and implementing policy and budgets over a short time frame--5 years of annual budgets--and

5. Evaulating (a) what was achieved, (b) changes that confirm or confound our policy, and (c) revisions based on the unfolding scene.

I would note that RPA incorporates "sunset" and "sunrise" concepts that require annual reports to Congress on authorities not needed, authorities needing change, and new authorities required to meet goals. It also requires annual accomplishment reports coming up with the budget!

Planning is a constant process, with actions set for short time frames. Planning as a total process covers not only what we want to do, but also encompasses what we do and how it comes out.

The planning process requires evaluation both of what is done and the effects of external elements derailing planned actions. This creates a problem because the political process depends on identifying only success in an adversary climate. Always remember, Congress is the technical-social arbitrator.

Congress seeks related perspectives -- an appreciation of the merits and weaknesses of alternative actions. In the terms this Workshop has used, Congress seeks a scenario showing the acts, the scenes, and the plot of the play. The willingness of Congress to accept the professional-technical-political-managerial judgements of the Executive Branch -- as compared to the judgements of those impacted by the scenario -- depends on the confidence Congress has that the Executive's scenario is the one most likely to unfold in the period ahead.

The RPA-RCA process gives you a tool for more logical recommendations for actions.

This Workshop has stimulated thought by broadening horizons as to knowledge needed, external factors deserving more attention, and organizational modifications that must be considered.

JOHN GRAY, Workshop General Chairman
Director, Pinchot Institute for Conservation Studies, Forest Service

On behalf of the three cosponsoring USDA agencies and the four cooperating organizations, thank you again for investing your valuable talent and time in helping us.

I want to identify one follow-up action in which we hope each of you will participate. After you get home and have a chance to mull over this total situation and your experience this week, we would welcome a letter from you addressing two points.

First, where do you think we should go from here in this effort, and -- if you are willing to continue to help us on it -- how might we best use your input in the future?

Second, if you were organizing a follow-up event of this general type, with the same or other players, how would you make it more effective? What would you retain? What would you change? What would you drop? What would you add?

Please address your letter to Dr. M. Rupert Cutler, Assistant Secretary, USDA, Washington, D. C. 20250.

A final thought on the significance of this effort--This week marked President Carter's presentation of his latest "State of the Union Message" to Congress. One hundred and sixteen years ago in December, 1867, another President stood before the Congress at a time when the day-to-day existence of the United States was in jeopardy, not to speak of its long-range future. With only a very slight modification on my part, a portion of President Lincoln's remarks seem particularly appropriate to the situation in which we find ourselves today!

"The dogmas of the quiet past are inadequate to the stormy present (and the indeterminate future). The occasion is piled high with difficulty and we must rise to the occasion. We must think anew and act anew, and thus we may help our country (and the world) meet the challenges we face."

Together in this workshop this week we have taken a step to meet the need to "think anew and act anew" with respect to outlining a "new foundation" for stewardship of the renewable natural resources which sustain us all.

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