

May 16, 1994

EPA-SAB-EPEC-94-014
Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

RE: SAB Review of the Strategic Plan for the Terrestrial Elements of EPA's Global Change Research Program

Dear Ms. Browner,

The Global Climate Change Research Subcommittee (GCCRS) of the Ecological Processes and Effects Committee (EPEC) of the Science Advisory Board has completed its review of the terrestrial elements of EPA's Global Change Research Program Strategic Plan. The Subcommittee met on September 14-15, 1993 to conduct its review. The Subcommittee heard briefings from Courtney Riordan and ORD laboratory scientists, as well as comments on research priorities from the Office of Policy, Planning, and Evaluation and the Office of Air and Radiation.

The Subcommittee addressed three areas within its charge for the review: the scientific merit of the current plan, the effectiveness of Agency management and program coordination (internally and nationally), and recommendations for future directions. The Subcommittee found that the specific research projects were of high quality. Several projects, however, appeared to be more appropriate for research by other Federal Agencies. The Subcommittee found that the scientific accomplishments appeared to be consistent with the funds invested. The Subcommittee is concerned that there does not appear to be a consistent strategy for selecting which topics to include or terminate, for engaging other Federal Agencies, or for involving program offices. Indeed, it was not clear to the Subcommittee how this research component was related to the policy needs of the Agency or that a consistent vision of EPA's role in the National Program has been formulated.

The Subcommittee strongly recommends that the Agency take an active role in: (1)

defining the ecological effects and risk assessment needs for the national program, (2) specifying the methodological development, data acquisition, and assessment research tasks necessary to meet those needs, and (3) implementing the research program as an integrated effort focused on clearly defined policy needs. There is a clear need to fund new policy-relevant research on ecological effects, assessments at different spatial and temporal scales, and response strategies, including mitigation. Therefore, research should be concluded on methane budgets, carbon storage and dynamics, and *UV-B* effects on rice (a major grain crop and considered a major methane source). Also, a primary earth systems model should be selected. EPA should develop a parallel research element to investigate the effect of industrial and related human activity on greenhouse gas production; areas particularly relevant to policies in the major regulatory programs of the Agency.

The Subcommittee finds that the Agency is uniquely qualified to conduct ecological effects assessment research that is critical to the National Program. We suggest that an Agency-wide forum be developed on Global Climate Change and include this topic on the agenda of the Science Policy Council. The Subcommittee believes a new opportunity exists for EPA to define its niche in the national program more effectively and more coherently, so that the long-term directions of the EPA program should evolve from the present gap-filling role to one of leadership in an integrated program of environmental effects and risk assessment. The Subcommittee strongly recommends that EPA take an active role in defining the ecological effects and risk assessment needs for the national program, specifying the methodological development, data acquisition, and effects assessment research tasks necessary to meet those needs, and implementing the research program as an integrated, focused activity that replaces the present disparate program. EPA should engage other Federal partners through jointly funded activities, including research on the contribution of industrial and related human activities on greenhouse gas production. EPA research programs must include support for extramural projects which are long-term and require continuity.

We appreciate the opportunity to review this element of an important area of research for the Agency. We would like to assist the Agency with the development of a comprehensive strategy for the Global Climate Change program by conducting a broad-based review of the total EPA Global Climate Program covering the research, modeling, and scientific activities of ORD, OAR, and OPPE. We look forward to your response to our recommendations.

Sincerely,

/signed/

Dr. Genevieve M. Matanoski, Chair
Executive Committee

/signed/

Dr. Kenneth L. Dickson, Chair
Ecological Processes and
Effects Committee

/signed/

Dr. William H. Smith, Chair
Global Climate Change
Research Subcommittee

U.S. Environmental Protection Agency

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ABSTRACT

This review by the Global Climate Change Research Subcommittee of the Ecological Processes and Effects Committee of the Science Advisory Board focused exclusively on the terrestrial elements of the Global Change Research Program under the direction of the Office of Research and Development (ORD) in EPA. Three questions were specifically addressed: (1) scientific merit of the current research plan, (2) effectiveness of Agency management and program coordination (internally and nationally), and (3) recommendations for future directions.

In general, the specific research projects appeared to be of high quality and adequately reviewed. Scientific accomplishments appeared consistent with the funds invested. Deficiencies, however, were revealed in program management. These deficiencies include absence of a clear vision of ORD's role in the National Program, lack of a strategic plan for implementing research, and inadequate linkage and integration with other Agency and Federal programs. The Subcommittee strongly recommends that EPA take an active role in: (1) defining and justifying the ecological effects and risk assessment needs for the National Program; (2) specifying the methodological development, data acquisition, and assessment research tasks necessary to meet those needs; and (3) implementing a national integrated research program focused on a clearly defined EPA role and national policy needs. There is a clear need to fund new policy-relevant research on ecological effects, assessments at different spatial and temporal scales, and responses strategies. Therefore, research should be concluded on methane budgets, carbon storage and dynamics, and *UV-B* impacts on rice. Also, a primary earth systems model should be selected.

KEY WORDS: Climate Change, Terrestrial Effects, Ecological Effects, Assessment

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1. EXECUTIVE SUMMARY

The Global Climate Research Subcommittee of the Ecological Processes and Effects Committee of the Science Advisory Board (SAB) met on September 14-15, 1994 in Washington, D.C. to review the terrestrial elements and the strategic plan for EPA's Global Change Research Program. The Office of Environmental Processes and Effects Research in the Office of Research and Development requested that the SAB conduct a review on August 12, 1993. The charge to the Subcommittee consisted of ten questions related to: (1) the scientific merit of the current program; (2) management and coordination of the program; and (3) recommendations for future directions of the program.

The Subcommittee found that the program consisted of research projects of high quality and that received adequate peer review. The Agency had been very successful in leveraging funds to stimulate research in a broad variety of areas. EPA's focus for its research efforts was on the terrestrial biosphere and its processes for affecting climate and responding to climate change. After a review of the research priorities ORD has set, the Subcommittee recommended that EPA take an active role in: (1) defining and justifying the ecological effects and risk assessment needs for the National Program; (2) specifying the methodological development, data acquisition, and assessment research tasks necessary to meet those needs; and (3) implementing a national integrated research program focused on a clearly defined EPA role and national policy needs.

The Subcommittee was concerned about several deficiencies in program management. First, the Global Change Research Program lacked strategic planning necessary to relate this research, which is part of a larger Agency program and a very small part of the national program, to the EPA program offices or to the goals of the national program. Second, the content of research program does not support the current objectives of the strategic plan with regard to changing human activities (particularly in the areas of industrial, commercial, and transportation activities) to slow accumulations of greenhouse gases. Third, the coordination with other US research needs to focus on environmental effects monitoring, adaptation and mitigation research.

For the future, the Subcommittee recommended that EPA fund new policy-relevant research on ecological effects, assessments at different spatial and temporal scales, and responses strategies. They recommended that research be concluded on methane budgets, carbon storage and dynamics, and *UV-B* impacts on rice, and that EPA choose a primary earth systems model.

2. INTRODUCTION

The EPA Global Change Research Program (GCRP), managed by the Office of Environmental Processes and Effects Research (OEPER) in EPA's Office of Research and Development (ORD), is part of a comprehensive US Global Change Research Program (USGCRP) which was conceived to be policy relevant. EPA has a particular focus on the terrestrial biosphere and its processes for affecting climate and responding to climate change. Within EPA, several offices in ORD, the Office of Air and Radiation (OAR), and the Office of Policy, Planning, and Evaluation (OPPE) sponsor a variety of research on global climate issues. Thus the research needs and directions for the Agency are divided among several offices, each with its own perspectives.

The priorities that ORD has established in its research-program strategic-plan are to provide scientific data bases and assessments that quantify the potential for land management options to sequester carbon, for ecosystems to be altered by climate change, and for ecosystems to affect fluxes of greenhouse gases. EPA is developing information on the consequences of climate change and the role of ecosystems in affecting the rate of climate change.

2.1 Charge to the Subcommittee

The Ecological Processes and Effects Committee (EPEC) of the Science Advisory Board was asked by the Office of Environmental Processes and Effects Research in the ORD to review the draft research plan for the Terrestrial Elements of the Global Climate Research Program. OEPER asked that the Subcommittee to address a series of questions contained in a memorandum from Dr. Courtney Riordan, Director of OEPER to Dr. Edward S. Bender of the SAB staff, dated August 12, 1993. The questions were related to: (1) the scientific merit of the current research plan; (2) the effectiveness of Agency management and coordination of the program (both internally and with the national program); and (3) panel recommendations for future directions. Each question is addressed as a subheading in our evaluation.

2.2 Subcommittee Review Procedures

The Global Climate Research Subcommittee of EPEC met on September 14-15, 1993 to receive briefings on the terrestrial elements of OEPER's global climate research plan. Before the meeting, ORD provided copies of the draft Strategic Plan for EPA's Global Change Research Program (June, 1993), the FY 1993 and 1994 U.S. Global Climate Research Program reports, and the FY 1992 EPA report on Global Change Stratospheric ozone research programs. Copies of research papers from each EPA Environmental Research Laboratory were distributed at the meeting, although they were not reviewed individually. The technical presentations covered: Agricultural Soils and the Carbon Cycle by Tom Barnwell, ERL-Athens;

Carbon Pools and Fluxes in Terrestrial Ecosystems by Allen Solomon, ERL-Corvallis; Trace Gas Fluxes from Ecosystems by Jack Jones, ERL-Athens; Effects of Global Change on Terrestrial Ecosystems by David Tingey ERL-Corvallis; and Earth System Modelling by Tom Barnwell, ERL-Athens. Following the discussion, the Subcommittee developed preliminary comments which formed the basis for this written evaluation.

3. EVALUATION OF THE PLAN

Global climate change, as emphasized in the SAB's Reducing Risk document, is one of the primary environmental risks. The importance of this issue justifies a strategic planning effort that is coordinated at the highest levels within the Agency. The EPA Science Policy Council, which supersedes the Risk Assessment Council, can provide an appropriate venue for developing an Agency-wide position on global climate change research to support its policy needs and negotiations with the US Global Change Research Program. EPA has a unique opportunity to provide comprehensive integration and assessment function for basic and applied research concerned with the assessment of global change and the mitigation/adaptation strategies that can be translated into public policy.

This review is focused on selected elements of ORD's five climate change research areas. The Subcommittee believes it will be appropriate for the Ecological Processes and Effects Committee in combination with other SAB committees to systematically review other elements of ORD's program and to periodically review the progress of all EPA global climate related science and technology programs.

3.1 Scientific Merits of the Program

3.1.1 Have the scientific accomplishments been consistent with the availability of resources?

The Climate Change Research Subcommittee believes that the scientific accomplishments have been consistent with the \$27 M in ORD funding at the current time. We would like to see more funds dedicated to EPA's ORD efforts provided that the Agency can make a convincing case of their critical role in the U.S. Global Change Research Program, especially in the areas of effects, environmental assessments, and response strategies. In some areas, such as methane budgets, sufficient data have been generated so that relevant questions can now be addressed and these research activities should be concluded. New research should begin on effects, assessments, and response strategies to support policy decisions.

The Subcommittee was briefed by EPA environmental research laboratory staff on a number of research programs dealing with the terrestrial impacts of global change. The Subcommittee feels that the quality of the science embodied in most of these individual research projects was good. The EPA research laboratories seemed to make effective use of the peer review system and had in general contracted with recognized and credible researchers. In addition, the Subcommittee finds that the EPA research laboratories have used the resources available to them in an effective manner. They did this through the wise use of university researchers and by taking advantage of existing research efforts.

3.1.2 Are the conclusions credible?

The Subcommittee believes that it is premature to determine whether the conclusions of the studies are valid. The research has scientific merit and the conclusions are generally credible, though they may not be relevant to long-term policy needs because the Agency has not developed a consolidated position.

The Subcommittee concludes that the research efforts on methane fluxes, carbon storage and dynamics, and rice agriculture (*uv*-B effects and trace gas fluxes), while of higher quality, are relatively mature fields of investigation, and they should be de-emphasized in the next three year programming. All of this valuable research should be included in assessments in the future. Methane, nitrous oxide, and carbon dioxide are important greenhouse gases that the U.S. may eventually need policies to mitigate.

Earth System Modeling is proceeding very well, but the luxury of funding three different modelling approaches (NCAR-EVE, CERES, and IGBP) may not be feasible in the future. The Subcommittee finds that the CERES framework approach may be of the least utility for policy relevant research and assessments. Model evaluation is a key part of the climate change research program since models are such a basic part of the program. Model evaluation includes parameterization, validation, sensitivity analysis, and uncertainty analysis. For example, validation of predictions of potential vegetation can be done by comparing models run with historical or paleo-climate data with historical or paleo-vegetation patterns. The inclusion of human disturbances makes validation more difficult. Models can be evaluated by considering: (1) whether model equations appropriately represent underlying processes, (2) key uncertainties in the models and data, (3) sensitive aspects of the models, and (4) how these different components contribute to the overall model and its predictions. Models should be focused on the key aspects of each process rather than considering all aspects of each process. The model objectives and outputs should be clearly related to an integrated strategic plan (as described below). The plan can be used to establish priorities for including specific environmental processes and parameters in models.

3.2 Management of the Current Program

3.2.1 Need for Strategic Planning

Based on the presentations to the Subcommittee and the material provided prior to the meeting, it appears that the GCRP fundamentally lacks strategic planning. The Subcommittee did not get a sense that there is a well developed strategic plan. An overall plan for GCRP should be developed that lays out the framework for:

- how EPA Global Climate Change Research relates to research in other federal agencies and internationally
- how different EPA/ORD research activities contribute to the goals
- how different EPA/ORD research activities relate to EPA/OPPE and EPA/OAR goals
- how the different EPA/ORD research activities relate to each other plus other programs with EPA (e.g., ozone research, NAPAP, EMAP, etc.)

The existing strategic plan (EPA, 1993) does not meet this need. Although the research programs are discussed, it is not clear how they interrelate or contribute to the commitments stated on page 3 of the strategic plan.

For example, there was little evidence of research that supports EPA GCRP's goal to reduce uncertainties about the role of human-activities on the global forest systems or on greenhouse gas accumulation or how to change human activities (page 3, EPA Strategic Plan).

The lack of an adequate strategic plan was reinforced by several other factors; lack of a coherent overview presentation, obvious lack of familiarity by GCRP team members of the work of other team members, and the idiosyncratic nature of projects (e.g., some reflect the talents and preferences of in-house personnel) being managed by the environmental research laboratories.

We encourage EPA to make the strategic plan more than a list of the different research projects. Instead it should be a systems-level conceptual model illustrating the linkages between research activities and the goals of the program. A strategic plan for the entire EPA GCRP (ORD, OPPE, and OAR) would allow determination of research priorities and relation of research to short- and long-term policy needs. Inputs into

integrated research strategy that may require a different process than issue-based research planning. The Subcommittee suggests that the new Science Policy Council should oversee the development of the strategic plan. The Agency should include all appropriate Agency and interagency stakeholders in the development of the strategic plan, conduct an SAB or other scientific peer review, and implement the final plan for at least one year without changes.

It is difficult to evaluate EPA's climate change program without having a strategic plan describing how the different components of the program fit together. The presentations gave a feeling for the breadth of EPA's climate change program but did not provide an understanding of how the various pieces interact. Therefore, the Subcommittee recommends that the program develop a list of their goals and determine how the various research projects contribute toward those goals. Development of this research framework will also allow for explicit assignment of research priorities.

A large part of the research program has focused on the terrestrial role in the future carbon cycle. The work plan includes many studies describing the vegetation which may occur in an area following a change in climate and plans to use transient vegetation models to explore the ecological processes. However, changes in land-use activities are a major factor in the carbon cycle requiring research and integration into the Earth Systems Modeling. EPA needs to evaluate how land use processes will be incorporated into their research design.

3.2.2 Response to Policy and the Distribution Between National and International Efforts

While individual research projects are of high quality, there remains a question about the policy relevance of some of the research projects, and the balance between national and international efforts. It is recommended that EPA examine its efforts in light of its primary mission of protecting human health and the environment. When compared with other environmental protection mandates for air, land, and water, the EPA global change research program seems to ignore many of the areas that it may be called upon to address in the future. The Strategic Plan states that the EPA GCRP Strategy is to determine "how much change in human activities may be required to slow accumulations of greenhouse gases in the atmosphere to an acceptable rate" and to find "what effective means are available to help produce such indicated changes in human activities?". Yet there is very little of the current research program that addresses any human activities outside of agriculture and forestry.

Although land-based activities and land-use changes are important sources (and potential sinks), their contribution to global warming is less than that of industrial, commercial, and transportation activities. Yet it is these latter activities in which EPA is likely to have major responsibility in the policy arena. It is also these areas that overlap most directly with EPA's major regulatory programs such as the Clean Air Act. It is recommended that EPA develop a program of research and modeling to understand the factors associated

with industrial and related human activity on greenhouse gas production. This program should parallel the terrestrial ecosystem work that is currently under way. By focussing on these two areas, EPA can better develop a policy-relevant program.

EPA needs to develop a more consistent set of criteria for adjusting the balance between national and international emphasis. There is good reason to continue a significant international presence. The US must continue its role as a participant in the International Geosphere-Biosphere Programme (IGBP), Intergovernmental Panel on Climate Change (IPCC), and other international research and policy relevant programs. It is also important for the US to have an independent capability to assess the activities and issues in other parts of the world and to provide assistance to developing countries that lack the technical capability to carry out analysis and research on their own. Neither of these rationales is clearly stated, however; in the current research plan. There is also a danger that an emphasis on some international projects such as tropical and boreal forests, or southeast Asian rice, without studying our own contribution of greenhouse gases, might be seen as an attempt to externalize the problem to other countries. In short, a consistent set of criteria for defining the geographical balance of the research is needed that reflects its importance to climate change.

3.2.3 Linkage with Other US Research Activities

The Subcommittee is concerned that EPA's limited resources are being used to complement global climate research at Federal laboratories whose agencies (NSF, NASA, and DOE) already have far more resources in the Global Climate Research Program than EPA. While many unique capabilities exist at national laboratories, the Subcommittee feels that EPA should be seeking strategic changes in the research priorities of the national program to focus on environmental effects monitoring and mitigation research. The research of all agencies should include projects relevant to national priorities.

The largest budgets for global climate change research activities exist in National Aeronautical Space Administration (NASA), National Ocean Atmospheric Administration (NOAA), Department of Energy (DOE), and National Science Foundation (NSF). In contrast, the USEPA has a wide array of regulatory, assessment and monitoring responsibilities, but currently it receives only 1.7% of the Global Climate Change Research budget. Therefore, the USEPA has adopted a strategy of leveraging their scarce resources by buying into the existing programs through interagency agreements.

The EPA Annual Report FY 1992 (Appendix II) lists 102 research projects funded by the ORD in the USEPA. Of these, 21 projects with a total budget of \$4,305,000 were implemented through interagency agreements. Many of these were granted to the more heavily funded agencies (NASA, NOAA, and DOE). A few of these research projects were awarded through a competitive, peer reviewed process. All of these research activities are very good, and the granting process followed the SAB recommendations (SAB, 1991).

Many other projects, however, were motivated by the fact that the USEPA needed data to ensure human health and/or ecological impact assessments were conducted, but the other agency or department did not have a priority program that they were willing to fund. The Federal Coordinating Committee for Science, Engineering, and Technology (FCCSET) is supposed to coordinate a highly integrated and cooperative interaction between governmental activities in the US Global Change Research Program. Research priorities should be set at this level and the relevant institution should fund the research and make the results available to all. In theory, the USEPA should not have to pay NASA \$110,000 per year to "characterize Global Tropospheric Ozone Concentrations" (Appendix II, page 71). Rather, EPA should present its rationale for needing the data, and assuming EPA's logic prevails, FCCSET should assign the task to an appropriate Agency. EPA should be allocating their scarce resources into effects assessments, response scenarios, and risk reduction documentation in a manner consistent with its strategic plan. The Subcommittee strongly recommends that EPA develop an Agency-wide position on its research priorities and its role in the national program.

3.2.4 Internal and Extramural Resources

The OEPER climate change research program is based on establishing partnerships between the Environmental Research Laboratories, research scientists in academia, other federal laboratories, and private sector scientists. Based on this review, it appears that most of the research funds have been allocated to support extramural research. The Subcommittee supports the use of Requests For Proposals (RFPs) and the peer review of proposals which appears to have been the process followed. However, the Subcommittee is concerned because it appears that some resources have been used to support the activities of research scientists at the EPA laboratories without a peer review process. The Subcommittee supports the a balance between external and internal resources. It is essential to have EPA research scientists actively involved in global climate research and not simply function as grant/contract managers. However, scientific peer review and competition should be applied to all research activities.

3.2.5 Terms of Research Projects

The Subcommittee is concerned about the apparent research management decision that all projects must be terminated after three years. In the ecological research area, it almost always takes more than three years to bound the inter-annual variability in habitat and ecosystem response. Arbitrary decisions only to fund for three years may jeopardize the validity and utility of some monitoring/stressor/response projects which are long term and high priority. In some cases, continuity of experienced scientists, site location, and scientific procedures are required to produce results. The Subcommittee recommends that the ORD-GCRP review projects at three year intervals with regard to their contribution(s) to a strategic plan, and continue funding projects whose design requires a longer project life if they are productive and if an objective of documenting

inter-annual variability is part of the project scope. EPA management, the science community, and the Inspector General must find a way to manage extramural research activities so that the quality and timeliness of the scientific results are not compromised.

3.3 Future Directions

3.3.1 Building on the Existing Science Base

A memorandum dated 8 July 1993 from John Gibbons, Assistant to the President for Science and Technology, (Appendix A) offers a clear statement of the need for an enhanced capability to assess natural and societal impacts of changes in the global environment and to improve the integration of scientific research and assessments with policy making. The memo also noted that a comprehensive assessment is necessary that integrates the full range of scientific studies through environmental and societal consequences and feedbacks for the US to identify, adopt, implement, and evaluate sound policies. These statements are an important redirection of national perspectives on the importance of effects assessments and comprehensive risk assessments in the national program. These new perspectives are consistent with the strong consensus of the Subcommittee on the future directions that are appropriate for the EPA ORD global change research program. Among all federal agencies participating in the national program, EPA is the logical institution to undertake these new components, as EPA has a history of and the expertise in conducting environmental effects assessment and is the lead agency in the development of this new paradigm on ecological risk assessment and risk management. The Subcommittee believes a new opportunity exists for EPA to define its niche in the national program more effectively and more coherently, so that the long-term directions of the EPA program should evolve from the present gap-filling role to one of leadership in an integrated program of environmental effects and risk assessment.

Similarly, the draft language of the Committee on Earth and Environmental Sciences working group on processes research discusses a new ecological initiative that provides guidance on what the long-term EPA ORD research program should entail, particularly its focus on ecological effects and feedbacks. The draft language suggests an integrated program of observations, experiments, and modeling that cuts across spatial, temporal, and hierarchical scales. The Subcommittee concurs and believes this should be a high priority now.

The prospective funding for various tasks of the ORD research program are inconsistent with this perspective and the opportunity it presents the Agency. The Subcommittee strongly recommends that EPA take an active role in defining the ecological effects and risk assessment needs for the national program, specifying the methodological development, data acquisition, and effects assessment research tasks necessary to meet those needs, and implementing the research program as an integrated, focused activity that replaces the present disparate program.

Accomplishing this may require structural changes in how the EPA global program is planned and managed. The Subcommittee was pleased with the degree of interactions noted by the representative from the Office of Policy, Planning, and Evaluation by staff of OPPE and ORD, and believes that this process should be expanded and institutionalized. One model that should be considered is to have a cross-office coordinating group established similar to the EPA Risk Assessment Forum, which actively involved a diverse group of scientists and managers from many different units of EPA in the development of a new paradigm for ecological risk assessment and in subsequently developing a series of ecorisk assessment guidelines. This process is so fundamental to the likelihood of success for EPA in this role that the Subcommittee believes an institutional structure similar to the Forum is required. Such a unit should not only provide for detailed exchange of ideas, needs, and progress presently performed by the ad hoc meetings among ORD and OPPE staff, but also a mechanism for formal guidance of the research and policy programs to be integrative and responsive to the new national perspectives. Even if EPA's global change research funding remains at present levels, the Subcommittee believes redirection of research that follows such an integrative strategy can be effective in addressing long-term needs of the national program through a more effective use of current funding.

3.3.2 Future shifts in research priorities

The EPA/GCCRP is at a crossroad where projects are nearing completion and new research areas are emerging. Therefore a strategic plan is essential to seize the opportunities that may arise. For example, using a research framework based upon risk assessment, monitoring environmental changes and adaptations, and assessing human activities as well as the current state of specific research projects, it is possible to identify projects with high future priority, because they may provide new information relevant to the framework and strategy and projects with low priority, which may have high scientific merit, but have reached a natural endpoint or do not relate to a central research framework.

Low Priority Research Areas

Methane Emissions Studies - This work is technically well done and mature. Future efforts in this area fall more properly within the domain of the USDA.

Rice Studies - This project is nearly complete, is being supported by other agencies, and is using resources that could be used for issues more relevant to the U.S.

Tropospheric chemistry measurements - this work falls within the domain of NCAR and NOAA.

High Priority Research Areas

The Earth System Model - this is an intellectually important research area, but resources may not be

sufficient to support 2 or 3 approaches for model development. The lack of approaches for validating the ESM, or estimating its error are a concern (See EPA-SAB-EEC-91-016 for further advice on model validation).

C02 - Tree Response Studies - The new facilities at Corvallis provide a unique opportunity to evaluate tree rhizosphere responses to elevated C02 and temperature. These studies have been well reviewed, are meritorious, and should continue. However, support from GRCP should only continue if direct relevance to the "new" strategic plan is demonstrated.

Vegetation Redistribution - The migration of vegetation in response to climate change scenarios is pivotal to the mission of the EPA/GCRP. The program should move toward methodologies for ecological risk assessment and include issues related to the human activities (e.g., demographics and resource demands).

Habitat and Biodiversity - The effects of climate change on habitat and biological diversity are central to the Agency's global climate program and should be substantially expanded.

Approaches for Ecological Risk Assessment -efforts must begin to define ecological risks associated with global climate change. No such approach currently exists, but it is essential for the EPA/GCRP.

3.3.3 Scenarios for the Future

The EPA/GCRP annual budget is \$27M. Although this budget has remained constant over the past several years, it is a small part of the EPA total budget and constitutes less than 2% of all federal funds spent on global climate change research. The EPA budget has declined from 2.2% of federal spending 3 years ago to only 1.7% now. The scenarios provided below are only examples and are meant to help the Agency develop their own ideas about the future.

The funding for the EPA/GCRP could decrease, remain constant, or increase. The scenarios below attempt to describe the possible consequences of the three funding options. These scenarios are meant to be helpful examples designed to stimulate thought and to encourage the Agency to go through the exercise of developing scenarios and choosing a plan to ensure its future in global climate research. In all cases, the research should fall within the policy-oriented strategic guidelines of ORD's global change program (yet to be developed).

Reduced Funding

In the face of reduced funding, the EPA/GCRP should collapse its efforts around the research of highest priority. Topics at the core of the Agency's mission should include: vegetative responses to elevated CO₂ and temperature, vegetation redistribution, and changes in habitat and biodiversity.

Sustained Funding

If budgets remain at \$25-\$30m per year, the EPA/GCRP should develop a framework embracing ecological risk assessment, pollution prevention, and assessing the impact of human activities. High priority topics identified earlier in this section should be added showing how they contribute to this framework and how this effort will lead to risk assessment products.

Increased Funding

An opportunity exists for EPA to obtain increased funding for global climate change research. Such increases could result from recognition that the EPA research framework is suitable for ecological risk assessment, adaptation of ecosystems, and analysis of the impacts of society on global climate change. If funding increases occur, the high priority topics already identified should form the core of the effort and a strategy should be devised for adding new programs and leveraging activities in other Federal agencies.

4. RECOMMENDATIONS

The Subcommittee believes that now more than ever, EPA must focus its limited resources in areas where they have unique talents among the Federal Research community that are essential to achieve the National Program goals. Therefore, the Subcommittee offers the following recommendations to help the Agency set its research priorities:

A. The Subcommittee recommends that EPA develop a strategic plan to identify critical research and data needs, to shape its research agenda, and to encourage jointly funded research with other Federal Agencies. This is a first step to set priorities and allocate limited resources.

B. The Subcommittee recommends that the Science Policy Council oversee the development of an agency-wide strategic plan on research to support the EPA and national Global Climate Change programs.

C. The Subcommittee recommends that the program concentrate on its strengths, namely the integration and assessment of basic and applied environmental effects research and research on mitigation and adaptation strategies and EPA should negotiate with other Federal Agencies to fund and conduct research appropriate to their domains. The program should also add assessments of human activities. These areas should be reflected in the strategic plan.

D. The Subcommittee strongly recommends that the Agency select a primary earth modeling system (CERES may be the least relevant to policy) which is consistent with the revised strategy. We suggest that the model focus on key aspects of each process rather than all aspects. Model validation must consider how it represents underlying processes, the key uncertainties in the models and the data, their sensitivities, and the contributions of the model components to the predictions.

E. The Subcommittee recommends that ORD review projects at three year intervals relative to their contribution to the strategic plan. Projects should continue if productive and if they meet an objective of the strategic plan.

F. The Subcommittee believes a new opportunity exists for EPA to define its niche in the national program more effectively and more coherently, so that the long-term directions of the EPA program should evolve from the present gap-filling role to one of leadership in an integrated program of environmental effects and risk assessment.

G. The Subcommittee strongly recommends that EPA take an active role in defining the ecological effects and risk assessment needs for the national program, specifying the methodological development, data

acquisition, and effects assessment research tasks necessary to meet those needs, and implementing the research program as an integrated, focused activity that replaces the present disparate program.

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Appendix A. Gibbons Memorandum

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**PREPARED BY THE GLOBAL
CLIMATE RESEARCH
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