



PAN-EARTH Project



**Summary of
Annual Report 1989-90**

**Global Environment Program
Cornell University**

**Activities Sponsored by
a Grant from the
Rockefeller Brothers Fund**

TABLE OF CONTENTS

Overview of 1989-1990 PAN-EARTH Activities	2
Case Study Activities	
China Case Study.....	3
National Workshop	
Visiting Scientists	
Data Development	
Africa Case Study.....	4
Workshop	
Funding Proposal	
Japan Case Study	5
Japan Climate Change Activities	
Scenarios and Assessments	
PAN-EARTH Japan Workshops	
Funding Status	
IBSNAT Model Usage for Japan	
Venezuela Case Study	6
Mini-Workshops	
Agricultural Workshop	
Climatology Workshop	
Ecological Workshop	
Funding	
Computer Connections	
Additional PAN-EARTH Activities	10
Outreach/Publications	
• IPPNW Meetings	
• India	
• <i>Nuclear Famine</i>	
• Technical Papers	
• <i>New York Times</i> Editorial	
• Speeches and Interviews on Nuclear Winter	
• Second Edition SCOPE 28	
• Earth Day 1990	
• IPCC	
• Peace Initiatives	
Core Funding	
IBSNAT Connections	
CNSF UNIX Workshop	
Associated Activities of the Global Environment Program	13
Cornell/NGA Conference Follow-up	
National Institutes for the Environment	
Cornell Global Institute Planning Grant	
Man and the Biosphere Directorate	
Move of Offices, Addition of Staff	
Publications Available from PAN-EARTH	14

OVERVIEW OF 1989-1990 PAN-EARTH ACTIVITIES

CASE STUDY ACTIVITIES

- **China Case Study**—The national participants in the China Case Study held a workshop in Beijing in February 1990, to review work done in the preceding year on studies pertaining to the effects of nuclear war and global climate change on agricultural and ecological systems. Dr. David Hsin-shih Chang, of the Institute of Biology, Academia Sinica, was a Visiting Fellow with the Global Environment Program at Cornell University for the summer of 1990.

- **Africa Case Study**—The first workshop for the Africa Case Study was held in Saly, Senegal in September 1989. The workshop formally established the PAN-EARTH Sub-Saharan Africa Collaborative Research Network. Coordinated by Dr. Taye Bezuneh, of the Semi-Arid Food Grain Research and Development Program (SAFGRAD), the workshop developed specific climate change scenarios for sub-Saharan Africa, based in part on results from general circulation models (GCMs) for doubled CO₂ and nuclear winter scenarios. Plans are underway to hold a second workshop in early 1991.

- **Japan Case Study**—The PAN-EARTH Japan Case Study Committee met with Drs. Mark Harwell and Tom Ackerman in October 1989, in Nagoya, Japan, to discuss the status of case study activities. Nuclear winter and CO₂ climate change scenarios for Japan and East Asia have been developed from results of GCM simulations. The potential effects from these scenarios will be analyzed using the statistical rice model and the net primary productivity model. PAN-EARTH will publish the results of these assessments.

- **Venezuela Case Study**—Dr. Miguel Acevedo, coordinator of the Venezuela Case Study, organized two mini-workshops in May 1989, to identify case study activities specific to Venezuela. A workshop on agricultural effects and crop modeling was held in Maracay in November 1989. A third workshop, convened in Mérida in April 1990, addressed climatology in Venezuela and the Caribbean. An ecological workshop was held in July 1990, to identify methodologies for assessing ecological effects of climate change in Venezuela. A number of agricultural and ecological models have been transferred to Venezuelan scientists, with plans to calibrate the models for use in Venezuelan climate change effects assessments.

ADDITIONAL PAN-EARTH ACTIVITIES

- PAN-EARTH scientists Drs. Harwell and Ackerman were invited to present papers on the consequences of nuclear war at the International

Physicians for the Prevention of Nuclear War (IPPNW) Congress held in Hiroshima, Japan, in October 1989.

- Collaboration between PAN-EARTH scientists and several eminent Indian scientists has resulted in the publication of a report addressing the potential impacts of nuclear war on Indian agriculture. The report was commissioned as a follow-up activity of the SCOPE-ENUWAR project.

- Materials developed from the SCOPE-ENUWAR project and the PAN-EARTH Project were published in 1990 in an instructional booklet and filmstrip entitled *Nuclear Famine*.

- PAN-EARTH has several publications in preparation dealing with crop modeling and sensitivity analyses for agricultural and ecological systems. Another publication on potential climate change effects on agriculture, food supplies, and environmental migration is in preparation. The National Academy of Sciences has solicited PAN-EARTH's publication of a white paper dealing with the relationships between climate change and deforestation in the humid tropics.

- In response to a negative editorial on nuclear winter published by the *New York Times*, Drs. Harwell and Robock each sent rebuttal editorials to the *Times*. Although the *Times* chose not to publish these rebuttals, PAN-EARTH distributed copies to a large number of ENUWAR collaborators and correspondents.

- During 1989-90, Dr. Harwell has accepted numerous speaking invitations and given several media interviews on the topics of nuclear war and the biological effects of nuclear winter.

- The second edition of SCOPE 28, *Environmental Consequences of Nuclear War, Volumes I and II*, has been published. Dr. Harwell wrote a new preface for the second edition.

- PAN-EARTH Project brochures were widely distributed during Earth Day 1990 activities at Cornell University.

- The Intergovernmental Panel on Climate Change has solicited Dr. Harwell's review of their second volume draft report on impacts of climate change.

- The Global Environment Program and Peace Initiatives co-sponsored the visit of Soviet and Czechoslovakian scientists to the U.S. Dr. Harwell presented a talk on nuclear winter research and climate change.

- A no-cost extension of the Rockefeller Brothers Fund contract will enable the PAN-EARTH Project to continue its mission through July 1991. New core funding for PAN-EARTH is being sought.

- PAN-EARTH has purchased a portable computer to allow IBSNAT crop models to be

demonstrated and installed in case study countries. Several PAN-EARTH scientists attended a training session for modelers on the use of the UNIX operating system. Knowledge of this modeling system may enhance current modeling activities of PAN-EARTH case study countries.

ASSOCIATED ACTIVITIES OF THE GLOBAL ENVIRONMENT PROGRAM

- As a follow-up to the 1989 Cornell University/National Governors' Association conference, the Global Environment Program has been asked to produce a proceedings volume based on speeches and workshop reports presented at the conference.

- Dr. Mark Harwell, Dr. Jay Jacobson, and Christine Harwell co-authored the climate change section of a proposal for federal legislation to establish a new National Institutes for the Environment.

- As a result of a proposal by GEP, Cornell University received a one-year grant to prepare a university-wide plan for multidisciplinary and individual research on global climate change biological/societal effects and feedbacks.

- Dr. Harwell was appointed vice chair of the Human-Dominated Ecosystem Directorate of the Man and the Biosphere Program, coordinated by the U.S. Department of State.

- The Global Environment Program moved to new office space on the Cornell campus. The new offices allow easier access to the biological sciences buildings at Cornell. A part-time secretary, a research support specialist, and two student interns have been added to the staff.

CASE STUDY ACTIVITIES

China Case Study

National Workshop

The national participants in the China Case Study held a workshop in February 1990, to review work done in the preceding year on studies of effects on agriculture and ecosystems of nuclear war and global climate change. The workshop was held at the Institute of Ecology of the Chinese Academy of Sciences, Beijing. Eighteen members of the PAN-EARTH research group attended. They came from the Institute of Botany and the Institute of Zoology of the Chinese Academy of Sciences, the Academy of Meteorological Sciences of the State Meteorological Administration, the Beijing Institute of Meteorology, and the Research Center of Ecology and Environment. The workshop received support from the National Natural Science Foundation of China and the Department of Life

Science. Professor Ma Shijun, co-coordinator of the China Case Study, opened the workshop. He spoke of the need to summarize the achievements made in the previous years, to improve research quality as a whole, and to try to achieve research goals as ably as possible. The work done in the PAN-EARTH Project will be the first steps of a new National Fund project, making a systematic and thorough research of the effects of climate changes on agriculture and ecosystems in China.

Fifteen papers were received and twelve papers were presented at the workshop. The fields covered include: 1) the effects of nuclear explosions on regional climate; 2) the possible effects of climate changes on agroclimatic resources, wheat growth and yield, and their numerical simulation; 3) the effects of climate change on the potential productivity of vegetation, the typical structure of grassland communities, and primary productivity; and 4) the possible effects of climate changes and air pollution on insect development and agriculture. In the coming year, the research work of the China Case Study will focus on the unified scenarios of climate changes and their effects to achieve the final project goals of the Case Study. Professor Ding Yihui, leader of the research group and Vice-President of the Academy of Meteorological Sciences, concluded the workshop, emphasizing the need for hard work in the group to raise the level of research and the need to focus on some questions related to the impacts and consequences of climatic changes on socio-economic activities.

All the papers have been translated into English and an agreement has been reached to have these papers edited and printed by the PAN-EARTH Project at Cornell.

Visiting Scientists

Dr. David Hsin-shih Chang, a co-leader of the China Case Study, was a Visiting Fellow with the Global Environment Program at Cornell University for the summer of 1990. Dr. Chang's main goals in working with GEP were to develop an accurate model to predict shifting vegetation distribution and productivity in China as a result of changing climatic factors. Dr. Chang used Budyko's method to predict how net primary productivity (NPP) will change with increasing concentrations of carbon dioxide and changes in temperature and precipitation. Dr. Chang has worked with many arithmetic models in the past for calculating potential evapotranspiration and vegetational-climatic classifications including Penman, Thornthwaite, Holdridge, Kira, etc. At the Laboratory of Quantitative Vegetation Ecology in

Beijing, Dr. Chang has been working with multivariate analysis. The laboratory has several data bases for China, including topographical, climatological, and plant communities.

Dr. Chang is facilitating the acquisition of data on China's climate and ecological systems for the case study. While at Cornell, Dr. Chang digitized vegetation distribution data for input to ordination programs to estimate shifts in vegetation distributions in response to the PAN-EARTH climate change scenarios. Professor Yang Dian-an, a computer expert, accompanied Dr. Chang to Cornell as a Visiting Scientist and assisted Dr. Chang in the summer's research. A publication based on this work is in preparation.

Drs. Chang and Harwell were invited to Washington, D.C. in July 1990, by the National Academy of Sciences/Chinese Academy of Sciences project leader on grasslands, Dr. James Reardon-Anderson. Dr. Reardon-Anderson will assist in obtaining funding from the National Science Foundation for further work on the ordination model as applied to grassland data.

Data Development

The weather data for all of China have been received by the Cornell research unit and distributed to Drs. Alan Robock and Wendell Cropper, for creation of climate scenarios for all of China and for modification of the weather module of the IBSNAT crop models. The scenarios for effectively-doubled CO₂ have been provided to the Chinese scientists, for both temperature and precipitation. Dr. Robock will be reading the maps and providing data for each station to Dr. David Chang.

Africa Case Study

Workshop

In September 1989, the first workshop for the Africa Case Study was held in Saly, Senegal. Financial support for the workshop, in addition to the core Rockefeller Brother Fund grant, was obtained from the U.S. Environmental Protection Agency, the Ford Foundation-West Africa Office, the International Development and Research Centre/Canada, the U.S. Agency for International Development, the Organization of African Unity's Semi-Arid Food Grain Research and Development Program (OAU/SAFGRAD), and the Institute for Agricultural Research in Senegal (ISRA). The workshop was coordinated by Dr. Taye Bezuneh (SAFGRAD), and co-hosted by ISRA. The Africa

Case Study was formally established at this workshop as the PAN-EARTH Sub-Saharan Africa Collaborative Research Network, coordinated by (OAU/SAFGRAD).

Specific climate change scenarios were developed at the workshop based in part on results from general circulation models (GCMs) for doubled-CO₂ and nuclear winter scenarios. Scenarios for sub-Saharan Africa include temperature increases of about 4°C for greenhouse scenarios, and significant shifts in the amounts, timing, and distribution of rainfall, with concomitant alterations in the growing season for both nuclear winter and greenhouse scenarios. Two other workgroups identified specific sub-Saharan ecosystems and agricultural systems to evaluate for potential effects from climate change, through a concerted approach of data acquisition and analysis, computer simulation model calibration, and extensive sensitivity analyses. A number of specific individuals and institutions were suggested for participation in the collaborative network.

Funding Proposal

A proposal for major support for the PAN-EARTH Sub-Saharan Africa Collaborative Research Network, *Assessment of the Vulnerability of Agricultural and Ecological Systems to Climate Change in Sub-Saharan Africa*, was submitted to the Ford Foundation in January 1990. The proposal was prepared by Dr. Harwell of the Cornell unit and Dr. Taye Bezuneh, leader of the Africa Case Study and Director of Research, OAU/SAFGRAD. The proposal was submitted by the Organization of African Unity's Scientific, Technical and Research Commission (OAU/STRC). The proposal was, unfortunately, not funded. SAFGRAD has received a training grant from the African Development Bank; plans are underway to hold a PAN-EARTH crop model training workshop early in 1991. Further sources of support for the Africa Case Study are being sought.

Japan Case Study

Japan Climate Change Activities

On 10-13 October 1989, Dr. Harwell and Dr. Tom Ackerman traveled to Nagoya, Japan, for a series of meetings with members of the PAN-EARTH Japan Case Study Committee, specifically Dr. Takeshi Ohkita, Director of the Nagoya National Hospital; Dr. Zenbei Uchijima, Professor of Agrometeorology at Ochanomizu University, Tokyo; and Dr. Tatsuo Urabe, Head of Research at the Nagoya University Computer Center (NUCC). Among topics of discussion were the status of the case study activities; computer crop model implementation and development; ecological studies; planned reports; planned workshops; and funding possibilities.

Dr. Uchijima reported on the recent activities in Japan on global climate issues. He is the chairman of a Japanese committee on climate change effects convened by the Japan Ministry for Agriculture, Forestry, and Fisheries. He presented a draft report (in Japanese) on these issues; it provides a summary of what is known about potential effects on Japan and specifies research activities needed in Japan. The focus in these studies will be on effects not only on Japan but also on South Asia and China. The report has been released by the Ministry, and Dr. Urabe has translated into English highlights from the report. This highlights report will be published by PAN-EARTH.

Scenarios and Assessments

Nuclear winter climate change scenarios have been developed for Japan and East Asia, and the results from GCM simulations at the Los Alamos and Lawrence Livermore National Laboratories have been given to Dr. Urabe by Dr. Steve Ghan of Livermore, following their discussions at the PAN-EARTH Beijing Workshop in 1988. Dr. Urabe has extracted from the global outputs that were provided to him the results specific to Japan and East Asia, and has provided these results to Dr. Uchijima. At present, Dr. Uchijima is analyzing the potential effects from these nuclear winter scenarios using his statistical rice model and the net primary productivity model. Dr. Uchijima presented preliminary results at Beijing, which were included as an appendix in the 1988 Beijing report. His more complete assessments using the GCM outputs will be completed, and a paper in English submitted to PAN-EARTH. Dr. Harwell has offered to assist in the preparation and publication of this final article.

The GCM outputs for greenhouse climate change scenarios, resulting from simulations of doubled CO₂ using the OSU, NCAR, GFDL, and GISS models, have been prepared by Dr. Alan Robock of the University of Maryland. Dr. Urabe will extract from these outputs (which include results for the entire world) the predictions for grids covering Japan and East Asia, and he will send these results to Dr. Uchijima and other Japanese scientists.

PAN-EARTH Japan Workshops

A small climate workshop was convened in early December 1989, among Japanese scientists to discuss the work done on effects assessments in 1989 and develop appropriate climate change scenarios using the GCM outputs discussed above and expert judgment, as has been done by PAN-EARTH for China and sub-Saharan Africa. Once these scenarios are agreed upon, effects on rice production and net primary productivity of ecological systems will be evaluated as for the nuclear winter scenarios. The climate scenario workshop involved only Japanese scientists associated with PAN-EARTH, as the present funding from the Japanese Ministry of Education that supports the case study is limited to support for Japanese participants. A proposal was submitted for financial support for a PAN-EARTH technical workshop to be held in Japan near the time of the next INTECOL Congress, to be held in Fujisawa, Japan, about 50 km from Tokyo, in August 1990. This proposal was, unfortunately, not funded.

Funding Status

The present activities of the PAN-EARTH Japan case study are supported by a grant of 4 million ¥ from the Ministry of Education for 1989, and 3 million ¥ for 1990. A proposal for additional support from the Toyota Foundation was not funded. Other research activities related and supplemental to PAN-EARTH (such as the committee chaired by Dr. Uchijima, discussed above) will add considerably to the scientific information and assessments available to PAN-EARTH for its synthesis reports.

IBSNAT Model Usage for Japan

At present, the primary methodology used for estimating effects on rice production in Japan involves a statistical model of rice production as a function of climate, developed by Dr. Uchijima. The PAN-EARTH links with IBSNAT provide an opportunity to expand that capability in Japan to include physiologically-based simulation models.

Japan's microcomputer systems are largely dominated by NEC-compatible machines and operating systems, which differ from the IBM-PC DOS world. Consequently the PC-based IBSNAT models will not run on the NEC computers. At the PAN-EARTH Senegal Workshop, Dr. Gerrit Hoogenboom provided Dr. Urabe with the source codes (in FORTRAN) for the IBSNAT crop models, and Dr. Urabe's staff is working to implement the models on NEC systems. However, the data entry, analysis, and graphics portions of the present IBSNAT package (DSSAT) are not readily transferable to other operating systems. Further, the IBSNAT models are continually being revised to incorporate improvements, so a continuous activity would be required for the NEC-based crop models to be up-to-date. Consequently, Dr. Urabe has applied to IBSNAT for the complete compiled package and continuing upgrades to be implemented on PC-compatible computers at NUCC. Further, Dr. Uchijima agreed to purchase a PC-compatible computer, for the IBSNAT models to be implemented at his laboratory. Discussions are underway between PAN-EARTH and IBSNAT to hold a joint training workshop on these models, perhaps in Hawaii, which scientists from each case study would attend.

Venezuela Case Study

Mini-Workshops

Two mini-workshop sessions were held in Venezuela in May 1989, to analyze problems related to potential global climate changes, such as the greenhouse effect, nuclear winter, and ozone depletion, and identify potential projects that could be carried out as part of the PAN-EARTH Venezuela Case Study. The organizer was Dr. Miguel Acevedo, coordinator of the Venezuela Case Study, and the facilitator was Dr. Giorgio Tonella, (University of the Andes). The first session took place in the headquarters of the National Council for Research in Science and Technology (CONICIT) in Caracas, and the second session was held in the Latin American Forestry Institute in Mérida. Funding for the mini-workshops was provided by CONICIT; the Sciences, Humanities, and Technology Development Council (CDCHT) of the University of the Andes; the PAN-EARTH Project at Cornell University; the Venezuela Academy of Physical, Mathematical and Natural Sciences; and the Latin American Forestry Institute.

The objectives of the first session were to: 1) identify and clarify the possible problems at the national level associated with global climate

changes; 2) structure the problems to obtain a better idea of the national problems resulting from the effects of global climate change; and 3) prepare the basis for the identification of the possible project options of the Venezuela Case Study. The objectives of the second session were to: 1) identify and clarify the possible research options to address specific groups of problems; and 2) prepare some research options for the main groups of problems identified in the PAN-EARTH Project.

The Caracas and Mérida sessions took place on 23 May and 25 May 1989, respectively. In Caracas, thirteen participants worked on the identification and clarification of the problems in relation to the issues. Interactive Management Methodology was used under the supervision of the facilitator. A total of 70 problems was identified. In Mérida, eighteen participants worked in four groups to identify and clarify options for research to deal with six groups of problems identified in the PAN-EARTH Project, complementing the problems identified in the Caracas session. The five more important options of each group were presented and discussed in the plenary meeting.

Agricultural Workshop

The PAN-EARTH Venezuela Case Study, under direction of Dr. Miguel Acevedo, in collaboration with FONAIAP (the Venezuelan institute for agriculture), organized a workshop on crop modeling and climate change, from 13-16 November 1989, in Maracay. Dr. Juan Comerma, of the FONAIAP unit at Maracay, hosted the workshop, with organizational support from Dr. Evelyn Bisbal, also of FONAIAP. In attendance were three PAN-EARTH scientists from the United States, plus scientists from FONAIAP, the University of Central Venezuela, the Ministry of Environment and Renewable Natural Resources (MARNR), the University of the Andes, ORSTOM (a French research organization), the Palmaven fertilizer company, and IVIC (a scientific research institute in Venezuela). Among the participants were ecologists, an agrometeorologist, crop modelers, agronomists, and soils scientists.

The objectives of the workshop were: 1) to expand the network of scientists in Venezuela participating in the PAN-EARTH Project; 2) to implement the IBSNAT crop models on Venezuelan computers and to train Venezuelan scientists in their use, applicability, data needs, and outputs; 3) to calibrate the maize model for a specific cultivar grown in Venezuela, using site-specific data on soils, climate, and crop cultivar characteristics; 4) to begin sensitivity analyses using crop models to examine potential effects from climate change; and

5) to establish plans for future PAN-EARTH agricultural, ecological, and meteorological activities in Venezuela. A detailed Maracay workshop report was published by PAN-EARTH.

Presentations were made by PAN-EARTH and Venezuelan scientists on general issues of global climate change and its effects on ecological and agricultural systems; the IBSNAT crop models, their features and applicability; crop modeling for climate change assessments as a part of a suite of methodologies incorporated in the PAN-EARTH Project; issues of uncertainties and sensitivity analyses; and aspects of climatology and crop modeling in Venezuela.

Six computers were used to demonstrate the characteristics of the crop models, so that small groups of three or four individuals were able to work directly on the models, as guided by Dr. Gerrit Hoogenboom (U Georgia), through the features of the IBSNAT model input/output shell, called the Decision Support System for Agrotechnology Transfer (DSSAT). Dr. Hoogenboom led the participants through the procedures to select particular models (implemented here were the maize, wheat, soybean, and peanut models), modify their parameters, conduct simulations, and evaluate text and graphical outputs. Two working groups were established. The first was assigned specific problems for solution by the IBSNAT maize model, specifically to determine the optimal set of soils, weather, and planting dates for maximizing yields of maize. Three historical weather records for Venezuela were used to drive the simulations, and three soil types and two crop cultivars from the region were examined. This working group divided into sub-groups, each using a computer for conducting the simulations. The second working group was charged with calibration of the maize model using specific experimental data for maize production at a FONAIAP research site, including soils, weather, and harvest data. It was agreed among the agricultural and modeling scientists involved in the working group that the calibration process for this cultivar of maize was quite satisfactory, in that available data were well-reproduced in the simulations. Further, it was agreed that the maize calibration is sufficient for conducting maize sensitivity analyses for climate change scenarios in Venezuela. A parallel exercise using soybean data and the IBSNAT SOYGRO model failed to attain satisfactory calibration. Data are being collected to continue attempts at soybean model calibration. As additional data are available from FONAIAP and other scientists in Venezuela, further calibrations can be completed for maize.

The workshop then divided into four new working groups: group 1 exercised the strategy evaluator to examine effects of alternative planting dates, cultivar types, and weather regimes on maize yields for three sites in Venezuela; group 2 worked to correct data errors in the weather files for three sites in Venezuela and entered additional data obtained in handwritten form; group 3 worked to calibrate the soybean model to a specific cultivar in Venezuela; and group 4 conducted sensitivity analyses on the maize model for three sites in Venezuela, using one historical year's weather data for the control runs, with changes in temperature and precipitation.

The workshop concluded with a session on future plans and activities for the PAN-EARTH Venezuela Case Study. The applicability of the crop models and their limitations were discussed, as well as the significant limitations of data and the importance of proper quality control on the input data

Climatology Workshop

The PAN-EARTH Venezuela Case Study and the Center for Advanced Studies of the Tropical Climate (CEACT) convened a workshop in Mérida, from 23-27 April 1990, on climate change in Venezuela and the Caribbean. The workshop was sponsored by the PAN-EARTH Project, CEACTION, the Ministry for the Environment and Renewable Natural Resources (MARNR), and the University of the Andes (ULA). Drs. Mark Harwell (Cornell), Alan Robock (University of Maryland), Herbert Riehl (University of Colorado and ULA), and Roger Pulwarty (University of Colorado) joined about 30 scientists from Venezuela, Trinidad and Tobago, and Costa Rica in the workshop. Four working groups were formed to: 1) examine existing climatic variability in the region, with attention to spatial and temporal variability in temperature and particularly precipitation; 2) develop climate change scenarios for the region; 3) begin sensitivity analyses using crop models to predict maize yield and phenology; and 4) examine potential hydrological impacts. The key product from the workshop was a set of detailed scenarios for regional climate change induced by greenhouse climate change, regional deforestation, and nuclear winter.

The scenario working group examined outputs from several general circulation models (GCMs) for the present climate of the region, including the Oregon State model (OSU), the Goddard Institute for Space Sciences model (GISS), the Geophysical Fluid Dynamics Laboratory model (GFDL), the Los Alamos National Laboratory model (LANL), and

the United Kingdom Meteorological Office model (UKMO). These outputs were compared with actual weather records for the region for the past three decades, including for several locations within the region and for each month of the year. It was clear that the UKMO model provides a very good prediction of temperature and precipitation for the region, even including the spatial and temporal distribution of precipitation. The other models were judged to provide inadequate representations of the regional climate. The next step was to examine the altered-atmosphere scenarios, with primary reliance on the UKMO results for greenhouse effects, the recent work by Shukla *et al.* (1990) on deforestation in the Amazon (using a variant of the SiB biosphere/atmosphere model), and the LANL model for nuclear winter. Local-scale scenarios were developed using expert judgment to adjust regional-scale outputs from the GCMs and using historical analogs for climate change in the region. A final set of scenarios was produced at three different levels of climate sensitivity (i.e., different expectations of global temperature changes at an effectively-doubled CO₂ atmosphere) for the rainy and dry seasons. These are presently being applied for agricultural and ecological effects assessments by selecting several historical years of weather data for several local stations near the agricultural and ecological research sites, simulating those systems for those years using models calibrated to the selected sites, and simulating the same systems with the weather altered as defined by the scenarios. In addition, a suite of sensitivity analyses are being initiated to examine effects of imposing the specified scenarios in different ways; e.g., if precipitation is predicted to increase by 25%, how much difference it would make to crop yields if that occurred by changing the number of rainy days, or changing the intensity of rainfall events, or changing the duration of the rainy season, etc. Plans were also developed at the Mérida workshop for the ecological workshop in July, sponsored by PAN-EARTH and the Venezuelan Scientific Research Institute (IVIC), on ecological effects issues.

Ecological Workshop

The PAN-EARTH Project and the Instituto Venezolano de Investigaciones Científicas (IVIC), a major scientific research institution in Venezuela, co-hosted a workshop on methodologies for assessing ecological effects of climate change in Venezuela. The workshop was held at IVIC, in the mountains above Caracas, on 16-20 July 1990, and was organized by the Venezuelan Case Study coordinator, Dr. Miguel Acevedo (University of the Andes), and by Dr. Ernesto Medina (IVIC). Participants included more than two dozen Venezuelan scientists and three participants from the U.S. (Drs. Mark Harwell [Cornell University], Wendell Cropper [University of Florida], and Mike Coughenour [Colorado State University]). The American scientists presented an ecological simulation model for deciduous forest composition and productivity (the FORNUT model developed by Cornell's David Weinstein); a pine plantation carbon allocation and productivity model (developed by Cropper and his colleagues); and a grassland/savannah ecosystem model and a landscape model (developed by Coughenour and his colleagues). These models were transferred to the Venezuelan scientists; specific model parameterizations and modifications necessary for adaptation to Venezuela were decided upon, and plans were made for calibrating the models for use in climate change effects assessments. Venezuelan scientists presented ongoing work on: use of ordination for ecological system characterization; geographic information systems under development; the Venezuela-specific climate change scenarios developed at the previous PAN-EARTH workshop in Mérida; the detailed vegetation mapping of Venezuelan vegetation; and details of Venezuelan forest, savannah, and other terrestrial ecosystems.

The workshop was funded by a recent grant awarded to the PAN-EARTH Venezuela Case Study by the Ayacucho Foundation, a government-funded foundation for advancing higher education in the country (see discussion below). The two-year Ayacucho grant will support the exchange of scientists between Venezuela and the U.S. to work on global climate change issues, as well as funds for Venezuelan participation in short courses on the IBSNAT crop modeling methodology.

Funding

• Ayacucho Foundation Support

The Ayacucho Foundation is a Venezuelan government-sponsored foundation with an annual budget of about \$12 million for advancing the educational capabilities in Venezuela. Dr. Leopoldo López Gil, president of the foundation, visited Cornell University in January 1990, and met with Christine Harwell on behalf of the Global Environment Program and the PAN-EARTH Project. In April 1990, Drs. Mark Harwell and Miguel Acevedo met with Dr. López in Caracas to discuss support to the PAN-EARTH Venezuela Case Study. Dr. Acevedo subsequently submitted a formal proposal to the foundation, which was approved for two years' support at about Bs.1.3 million per year. This funding is for the following activities during 1990: 1) PAN-EARTH ecology workshop (held in July 1990 at IVIC, Caracas), including costs for Venezuelan and U.S. participants; 2) IBSNAT crop model training, for five Venezuelan scientists to attend a two-week long, detailed course on crop modeling held at the University of Florida in September 1990; and 3) visits by four U.S. scientists to Venezuela and four Venezuelan scientists to the U.S. for periods of days to weeks each, for intensive work on model development, data analysis, and other scientific activities. During 1991, similar activities will be supported by the Ayacucho Foundation grant. These funds will substantially improve the capability of the Venezuelan case study to reach its objectives.

• Funding Visits in November 1989

Drs. Harwell and Acevedo met with members of the Cornell Club of Venezuela in November 1989. About a dozen members of the Club were present to discuss the visit of Venezuelan President Pérez to Cornell and the resulting activities for collaboration between the University and Venezuela. During that visit, President Pérez proposed to President Rhodes of Cornell a bilateral agreement for cooperation, with emphasis on management training for middle- and upper-level government officials. The members of the Cornell Club offered specific advice about potential financial support sources.

Dr. Harwell and Acevedo met with Dra. Dulce Arnao, head of the Ministry for Science and Technology (CONICIT) and the CONICIT Vice Minister, Cesar Martinez, to discuss the PAN-EARTH Project and the Venezuela Case Study. The Minister indicated strong interest in the problem for Venezuela and the need for expanding the activities of the scientific community in Venezuela on related issues. She referred to the

bilateral agreement between Cornell and the Venezuelan President's office, indicating a strong desire on her part to expand beyond management focus to involve scientific cooperation.

Drs. Harwell and Acevedo met with Mr. Virgilio Urbina, Program Officer, Polar Foundation, to discuss the proposal that PAN-EARTH had submitted for support from the Polar Foundation to the project. This proposal was prepared following a previous meeting with these three participants in May, 1989, and initial indications from Polar had been that it would be partially funded. However, just prior to the Maracay workshop, Dr. Acevedo was informed that the proposal was not funded. Mr. Urbina indicated that the proposal was not rejected, but has been recycled into a queue for proposals to the environment committee for Polar, as the present funds for ecological research are already committed, primarily to three projects. The PAN-EARTH scientists explored the possibility of a new proposal focusing on maize production at three Polar research sites, specifically to adapt the IBSNAT maize model to the sites and calibrate to the cultivars used there. The applicability of such adapted models to a host of research and management issues of importance to Polar was explained. This idea was well-received, and plans made for demonstration of the maize model for the consulting expert Polar has retained to deal with agricultural issues. Discussion followed of PAN-EARTH activities supplementing ongoing Polar Foundation-supported research on developing geographic information systems (GIS) for Venezuela; it was agreed to explore this avenue.

An invitation to Dr. Harwell from Mr. Julio Sosa-Rodriguez (a member of the Cornell Council, President of the Board of Directors of Metropolitan University, Caracas, and former Venezuelan Ambassador to the United States) was given during his visit to Cornell with President Pérez. Drs. Harwell and Acevedo discussed with him climate change causes and effects, the PAN-EARTH Project, and the Venezuelan Case Study. The difficulties in securing adequate financial resources were discussed. Mr. Sosa-Rodriguez offered to contact the President of the InterAmerican Development Bank (IADB) and the Venezuelan representative for the IADB, Ms. Sonia Pérez, daughter of the Venezuelan President, concerning the PAN-EARTH Venezuela Case Study. Dr. Harwell has corresponded with Ms. Pérez and plans on meeting with her to discuss the proposal for PAN-EARTH support prepared (in Spanish) by Dr. Acevedo.

Mr. Sosa-Rodriguez also suggested several other sources of funding he would help explore.

The Venezuelan Minister for the Environment and Renewable Natural Resources (MARNR) formally included the PAN-EARTH Venezuela Case Study in his written input to the international meeting held in November 1989 in The Netherlands on policy responses to global climate change. Three MARNR scientists have been formally designated as representatives from MARNR to the PAN-EARTH case study.

Dr. Alicia Moreau, MARNR—Director, Cartography and Geography Branch, has agreed to become the co-leader of the Venezuela Case Study. Dr. Moreau will bring considerable expertise on hydrological and meteorological data in Venezuela, plus extensive management experience and ties to the Venezuelan government and business communities.

Computer Connections

Drs. Harwell and Acevedo met, in November 1989, with Dr. Edgar Zorilla, Director of Information at CONICIT, to discuss procedures for linking ULA to BITNET. At present there is a 300 baud connection between ULA (Mérida) and the CONICIT computing center (Caracas), and Dr. Acevedo has successfully connected his IBM-PC-compatible computers to the CONICIT computer. A set of TELNET phone lines are available for 300-baud transmission of data to computers in the United States connected to TELNET. A computer account has been established at Yale University for CONICIT, and Dr. Zorilla gave Dr. Acevedo the account name and password so that he may log on directly to the Yale computer. During the meeting this was done, and Dr. Harwell explained the procedures for using the MAIL system on the Yale machine and for sending and receiving BITNET messages. At present the methods for uploading and downloading between the Yale computer and the Venezuela microcomputers have not been established, but sending and receiving mail was accomplished with no difficulty. Dr. Harwell will explore a TELNET link directly to the Cornell computer system, in which case an account for Dr. Acevedo will be established. If this is not feasible, the Yale contact (Dr. Ruben Quintero) will be queried for establishing a separate account for Dr. Acevedo. In the interim, Dr. Zorilla offered PAN-EARTH use of his account at Yale for sending and receiving messages.

ADDITIONAL PAN-EARTH ACTIVITIES

Outreach/Publications

• IPPNW Meetings

Drs. Mark Harwell and Tom Ackerman traveled to Hiroshima, Japan, to attend the International Physicians for the Prevention of Nuclear War (IPPNW) Congress 7-10 October 1989. The Congress was held at the Peace Memorial Park at the site of the Hiroshima nuclear detonation. In attendance were approximately 2500 participants from countries around the world. IPPNW convened a series of colloquia, and basic and advanced core curricula on issues related to nuclear weapons and nuclear war. In the advanced core curricula, the topic of the physical and climatological effects of nuclear winter was presented by Dr. Ackerman, and the topic of the ecological, agricultural, and human consequences of nuclear war was presented by Dr. Harwell.

• India

A report has recently been issued by S.K. Sinha and P.K. Aggarwal (Water Technology Centre, Indian Agricultural Research Institute) titled *Impact of Nuclear War on Indian Agriculture (First Estimate)*. The report was commissioned as a follow-on activity to SCOPE-ENUWAR by Prof. M.G.K. Menon, Minister of State, Science and Technology. Financial assistance was provided by Dr. M.R. Srinivasan, Chairman, Atomic Energy Commission of India.

Dr. Harwell visited India in 1987, to discuss incorporating Indian research into the PAN-EARTH Project, and it was at this time that this report was conceived. The authors also attended ENUWAR meetings in Geneva and Moscow, to further develop their background knowledge for these research activities. Climate change scenarios for India as a result of nuclear winter were prepared and sent by Dr. Steve Ghan, Lawrence Livermore National Laboratory. A simulation model for irrigated wheat, WTGROWS, was developed by Dr. Aggarwal, and the model was validated using Indian data. The model was run for a 1 July onset of nuclear war only. A serious limitation of using the GCM output directly for studies of this kind are that modifications based on local experience are not incorporated into the scenarios that are used as input for the crop models. Here, the effects on the monsoon are not quantified, and thus only irrigated wheat crops were examined for effects. If water limitations are not considered, wheat production during the non-monsoon season would increase, though the authors stated "the observed increase in wheat yields may, however, be quite illusory once

water availability is considered." Effects on other crops were described, based on physiological studies and expert judgment. The known temperature decreases would eliminate the possibility of growing rice, legumes, and other important crops in the monsoon season. The conclusion is that the food security of India would be seriously affected by a nuclear winter.

- *Nuclear Famine*

An instructional booklet and filmstrip entitled *Nuclear Famine* were published in 1990 by Carolina Biological Supply, a major supplier of instructional materials for high schools and colleges. The booklet was written by Christine and Mark Harwell, and contained materials developed both from the SCOPE-ENUWAR project and from the subsequent PAN-EARTH Project. More than 300 copies were distributed to a worldwide mailing list.

- *Technical Papers*

At present a series of articles are planned for publication of PAN-EARTH analyses in the open scientific literature. These articles are: 1) an overview of the methodology for PAN-EARTH in scenario development, model calibration, and effects assessments; 2) an article defining the crop model input specificity for conducting effects assessments, including such issues as the level of model calibration needed, the time-resolution of input weather data, etc.; 3) an article on scenario development using global models and other inputs to derive regional- and local-scale climate change scenarios, using the Africa, China, and Venezuela case studies as examples; 4) an article on crop model sensitivity analyses, using the country-specific range of climate change scenarios to guide the range of parameter changes imposed on the crop models, to identify the sensitivity of effects on crop production and phenology to differences in model inputs and model parameters; 5) an article on sensitivity analyses for ecological systems; and 6) an article summarizing the effects assessments of climate change affecting each of the case study regions. Other articles planned include examinations of potential effects of climate change in sub-Saharan Africa, using historical analogs of drought effects on agriculture, food supplies, migration, and the distribution of vegetation.

The National Academy of Sciences has a committee on sustainability and tropical ecological systems. That committee has requested a white paper be prepared by Drs. Acevedo and Harwell on the relationships between climate change and deforestation in the humid tropics, with attention to impacts on the rates of transition from forests to

agriculture; the characteristics of buffer zones needed to protect forested ecosystems; feedbacks from deforestation to regional- and global-scale changes in climate; and recommendations for research on these issues. The white paper will be a point for discussion at an international conference on the topic to be convened by NAS early in 1991.

- *New York Times Editorial*

After the publication in *Science* of an update article on nuclear winter by the original TTAPS authors (Drs. Turco, Toon, Ackerman, Pollack, and Sagan), there was a negative editorial in the *New York Times* on the subject, written by Nicholas Wade. In response, Drs. Harwell and Robock each sent an editorial reply. There was considerable discussion with the *Times* staff about the possibility of publishing these responses, but it was decided to publish a response letter from Drs. Sagan and Turco instead. The editorial, Harwell's and Robock's responses, and the Sagan/Turco letter were distributed to a large number of ENUWAR collaborators and correspondents.

- *Speeches and Interviews on Nuclear Winter*

Dr. Harwell has given speeches and interviews on the topic of nuclear war, nuclear winter, and the biological effects of nuclear winter to: University of North Texas, Gannett News Service, World Resources Institute, Virginia Institute of Marine Sciences, University of Maryland, Finger Lakes Club, 2nd International Conference on Environmental Analytical Chemistry, annual conference of the International Physicians for the Prevention of Nuclear War (see above), and the Nagoya, Japan, newspaper and local television station.

- *Second Edition SCOPE 28*

The second edition of SCOPE 28, *Environmental Consequences of Nuclear War*, was published in softcover by Wiley & Sons in 1990. A new preface was written for Volume II by Dr. Harwell. A copy of the text of that new preface was presented as Appendix G in the 1988-89 PAN-EARTH Annual Report.

- *Earth Day 1990*

The Global Environment Program at Cornell actively participated in the Earth Day program. During the day, more than 100 copies of a PAN-EARTH Project brochure were distributed to the faculty, staff and students at Cornell. Judy Landers of the Global Environment Program was responsible for these activities.

- IPCC

The Intergovernmental Panel on Climate Change was commissioned by the World Meteorological Organization and the United Nations Environment Programme to provide a three-volume evaluation of climate change for the Second World Climate Conference meeting in Geneva, November 1990. Dr. Harwell was asked to contribute to the draft report of the second volume, on impacts.

- Peace Initiatives

A group of students from the U.S. traveled to Siberia in 1989 to work with local scientists on environmental problems. They formed a group called Peace Initiatives after that visit and invited the Soviet scientists for a reciprocal visit to the U.S. The Global Environment Program was a sponsor of the visit of that 10-member group to the Cornell campus in June 1990. Dr. Harwell presented a talk to the group on nuclear winter research and climate change. He was asked many questions by the Soviet visitors about the nuclear winter information, with which they were very familiar. Judy Landers of the Global Environment Program was responsible for organizing these activities.

Core Funding

A no-cost extension of the contract with Rockefeller Brothers Fund has been arranged for 1990-91. This will allow the expenditure of committed funds for activities that are not yet complete at the date of termination of the original two-year project. New core funding for the PAN-EARTH Project has been sought at meetings between Dr. Harwell and representatives of several foundations and a number of executives of the World Bank.

IBSNAT Connections

In 1989, PAN-EARTH funds purchased a Toshiba 5200 portable computer, a 20 MHz 386-machine. This computer allowed the IBSNAT crop models (and the ecological models being used) to be installed and demonstrated in the case study countries. The Toshiba was used at training sessions at workshops in Africa and Venezuela.

All of the currently available IBSNAT crop models and copies of the user's guides have been sent to all the case study countries, and they have been installed on computers in those countries. The models are currently being calibrated for several crops in those countries, in order to run the models with a variety of weather inputs to determine effects of nuclear winter and greenhouse scenarios.

Dr. Harwell met with Dr. Goro Uehara and Dr. Tej Gill of the IBSNAT Program of U.S. AID several times during 1989-90, concerning the future use of the IBSNAT models in PAN-EARTH studies, using the PAN-EARTH methodology and procedures as a model for future IBSNAT activities, and setting up a model training workshop for participants from all the PAN-EARTH case studies.

As a result of these meetings, Dr. Gill assisted in forming an advisory group to write a prospectus for a long-term modeling project, based on the IBSNAT and PAN-EARTH methodologies. The OIKOS Project prospectus has been circulated to a number of potential funding sources throughout the world. Further activities will involve following up promising sources of funds for a planning grant, constructing a research plan, and obtaining long-term core funding for the project. The objective is to develop a library of ecological and agricultural models that can be utilized as flexible modules by scientists and, more importantly, decision makers at the regional and national level, even though they have little familiarity with modeling. The models would allow a variety of scenarios to be developed and followed through to determine environmental, economic, and social effects.

In January 1990, the U.S. Environmental Protection Agency and U.S. AID held a joint workshop on using the IBSNAT models to examine global climate change issues. Dr. Harwell attended as an advisor, at the invitation of EPA. This study is looking at climate change effects on agriculture in several countries. However, the scenarios being used have serious flaws and the crop models are not adequately calibrated to the conditions in each country, so it is not anticipated that the results from this study will be sufficiently reliable for use by the PAN-EARTH Project.

CNSF UNIX Workshop

The Cornell National Supercomputing Facility (CNSF) held a workshop on the Cornell campus to discuss and train modelers on the use of the UNIX operating system. This system will be in place on the supercomputer at Cornell within the next few months. This will directly affect the decisions about obtaining a General Circulation Model and installing it on the supercomputer, then running it to obtain input for the various ecological and agricultural models being used in global climate change effects research at Cornell. Dr. Harwell attended the two-day workshop to begin learning the UNIX system and to explore its utility for future PAN-EARTH modeling activities.

ASSOCIATED ACTIVITIES OF THE GLOBAL ENVIRONMENT PROGRAM

Cornell/NGA Conference Follow-up

As a result of the three-day conference on global climate change held in New York in 1989, co-sponsored by Cornell University and the National Governors' Association, the NGA formed a task force that released an advisory report this summer recommending policy choices for dealing with climate change effects.

Additionally, the Global Environment Program has been promised funding to produce a proceedings volume based on speeches and workgroup reports presented at the conference. There were a number of PAN-EARTH case study members attending the conference, and chapters in the proceedings volume, to be edited by Christine and Mark Harwell, will focus on effects studies, particularly the PAN-EARTH Project methodologies and modeling results.

National Institutes for the Environment

Dr. Harwell was asked to prepare a proposal for legislation to establish an Institute for Climate Change as a division of a new National Institutes for the Environment. This is modeled on the existing National Institutes for Health operations. There were six institutes proposed. Dr. Mark Harwell and Christine Harwell, with Dr. Jay Jacobson of the Boyce Thompson Institute for Plant Research, authored the section on the climate change institute. This proposal was submitted as part of testimony by Dr. Henry Howe (U Illinois) to a House of Representatives Science and Technology Committee hearing in May 1990, and published as a part of the Congressional Record.

Cornell Global Initiative Planning Grant

Cornell University received a one-year planning grant from an anonymous donor to prepare a proposal for establishing an institute for climate change effects research at Cornell University. Dr. Mark Harwell and Dr. Ray Oglesby were co-principal investigators for the planning grant proposal, and the Global Environment Program was chosen to implement the grant's planning activities.

The activities include publication of a monthly newsletter containing information on climate change activities both on- and off-campus, review of recent publications, and research news and sources of funding. Several working groups have been established to develop multi-disciplinary research themes for the University. Short courses

on climate change causes and effects have been held on campus. A research plan will be written and submitted for funding by 1991.

Man and the Biosphere Directorate

The Man and the Biosphere Program, coordinated by UNESCO and in this country by the U.S. Department of State, recently reorganized to create five new directorates. Dr. Harwell is vice chair of the Human-Dominated Ecosystem Directorate (chaired by Dr. Roberta Miller, head of the National Science Foundations' division of social and economic research). This MAB directorate is developing a research plan for examining ecological sustainability in the face of global change. The MAB Biosphere Reserves will provide a few case studies for examining such issues as ecological indicators of the health of the ecosystem; effects on the ecosystems from global climate change and other anthropogenic stresses; and institutional and societal factors affecting the achievement of sustainability of the ecosystems. Some of the methodologies and data bases developed in PAN-EARTH will contribute to this activity.

Move of Offices, Addition of Staff

In December, 1989, the Global Environment Program moved from Hollister Hall to Wing Hall on the Cornell campus. This put the GEP within easier access to the biological sciences buildings at Cornell and allowed for expansion of office space. A part-time secretary was hired in September 1989, and a research support specialist was hired in April 1990, to assist in implementing Cornell's global initiative planning grant (see above). During the summer of 1990, two student interns assisted GEP with preparing workshop reports, a book on environmental connections of office activities, a newsletter, and research for the articles in preparation on the PAN-EARTH case studies (see above).

PUBLICATIONS AVAILABLE FROM PAN-EARTH

A list follows of all the PAN-EARTH publications available. To obtain copies, write to:

Global Environment Program
407 Wing Hall
Cornell University
Ithaca, New York 14853-8101
USA

China Case Study

- 1st Annual Workshop Report (Beijing), September 1988
- 2nd Annual Workshop Report (Beijing), February 1990 (English version in preparation)

Venezuela Case Study

- Mini-Workshops Report (Caracas and Mérida), May 1989
- Agricultural Workshop Report (Maracay), November 1989 (in English and Spanish)
- Climatology Workshop Report (Mérida), April 1990
- Ecological Workshop Report (Caracas), July 1990 (in preparation)

Japan Case Study

- Highlights of Japan Case Study Committee Workshop, December 1989

Africa Case Study

- Sub-Saharan Africa Workshop Report (Senegal), September 1989

Annual Reports

- 1988-89
- 1989-90

Conference

- Report of the Cornell University/National Governors' Association Conference on Global Climate Change, March 1989

