

I. The Winners of the Blue Planet Prize

1992

1992

Blue Planet Prize

Dr. Syukuro Manabe (U.S.A.)

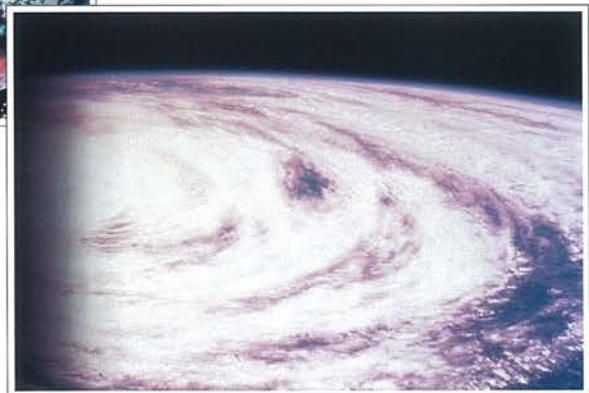
Member of the Senior Executive Service of the Geophysical Fluid Dynamics Laboratory at the National Oceanic and Atmospheric Administration



International Institute for Environment and Development (IIED) (Founded in the United Kingdom)



At the 1992 Blue Planet Prize awards ceremony, the opening slide presentation highlighted the beauty of our blue planet with images of the Earth seen from outer space. Each year, the awards ceremony features a slide presentation on a different theme.





Prime Minister Kiichi Miyazawa gives a congratulatory speech at the opening ceremony.



As the chairman of the Presentation Committee, Dr. Saburo Okita reports on the selection process.



Hideaki Yamashita, chairman of the Asahi Glass Foundation, delivers the opening address.



Asahi Glass Foundation Chairman Hideaki Yamashita shakes hands with Michael Armacost, ambassador of the United States of America to Japan. Directly behind Mr. Armacost is Sir John Boyd, Her Britannic Majesty's ambassador.



On the day following the awards ceremony, a symposium was held on the topic of creating a new civilization in harmony with nature. Symposium panelists, from left; Keiko Nakamura, Professor, School of Human Sciences, Waseda University; Takamitsu Sawa, head of Kyoto University's Institute of Economic Research; Symposium Coordinator Hirotada Hirose, Professor, College of Arts and Sciences, Tokyo Women's Christian University; Kenzaburo Oe, author; and Hiroyuki Ishi, Senior Staff Editor, Asahi Shimbun Publishing Company.



Seated with other members of the audience, the laureates participate in a panel discussion that followed the symposium.

Profile

Dr. Syukuro Manabe

Senior Scientist, Geophysical Fluid Dynamics Laboratory, National Oceanic and Atmospheric Administration, Princeton, New Jersey

Education and Academic and Professional Activities

- 1953 Bachelor of Science, University of Tokyo
- 1955 Master of Science, University of Tokyo
- 1958 Doctor of Science, University of Tokyo
- 1958 Research Meteorologist, General Circulation Research Section, U.S. Weather Bureau, Washington, D.C.
- 1963– Senior Scientist, Geophysical Fluid Dynamics Laboratory at the National Oceanic and Atmospheric Administration, Princeton, New Jersey
- 1966 Fujiwara Award, Japan Meteorological Society
- 1967 Mesinger Award, American Meteorological Society
- 1968– Lecturer with rank of professor, Princeton University
- 1970 Gold Medal Award, Department of Commerce
- 1977 2nd Half-Century Award, American Meteorological Society
- 1979 Member of the Senior Executive Service, U.S.A., Geophysical Fluid Dynamics Laboratory, National Oceanic and Atmospheric Administration, Princeton, New Jersey
- 1981–87 World Meteorological Organization/International Council of Scientific Union/United Nations Environmental Program, Joint Scientific Committee
- 1989 Meritorious Executive Award, President of the U.S.A.
- 1989–90 Intergovernmental Panel on Climate Change, Lead Author for Group I Report (Scientific Assessment)
- 1990 Elected Member, National Academy of Sciences
- 1992 Blue Planet Prize, Asahi Glass Foundation
- 1993 Revelle Medal, American Geophysical Union
- 1994 Elected Foreign Member, Academia Europaea
- 1995 Elected Foreign Member, Royal Society of Canada
- 1995 Asahi Prize, Asahi Shimbun Cultural Foundation

Dr. Syukuro Manabe, a naturalized U.S. citizen, was born in Ehime Prefecture, Japan, in 1931. Dr. Manabe received a doctor of science degree from the University of Tokyo in 1958, when he was invited to join a research group of the U.S. Weather Bureau as a research meteorologist. Dr. Manabe has since then continued to work at the same U.S. institution, which is currently called the Geophysical Fluid Dynamics Laboratory of the National Oceanic and Atmospheric Administration.

Dr. Manabe is a leader in developing computer models for the study of climate. Using a one-dimensional model of climate which incorporates convective as well as radiative transfer of heat in the atmosphere, he successfully elucidated the role of greenhouse gases (e.g. carbon dioxide, water vapor and ozone) in maintaining the vertical thermal structure of the atmosphere. He and his collaborators made pioneering contributions to the projection of global warming through the imaginative use of the one-dimensional, radiative-convective model mentioned above and three-dimensional, general circulation models of the coupled ocean-atmosphere system. Their contributions had a profound impact upon the assessments of climate change which were conducted by the Intergovernmental Panel on Climate Change in 1990 and 1995. The scope of his modeling activity is very extensive, covering not only the present and future climates, but also the climate of the geological past. Dr. Manabe has played a leading role in the emergence of the modeling approach as one of the most promising avenues for the study of climate.

Essay

Model Assessment of Observed Global Warming Trend

Dr. Syukuro Manabe

April 1997

Prologue

When we discuss global warming, one of the questions which we ask frequently is, "Have we detected global warming?" In this essay, I would like to answer this question using a general circulation model of the coupled ocean-atmosphere system, which will hereinafter be called the "coupled model" for simplicity.

Since the basic structure of the coupled model was described in my commemorative lecture of the 1992 Blue Planet Prize contained in this volume, I shall not repeat it here. I would like to note, however, that the coupled model has become a very valuable tool for the study of climate, successfully simulating both its interannual and decadal variabilities (Manabe and Stouffer, 1996).

Figure 1 illustrates the time series of global averaged, annual mean surface air temperature (SAT) that Jones and Wigley (1991) constructed, based upon past observations of SAT. In addition to the low frequency fluctuations of global mean temperature at interannual to decadal time scales, this time series exhibits the global warming trend that began around the turn of this century. In this essay, I would like to discuss whether the sustained warming trend of global mean temperature during the 20th century is induced by thermal forcing, as a result of increasing greenhouse gases, or generated internally through the interaction among the

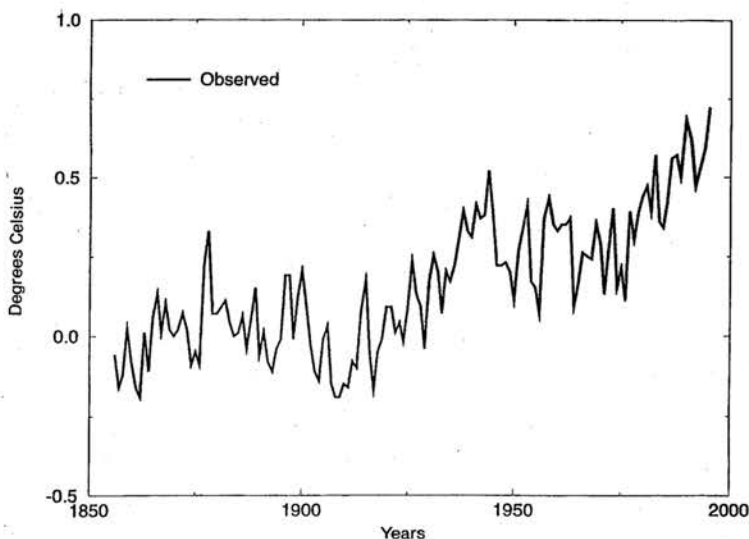


Figure 1 Time series of globally averaged, annual mean SAT anomalies (i.e., the departures from the 1880–1920 base-period means) obtained by Jones and Wigley (1991).

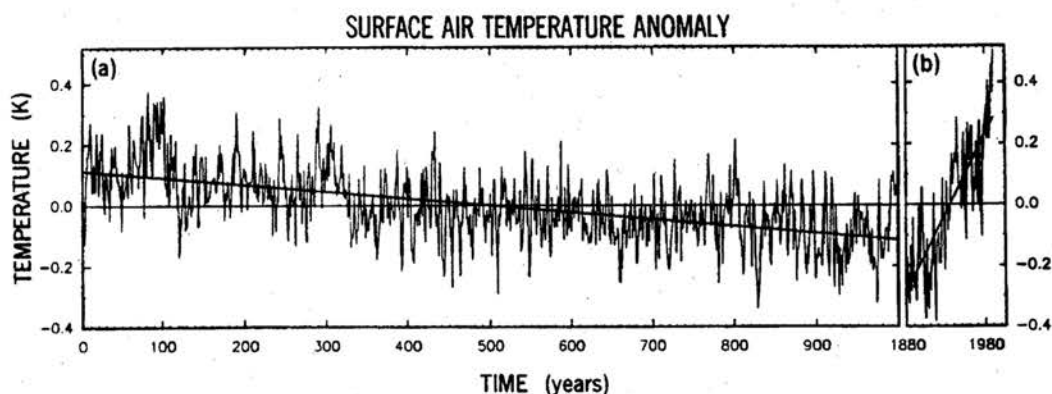


Figure 2 Time series of globally averaged, annual mean SAT anomaly from the long-term mean.

(a) 1,000-year time series from the coupled ocean-atmosphere model

(b) 110-year time series (1881–1990) of observed, globally averaged temperature.

The straight lines through both time series are such that the sum of squared distance between the time series and the straight line is minimized.

atmosphere, oceans, and land surface.

Simulated natural variability

In order to study the natural variability of climate internally generated in the coupled system, we conducted a 1,000-year integration of the coupled model at the Geophysical Fluid Dynamics Laboratory of NOAA. The 1,000-year time series of global mean SAT anomaly obtained from this time integration is illustrated in Fig. 2a and is compared to the time series of observed anomaly between 1881 and 1990 (Fig. 2b).

Stouffer et al. (1994) assessed the probability of finding in the simulated 1,000-year time series a century-scale warming trend such as that observed between 1881 and 1990 (Fig. 2b). They calculated the probability for linear trends exceeding $0.5^{\circ}\text{C}/\text{century}$, which is the observed trend between 1881 and 1990 (Jones and Wigley, 1991). It was found that, for intervals longer than ~ 60 years, there are no trends as large as $0.5^{\circ}\text{C}/\text{century}$. In other words, the observed warming trend of $0.5^{\circ}\text{C}/\text{century}$ is not found in the coupled model time series for any intervals longer than ~ 60 years. If our model behavior is realistic, it is not likely that the ocean-atmosphere-land interaction in the coupled model could randomly generate a substantial long-term warming trend such as that observed since the end of the last century.

To examine spectrally how realistic is the time series of global mean SAT anomaly shown in Fig. 2, the power spectrum of detrended and globally averaged, monthly mean SAT anomaly from the 1,000-year integration of the coupled model is compared in Fig. 3 with the spectrum of detrended, observed SAT compiled by Jones and Wigley (1991). (The detrending of the observed time series reduces the contributions from the fluctuations on time scales longer than 100 years.) This comparison indicates that, at multidecadal and shorter time scales, the coupled model simulates the observed spectrum reasonably well.¹

However, the coupled model fails to simulate any large warming trend of centennial time scale such as that observed during this century. This failure suggests that the observed

warming trend was not generated internally in the coupled system, but was thermally forced.

Thermally forced response

As noted in my commemorative lecture of 1992, the coupled model overestimates the warming trend of the 20th century, if it were forced by greenhouse gases alone. Recently, Mitchell et al. (1995) of the U.K. Meteorological Office obtained a more realistic trend by forcing their coupled model with the effect of sulfate aerosols in addition to increasing greenhouse gases. At the Geophysical Fluid Dynamics Laboratory, we have conducted a similar experiment using the coupled model. The temporal variation of sulfate aerosols and the CO₂-equivalent concentration of greenhouse gases used for our experiment are practically identical to those used by Mitchell et al.² Starting from the initial condition, which is a snapshot of the 1,000-year control integration described in the previous section, Haywood et al. (1997) performed the integration of the coupled model over the period from 1765 to 2065 with thermal forcing of combined greenhouse gases and aerosols, as described above.

Figure 4 illustrates the temporal variation of the globally averaged, annual mean SAT anomalies of the coupled model from 1850 to 2000. For comparison, the time series of observed, global mean SAT anomaly compiled by Jones and Wigley (1991) is added to the same figure. This figure indicates that the simulated warming trend during the past 100 years is remarkably similar to the observed trend. The model also reproduces the magnitude of the observed decadal variability reasonably well, as discussed in the previous section.

In view of the large uncertainty in the estimation of the atmospheric loading of various aerosols and their radiative effect, the close agreement of the simulated and observed warming trends during this century could be fortuitous. For example, many radiative forcings other than sulfate aerosols are neglected in this experiment, including those due to ozone changes, other anthropogenic aerosols, indirect aerosol effects on cloud brightness, and changes in the solar irradiance. Furthermore, the climatic response to these forcings is also uncertain. It appears significant, however, that we are unable to simulate the observed warming during the last 100 years unless the combined effect of increasing greenhouse gases and sulfate aerosols is incorporated.

Concluding remarks

Based upon the comparison between the observed and simulated variability of global mean SAT, we suggest that the sustained warming trend of this century was not generated internally through the interaction among the atmosphere, oceans, and land surface. Instead, it appears to have been forced by natural and anthropogenic thermal forcing such as that resulting from the

¹ The coupled model spectrum is inside the 95% confidence interval of the observed system, though the similarity between the two spectra does not hold too well at the time scale of 2–7 years. Because of its coarse computational resolution, the coupled model underestimates the amplitude of the Southern Oscillation with this time scale (see Knutson and Manabe, 1994; Knutson et al., 1997).

² The CO₂-equivalent radiative forcing of greenhouse gases from 1765 to 1900 was based upon the 1990 report of the Intergovernmental Panel on Climate Change (IPCC, 1990). After 1990, it was assumed to increase by 1% per year, following approximately the best guess IPCC 1992a scenario (IPCC, 1992). The direct effect of sulfate aerosols was added by increasing surface albedo at each grid box, yielding the 1990 global mean thermal forcing of $\sim 0.6 \text{ W/m}^2$.

increase of solar irradiance (Lean, 1991) and greenhouse gases in the atmosphere. A similar inference could also be drawn from analysis of the time series of global mean SAT obtained from the coupled model developed at the Hadley Centre of the U.K. Meteorological Office (Mitchell et al., 1995).

In addition to analyzing the time series of global mean SAT, other approaches have been employed for the detection of global warming. By comparing the pattern of the observed SAT models, Hegerl et al. (1996) concluded that statistically significant, externally induced warming has been observed. Saner et al. (1996) noted that the observed pattern of temperature change in the free atmosphere from 1963 to 1997 is similar to those obtained by climate models which incorporate various combinations of changes in carbon dioxide, anthropogenic sulfate aerosols and stratospheric ozone concentrations. The conclusions of these studies are clearly in support of the recent statement of the IPCC (IPCC, 1996): “The balance of evidence suggests a discernible human influence on global climate.”

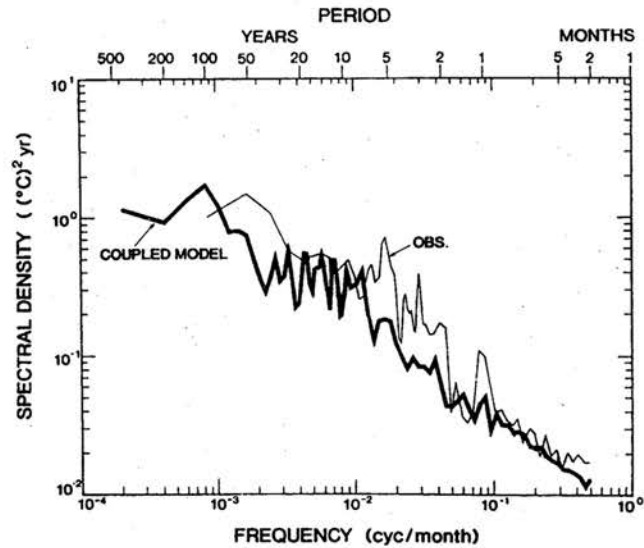


Figure 3 Power spectra of detrended globally averaged, monthly mean SAT anomaly. The thick solid line represents the spectrum of the coupled model time series shown in Fig. 2a, and the thin solid line represents the spectrum of the observed time series (obtained by use of the data compiled by Jones and Wigley (1991)). The spectra are the smoothed Fourier transform of autocovariance function using a Tukey window with a maximum of 2,400 lags (200 years) for the models and 480 lags (40 years) for the observed. They are smoothed by equally weighted averaging over the logarithmic (base 10) interval of 0.04 in frequency.

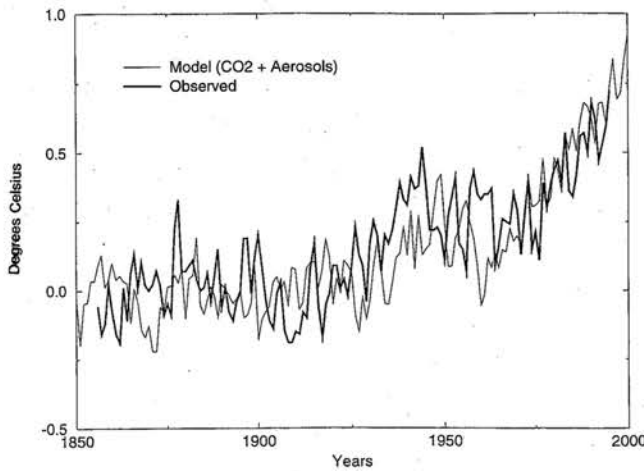


Figure 4 Time series of globally averaged, annual mean SAT anomalies (i.e., deviations from the 1880–1920 mean). Thick solid line: observed (Jones et al., 1991); thin solid line: simulated.

References

- Haywood, J.M., R.J. Stouffer, R.T. Wetherald, S. Manabe, and V. Ramaswamy. "Transient Response of a Coupled Model to Estimated Changes in Greenhouse Gases and Sulfate Concentrations," *Geophys. Res. Letters*, (1997), (in press).
- Hegerl, G.C., H. von Storch, K. Hasselmann, B.D. Santer, U. Cusbach, and P.D. Jones. "Detecting Greenhouse Gas-Induced Climate Change with an Optimum Fingerprint Method," *J. Climate*, 9 (1996), 2281-2306.
- Intergovernmental Panel on Climate Change. *Climate Change: The IPCC Scientific Assessment*, edited by J.T. Houghton, G.J. Jenkins, and J.J. Ephraums. Cambridge: Cambridge University Press, 1990.
- Intergovernmental Panel on Climate Change. *Climatic Change, 1992: The Supplementary Report to the IPCC Scientific Assessment*. Cambridge: Cambridge University Press, 1992.
- Intergovernmental Panel on Climate Change. *Climatic Change, 1995: The Science of Climate Change*. Cambridge: Cambridge University Press, 1996.
- Jones, P. and T.M.L. Wigley. "Global and Hemispheric Anomalies." In *Trends '91: A Compendium of Data on Global Change*, edited by T.A. Boden, R.J. Sepanski, and F.W. Stoss. Oak Ridge: Oak Ridge National Laboratory, 512-517.
- Knutson, T.R. and S. Manabe. "Impact of Increased CO₂ on ENSO-Like Phenomena in a Coupled Ocean-Atmosphere Model," *Geophys. Res. Letters*, 21/21 (1994), 2295-2298.
- Lean, J. "Variation in the Sun's Radiative Output," *Rev. Geophys.*, 29 (1991), 505-535.
- Manabe, Syukuro and R.J. Stouffer. "Low-Frequency Variability of Surface Air Temperature in a 1,000-Year Integration of a Coupled Atmosphere-Ocean-Land Surface Model," *J. Climate*, 9/2 (1996), 376-393.
- Mitchell, J.F.B., T.C. Johns, J.M. Gregory, and S.F.B. Tett. "Climate Response to Increasing Levels of Greenhouse Gases and Sulphate Aerosols," *Nature*, 376 (1995), 501-504.
- Santer, B.D., K.E. Taylor, T.M.L. Wigley, T.C. Johns, P.D. Jones, D.J. Karoly, J.F.B. Mitchell, A.H. Oort, J.E. Penner, V. Ramaswamy, M.D. Schwarzkopf, R.J. Stouffer, and S.F.B. Tett. "A Search for Human Influences on the Thermal Structure of the Atmosphere," *Nature*, 382 (1996), 39-46.
- Stouffer, R.J., S. Manabe, and K.Y. Vinnikov. "Model Assessment of the Role of Natural Variability in Recent Global Warming," *Nature*, 367 (1994), 634-636.

Lecture

Future Projection of Global Warming by Climate Models

Dr. Syukuro Manabe

This lecture describes briefly my involvement in the development of climate models during the last 35 years and the application of these models to the study of global warming. The lecture concludes with a discussion of the strategy towards the reliable projection of the long-term change of climate in the future.

My involvement in the modeling study of climate began in the fall of 1958 when Dr. Joseph Smagorinsky of the U.S. Weather Bureau invited me to join his group and participate in a very ambitious project for the development of comprehensive models of climate. My initial assignment was the incorporation of the radiative effect of various greenhouse gases (e.g., water vapor, carbon dioxide and ozone) into a three-dimensional general circulation model of the atmosphere. As the first step towards this goal, we constructed a one-dimensional radiative-convective model of the atmosphere which included the effects not only of radiative transfer but also the convective restoration of the neutral, vertical temperature gradient due to cumulus convection and synoptical scale disturbances (Manabe and Strickler, 1964; Manabe and Wetherald, 1967).

Figure 1 illustrates the vertical distribution of the global mean temperature which is in radiative-convective equilibrium. The equilibrium state was approached asymptotically through a long-term integration of the radiative-convective model mentioned above. The heat balance of the convective troposphere is maintained between the convective heating and net radiative cooling, whereas the stably stratified stratosphere aloft is in radiative equilibrium without convective heating. The state of radiative equilibrium obtained compares favorably with the U.S. standard atmosphere which is added to Figure 1 for comparison.

To evaluate the response of the model atmosphere to changes in atmospheric CO₂ concentration, numerical experiments were performed with the radiative-convective model of the atmosphere. Figure 2 illustrates the vertical distribution of the simulated, global mean thermal equilibrium temperature of the atmosphere for the normal, half the normal, and twice the normal concentration of CO₂. In response to the doubling of atmospheric CO₂ from the normal to twice the normal concentration, for example, the equilibrium surface temperature of the model increases by about 2.3 °C. The figure also reveals that the magnitude of the cooling resulting from the halving of the CO₂ concentration (from the normal to half the normal concentration) is approximately equal to the magnitude of the warming from the doubling of CO₂ concentration.

The physical mechanism of the greenhouse effect may be understood by realizing that greenhouse gases such as CO₂ and H₂O can absorb and emit terrestrial radiation but absorb a

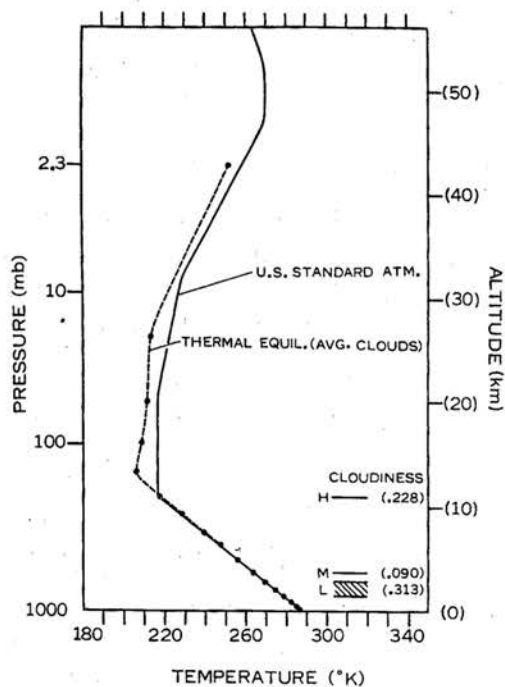


Figure 1. Dashed line shows the vertical distribution of global mean temperature of the atmosphere in radiative-convective equilibrium. (The prescribed cloudiness is indicated on the right-hand side of the figure.) The solid line shows the U.S. standard atmosphere. From Manabe and Strickler (1964).

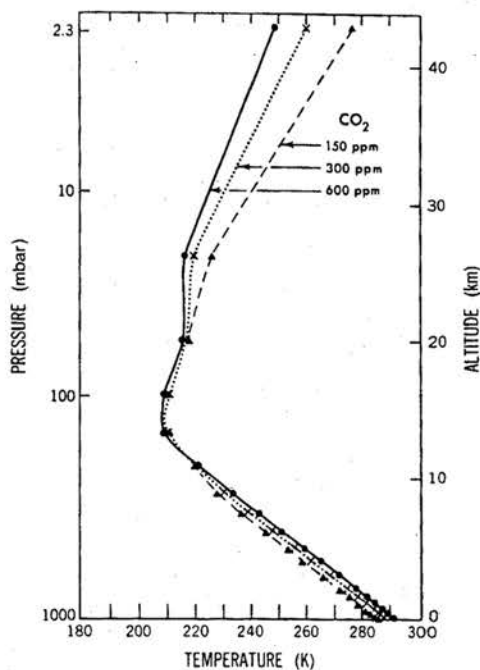


Figure 2. Vertical distribution of temperature in radiative-convective equilibrium for various values of atmospheric CO₂ concentration, i.e., 150, 300, and 600 ppm by volume. From Manabe and Wetherald (1967).

relatively small fraction of solar radiation. In the mid-troposphere, these gases absorb and re-emmit a major fraction of the upward terrestrial radiation emitted from the Earth's surface and the lower troposphere. Thus, the effective source of emission of the outgoing terrestrial radiation at the top of the atmosphere is located in the mid-troposphere rather than the Earth's surface. On the other hand, in an atmosphere without greenhouse gases, the source of emission would be confined to the Earth's surface which is warmer than the mid-troposphere. In order to maintain the compensation between the net incoming solar radiation and outgoing terrestrial radiation at the top of the atmosphere, it is therefore necessary that the thermal equilibrium temperature of the troposphere with greenhouse gases be much higher than that of the greenhouse gas-free atmosphere. Thus, greenhouse gases help maintain the surface temperature of our planet at a level which sustains the biosphere. These discussions also imply that an increase in the atmospheric concentration of CO₂ raises the altitude of the effective source of emission and reduces the outgoing terrestrial radiation, thereby contributing to the global warming of the combined surface-troposphere system.

It is expected that, associated with global warming, the absolute humidity in the model troposphere increases because of the dependence of saturation vapor pressure upon air temperature. Since water vapor is a greenhouse gas which absorbs and emits terrestrial radiation very effectively, the increase in the absolute humidity of air raises the altitude of the effective

Coupled Ocean-Atmosphere-Land Model

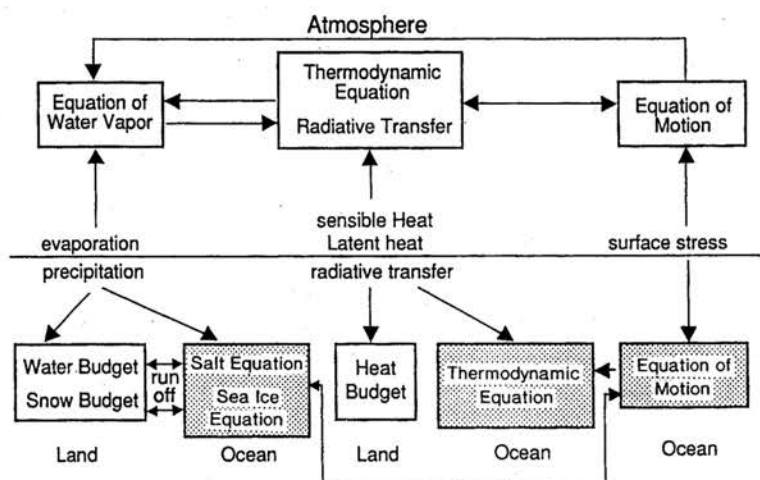


Figure 3. Box diagram which illustrates the structure of the coupled ocean-atmosphere model.

source of outgoing terrestrial radiation. Thus, the temperature of the model troposphere increases further, maintaining the radiation balance of the surface-atmosphere system as a whole. In addition, the increase of absolute humidity increases the fraction of solar radiation absorbed by the model atmosphere, thereby decreasing the planetary albedo and enhancing the CO₂-induced warming. In short, water vapor plays an important role in enhancing the CO₂-induced warming of the atmosphere. Using the radiative-convective model, we succeeded for the first time to correctly evaluate the positive feedback effect of water vapor (Manabe and Wetherald, 1967).

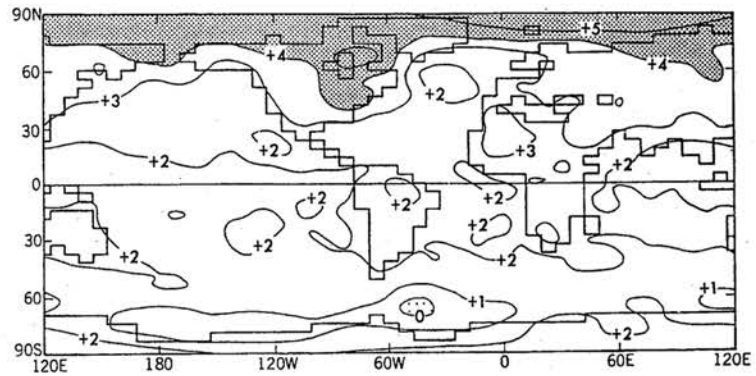
The development of the simple radiative-convective model described above was an important step towards the construction of the three-dimensional, general circulation model (GCM) of the atmosphere.¹ The success of the GCM in the 1960s and early 1970s in simulating many basic features of atmospheric circulation and climate (e.g., Manabe and Holloway, 1975) encouraged us to use the GCM for evaluating global warming (Manabe and Wetherald, 1975; Manabe and Stouffer, 1980).

One of the important factors which control the transient response of climate to a greenhouse forcing is the oceans. If the heat trapped by increasing greenhouse gases is stored in the upper layer of the oceans, or is sequestered into the deeper ocean through vertical mixing, it is possible that global warming could be delayed significantly. Thus, oceans can affect substantially the rate and distribution of global warming. This was one of the important reasons why we started developing the so-called coupled ocean-atmosphere models in the 1960s (Manabe and Bryan, 1969).

I would like to describe here the results from a recent numerical experiment which

¹ For more detailed discussion on early developments in the model study of the greenhouse effect, see my recently published review paper :
Manabe, S. "Early Development in the Study of Global Warming: The Emergence of Climate Models." *Ambio* (1997, in press).

Figure 4. The geographical distribution of the changes in surface air temperature of the coupled ocean-atmosphere model in response to the 1%/year increase (compounded) of atmospheric CO₂. It represents the warming averaged over the 60th-80th year period when the CO₂ concentration is doubled (Manabe et al., 1991).



explored the transient response of a coupled ocean-atmosphere model to a gradual increase of atmospheric CO₂ (Stouffer et al., 1989; Manabe et al., 1991).² The coupled model consists of an atmospheric GCM, an oceanic GCM and a simple model of the continental surface that involves the budget of heat and water (Figure 3). It is a global model with realistic geography. The atmospheric component of the model has seasonal variation of insolation, and predicted cloud cover which depends only on relative humidity. It has nine vertical finite difference levels. To improve the accuracy of hydrodynamic calculations, the horizontal distributions of variables specified at grid points are represented by spherical harmonics at each time step. The oceanic GCM uses a finite difference technique and has a regular grid system with $4.5^\circ \times 3.75^\circ$ (latitude $\times$ longitude) spacing and 12 vertical finite difference levels. The atmospheric and oceanic components of the model interact with each other continuously through the exchange of heat, water, and momentum, as illustrated by Figure 3.

The rate of increase in atmospheric CO₂ concentration chosen for this transient response experiment is 1%/year. This rate is approximately equal to the rate at which the total CO₂-equivalent concentration of all greenhouse gases (except water vapor) is increasing currently. Figure 4 illustrates the geographical distribution of the increase in annual mean surface air temperature when the atmospheric concentration of CO₂ is doubled (i.e., 70th year of the experiment). The doubling of the CO₂-equivalent concentration of greenhouse gases from the preindustrial level may realized around the middle of next century (IPCC, 1990). The figure indicates that the simulated response of surface air temperature is slow over the northern North Atlantic and the Circumpolar Ocean of the Southern Hemisphere, where the vertical mixing of the heat trapped by the increased greenhouse gas penetrates very deeply. However, in most of the Northern Hemisphere and low latitudes of the Southern Hemisphere, the distribution of the change in surface air temperature is very similar to the results obtained earlier without the delaying effect of the oceans. For example, surface air temperature increases with increasing latitudes in the Northern Hemisphere and is larger over continents than oceans. The increase is at a maximum over the Arctic Ocean and its surroundings in the early winter and is mini-

² For more recent overview of climate change studies by coupled atmosphere models, see the review paper by Manabe et al. (1994).

Manabe, S., R.J. Stouffer, and M.J. Spelman. "Response of a Coupled Ocean-Atmosphere Model to Increasing Atmospheric Carbon Dioxide." *Ambio*, 23 (1994), 44-49.

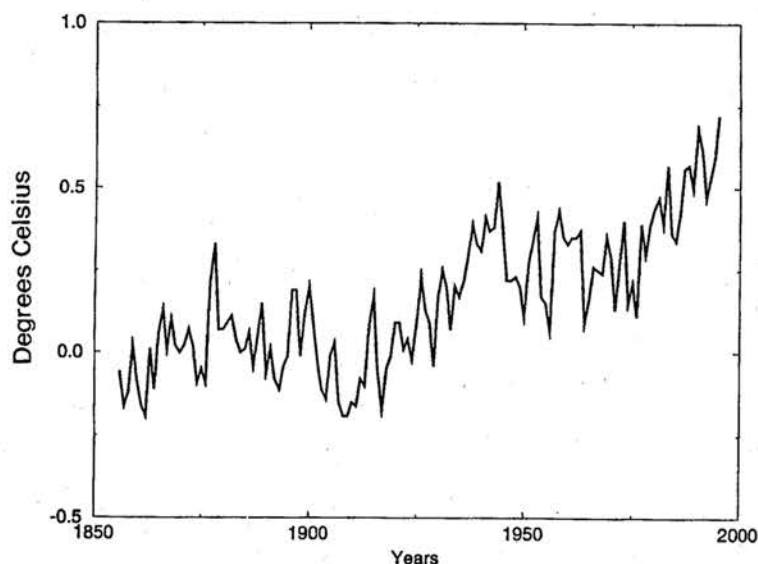


Figure 5. Time series of globally averaged, annual mean surface air temperature anomalies (i.e., the departures from 1961-1990 base-period means) obtained by Jones and Wigley (1991).

imum in summer. The enhanced heat conduction through thinner sea ice is responsible for the early winter maximum, whereas sea ice prevents the temperature of the oceanic mixed layer and the overlying air to rise substantially above the freezing point in summer, and is responsible for the summer minimum in warming. Although the Arctic sea ice loses its thickness in winter as mentioned above, it becomes less extensive as well as thinner in summer.

The increase of a greenhouse gas affects not only the thermal structure of the coupled system but also the hydrologic cycle. For example, the global mean rates of both precipitation and evaporation increase (Manabe and Wetherald, 1975). Because of the increase in the poleward, atmospheric transport of water vapor associated with the increase in the moisture content of air, the increase of precipitation rate in high latitudes far exceeds that of evaporation rate, markedly increasing runoff and reducing the surface salinity in the Arctic and surrounding oceans. This capping of the oceanic surface by relatively fresh water reduces the convective activity in high latitudes and weakens the thermohaline circulation which advects warm and saline surface water northwards, further reducing the greenhouse warming in the northern North Atlantic and surrounding regions (Manabe et al., 1991). It has also been noted that the soil moisture is reduced in summer over extensive mid-continental regions of both the Eurasian and North American continents of the model (Manabe et al., 1981). Thus, it is likely that summer droughts may become more frequent as the greenhouse warming intensifies.

Figure 5 illustrates the temporal variation of the globally averaged, annual mean surface air temperature anomaly compiled by Jones and Wigley (1991) during the last 140 years.³ The figure shows that the global mean temperature has increased by about 0.6 °C since the begin-

³ For the recent model assessment of the temporal variation of the global mean surface air temperature shown in Figure 4, see recent review article by Manabe and Stouffer:

Manabe, S. and R.J. Stouffer. "Climate Variability of a Coupled Ocean-Atmosphere-Land Surface Model: Implication for the Detection of Global Warming." *Bull. Amer. Meteor. Soc.* (1997, in press).

PREDICTION OF GLOBAL CLIMATE

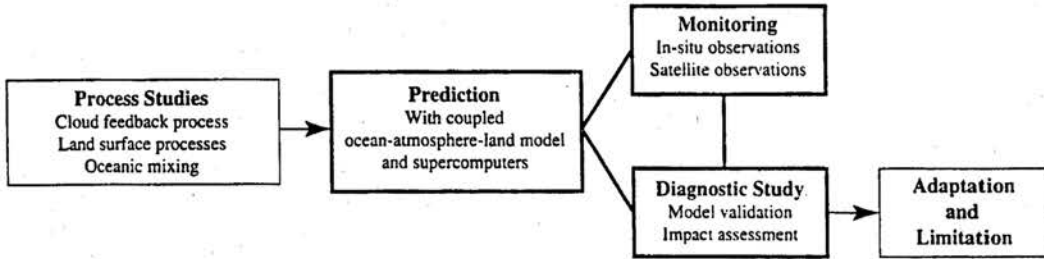


Figure 6. Diagram which illustrates the strategy for the projection of future climate change.

ning of the century. We found that, in response to the observed increase of greenhouse gases, the coupled model generates an increase of global mean surface air temperature which is larger than observed by the factor of about 1.5. This overestimate of global warming may result from our neglect of the cooling effect of sulfate aerosols which reflect incoming solar radiation. Because of fossil fuel combustion, the atmospheric loading of sulfate aerosols has increased rapidly during the last several decades (Charlson et al., 1990). It is therefore very urgent to monitor the temperature variation of various thermal forcings, such as those due to the increase of aerosols, as well as greenhouse gases.

The overestimate of global warming mentioned above may also be attributable to the excessive sensitivity of the coupled model which we constructed. It is therefore desirable to evaluate the sensitivity of the model by comparing the simulated and actual changes of climate. The agreement between these climate changes should enhance our confidence in our ability to project the future change of climate.

A comprehensive strategy for the successful validation of a climate model is illustrated by the box diagram in Figure 6. It involves:

1. reliable, long-term monitoring of climate and its thermal forcings such as changes in the concentration of greenhouse gases and aerosols in the atmosphere;
 2. simulation of observed climate change by a coupled model;
- and
3. comparative assessment of the simulated and observed changes of climate.

The insight gained from this comprehensive effort is indispensable for the reliable projection of future climate change and successful adaptation to and mitigation of anthropogenic climate change in the future.

The execution of the comprehensive strategy identified above requires the construction of supercomputers and the development of artificial satellites, in which the contribution of Japanese engineers is increasing rapidly. I hope that Japanese scientists will also play an increasingly important role in modeling and observing the future change of global environment by using these powerful tools.

References

- Manabe, S., and R.F. Strickler. "Thermal Equilibrium of the Atmosphere with a Convective Adjustment." *J. Atmos. Sci.*, 21 (1964), 361-385.

- Manabe, S., and R.T. Wetherald. "Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity." *J. Atmos. Sci.*, 24 (1967), 241-259.
- Manabe, S., and J.L. Holloway, Jr. "The Seasonal Variation of the Hydrological Cycle as Simulated by a Global Model of the Atmosphere." *J. Geophys. Res.*, 80 (1975), 1617-1649.
- Manabe, S., and R.T. Wetherald. "The Effect of Doubling the CO₂ Concentration on the Climate of a General Circulation Model." *J. Atmos. Sci.*, 32 (1975), 3-15.
- Manabe, S., and R.J. Stouffer. "Sensitivity of a Global Climate Model to an Increase of CO₂ Concentrations in the Atmosphere." *J. Geophys. Res.*, 85 (C10), (1980), 5529-5554.
- Manabe, S., and K. Bryan. "Climate Calculation with a Combined Ocean-Atmosphere Model." *J. Atmos. Sci.*, 26 (1969), 786-789.
- Stouffer, R.J., S. Manabe, and K. Bryan. "Interhemispherical Asymmetry in Climate Response to a Gradual Increase of Atmospheric Carbon Dioxide." *Nature*, 342 (1989), 660-662.
- Manabe, S., R.J. Stouffer, M.J. Spelman, and K. Bryan. "Transient Response of a Coupled Ocean-Atmosphere Model to Gradual Changes of Atmospheric CO₂. Part I: Annual Mean Response." *J. Climate*, 4 (1991), 785-818.
- Intergovernmental Panel on Climate Change. *Climate Change: The IPCC Scientific Assessment*, edited by J.T. Houghton, G.J. Jenkins and J.J. Ephraums. Cambridge University Press, 1990.
- Manabe, S., R.T. Wetherald, and R.J. Stouffer. "Summer Dryness due to an Increase of Atmospheric CO₂ Concentration." *J. Climate Change*, 3 (1981), 336-376.
- Jones, P., and T.M.L. Wigley. "Global and Hemispheric Anomalies." In *Trend '91: A Compendium of Data on Global Change*, edited by T.A. Boden, R.J. Sepanski, F.W. Stoss, Oak Ridge National Laboratory, 1991, 512-517.
- Charlson, R.J., J. Langner, and H. Rodhe. "Sulfate Aerosol and Climate." *Nature*, 348 (1990), 22.

Major Publications

Dr. Syukuro Manabe

Articles

- Manabe, Syukuro. "On the Development and Energetics of the Westerly Waves." *J. Meteorol. Soc. Japan*, 33/2 (1955), 76–88.
- Gambo, K., K. Katow, S. Manabe and M. Aihara. "Numerical Forecasting over the Far East by the Double Fourier Series Method." *J. Meteorol. Soc. Japan*, 33/3 (1955), 133–139.
- Syono, S., M. Gambo, K. Miyakoda, M. Aihara, S. Manabe and K. Katow. "Report on the Numerical Prediction of the 500-mb Contour Height Change with Double Fourier Series Method." *J. Meteorol. Soc. Japan*, 33/4 (1955), 174–176.
- Komabayashi, M., K. Miyakoda, M. Aihara, S. Manabe, and K. Katow. "The Quantitative Forecast of Precipitation with the Numerical Prediction Method." *J. Meteorol. Soc. Japan*, 33/5 (1955), 205–216.
- Manabe, Syukuro. "A Note on the Barotropic Forecast Using a Moving Coordinate System." *J. Meteorol. Soc. Japan*, 33/7 (1955), 164–168.
- . "On the Contribution of Heat Released by Condensation to the Change in Pressure Pattern." *J. Meteorol. Soc. Japan*, 34/6 (1956), 308–320.
- . "On the Modification of Air-Mass over the Japan Sea When the Outburst of Cold Air Predominates." *J. Meteorol. Soc. Japan*, 35/6 (1957), 311–326.
- Syono, S., K. Miyakoda, S. Manabe, T. Matsuno, T. Murakami and Y. Okuta. "Broad-Scale and Small-Scale Analyses of a Situation of Heavy Participation over Japan in the Last Period of Baiu Season 1957." *Japan J. Physics*, 2/2 (1959), 59–103.
- Manabe, Syukuro. "On the Estimation of Energy Exchange Between the Japan Sea and the Atmosphere During Winter Based upon the Energy Budget of Both the Atmosphere and the Sea." *J. Meteorol. Soc. Japan*, 26/4 (1958), 123–133.
- Moller, F. and S. Manabe. "Über das Strahlungsgleichgewicht der Atmosphäre" Sonderdruck aus, *Zeitschrift für Meteorologie*, 15/1-6 (1961), 3–8.
- Manabe, Syukuro and F. Moller. "On the Radiative Equilibrium and Balance of the Atmosphere." *Mon. Wea. Rev.*, 89/12 (1961), 503–532.
- Manabe, Syukuro and R.F. Strickler. "Thermal Equilibrium of the Atmosphere with a Convective Adjustment." *J. Atmos. Sci.*, 21/4 (1964), 361–385.
- Smagorinsky, Joseph, S. Manabe and J. L. Holloway, Jr. "Numerical Results from a Nine-Level General Circulation Model of the Atmosphere." *Mon. Wea. Rev.*, 93/12 (1965), 727–768.
- Manabe, Syukuro, J. Smagorinsky and R.F. Strickler. "Simulated Climatology of a General Circulation Model with a Hydrologic Cycle." *Mon. Wea. Rev.*, 93/12 (1965), 769–798.
- Manabe, Syukuro and Smagorinsky, Joseph. "Simulated Climatology of a General Circulation Model with a Hydrologic Cycle: II. Analysis of the Tropical Atmosphere." *Mon. Wea. Rev.*, 95/4 (1967), 155–169.
- Manabe, Syukuro and R.T. Wetherald. "Thermal Equilibrium of the Atmosphere with a Given

- Distribution of Relative Humidity." *J. Atmos. Sci.*, 24/3 (1967), 241–259.
- Manabe, Syukuro. "General Circulation of the Atmosphere, Transactions." *Am. Geophys. Union.*, 48/2 (1967), 427–431.
- Smagorinsky, J., R.F. Strickler, W.E. Sangster, S. Manabe, J.L. Holloway and G.D. Hembree. "Prediction Experiments with a General Circulation Model." Proc. IAMAP/WMO International Symposium on Dynamics of Large-Scale Processes in the Atmosphere. (Moscow, USSR, 1965) (1967), 70–134.
- Manabe, Syukuro and B.G. Hunt. "Experiments with a Stratospheric General Circulation Model: I. Radiative and Dynamic Aspects." *Mon. Wea. Rev.*, 96/8 (1968), 477–502.
- Hunt, Barrie G. and S. Manabe. "Experiments with a Stratospheric General Circulation Model: II. Large-Scale Diffusion of Tracers in the Stratosphere." *Mon. Wea. Rev.*, 96/8 (1968), 503–539.
- Stone, Hugh M. and S. Manabe. "Comparison Among Various Numerical Models Designed for Computing Infrared Cooling." *Mon. Wea. Rev.*, 96/10 (1968), 735–741.
- Hunt, B.G. and S. Manabe. "An Investigation of Thermal Tidal Oscillations in the Earth's Atmosphere Using a General Circulation Model." *Mon. Wea. Rev.*, 96/11 (1968), 753–766.
- Manabe, Syukuro and K. Bryan. "Climate Calculations with a Combined Ocean-Atmosphere Model." *J. Atmos. Sci.*, 26/4 (1969), 786–789.
- Manabe, Syukuro. "Climate and Ocean Circulation: I. The Atmospheric Circulation and the Hydrology of the Earth's Surface." *Mon. Wea. Rev.*, 97/11 (1969), 739–774.
- . "Climate and Ocean Circulation: II. The Atmospheric Circulation and the Effect of Heat Transfer by Ocean Currents." *Mon. Wea. Rev.*, 97/11 (1969), 775–805.
- Manabe, Syukuro, J. Smagorinsky, J.L. Holloway, Jr. and H.M. Stone. "Simulated Climatology of a General Circulation Model with a Hydrologic Cycle: III. Effects of Increased Horizontal Computational Resolution." *Mon. Wea. Rev.*, 98/3 (1970), 175–212.
- Manabe, Syukuro, J.L. Holloway, Jr. and H.M. Stone. "Tropical Circulation in a Time-Integration of a Global Model of the Atmosphere." *J. Atmos. Sci.*, 27/4 (1970), 580–613.
- Manabe, Syukuro and J.L. Holloway, Jr. "Simulation of the Hydrologic Cycle of the Global Atmospheric Circulation by a Mathematical Model." Proc. Reading Symposium on World Water Balance, International Association of Scientific Hydrology. (1970), 387–400.
- Manabe, Syukuro. "Cloudiness and the Radiative, Convective Equilibrium." Proc. AAAS Air Pollut. Session Dallas, Texas. In *Global Effects of Environmental Pollution*, edited by S. Fred Singer. D. Reidel, 1970, 156–157.
- . "The Dependence of Atmospheric Temperature on the Concentration of Carbon Dioxide." Proc. AAAS Air Pollut. Session Dallas, Texas. In *Global Effects of Environmental Pollution*, edited by S. Fred Singer. D. Reidel, 1970, 25–29.
- Manabe, Syukuro and J.K. Holloway, Jr. "Climate Modification and a Mathematical Model of Atmospheric Circulation." Proc. of Joint Symposium Commemorating the Centennial of the US Weather Service and Golden Anniversary of the Am. Meterol. Soc., Wash., D.C., *A Century of Weather Progress*, edited by James E. Caskey, Jr. Lancaster Press, 1970, 157–164.
- Holloway, J. L. Jr. and S. Manabe. "Simulation of Climate by a Global General Circulation

- Model: I. Hydraulic Cycle and Heat Balance." *Mon. Wea. Rev.*, 99/5 (1971), 335–370.
- Manabe, Syukuro. "General Circulation of the Atmosphere." *EOS, Transactions Am. Geophys. Union (Meteorol.: US National Report, IUGG Fifteenth General Assembly)*, 52/6 (1971), 313–320.
- . "Estimates of Future Change of Climate Due to the Increase of Carbon Dioxide Concentration in the Air." *Man's Impact on the Climate*, edited by W.H. Matthews, W.W. Kellog and G.D. Robinson. Cambridge, MA: MIT Press, 1971, 250–264.
- Wetherald, Richard T. and S. Manabe. "Response of the Joint Ocean-Atmosphere Model to the Seasonal Variation of the Solar Radiation." *Mon. Wea. Rev.*, 100/1 (1972), 45–59.
- Mahlman, Jerry D. and S. Manabe. "Numerical Simulation of the Stratosphere: Implications for Related Climate Change Problems." *Proc. Survey Conference on the Climatic Impact Assessment Program, Dept. of Transportation Report DOT-TSC-OST-72-13*, (1972), 186–193.
- Holloway, J. Leith Jr., M.J. Spelman and S. Manabe. "Latitude-Longitude Grid Suitable for Numerical Time Integration of a Global Atmospheric Model." *Mon. Wea. Rev.*, 101/1 (1973), 69–78.
- Manabe, Syukuro and T.B. Terpstra. "The Effects of Mountains on the General Circulation of the Atmosphere as Identified by Numerical Experiments." *J. Atmos. Sci.*, 31/1 (1974), 3–42.
- Manabe, Syukuro, D.G. Hahn, and J.L. Holloway, Jr. "The Seasonal Variation of the Tropical Circulation as Simulated by a Global Model of the Atmosphere." *J. Atmos. Sci.*, 31/1 (1974), 43–83.
- Holloway, J. Leith Jr. and S. Manabe. "Numerical Simulation of the Seasonal Variation of the Atmospheric Hydrologic Cycle." *J. Phys. Oceanogr.*, 5/1 (1975), 3–29.
- Bryan, Kirk, S. Manabe and R.C. Pacanowski. "A Global Ocean Atmosphere Climate Model: Part II. The Oceanic Circulation." *J. Phys. Oceanogr.*, 5/1 (1975), 30–46.
- Manabe, Syukuro and R.T. Wetherald. "The Effects of Doubling the CO₂ Concentration on the Climate of a General Circulation Model." *J. Atmos. Sci.*, 32/1 (1975), 3–15.
- Manabe, Syukuro and J.L. Holloway, Jr. "The Seasonal Variation of the Hydrologic Cycle as Simulated by a Global Model of the Atmosphere." *J. Geophys. Res.*, 80/12 (1975), 1617–1649.
- Manabe, Syukuro. "The Use of Comprehensive General Circulation Modeling for Studies of the Climate and Climate Variation." *The Physical Basis of Climate and Climate Modeling Report of the International Study Conference in Stockholm*, GARP Publication Series 16 (1975), 148–162.
- Hahn, Douglas G. and S. Manabe. "The Role of Mountains in the Southeast Asian Monsoon Circulation." *J. Atmos. Sci.*, 32/8 (1975), 1515–1541.
- Wetherald, Richard T. and S. Manabe. "The Effects of Changing the Solar Constant on the Climate of a General Circulation Model." *J. Atmos. Sci.*, 32/11 (1975), 2044–2059.
- Manabe, Syukuro and J.D. Mahlman. "Simulation of Seasonal and Interhemispheric Variations in the Stratospheric Circulation." *Climate of an Ice Age.* *J. Atmos. Sci.*, 33/11 (1976), 2185–2217.

- Hahn, Douglas G. and S. Manabe. "Reply." *J. Atmos. Sci.*, 33/11 (1976), 2258–2262.
- Manabe, Syukuro and D.G. Hahn. "Simulation of the Tropical Climate of an Ice Age." *J. Geophys. Res.*, 82/27 (1977), 3889–3911.
- Manabe, S., K. Bryan and M.J. Spelman. "A Global Ocean-Atmosphere Climate Model with Seasonal Variation for Future Studies of Climate Sensitivity." *Dynamics of Atmospheres and Oceans*, 3 (1979), 393–426.
- Hahn, Douglas G. and S. Manabe. "Simulation of Atmospheric Variability." Proc. Fourth Annual Climate Diagnostics Workshop, Inst. for Environ. Studies, Univ. of Wisconsin (1979), 398–402.
- Kurbatkin, G.P., S. Manabe and D.G. Hahn. "The Moistening of Continents and the Intensity of Monsoon Circulation." *Meteorol. and Hydrol.*, 11/6 (1979), 5–11.
- Manabe, Syukuro and R.J. Stouffer. "A CO₂ -Climate Sensitive Study with a Mathematical Model of the Global Climate." *Nature*, 282 (5738) (1979), 491–493.
- Manabe, Syukuro, D.G. Hahn and J.L. Holloway, Jr. "Climate Simulations with GFDL Spectral Models of the Atmosphere: Effect of Spectral Truncation." Proc. JOC Study Conf. on Climate Models: Performance, Intercomparison and Sensitivity Studies, Wash., D.C., edited by W. Lawrence Gates, Garp Publication Series, 22/1 (1979), 41–49.
- Manabe, Syukuro and R.T. Wetherald. "On the Horizontal Distribution of Climate Change Resulting from an Increase in CO₂ Content of the Atmosphere." *J. Atmos. Sci.*, 37/1 (1980), 99–118.
- Wetherald, Richard T. and S. Manabe. "Cloud Cover and Climate Sensitivity." *J. Atmos. Sci.*, 37/7 (1980), 1485–1510.
- Manabe, Syukuro and R.J. Stouffer. "Sensitivity of a Global Climate Model to an Increase of CO₂ Concentration in the Atmosphere." *J. Geophys. Res.*, 85/C10 (1980), 5529–5554.
- . "Study of Climatic Impacts of CO₂ Increase with a Mathematical Model of the Global Climate." *Report from AAAS-DOE Workshop on Environmental and Societal Consequences of a Possible CO₂-Induced Climate Change*, Annapolis, MD: Dept. of Energy, 1980, 127–140.
- Wetherald, Richard T. and S. Manabe. "Influence of a Seasonal Variation upon the Sensitivity of a Climate Model." *J. Geophys. Res.*, 86/C2 (1981), 1194–1204.
- Manabe, Syukuro, R.T. Wetherald and R.J. Stouffer. "Summer Dryness Due to an Increase of Atmospheric CO₂ Concentration" *Climate Change*, 3/4 (1981), 336–376.
- Manabe, Syukuro and D.G. Hahn. "Simulation of Atmospheric Variability." *Mon. Wea. Rev.*, 109/11 (1981), 2260–2286.
- Bryan, K., F.G. Komro, S. Manabe and M.J. Spelman. "Transient Climate Response to Increasing Atmospheric Carbon Dioxide." *Science*, 215, (1982), 56–58.
- Manabe, Syukuro. "Simulation of Climate by General Circulation Models with Hydrologic Cycles." In *Land Surface Processes in Atmospheric General Circulation Models*, edited by P.S. Eagleson. Cambridge: Cambridge University Press, 1982, 19–66.
- Manabe, Syukuro and R.J. Stouffer. "Seasonal and Latitudinal Variatudinal Variation of the CO₂ Induced Change in a Climate of an Atmosphere-Mixed Layer Ocean Model." Proc. DOE Workshop on First Detection of Carbon Dioxide Effects, June 8–10, 1981, Harpers

- Ferry, West Virginia, 1982, 79–94.
- Manabe, Syukuro. "Comments on Paper—Simulating Seasonal and CO₂-Induced Climate Change with Mathematical Climate Models: Capabilities, Limitations and Prospects by Michael E. Schlesinger." *PrO₂ Research Conference and Workshop*, Sept. 19–23, 1982, Coolfont, West Virginia, III, 1983, 145–159.
- . "Carbon Dioxide and Climate Change." In *Advances in Geophysics*, 25, *Theory of Climate*, edited by Barry Saltzman. New York: Academic Press, 1983, 39–84.
- Yeh, T.C., R.T. Wetherald and S. Manabe. "A Model Study of the Short-Term Climatic and Hydrologic Effects of Sudden Snow-Cover Removal." *Mon. Wea. Rev.*, 111/5 (1983), 1013–1024.
- Spelman, M.J. and S. Manabe. "Influence of Oceanic Heat Transport Upon the Sensitivity of a Model Climate." *J. Geophys. Res.*, 89/C1 (1984), 571–586.
- Yeh, T.C., R.T. Wetherald and S. Manabe. "The Effect of Soil Moisture on the Short-Term Climatic and Hydrology Change—A Numerical Experiment." *Mon. Wea. Rev.*, 112/3 (1984), 474–490.
- Manabe, S. and A.J. Broccoli. "Ice-Age Climate and Continental Ice Sheets: Some Experiments." *Annals of Glaciology*, 5 (1984), 100–105.
- . "Influence of the CLIMAP Ice Sheet on the Climate of a General Circulation Model: Implications for Milankovitch Theory." In *Milankovitch and Climate, Part 2*, edited by A.L. Berger et al. D. Reidel, 1984, 789–799.
- . "The Influence of Continental Ice Sheets on the Climate of an Ice Age." *J. Geophys. Res.*, 90/C2 (1985), 2167–2190.
- Bryan, K. and S. Manabe. "A Coupled Ocean-Atmosphere and the Response to Increasing Atmospheric CO₂." *Proceedings of the Liege Colloquium (1984), World Climate Research Programme. Coupled-Ocean Atmosphere Models*, edited by J.C.J. Nihoul. Amsterdam: Elsevier, 1984, 1–6.
- Manabe, S. and R.T. Wetherald. "CO₂ and Hydrology." In *Advances in Geophysics (28), A Climate Dynamics*, edited by B. Saltzman. New York: Academic Press, 1985, 131–156.
- Manabe, Syukuro and K. Bryan, Jr. "CO₂-Induced Change in a Coupled Ocean-Atmosphere Model and Its Paleoclimatic Implications." *J. Geophys. Res.*, 90/C11 (1985), 689–707.
- Manabe, S. and A.J. Broccoli. "A Comparison of Climate Model Sensitivity with Data from the Last Glacial Maximum." *J. Atmos. Sci.*, 42 (1985), 2643–2651.
- Wetherald, R.T. and S. Manabe. "An Investigation of Cloud Cover Change in Response to Thermal Forcing." *Climatic Change*, 8 (1986), 5–23.
- Manabe, S. and R.T. Wetherald. "Reduction in Summer Soil Wetness Induced by an Increase in Atmospheric Carbon Dioxide." *Sciences Magazine*, 232 (1986), 626–628.
- Broccoli, A.J. and S. Manabe. "The Influence of Continental Ice, Atmospheric CO₂, and Land Albedo on the Climate of the Last Glacial Maximum." *Climate Dynamics*, 1, Berlin: Springer, 1987, 87–99.
- Manabe, S. and R.T. Wetherald. "Large Scale Changes of Soil Wetness Induced by an Increase in Atmospheric Carbon Dioxide." *J. Atmos. Sci.*, 44 (1987), 1211–1235.
- Broccoli, A.J. and S. Manabe. "The Effects of the Laurentide Ice Sheet on North American

- Climate during the Last Glacial Maximum." *Geographie Physique et Quaternaire*, XLI/2 (1987), 291–299.
- Wetherald, R.T. and S. Manabe. "Cloud Feedback Processes in a General Circulation Model." *J. Atmos. Sci.*, 45/8 (1988), 1397–1415.
- Bryan, K., S. Manabe and M.J. Spelman. "Interhemispheric Asymmetry in the Transient Response of a Coupled Ocean-Atmosphere Model to a CO₂ Age Forcing." *J. Phys. Oceanogr.*, 18/6 (1988), 851–867.
- Delworth, T. and S. Manabe. "The Influence of Potential Evaporation on the Variabilities of Soil Wetness and Climate." *J. Climate*, 1/5 (1988), 523–547.
- Manabe, S. and R.J. Stouffer. "Two Stable Equilibria of a Coupled Ocean-Atmosphere Model." *J. Climate*, 2/9 (1989), 841–866.
- Delworth, Thomas and S. Manabe. "The Influence of Soil Wetness on Atmospheric Variability." *J. Climate*, 2/12 (1989), 1447–1462.
- Stouffer, R.J., S. Manabe and K. Bryan. "On the Climate Change Induced by a Gradual Increase of Atmospheric Carbon Dioxide." *Nature*, 342 (1989), 660–662.
- Manabe, S. and A.J. Broccoli. "Mountains and Arid Climates of Middle Latitudes." *Science*, 247 (1990), 192–195.
- Manabe, S. and T. Delworth. "The Temporal Variability of Soil Wetness and its Impact on Climate." *Climatic Change*, 16/2 (1990), 185–192.
- Manabe, Syukuro, K. Bryan and M.J. Spelman. "Transient Response of a Global Ocean-Atmosphere Model to a Doubling of Atmospheric Carbon Dioxide." *J. Phys. Oceanogr.*, 20/5 (1990), 722–749.
- Wetherald, R.T. and S. Manabe. "Hydrologic Sensitivity to CO₂-Induced Global Warming." *Civil Engineering Practice*, 5/1 (1990), 33–36.
- Broccoli, A.J. and S. Manabe. "Can Existing Climate Models be Used to Study Anthropogenic Changes in Tropical Cyclone Climate?" *Geophysical Research Letters*, 17/11 (1990), 1917–1920.
- Wetherald, R.T., V. Ramaswamy and S. Manabe. "A Comparative Study of the Observations of High Clouds and Simulations by an Atmospheric General Circulation Model." *Climate Dynamics*, 5, (1991), 135–143.
- Manabe, Syukuro. "Studies of Glacial Climates by Coupled Atmosphere-Ocean Models: How Useful Are Coupled Models?" In *Global Change of the Past*, edited by R.S. Bradley. Boulder, CO: UCAR/Office for Interdisciplinary Earth Studies, 1989.
- Mitchell, J.F.B., S. Manabe, V. Meleshko, and T. Tokioka. "Equilibrium Climate Change and Its Implications for the Future." In *Climate Change, The J.T. Houghton, Scientific Assessment*, edited by J.T. Houghton, G.J. Jenkins, and J.J. Ephraums. Cambridge: Cambridge University Press, 1990.
- Manabe, Syukuro, R.J. Stouffer, M.J. Spelman, and K. Bryan. "Transient Responses of a Coupled Ocean-Atmosphere Model to Gradual Changes of Atmospheric CO₂, Part I: Annual Mean Response." *J. Climate*, 4/8 (1991), 785–818.
- Manabe, Syukuro, M.J. Spelman, and R.J. Stouffer. "Transient Responses of a Coupled Ocean-Atmosphere Model to Gradual Changes of Atmospheric CO₂, Part II: Seasonal

- Response," *J. Climate*, 5/2 (1992), 105–126.
- Broccoli, A.J. and S. Manabe. "Reply to Comment by L.L. Evans on 'Can Existing Models Be Used to Study Anthropogenic Changes in Tropical Cyclone Climate?'," *Geophys. Res. Letters*, 19/14 (1992), 1525–1526.
- Delworth, T.L., S. Manabe, and R.J. Stouffer. "Interdecadal Variability of the Thermohaline Circulation in a Coupled Ocean-Atmospheric Model." Proc. of the Principal Investigators' Meeting, Atlantic Climate Change Program, Miami, March 9–11, 1992. NOAA Climate and Global Change Program, Special Report No. 7, 1992.
- Broccoli, A.J. and S. Manabe. "The Effects of Orography on Midlatitude Northern Hemisphere Dry Climates," *J. Climate*, 5/11 (1992), 1181–1201.
- Manabe, Syukuro and R.J. Stouffer. "Reply," *J. Climate*, 6/1 (1993), 178–179.
- Delworth, T.L. and S. Manabe. "Climate Variability and Land Surface Processes," *Advances in Water Resources*, 16 (1993), 3–20.
- Manabe, Syukuro and R.J. Stouffer. "Century Scale Effects of Increased Atmospheric CO₂ on the Ocean-Atmosphere System," *Nature*, 364 (6434) (1993), 215–217.
- Delworth, T.L., S. Manabe, and R.J. Stouffer. "Interdecadal Variability of the Thermohaline Circulation in a Coupled Ocean-Atmospheric Model," *J. Climate*, 6/11 (1993), 1993–2011.
- Broccoli, A.J. and S. Manabe. "Climate Model Studies of Interactions between Ice Sheets and the Ocean-Atmosphere System." In *Ice in the Climate System*, NATO ASI Series, edited by W.R. Peltier. Berlin: Springer, 1993, 271–290.
- Manabe, Syukuro and R.J. Stouffer. "Multiple-Century Response of a Coupled Ocean-Atmosphere to an Increase of Atmospheric Carbon Dioxide," *J. Climate*, 7/1 (1994), 5–23.
- Manabe, Syukuro, R.J. Stouffer, and M.J. Spelman. "Response of a Coupled Ocean-Atmosphere Model to Increasing Atmospheric Carbon Dioxide," *AMBIO*, 23/1 (1994), 45–49.
- Stouffer, R.J., S. Manabe, and K.Y. Vinnikov. "Model Assessment of the Role of Natural Variability in Recent Global Warming," *Nature*, 367 (1994), 634–636.
- Knutson, T.R. and S. Manabe. "Impact of Increasing CO₂ on the Walker Circulation and ENSO-Like Phenomena in a Coupled Ocean-Atmosphere Model." Preprints from 6th Conference on Climate Variation, Nashville, TN, 23–28 January, 1994. Boston: American Meteorological Society, 1994.
- Knutson, T.R. and S. Manabe. "Impact of Increased CO₂ on ENSO-Like Phenomena in a Coupled Ocean-Atmosphere Model," *Geophys. Res. Letters*, 21/21 (1994), 2295–2298.
- Manabe, Syukuro, R.J. Stouffer, and M.J. Spelman. "Interaction between Polar Climate and Global Warming," Fourth Conference on Polar Meteorology and Oceanography, Dallas, TX, 15–20 January, 1995. Boston: American Meteorological Society, 1995.
- Delworth, T.L., S. Manabe, and R.J. Stouffer. "Interannual to Interdecadal Variability in a Coupled Ocean-Atmosphere Model." Proc. of International Workshop on Numerical Prediction of Oceanic Conditions, Tokyo, Japan, March 7–11, 1995.
- Knutson, T.R. and S. Manabe. "Time-Mean Response over the Tropical Pacific to Increased CO₂ in a Coupled Ocean-Atmosphere Model," *J. Climate*, 8/9 (1995), 2183–2199.
- Manabe, Syukuro and R.J. Stouffer. "Simulation of Abrupt Climate Change Induced by

- Freshwater Input to the North Atlantic Ocean," *Nature*, 378 (1995) 165–167.
- Broccoli, A.J. and S. Manabe, J.F.B. Mitchell, and L. Bengtsson. "Global Climate Change and Tropical Cyclones," *Bull. Am. Meteor. Soc.*, 76/11 (1995), 2243–2245.
- Wetherald, R.T. and S. Manabe. "The Mechanisms of Summer Dryness Induced by Greenhouse Warming," *J. Climate*, 8/12 (1995), 3096–3108.
- Manabe, Syukuro and R.J. Stouffer. "Low-Frequency Variability of Surface Air Temperature in a 1,000-Year Integration of a Coupled Atmosphere-Ocean-Land Surface Model," *J. Climate*, 9/2 (1996), 376–393.
- Vinnikov, K.Y., A. Robock, R.J. Stouffer, and S. Manabe. "Vertical Patterns of Free and Forced Climate Variations," *Geophys. Res. Letters*, 23/14 (1996), 1801–1804.
- Knutson, T.R., S. Manabe, and D. Gu. "Simulated ENSO in a Global Coupled Ocean-Atmosphere Model: Multi-Decadal Amplitude Modulation and CO₂ Sensitivity," *J. Climate*, 9/10 (1996).
- Manabe, Syukuro. "Early Development in the Study of Greenhouse Warming: The Emergence of Climate Models," *AMBIO* (1997), (in press).
- Milly, P.C.D. and S. Manabe. "The Reduction in Summer Soil Wetness Caused by Increased Atmospheric Carbon Dioxide: Sensitivity to Change in Plant Rooting Depth," *Nature*, (1996).
- Broccoli, A.J. and S. Manabe. "Mountains and Midlatitude Aridity." In *Global Tectonics and Climate Change*, 1997.
- Manabe, Syukuro and R.J. Stouffer. "Coupled Ocean-Atmosphere Model Response to Freshwater Input: Comparison to Younger Dryas Event," *J. Paleo-Oceanography*, (1997), (in press).
- Delworth, T.L., S. Manabe, and R.J. Stouffer. "Multidecadal Climate Variability in the Nordic Seas and Surrounding Regions: A Coupled Model Simulation," *Geophys. Res. Letters*, 24 (1997), 257–260.
- Manabe, Syukuro and R.J. Stouffer. "Climate Variability of a Coupled Ocean-Atmosphere-Land Surface Model: Implication for the Detection of Global Warming," *Bull. Am. Meteor. Soc.*, (1997), (in press).
- Haywood, J.M., R.J. Stouffer, R.T. Wetherald, S. Manabe, and V. Ramaswamy. "Transient Response of a Coupled Model to Estimated Changes in Greenhouse Gases and Sulfate Concentrations," *Geophys. Res. Letters*, (1997), (in press).

Profile

International Institute for Environment and Development (IIED)

History

- 1971 The IIEA (Institute for Environmental Affairs) was founded by Robert O. Anderson.
- 1972 The Institute was a key player in the UN Conference on Human Development. Barbara Ward highlighted the critical linkage between environment and development and coined the phrase "sustainable development." The Institute changed its name to IIED, headed by Barbara Ward.
- 1974 The first IIED symposium was held at the UN World Food Conference. This issued a declaration that was front-page news on three continents. Global food supply has been an IIED issue ever since.
- 1975 IIED and the United Nations Environment Programme (UNEP) established an independent information unit, Earthscan, as a way of increasing public awareness of key global environmental issues and providing accurate environmental information to key leading media around the world.
- 1976 IIED played a central role in HABITAT, the first UN Conference on Human Settlements in Vancouver. Some 20 years later, in 1996, it was responsible for preparing the official report for the second human settlements conference.
- 1980s By 1980, IIED had established a special role in the international arena. It was linked closely with three centers of power and influence: the UN agencies and other international institutions; national governments and their agencies, especially those concerned with environment and development issues; and national and international NGOs. A major part of IIED's success has been the influence it has had in ensuring the allocation of more than \$50 billion a year in aid by OECD countries.
- 1985 Together with the World Resources Institute, IIED began producing a biennial World Resources Report. The Institute started to pursue practical solutions to problems through its projects.
- 1987 Our Common Future, the report of the World Commission on Environment and Development led by Norway's prime minister, Mrs. Gro Bruntland, was published and publicly acknowledged IIED's leading role. It laid down a "global agenda for change."
- 1990s National and international problems often require local solutions. IIED therefore pioneered methods that involve local "stakeholders" in developing policies and processes that work.
- 1992 In the run-up to the Earth Summit at Rio, IIED played a significant role in bringing together NGOs and mobilizing international interest. IIED's preparatory work had an important impact on the process and eventual shape of UNCED's Agenda 21.

1995 Each of IIED's program areas is integrated by cross-cutting themes that include collaborative research and the development of tools for sustainable development. IIED completed a major research project, "Towards a Sustainable Paper Cycle," for the World Business Council for Sustainable Development. Through this, IIED has established an approach to working with the private sector.

The IIED is an independent, nonprofit think tank. From its inception, IIED has promoted the concept of sustainable development and sought to focus attention on the necessity for development in harmony with the natural environment through various projects in the North as well as the South.

Over the last 25 years, through its research, training, and publishing activities, the Institute has changed or influenced international programs. It has ensured that many more local voices are heard in the larger decision-making processes. It has altered the basis by which we understand environmental problems by emphasizing their environmental and social dimensions. It has shown that, ultimately, solving many so-called global problems really comes down to making changes locally, and that local people can be empowered to achieve their own solutions, provided the right institutional framework is in place. There is, though, some way to go to live up to the ideals that Barbara Ward set out at the Institute's beginnings.

IIED's professional staff presently number over 50. The chairman of IIED's board is Sir Martin Holdgate and the executive director is Richard Sandbrook. Support comes from all of the governments of Western Europe, the EU, foundations, and the international agencies.

Rio Plus Five—What Has Happened and What Next?

Richard Sandbrook
Executive Director, IIED

May 1997

Anyone setting out to give a global assessment of progress since the events in Rio in 1992 could well be considered as either a fool, or arrogant or both. There is so much one could report on and in so many places that the task seems absurd. So all that can be done is to attempt a comparison of expectations then with realities now. Hardly a scientific exercise based on empirical research to be sure.

This paper is not the result of an extensive survey or anything that could be considered as methodical research. It is the impression that a group of us have formed at the IIED, an organization that was very involved in the Rio process before and since. I have also drawn on a number of documents that are listed at the end of this essay.

The Rio process

Before Rio happened it was clear that the summit was in many ways a media/interest group circus on one level and a serious intergovernmental process on another. The former were being pushed by a variety of nongovernmental actors who could provide evidence of widespread environmental damage while the latter had to negotiate some of their own sovereignty away in order to do anything about it.

But one should not be naive. Many interest groups were in it for the ride all along and made it clear that the governmental process was not something they took too seriously in the first place. The same can be said of many political "leaders" who came in such numbers to Brazil. Rio gave them every opportunity to show off their environmental bona fides. All sorts of impressive things were said and a few impressive promises made. Some of this was followed up but much was not.

But on balance the Earth Summit in 1992 can be still be seen as a high point of political commitment to solving global environment and development problems. What failed was the "bargain" that some sought at Rio. This was broadly that in return for addressing the big environmental issues of climate change, biodiversity loss, and deforestation the wealthy world would help to finance and support with technology, accelerated development for the South. The agenda for all this was called "Agenda 21," a shortened form of "Agenda for the 21st Century".

Since then, we have seen a global recession. Financial cut-backs at home meant that financing sustainable development in the South has slipped down the OECD's agenda. This has made it difficult to carry out the tough task of translating the broad recommendations of Agenda 21 into practical policy options. Furthermore, shortly after Rio the Uruguay Round of GATT was completed very much to the disadvantage of many in the South. Today we have a world in which "globalization" or the liberalization of trade is taking place. Competition for markets is leading to more and more strain on the externalities that are environment and social costs; and more and more inequity. Nothing, it seems, changes—at least not when it comes to market failures.

The immediate aftermath

This is not to say no one has tried. Take the Europeans as an example. Immediately after UNCED, at the Lisbon Summit, the European Council adopted an eight-point plan of action to follow it up. The major outputs included action on National Sustainable Development Strategies and "Round Tables," the Forest Principles, the Climate Plan and Biodiversity. The Community has ratified the Biodiversity and Climate Conventions, and it has been a major force behind the establishment of the Intergovernmental Panel on Forests. The Commission has also submitted annual progress reports to the new Commission on Sustainable Development (CEC, 1993a; CEC, 1994a; CEC, 1995). More importantly, the Environmental Council chose to call the Community's Fifth Environmental Action Programme, Towards Sustainability, as "point of departure for the implementation of Agenda 21 by the Community and the Member States" (CEC, 1993a). (The Programme had been prepared during the UNCED process and shares many of the same principles and objectives.)

Unfortunately, what the European Union has been unable to agree upon are the specifics. These include mechanisms for realizing the ECU3 billion aid pledge for Agenda 21 made at Rio. After the event, the Community and Member States struggled to decide how to meet its pledge. Questions arose, including what the money should be spent on, how the amount should be divided between the EC and the Member States, what proportion should be "new and additional resources" and over what period the money should be spent. All attempts to reach a consensus appear to have stopped and in its report on progress to this year's fifth anniversary meetings in New York the Commission avoids mention of the ECU3 billion pledge.

This is not surprising. The world has changed: while we have witnessed the recession in the OECD so too have we seen the emergence of a new class of "rich" emerging economies. We did not realize in 1992 just how poor the old USSR was (and is); nor did we realize the impact that the far right would have in the USA on their foreign policy. In 1992 South Africa was still a divided country and Rwanda still a jewel in the French aid program. Since then, all confidence in finding solutions to Africa's "crises" has gone. And the debt of the least well off continues to haunt them.

But one thing has not changed. The polarity of wealth (within and between nations) is still with us overall and getting worse. We still have a billion living in absolute poverty, over 30,000 children dying every day from malnutrition and water-borne diseases and so much else besides.

Resources . . . no more!

It is little wonder, then, if you ask one of those making a living by speaking for the South, that you find great cynicism about the Rio process and just how little it achieved in terms of the North-South transfer debate. The promise for an extra ECU3 billion on the table from the EU soon became insignificant as the whole "aid" frame declined from some \$65 billion then to under \$52 billion today. All this will be the cause of much huffing and puffing in 1997 but were the expectations real in the first place? Sadly no!

For example the African group persuaded themselves at the time that a convention for deserts was the way to take part in the newly created Global Environment Facility. They were soon to learn otherwise. The new Convention for drylands is an excellent codification of best practice but it is unfinanced. Any idea of reaching the mythical 0.7% of GNP in the OECD for aid demanded by the development set is as out of the question now as it was then. Even the much-heralded additionality of the Global Environmental Facility has not been without problems in terms of its governance, purpose, and renewal.

An assessment on this broad level is complicated by the shift that is occurring in the international institutions themselves. Since 1992 the crisis in the UN has deepened. The USA has gone on a "rent strike" in that it became deeply in debt to the UN (and still is, although Clinton has made promises to Cofi Annan, the new Secretary General). Such budget as there is has been increasingly diverted from development toward peace-keeping. And attempts at UN reform to reduce waste have been thwarted. The policy is to squeeze until the (UN) "pips squeak." Thus any evaluation of how well the UN and its family of agencies have done in following up on the Earth Summit are complicated by the general anti-UN environment that has developed in the OECD and elsewhere. We must hope that the recent signs that things are now improving, or at least moving, are maintained. But morale in the UN is so low overall that one gets a strong feeling that no one really cares any more unless there is money on the table.

Since Rio, the UN interagency coordination for the environment (through the task force on the topic) has improved although the exact role of UNEP, UNDP and the UN Commission for Sustainable Development (UNCSD) still seem a little confused. The process in the UNCSD also has been a limited success in so far as it has methodically followed up on Agenda 21 in terms of national reporting and coercion. But this progress has only really concerned the environment and environment ministers. The hoped-for integration of the environment into a system of "sustainable development" has not really happened. The economic powers still meet in the context of the Bretton Woods institutions and do not see the Commission, or perhaps even the UN, as important.

Local versus global

After all of this one must conclude that Rio did very little to change the world at a global level toward a concerted style of development based around the environment: sustainable development if you will. But I would maintain that the Earth Summit was a watershed in terms of how we tackle such issues anyway. It was the event when many governments came at last to appreciate that there are no global solutions to be had to sort out many worldwide problems. The onus of proof was shifted away from the supranational to the national and even the local level.

Much of the world caught up with the idea of subsidiarity at Rio, namely the importance of placing responsibilities at the most local level of administration consistent with a result.

At Rio and shortly afterwards, the UN system also caught up with the idea that there is a limit to how much the North can pay up for a development agenda framed in New York and Geneva! Rio and the social summit at Copenhagen were a much-needed purge of the “internationalist” thinking of the 1960s and ’70s that had somehow survived to the ’90s. Thus the real place to assess the follow up to the Earth Summit is at the local level. That is where the specifics are to be found.

... and what do we measure?

Two years after Rio, my institute (the IIED), was asked to examine the Swedish aid program against the Rio Declaration of Principles and Agenda 21. In order to break this task down we identified a series of themes as follows:

- integration of policies, particularly the integration of socioeconomic with environmental concerns
- capacities to deliver results
- governance to give frameworks
- vision and values to underpin the whole

The point of giving this list is not only to illustrate how very comprehensive the scope of Rio was but also to show the sort of factors that must go into an evaluation of progress. In many ways the Earth Summit gave us a new agenda for all development activities. It was a codification of what many thought important in the business of achieving a more durable existence for life on the planet. It had not been written down before by so many and with such consensus. And there has been some very impressive follow-up along these broad lines, particularly with local Agenda 21 processes and national round tables for sustainable development. There are some 60 countries with some kind of national follow-up forum; IIED has surveyed the OECD governments and, together with IUCN, drawn up a guide to all the strategy processes that are going on.¹ There is much that is positive to report. How far this can be directly attributed to the Rio process is arguable for there were many such processes in hand well before 1992. However, without doubt the international beauty contest that was Rio, institutionalized in the CSD, acted as a spur to progress.

Limited capacities

The real constraint to progress comes back to the theme that ran all through the Rio process, namely “capacities.” There is a feeling at times that the whole system is locked into an enormous catch-22. More plans to raise capacities, no capacities to raise plans. Conventions to mobilize resources, no resources to mobilize conventions. And while a certain amount of planning is needed, all too often in the past five years the planning stage has been an excuse for

¹*Strategies for National Sustainable Development*, IUCN/IIED, published by Earthscan, ISBN 1-85383-193-X.

inaction. Too much planning and not enough doing!

Before we all leap to the international convention reflex again in respect of, say forests or water, or fish, we ought to have a clear idea of what will be done by way of a convention that is different and who will pay. International accords are a way of blurring sovereignty in the interest of a common good but they go nowhere if benefits foregone are not compensated for or if costs incurred cannot be met. They are also very expensive to negotiate, as the deserts convention illustrated.² If the benefits are not very clear from the outset why not rely on nation states and existing processes?

What next?

The Rio process was not the complete waste of time that some cynics allege. It was a complex affair that will take years to see through. It is a part of a continuum: Stockholm, Brundtland, Rio, Rio +5 and so on . . . gradually as environmental "stress" impacts upon economies and the public, so things will change for the better. But are we keeping up with the trends in the other direction? Many would argue no.

There are many different ways to accelerate change so as to see more positive outcomes in the future. Much the most important are those at the national and the local levels. Thus the so-called "spirit of Rio" will best be maintained by encouraging the local and national responses that we already see. In this regard much more could be done to accelerate the sharing of good practice (in all sectors) to identify policies that work and to encourage processes that result in a clearer set of priorities for action and reform. Transparency and accountability are the preconditions for consensus dialogue around the priorities, and setting priorities saves money. As the recent case study of the paper industry by IIED illustrated billions are being spent in some OECD countries cleaning up emissions that do very little comparative harm whilst ignoring other more important sources.³ Spending money that at the margin has very little effect is to waste money, no matter who pays (in this case the consumer). This means that those who advocate change must be challenged to join in a dialogue on the costs and benefits and not simply stand outside mobilizing public opinion via the media. More multi-stakeholder processes are needed with the resource to enable civil society to join in mobilization.

The UNCSD process, whereby all this national activity is reported upon, is insufficient. The UN does not tell the truth; it merely reports what governments ask it to report. Thus we still need an independent system of review and monitoring. The idea of an Amnesty International for the environment was nearly achieved by the Green Cross and the Earth Council. Sadly it did not happen. We need such a referee if we are to take half of what is written seriously. Most countries of the world still do not have a "civil" sector that is capable of exposing those who are economical with the truth. The need for independent verification of environment and development trends is still evident. If UNEP could begin to facilitate this

²*Deserts in Development and Cooperation*, Peter Schipuller, DSE no 3/1996, ISSN 0721-2178.

³For example, in the USA, the EPA is busy removing methanol emissions from the paper industry stacks. This will cost an estimated US\$10 billion and more. Why? No one suffers from methanol emissions as far as I know. IIED/WBCSD "Towards a Sustainable Paper," ISBN 1 899825 40 1.

process so much the better, but an alliance of NGOs working with a rejuvenated UNEP would be more likely to succeed.

At an international level the reform of the UN is the priority. There are any number of reports and commissions and initiatives to this effect. But those in the Security Council and those that are powerful within the Bretton Woods institutions have a special role to play. The follow-up to the development/environment/social agenda-setting conferences of the last decade provide the priority. As we approach the millennium surely there is a real opportunity for the G7 and a wider circle to take the initiative. We need a better process for UN reform than death by a thousand cuts and the G7 is in a position to start it. Rio+5 is a chance to start. In 1995 the Commission on Global Governance published their report "Our Global Neighbourhood."⁴ This soon disappeared without trace but it did contain some very thoughtful ideas on UN reform. For example, the abolition of ECOSOC, the creation of a new economic security council, transforming the trusteeship council into an organ for the global commons and much more. One important gap to fill is the need for strong countervailing institutions to the economic and trade organizations (the Bretton Woods family). Trade liberalization and structural adjustment are going to go very wrong without a balance for social, environmental, and equity issues. The EU works (just) because it has such checks and balances. Many countries are working out the needed sense of balance too. But at an international level all we have are weak and nearly bankrupt agencies. In the case of UNEP hope of reform is all but gone. Only governments can stop the rot.

We should see far greater attention to positive cooperation to reform our lending and donor institutions toward a common agenda for "sustainability." Redefining the aid agenda to reach those that the market does not reach, toward building capacities in civil society and acting as an investor in global security is a real policy challenge to all involved.

So much is down to leadership. Politicians and senior officials come and go but we rarely use their experience wisely in the international system. There is a class of 1992–5 that is very experienced and that has shown leadership in the follow-up to Rio. It would be good if the Asahi Glass Foundation could act as host to some of them and work out a way of forming a useful "club" to carry forward their example to others. One is not suggesting an interfering way (to those in power now and in the future) but as a resource for an increasingly difficult world that our children face.

⁴Our Global Neighborhood, published by Oxford University Press

IIED's Post-Earth-Summit Strategy

Richard Sandbrook, Executive Director, IIED

Lloyd Timberlake, IIED

SANDBROOK: We have decided to deliver this talk together today. Having come this great distance, it seems to me we shouldn't waste resources, and therefore we should have a collaborative venture. I'd like to begin by saying what a great honor and a great privilege it is for both of us to be here. We have, as you realize, a language problem, because we sadly don't speak the language of the majority of the audience. And so we've tried hard to liaise with the interpreters to ensure that you understand what we're saying. And I'd just like to take this opportunity to very particularly thank the Asahi Glass Foundation for having made us the recipient of its first award. And I'd like to express that on behalf of my colleagues in London, as well.

Generally, the world took a pretty negative view to what went on at the UN conference in Rio this summer. Most said that the so-called Earth Summit was a failure because it failed to reach firm agreement with targets for the protection of the atmosphere, for the world's forests, and for biodiversity. IIED does not subscribe to the view that it was overall a failure, or at least not fully. For us, the preparations and the event itself were full of achievements. A great number of diplomats and government officials in virtually all of the world's nations spent over two years learning the realities of the globe's environment and development challenges. Indeed, I've been heard to call Rio the greatest open university course for diplomats that we could possibly have devised. Heads of state had to develop and express an informed opinion before they took to the podium in Rio. And many of the achievements have much to offer that is both hopeful and positive, provided we now follow through.

In giving this lecture on the occasion of the first Blue Planet award, Lloyd and I want to concentrate on five themes that were well covered in Rio and that now need to be followed up. First is the need for information and education to the public. Second is the need to think and reform our economics so that it takes better account of the environment, most particularly so that there are incentives for the long run within the economic framework. Third is the need to involve the private sector much more deliberately in delivering solutions to our problems. Fourth is the whole question of how we, in the future, invest in human capacities and human abilities to cope. And finally, we will be saying something about the community-driven solutions that my institute has spent so much time working with. In fact, all of these themes are drawn from our experience in recent years and relate to issues on which we will continue to be working. And this is a wonderful opportunity to share them with you.

But first, let's cast our minds back 20 years, 20 years of environment development activities. Now there's been a remarkable shift in attitudes since the first conference on environment in 1972. In the 1970s, the environment was not regarded as an important issue by any econo-

mists, by business leaders, international diplomats, or by many politicians. Many in the industrialized world saw environmental issues only in terms of value issues, or quality-of-life issues. But to many, they are not quality-of-life issues, but life-and-death issues.

Now events have changed thinking, and for example I believe the tragedy of Minamata here in Japan helped to show the Japanese people and the business leaders in Japan that environment can indeed be a life-and-death issue, and this played a role in helping Japan's early start to successfully managing its domestic environment. But education has also been key. In Stockholm, the issue of development, or progress for the poorest nations in this particular case, was hardly mentioned. The richest nations were concerned with pollution and with the creation of international standards to abate it—the famous “level playing field.” Poorer nations wanted to advance their own development, almost at any price, including that of pollution. And it's ironic, also, to remember that the communist countries did not come to the first conference in Stockholm on the environment. They refused to attend on the issue of whether or not we recognized East Germany. But they sent messages to say that they didn't have pollution problems in the communist world, anyway.

Now much has changed. First, the key pollution issues nowadays are not regarded as end-of-pipe problems, which can be solved only by national laws. They're now regarded as global issues, and they are global: acid rain, global warming, ozone depletion. And these are problems that can only be tackled by international cooperation of a type and complexity we've never attempted before.

Second on the environmental front, lines have moved from pollution in the urban North to issues of resource management in the rural South. We have to, and in fact I believe we have come to recognize that the pollution of poverty is alongside the offense of overconsumption. But the most important change has been the change of mindset. The IIED was founded a little more than 20 years ago by a woman who was about 15 years ahead of her time. Barbara Ward realized at the time in Stockholm, before anybody else, that it was useless to worry about the environment when millions of people lived in such deep poverty that they must destroy their very environment in order to survive. And it is pointless to strive for progress and development if that progress destroys the environment, which is the foundation of all progress.

Now for years IIED, and I must confess many others, have labored, often apparently in vain, to change this mindset; to persuade the world that the concern for the environment and a concern for development are and must be inseparable. But from the mid-1980s onward, and really consecrated at Rio, much of the world has at last come around to that way of thinking.

TIMBERLAKE: Thus, IIED was very active in the work of the World Commission for Environment and Development, the so-called Brundtland Commission, which completed its work here in Tokyo five years ago. The commission's final report, which IIED staff helped to write, explained and championed the concept of sustainable development, which it defined as forms of progress which meet the needs of today, while not compromising the ability of future generations to meet their own needs. This concept gives environmental resources their rational and rightful place in human activities. It has also had the effect of drawing into the environment and development debate the economists, the lawyers, the business people, and the

politicians who had previously remained uninterested.

It was the Brundtland Commission which in fact called for the holding of an earth summit. It was also the Brundtland Commission which noted that one cannot talk about sustainable development or environmental management without talking about economic systems, trade, debt, democracy, security issues, and population. All of these issues were either ignored or were fudged at the Earth Summit in Rio, proving that we're still a long way from a mature and realistic approach to sustainable development. We're now faced with the problems of defining the roles of the global environment facility and with the newly formed sustainable development commission. It is far too soon to judge the worth of either.

But despite its shortcomings, Rio was a success in that it was the first major conference to bring together both the environment and development agendas. One speaker argued that in the term "environment and development" it's not the word "environment" that is most important, nor is it the word "development" which is most important. But it's the small word "and" which is the most important in that expression. The summit's sheer scale and complexity was unprecedented and, as such, left most people very bemused. In bringing together the two agendas on such a scale was a great and a positive achievement, much of which was due to efforts of the nongovernmental community. We never thought it was going to be easy.

Also, let us not forget that people—common people, particularly if they are poor people—have always known that their livelihoods ultimately come from nature. But now there's a widespread consensus on the same point among governments, corporations, diplomats, and many diverse organizations. The agenda of the poor is rapidly becoming everyone's agenda, our own agenda. We have to protect and in many cases restore natural stocks and systems if we are to survive economically in the long run. We should not minimize this new widespread agreement and understanding, nor should we take it for granted. It must be nurtured with a continuing program of public information and education. But to have got this far is progress indeed.

SANDBROOK: Now a major challenge that remains, of course, is to integrate sound environmental practice with economic planning in order to achieve this notional thing called sustainable development, at least cost and for the greatest number. That process was only just begun in Rio. The conference set out a vast and complex agenda, a shopping list if you like, for achieving the goal of sustainability, and they called it Agenda 21. Now let me assure you, for those who don't know the UN, Agenda 21 is not a particularly exciting read. But it can be called a comprehensive document. Never before has the UN attempted to put all of the issues together in the way that has been achieved in Agenda 21. Nor has it managed to do it with the consent of so many diverse interests and cultures. However, Agenda 21 does not list or set priorities. It lists all the things we should do, but it does not put them in any sense of order or time sequence.

Now, in order to organize priorities—and we have to if the entire UN and international system is not to collapse under the burden of this shopping list—we have to get involved in the business of politics. But we also believe strongly that politicians need rigorous economic analysis alongside political process. What are the costs and benefits of various courses of

action? How are we to translate the many environmental and developmental priorities into activities with priority for the private sector, nongovernmental organizations (NGOs), and the communities, and so on? How are we going to move the rhetoric to action?

The challenge is to integrate economics and the natural applied sciences in order to cost and set priorities. And most particularly, to design economic incentives. Economics must be involved, as regulations, we know, are not enough. And surely economics must be involved in order that we can set the priorities sensibly. How foolish it is at the moment to spend millions of dollars in the industrial world to slightly decrease the nitrate concentrations in our drinking water, while millions more could be saved in the Third World for a mere dollar or two a year. We have to bring some order to all of this, and we need research and analytical tools to help provide it. And one of those tools is environmental economics, which IIED has had such a hand in developing. It provides us with a means of organizing economic process around the very essence of the problem, that of protecting and restoring natural capital.

TIMBERLAKE: Business and industry are crucial in this transformation. But the very mention of business and industry in respect to the environment and development tends to provoke negative reactions. So many environmental organizations have invested heavily in opposing the multinational corporations, in blocking much of what they do, and in accusing them of being the main cause for all of our problems. We in IIED have had a very different experience. In the run-up to the Earth Summit in Rio, IIED worked closely with the Business Council for Sustainable Development, a group of 48 international business leaders, chief executive officers (CEOs), chairmen and chairwomen of boards of companies. Several of these were leaders of large Japanese firms. And all worked to offer a business perspective on environment and development issues. We helped them to prepare their 350-page report, called *Changing Course*, which is now available in Japanese as well as six other languages.

At their first meeting, these business leaders were almost completely overwhelmed by the complexity and the scientific and economic uncertainty of saying anything intelligent about the environment. One suggested that they all give up writing a report and simply issue a call for more research. But as they debated, they realized that sustainable development has its own inexorable logic, even for and perhaps especially for business. They were all capitalists, and all believed in open competition of the marketplace as the best way to meet the needs of people and to improve technology. But they also realized, and they wrote strongly in their report, that capitalism and markets will ultimately fail unless the system can be made to reflect the environmental truth, as well as the economic truth.

You may remember that right before the Earth Summit U.S. President George Bush made a speech to the nation pledging not to go to Rio and sign any agreements that would hurt U.S. business competitiveness. At about this time, the U.S. members of the Business Council met with Bush at the White House and presented him with a copy of the book. And they also told him frankly that they had come to a conclusion that was precisely the opposite of his own. They said they felt that those companies and those countries which are not environmentally clean and efficient are the ones which will suffer the loss of competitiveness. And they offered President Bush several reasons for this opinion. First, they noted customers are demanding

cleaner products. Banks are more willing to lend to companies that prevent pollution rather than pay much larger amounts for clean-up later on. Insurance companies are more amenable to covering clean companies. Employees, especially the bright young employees, prefer to work for environmentally responsible corporations. Environmental regulations are getting ever more stringent, and new economic instruments such as taxes, charges, tradable permits, or rewarding will continue to reward the cleanest companies. All of these trends, which will accelerate as science offers more evidence of environmental damage, mean that investments in eco-efficiency will help rather than hurt corporate profitability. It is the eco-efficient companies that will emerge more competitive as these trends take hold.

This is also true of eco-efficient nations. Professor Michael Porter at Harvard Business School reported after a global study that it was the nation with the most rigorous environmental standards at home which often led in the exports of the very products affected by those standards. He mentioned the success of Germany and of Japan, and also the success of the chemicals, plastics, and the paint industries in the United States. Japan historically has suffered from a deficiency of raw materials. And as the 20th century draws to a close and industry tries to move from a linear throughput system toward a more circular recycling system, as in the natural world, then it becomes obvious that this deficiency of natural resources was in part a blessing in disguise. Japan, to use the language of the Business Council, is more eco-efficient than many of its rivals. It uses less energy, less water, less resources in general in its production processes. This not only creates products which are highly competitive, but it also has created a profitable line of efficient production equipment, which the rest of the world will need more and more.

I know that the private sector—business and industry—is only in the first fumbling stages of its progress toward sustainability. But I also know that the operations of business and industry will determine more than any other sector the conditions of our common global future. Governments and not-for-profit organizations such as our own do not deliver the goods and services needed for the relief of poverty and the provision of basic needs. Who supplies water? The private sector. Who supplies food? The private sector. Who builds houses? Business and industry. The entrepreneur has a vital role to play in providing the needs expressed so coherently in Agenda 21. It is time that many more cooperated with business and industry.

But to move this forward, particularly in the developing world, we need a series of intermediaries so that the cut and thrust of the market can be meshed with realities of both the urban and the rural poor. Foundations sponsored by the corporate giants are a start. Just look at their record worldwide, including that of the Asahi Glass Foundation, which brings us here today. Another step is to ensure that the large companies help the medium and small to develop and use low-impact and environmentally efficient technologies. Success in this challenge of technology transfer, or technology cooperation, will involve new sorts of partnerships between business and government. The whole process of development assistance or aid needs to be turned into sustainable development assistance. We must stop dumping unwanted grain and unwanted technologies upon the poorer nations, and instead help business transfer more eco-efficient technology and to form a partnership with communities building their own development.

SANDBROOK: Corporate leadership is needed to take on these issues. And we also of course need more corporate involvement in community problems. In the past, the corporate sector has demonstrated they can do this, particularly with respect to education and certain social needs. I believe it is now the turn of the environment and development agenda to get the cooperation of the business community. The Rio conference embraced the market approach, and in return the leaders of the market approach must embrace the needs of the environment and the poor.

Two statistics taken together offer the greatest challenge to sustainability. The first is that 20% of the planet's population use 80% of the planet's resources, leaving the poorer 80% of the people to make do with a mere fifth of the resource base. Now add to that fact the fact that over 90% of all future population growth is suggested to be taking place in the poorer economies, and you can see the problem. Obviously, for business to play a positive role in our common future it must develop ways of turning the needs of the poorest into markets in order to meet those needs, and it must rely less and less on creating artificial needs for luxury products through advertising and the like among the shrinking proportion of the world's population that is in the North. This makes good development sense and good business sense. We have to start using the business sector to solve the development problem.

Now having talked of the capabilities of business leaders, I want to widen the topic to human capacities in general. So often, large parts of the world simply lack the necessary human skills and the institutions and the organizations required to do the job. The Rio summit recognized that we need to build capacities, human capacities, and this implies skill and training transfer. It takes time to build up the capacities of organizations and managements. In other words, we're in for a long haul. Our idea itself has taken 20 years to get where it's got to, and we have still a long way to go.

Now sadly, worldwide we see far too little investment in building human capital, far more diverted to laying down concrete and building physical capital. Rio makes some very optimistic assumptions about our collective ability to manage the world's natural resource base, yet most government administrations are very, very weak and poor at setting and sticking to the sort of long-term policies needed to manage those resources. This is not only true for poorer nations, where most people's lives are directly related to the natural resource stock, but it is also true of the rich nations. The United States, with its wealth of management skills, is finding it difficult to effectively manage its water and its timber. The United Kingdom, a small and crowded island which I come from, still gets rid of 80% of its waste by ill-planned land use for reasons that are quite beyond me. My own government still declines to invest in public transport systems, so that business in the city becomes less and less possible as London comes to a grinding halt daily. So in other words, both rich and poor have much to learn in coping for the long-term future in the planning sense.

Cities, particularly in the South, are expanding with little guidance or planning at all. The directions of growth are chosen mainly by the poorest people when they choose the illegal and dangerous bits of ground on which to site their shanties. And despite this obvious truth, the national governments are loathe to provide city governments with the funds they need to develop. Local government is a really underinvested sector everywhere. And governments

which claim to be encouraging economic development in the countryside still of course practice policies which encourage people to move from the country to the city by assuring the best education, health care, and job opportunities there, and of course subsidies and all manner of other goods and services.

Our economic systems expand and accelerate haphazardly, consuming natural resources and pushing out pollutants. Again, too few are involved in energy and water management, in recycling resources, in conserving of lands. The whole problem needs to be addressed. How do we manage these economies better? One has to marvel at the skill and the persistence of the poor, who cope with all the uncertainty and all the chaos that makes up their everyday lives. I believe as things get worse mostly due to population increases and the added environmental stress that will bring, the poor will be less and less able to cope. And we should recognize that now. Unless we improve management capacities to put all the fine ideas of Rio into practice, we're merely indulging in cheap talk.

For example, the national sustainable development plans called for in Rio by all the governments demand a very high level of informed and integrated planning techniques. We have to invest now in exactly those techniques if we're going to bring the ideas of Rio into reality and make them available in application. So human capacity building is another of the priorities of IIED.

TIMBERLAKE: We'd like to turn now to those at the bottom of the international ladder, the very poor and the rural and urban communities in which they live. IIED believes in a community-driven bottom-up development, which is enabled and empowered by top-down processes and frameworks. It is where we now do more than 50% of our work in terms of staff time. Our efforts in this area come under the heading of primary environmental care, or PEC. PEC is based on three very simple concepts: empowering communities, meeting basic needs, and safeguarding the environment. The Rio conference and Agenda 21 had much to say on all three items and on the importance of community-driven approaches in general. This was a triumph for the advocates of this approach.

Yet how many countries, really, enable and empower their citizens to look after themselves? How many can claim to be decentralizing government, establishing equitable land-holdings, establishing open and participatory methods of planning, and improving the lot of women? And how many can rightly claim to be giving incentives to the poor over the longer term? The Brundtland Commission concluded that the first prerequisite for development was, and I quote, "a political system based on effective citizenship participation in decision-making." This participation must exist at the national level, at the village level, and at various levels in between. The commission also declared that people, individuals, and people's groups had a right to participate in decisions, a right to information about their environments, and a right to redress in cases of environmental damage not of their own doing. The reason for these rights have nothing to do with human rights, but are practical. For it's the poorest people—which are the majority in most developing countries—who are the real environmental decision-makers. It is they who decide each day which tree to cut, how many sheep to graze in a given field, or in cities, how to dispose of the family's waste.

IIED has had much experience in the developing world at this level. We've created systems of empowering the poor by giving them knowledge of their environment and their environmental resource base, and then by working with them to better manage those resources. We've made this approach more popular among the big aid agencies of the industrialized nations, for we can actually demonstrate the positive results of empowering the poor. Deserts can be turned into productive land, trees and forests regenerated, barren land made productive, water and housing supplied. How is all this done? By giving people the right to organize, by giving them a stake in their future and rewards for their efforts, and by providing them with a knowledge of their environment.

It all sounds simple and straightforward, but making it happen takes persistence and commitment and an attitude of mind that is centered on the belief in people and their culture. And I should add that this approach is also the linchpin of any entrepreneurial society.

SANDBROOK: Now I want to close with one perhaps slightly philosophical thought about this concept of sustainable development. We in IIED have been focusing in the past on the practical and pragmatic reasons why governments, why industry and business, and ordinary people should pursue this goal. But the concept has one very serious flaw, and that lies in the fact that ultimately it is based on our concern for future generations and for our children and their children. Indeed, it is also based on concern for the needs of the present, but it's basically about the future. Let's be frank: we in the industrial world have managed to get along quite happily in a world in which a billion people live in abject poverty. Their plight doesn't really affect us very much, and it certainly doesn't seem to affect our economic decisions or our political decisions very much.

Can we show a more serious practical concerns for the needs of future generations? I wonder. We have no institutions championing the needs of future generations, or working for intergenerational equity, a concept which transfers resources from one to the next. Our most sophisticated democratic governments are guided by the decisions of those who vote today, not of those who will be voting in the next century. We have businesses, in fact our entire economic system follows the lead of the money market and the consumers who live today, not those yet to be born. So isn't it all rather idealistic to think that we can move to suddenly consider intergenerational questions?

Perhaps the sort of revolution required is actually impossible. That could be. But there have in the past been huge major changes which were seen to be impossible before. And they were not, of course, led by governments, and they were not really led by the very poor or the dispossessed. These changes were usually led by well-informed people, reasonably well off, working in small groups creating a fuss. And they usually accomplished what they accomplished in the face of all expert advice. Accepted wisdom some while back was that in slave-owning regions of the world, the abolition of slavery would completely ruin the market system. Later, the same was said of child labor: if you destroy child labor, you will ruin our economic system. And of course there were plenty who resisted anything being done in the industrialized world to look after the most vulnerable.

Today, we're often told, occasionally by people who are referred to as world leaders,

that we cannot possibly move to more equitable patterns of development, patterns which respect environmental and human realities, without destroying our own Northern economies. We have to wait before we can start looking after the Third World, wait for better times. In fact, I would put it all very differently. Global security will only be achieved and maintained when we do look after the divisions which currently face us in terms of equity. A world of 10 billion people will not be stable if it is split between the haves and have nots, between those who have a voice and those who do not, between green fields on the one hand and deserts on the other. We must start to build now a new concept of global security. Otherwise, we will not achieve sustainable development.

TIMBERLAKE: The final verdict on the Earth Summit has yet to be given. We cannot say it was a success, we cannot say it was a failure. But we do know it was a start in the right direction. We believe firmly that the future will be brighter if the achievements of Rio can be acted upon positively. IIED intends to be a part of that future by concentrating on five key points. We want to help, and I really mean to help, to inform and educate the public; to reform economics to take better account of the environment, and to provide incentives for moving in the right direction; to involve the private sector, business and industry, in delivering solutions; to invest in human capacities; and to reinforce community-driven solutions. If governments, NGOs, and academics work for policies in this direction, we will see answers to the problems of poverty and the protection of the planet within our own lifetimes. If we do not work with commitment in these directions, we will see an insecure, introverted, protectionist, and besieged world of contrasted rich and poor. We owe our children better than this. We have a duty to them and to their children. As Barbara Ward was fond of saying, we also have a duty to hope.

I cannot close without echoing our thanks to all of you for coming to listen to us today, and to the Asahi Glass Foundation for making the award and this occasion possible. Thank you very much.

Major Publications

IIED

Human Settlements Programme

- Satterthwaite, David, Roger Hart, Caren Levy, Diana Mitlin, David Ross, Jac Smit, and Carolyn Stephens. *The Environment for Children*, 1996.
- Hardoy, Jorge E., Diana Mitlin, and David Satterthwaite. *Environmental Problems in Third World Cities*, 1993.
- Mitlin, Diana and David Satterthwaite. *Sustainable Development and Cities*, 1994.
- IIED. *Sustainable Cities*, 1992.
- IIED. *Sustainable Development and the Global Commons* — a Third World Re-assessment, 1992.
- Arrossi, Silvina, Felix Bombarolo, Jorge E. Hardoy, Diana Mitlin, Luis P. Coscio, and David Satterthwaite. *Funding Community Initiatives*, 1994.
- IIED. *Funding Community Level Initiatives*, 1993.
- Patel, Sheela. *SPARC and its work with National Slum Dwellers Federation and Mahila Milan, India*, 1996.
- Schusterman, Ricardo, and Ana Hardoy. *Reconstructing Social Capital in a Poor Urban Settlement: The Integrated Improvement Programme, Barrio San Jorge*, 1996.
- OPP Research and Training Institute. *The Orangi Pilot Project, Pakistan*, 1996.
- Boonyabancha, Somsook. *The Urban Community Development Office, Thailand*, 1996.
- Cabannes, Yves. *From Community Development to Housing Finance: From Mutiroes to Casa Melhor in Fortaleza, Brazil*, 1996.
- Stein, Alfredo. *Decentralization and Urban Poverty Reduction in Nicaragua: The Experience of the Local Development Programme (PRODEL)*, 1996.
- Ortiz, Enrique. *FONHAPO: The Experience of the National Fund for Low Income Housing in Mexico*, 1996.
- Albee, Alana and Nandasiri Gamage. *Our Money; Our Movement (case study of the Women's Credit Union in Sri Lanka)*, 1996.
- Satterthwaite, David. *Urban Poverty: Reconsidering its Scale and Nature*, 1996.
- Mitlin, Diana. *Reaching Low-Income Groups with Housing Finance*, 1996.
- Mitlin, Diana and David Satterthwaite. *City-based Funds for Community Initiatives*, 1996.
- IIED. *Urban Poverty: characteristics, causes and consequences*, 1995.
- IIED. *Urban Poverty II: From understanding to action*, 1995.
- Atkinson, Sarah J., and Alfred Merkle. *Urban Health in Africa*, 1994.
- IIED. *Health and Wellbeing in Cities*, 1993.
- Mitlin, Diana. (ed.) *Housing Finance and Resource Mobilization. Workshop Report: 5–8 May 1996, South Africa*, 1996.
- Leckie, Scott. *From Housing Needs to Housing Rights: An Analysis of the Right to Adequate Housing Under Human Rights Law*, 1992.
- IIED. *RRA Notes 21: Special issue on participatory tools and methods in urban areas*, 1995.

- Satterthwaite, David. *The Scale and Nature of Urban Change in the South*, 1996.
- Arrossi, Silvina, Felix Bombarolo, Jorge E. Hardoy, Diana Mitlin, Luis P. Coscio, and David Satterthwaite. *Financiamiento de iniciativas comunitarias*, 1993.
- Pérez, Pedro, Claudio Minoliti, and Marcos Novaro. *Municipio, necesidades sociales y política local*, 1991.
- del Carmen Feijoo, Maria, and Hilda Maria Herzer. (eds.) *Las murjeres y la vida de las ciudades*, 1991.
- Hardoy, Jorge E., and Richard Morse. (comps.) *Repensando la ciudad de América Latina*, 1992.

Environmental Planning Group

- Dalal-Clayton, Barry. *Getting to Grips with Green Plans: Recent Experience in Industrial Countries*, 1996.
- Dalal-Clayton, Barry. *Great Expectations? Green Planning in Industrial Countries. (Environmental Planning Issues Series No. 10.)* 1996.
- Hughes, Ross and Barry Dalal-Clayton. *Participation in Environmental Impact Assessment: A Review of Issues. (Environmental Planning Issues Series No. 11.)* 1997.
- Koziell, I. and H. Sosovele. *A Review of District-level Environmental Initiatives in Tanzania. (Environmental Planning Issues Series No. 12.)* 1997.
- Dalal-Clayton, Barry. *Southern Africa Beyond the Millenium: Environmental Trends and Scenarios to 2015. (Environmental Planning Issues Series No. 13.)* 1997.
- Leader-Williams, N., J.A. Kayera, and G.L. Overton. (eds.) *Mining in Protected Areas in Tanzania: Proceedings of a Workshop Held in March 1994. (Wildlife and Development Series No. 9.)* 1996.
- Roe, Dilys, Nigel Leader-Williams, and Barry Dalal-Clayton. *The Environmental Effects of Wildlife Tourism: An Overview. (Wildlife and Development Series No. 10.)* 1997.
- Mwalyosi, Raphael, Ross Hughes, and Bryan Spooner. *EIA in Tanzania: An Introductory and Training Resource Manual*, 1997.
- Mwalyosi, Raphael, Ross Hughes, and Bryan Spooner. *EIA in Tanzania: An Orientation Training and Resource Manual*, 1997.
- Mwalyosi, Raphael, Ross Hughes, and Bryan Spooner. *EIA in Tanzania: A Training and Resource Manual for EIA Review*, 1997.
- Carew-Reid, Jeremy, Robert Prescott-Allen, Stephen Bass, and Barry Dalal-Clayton. *Strategies for National Sustainable Development: A Handbook for their Planning and Implementation*, 1994.
- Dent, D.L., and L.K.P.A. Goonewardene. *Resource Assessment and Land Use Planning in Sri Lanka: A Case Study. (Environmental Planning Issues Series 4.)* 1993.
- Bass, Stephen, Barry Dalal-Clayton, and Jules Pretty. *Participation in Strategies for Sustainable Development. (Environmental Planning Issues Series No. 7.)* 1995.
- Bass, Stephen and Barry Dalal-Clayton. *Small Island States and Sustainable Development: Strategic Issues and Experience. (Environmental Planning Issues Series No. 8.)* 1995.
- Dalal-Clayton, Barry and Barry Sadler. *Strategic Environmental Assessment: A Briefing Paper*,

1995.

- Stone, Paula, and Barry Dalal-Clayton. (eds.) *Environmental Synopses (prepared by IIED for the Overseas Development Administration)*. Ghana 1992; Indonesia 1994; Pakistan 1992; Sri Lanka 1992; Uganda 1992; Zimbabwe 1992.
- Hughes Ross, Shapan Adnan, and Barry Dalal-Clayton. *Flood Plains or Flood Plans?: A Review of Approaches to Water Management in Bangladesh*, 1994.
- Roe, Dilys, Barry Dalal-Clayton, and Ross Hughes. *A Directory of Impact Assessment Guidelines*, 1995.
- IIED. *Whose Eden?: An Overview of Community Approaches to Wildlife Management*, 1994.
- IIED. *The Campfire Papers*, 1996.
- Dalal-Clayton, B. *Modified EIA and Indicators of Sustainability: First Steps Towards Sustainability Analysis. (Environmental Planning Series No. 1.)* 1993.
- Dalal-Clayton, B. and D. Dent. *Surveys, Plans and People: A Review of Land Resource Information and its Use in Developing Countries. (Environmental Planning Issues Series No. 2.)* 1993.
- Kauzeni, A.S., I.S. Kikula, S.A. Mohamed, J.G. Lyimo, and B. Dalal-Clayton. *Resource Assessment and Land Use Planning in Tanzania: A Case Study. (Environmental Planning Issue Series No. 3.)* 1993.
- Dalal-Clayton, B., S. Bass, B. Sadler, K. Thomson, R. Sandbrook, N. Robins, and R. Hughes. *National Sustainable Development Strategies: Experience and Dilemmas. (Environmental Planning Issues Series No. 6.)* 1994.
- Mwalyosi, R., S. Mohamed, R. Hughes, and B. Dalal-Clayton. *Environmental Assessment in Tanzania: A needs Assessment for Training. (Environmental Planning Series No. 9.)* 1995.

Forestry and Land Use Programme

- IIED and the World Conservation Monitoring Centre. *Forest Resource Accounting: Strategic Information for Sustainable Forest Management*, 1996.
- Keogh, Raymond. *Teak 2000: A Consortium Support Model for greatly increasing the contribution of quality tropical hardwood plantations to sustainable development. (Forestry and Land Use Series No. 9.)* 1996.
- Mayers, James, Caroline Howard, E. Nii Ashie Kotey, Edward Prah, and Michael Richards. *Incentives for Sustainable Forest Management: A Study in Ghana. (Forestry and Land Use Series. No. 6.)* 1996.
- Mayers, James and E. Nii Ashie Kotey. *Local Institutions and Adaptive Forest Management in Ghana. (Forestry and Land Use Series. No. 7.)* 1996.
- Upton, Christopher and Stephen Bass. *The Forest Certification Handbook*, 1995.
- Mayers, James, and Basil Peutalo. *NGOs in the Forest: Participation of NGOs in National Forestry Action Programmes: New Experience in Papua New Guinea. (Forestry and Land Use Series No. 8.)* 1995.
- Mayers, James, Basil Peutalo, and Meera Kaul Shah. (eds.) *Adapting Tools for Local Forest Management*, 1994.
- Bass, Stephen and Elaine Morrison. *Shifting Cultivation in Thailand, Laos and Vietnam:*

Regional Overview and Policy Recommendations. (Forestry and Land Use Series No. 2.) 1994.

Dinh Sam, Do. *Shifting Cultivation in Vietnam: its Social, Economic and Environmental Values relative to Alternative Land Use. (Forestry and Land Use Series No. 3.)* 1994.

Rerkasem, Kanok and Benjavan Rerkasem. *Shifting Cultivation in Thailand: its Current Situation and Dynamics in the Context of Highland Development. (Forestry and Land Use Series No. 4.)* 1994.

Souvanthong, Pheng. *Shifting Cultivation in Lao PDR: an Overview of Land Use and Policy Initiatives. (Forestry and Land Use Series No. 5.)* 1995.

Sargent, Caroline and Stephen Bass. (eds.) *Plantation Politics: Forest Plantations in Development*, 1992.

Sargent, Caroline, John Palmer, and Elaine Morrison. (eds.) *Proceedings of the National Seminar on Setting Priorities for Research in the Land Use Continuum in Vietnam. Hoa Binh, September 1991*, 1991.

Howard, Caroline. (ed.) *Current Land Use in Vietnam. Proceedings of the Second Land Use Seminar, Bac Thai, Vietnam. September 1994*, 1995.

Howlett, D. and Caroline Sargent. (eds.) *Technical Workshop to Explore Options for Global Forestry Management. Bangkok 1991. Proceedings*, 1991.

Oksanen, Tapani, Matts Heering, and Bruce Cabarle. *A Study on Coordination in Sustainable Forestry Development*, 1993.

Sustainable Agriculture Programme

Pretty, Jules N., Irene Guijt, Ian Scoones, and John Thompson. *A Trainer's Guide for Participatory Learning and Action*, 1995.

Murray Bradley, Sarah. *How People Use Pictures: An Annotated Bibliography and Review for Development Workers*, 1995.

Messerschmidt, Donald A. *Rapid Appraisal for Community Forestry: The RA Process and Rapid Diagnostic Tools*, 1995.

Guijt, Irene, Andreas Fuglesang, and Tony Kisadha. (eds.) *It is the Young Trees That Make a Thick Forest: A Report on Redd Barna's Learning Experiences with Participatory Rural Appraisal in Kyakatebe, Uganda*, 1994.

Thompson, John, Jafar Shah, and Erhard Foellmi. (eds.) *Planning for a Change: Participatory Rural Appraisal for Community-Based Development*, 1994.

Guijt, Irene and Koos Neefjes. (eds.) *Técnicas de Comunicação Para Extensionistas: Relatório dum Seminário em Diagnóstico Rural (Rápido) Participativo Santo António, Cape Verde*, 1991.

Guijt, Irene and Ian Scoones. (eds.) *Rapid Rural Appraisal for Local Level Planning, Wollo Province, Ethiopia (1)*, 1991.

PLA. *PLA Notes 27: October 1996. Participation, Policy and Institutionalisation*, 1996.

PLA. *PLA Notes 26: June 1996*, 1996.

PLA. *PLA Notes 25: February 1996. Includes a special issue on children's participation*, 1996.

- PLA. *PLA Notes 24: October 1995. Critical Reflections from Practice*, 1995.
- PLA. *PLA Notes 23: June 1995. Includes section on participatory approaches to HIV/AIDS programmes*, 1995.
- PLA. *PLA Notes 22: February 1995*, 1995.
- PLA. *RRA Notes 21: November 1994. Special Issue: Participatory tools and methods in urban areas*, 1994.
- PLA. *RRA Notes 20: April 1994. Special Issue: Livestock*, 1994.
- PLA. *RRA Notes 19: February 1994. Special Issue: Training*, 1994.
- PLA. *RRA Notes 18: June 1993*, 1993.
- PLA. *RRA Notes 17: March 1993*, 1993.
- PLA. *RRA Notes 16: July 1992. Special Issue: Application for Health*, 1992.
- PLA. *RRA Notes 15: May 1992. Special Issue: Wealth Ranking*, 1992.
- PLA. *RRA Notes 14: December 1991*, 1991.
- PLA. *RRA Notes 13: August 1991. Proceedings of the February 1991 Bangalore PRA Trainers' workshop, IIED/MYRADA*, 1991.
- PLA. *RRA Notes 12: July 1991*, 1991.
- PLA. *RRA Notes 11: May 1991. Special Issue: Proceedings of joint IIED and Development Administration Group (University of Birmingham), Local Level Adaptive Planning Workshop, London*, 1991.
- PLA. *RRA Notes 10: February 1991*, 1991.
- Kerr, John, N.K. Sanghi, and G. Sriramappa. *Subsidies in watershed development projects in India: distortions and opportunities*, 1996.
- Pretty, Jules N., John Thompson, and Fiona Hinchcliffe. *Sustainable Agriculture: Impacts on food production and challenges for food security*, 1996.
- Harris, Frances. *Intensification of Agriculture in Semi-arid Areas: Lessons from the Kano Close-settled zone, Nigeria*, 1996.
- Pretty, Jules N. *Regenerating Agriculture*, 1995.
- Scoones, Ian and John Thompson. (eds.) *Beyond Farmer First*, 1994.
- Pretty, Jules N. and Rupert Howes. *Sustainable Agriculture in Britain: Recent Achievements and New Policy Challenges*, 1993.
- Conway, Gordon and Jules N. Pretty. *Unwelcome Harvest. Agriculture and Pollution*, 1991.
- Kerr, John, N.K. Sanghi, and G. Srirampappa. *Subsidies in watershed development projects in India: distortions and opportunities. (Gatekeeper Series SA 61.)* 1996.
- Pretty, Jules N., John Thompson, and Fiona Hinchcliffe. *Sustainable Agriculture: Impacts on food production and challenges for food security. (Gatekeeper Series SA 60.)* 1996.
- Harris, Frances. *Intensification of Agriculture in Semi-arid Areas: Lessons from the Kano Close-settled zone, Nigeria. (Gatekeeper Series SA 59.)* 1996.
- Starkey, P. *Networking for Sustainable Agriculture: Lessons from animal traction development. (Gatekeeper Series SA 58.)* 1996.
- Sinha, S. *The Conditions for Collective Action: Land tenure and farmers' groups in the Rajasthan Canal Project. (Gatekeeper Series SA 57.)* 1996.
- Bentley, J. and K. Andrews. *Through the Roadblocks: IPM and Central American smallhold-*

- ers. (*Gatekeeper Series SA 56.*) 1996.
- Bunch, R. and López. *Soil Recuperation in Central America: Sustaining innovation after intervention.* (*Gatekeeper Series SA 55.*) 1995.
- Zwarteveen, M. *Linking Women to the Main Canal: Gender and irrigation management.* (*Gatekeeper Series SA 54.*) 1995.
- Cousins, B. *A Role for Common Property Institutions in Land Redistribution Programmes in South Africa.* (*Gatekeeper Series SA 53.*) 1995.
- Grimble, R., M-K. Chan, J. Aglionby, and J. Quan. *Trees and Trade-offs: A Stakeholder Approach to Natural Resource Management.* (*Gatekeeper Series SA 52.*) 1995.
- Sperling, L. and U. Scheidegger. *Participatory Selection of Beans in Rwanda: Results, methods and institutionalised issues.* (*Gatekeeper Series SA 51.*) 1995.
- Hinchcliffe, F., I. Guijt, J.N. Pretty, and P. Shah. *New Horizons: The Economic, Social and Environmental Impacts of Participatory Watershed Development.* (*Gatekeeper Series SA 50.*) 1995.
- Cleaver, F. and D. Elson. *Marginalisation of Women in Water Resource Management.* (*Gatekeeper Series SA 49.*) 1995.
- Osborn, T. *Participatory Agricultural Extension: Experiences from West Africa.* (*Gatekeeper Series SA 48.*) 1995.
- Swallow, B. *The Role of Mobility Within the Risk Management Strategies of Pastoralists and Agro-Pastoralists.* (*Gatekeeper Series SA 47.*) 1994.
- Rosett, P. and M. Benjamin. *Two Steps Back, One Step Forward: Cuba's National Policy for Alternative Agriculture.* (*Gatekeeper Series SA 46.*) 1994.
- Tiffen, M., M. Mortimore, and F. Gichuki. *Population Growth and Environmental Recovery: Policy Lessons from Kenya.* (*Gatekeeper Series SA 45.*) 1994.
- Fujisaka, S. *Will Farmer Participatory Research Survive in the International Agricultural Research Centres?* (*Gatekeeper Series SA 44.*) 1994.
- Farrington J. and A. Bebbington. *From Research to Innovation: Getting the Most from Interaction with NGOs in Farming Systems Research and Extension.* (*Gatekeeper Series SA 43.*) 1994.
- Campbell, A. *Community First — Landcare in Australia.* (*Gatekeeper Series SA 42.*) 1994.
- Hoogerbrugge, I. And L. Fresco. *Homegarden Systems: Agricultural Characteristics and Challenges.* (*Gatekeeper Series SA 39.*) 1993.
- Gill, G. O.K., *The Data's Lousy, But It's All We've Got (Being a Critique of Conventional Methods).* (*Gatekeeper Series SA 38.*) 1993.
- Powell, J., and T. Williams. *Livestock, Nutrient Cycling and Sustainable Agriculture in the West African Sahel.* (*Gatekeeper Series SA 37.*) 1993.
- Murphree, M. *Communities as Resource Management Institutions.* (*Gatekeeper Series SA 36.*) 1993.
- Fowler, A. *Prioritizing Institutional Development: A New Role for NGO Centres for Study and Development.* (*Gatekeeper Series SA 35.*) 1992.
- Kerr, J. and N. Sanghi. *Indigenous Soil and Water Conservation in India's Semi-Arid Tropics.* (*Gatekeeper Series SA 34.*) 1992.

- Hyman, E. *Local Agro-Processing with Sustainable Technology: Sunflowerseed Oil in Tanzania*. (Gatekeeper Series SA 33.) 1992.
- Ibrahim, Mamman A. *The Information Drain: Obstacles to Research in Africa*. (Gatekeeper Series SA 32.) 1992.
- Uphoff, N. *Local Institutions and Participation for Sustainable Development*. (Gatekeeper Series SA 31.) 1992.
- Haugerud, A. and M. Collinson. *Plants, Genes and People: Improving the Relevance of Plant Breeding*. (Gatekeeper Series SA 30.) 1991.
- Pimbert, M. *Designing Integrated Pest Management for Sustainable and Productive Futures*. (Gatekeeper Series SA 29.) 1991.
- Arnold J. *Tree Products in Agroecosystems: Economic and Policy Issues*. (Gatekeeper Series SA 28.) 1991.
- Reij, C. *Indigenous Soil and Water Conservation in Africa*. (Gatekeeper Series SA 27.) 1991.
- Bebbington, A. *Farmer Organisations in Ecuador: Contributions to Farmer First Research and Development*. (Gatekeeper Series SA 26.) 1991.
- Gaventa, J. and H. Lewis. *Participatory Education and Grassroots Development: The Case of Rural Appalachia*. (Gatekeeper Series SA 25.) 1991.
- Jodha, N. *Rural Common Property Resources: A Growing Crisis*. (Gatekeeper Series SA 24.) 1991.
- Chambers, R., M. Leach, and C. Conroy. *Trees as Savings and Security for the Rural Poor* (2nd edition). (Gatekeeper Series SA 3.) 1993.
- Guijt, Irene, Fiona Hinchcliffe, and Mary Melnyk. (comps.) *The Hidden Harvest: The Value of Wild Resources in Agricultural Systems*. (A Project Summary), 1995.
- Bishop, Josh and Ian Scoones. *Beer and Baskets: The economics of women's livelihoods in Ngamiland, Botswana*, 1994.
- Hot Springs Working Group. (comp.) *Local-Level Economic Valuation of Savanna Woodland Resources: Village Case from Zimbabwe*, 1993.
- Scoones, Ian, Mary Melnyk, and Jules N. Pretty. (eds.) *The Hidden Harvest: Wild Foods and Agricultural Systems. A Literature Review and Annotated Bibliography*, 1992.

Drylands Programme

Programme Zones Arides

- Reij, Chris, Ian Scoones, and Camilla Toulmin (eds.) *Sustaining the Soil. Indigenous Soil and Water Conservation in Africa*, 1996.
- Lane, Charles. *Pastures Lost: Barabaig Economy, Resource Tenure and the Alienation of their Land in Tanzania*, 1996.
- Scoones, Ian with Chinaniso Chibudu et al. *Hazards and Opportunities. Farming Livelihoods in Dryland Africa: Lessons from Zimbabwe*, 1996.
- Toulmin, Camilla, Nick Robins, Krystyna Swiderska and Koy Thomson. *Capacity Development in the Human Dimensions of Global Environmental Change. The Role of Collaborative Research. ENRICH workshop. Edinburgh 9–10 October 1995*, 1995.
- Scoones, Ian. (ed.) *Living with Uncertainty. New Directions in Pastoral Development in*

Africa, 1995.

David, Rosalind. (coord.) *Changing Places? Women, Resource Management and Migration in the Sahel. Case Studies from Senegal, Burkina Faso, Mali and Sudan*, 1995.

IIED. *Proceedings from a Workshop on Nutrient Cycling and Soil Fertility Management in Africa, Soddo, Welaita, Ethiopia 26 November – 2 December 1995*, 1995.

Toulmin, Camilla. *Gestion de Terroirs: concept and development*, 1994.

IIED/Centre for Development Cooperation Services. *Indigenous Soil and Water Conservation in Africa. Proceedings of the Workshop in Addis Ababa, Ethiopia 6–9 June 1994*, 1994.

Cumar Ibrahim, Maxamuud. *Aas-aaska: Aqoonta Dhirta Iyo Deegaanka*, 1993.

DENIVA/IIED. *The Pestle and the Mortar. Researchers and NGOs Working Together for Sustainable Development, Mukono, Uganda 18–21 January 1993*, 1993.

Kolawole, A., M.O. Awogbade, and J. Voh. *Sustainable Use of Fadama in northern Nigeria. Proceedings of a National Policy Workshop, Maiduguri, Nigeria February 1993*, 1993.

Edwards, Sue, and Tefesse Mesfin (eds.) *Conference on Pastoralism in Ethiopia, 4–6 February 1993*, 1996.

Potkanski, Tomasz. *Pastoral Economy, Property Rights and Traditional Mutual Assistance Mechanisms among the Ngorongoro and Salei Maasai of Tanzania*, 1997.

Moorehead, Richard. *Structural Chaos: Community and State Management of Common Property in Mali*, 1997.

Mustafa, Kemal. *Eviction of Pastoralists from the Mkomazi Game Reserve in Tanzania: an historical review*, 1997.

ole Ngulay, Saruni. *Report on the Second Maa conference on Sustainable Pastoral Development held in Arusha, June 1994*, 1997.

ole Ngulay, Saruni. *Kisongo Maasai Customary Land Tenure Arrangements: social and ecological considerations for sustainable pastoral livelihoods in Tanzania*, 1997.

Shivji, Issa. *Problems of Land Tenure in Tanzania: A review and appraisal of the report of the Presidential Commission of Inquiry into land Matters*, 1992, 1997.

Bradbury, Mark, Simon Fisher, and Charles Lane. *Working with Pastoralist NGOs and Land Conflicts in Tanzania: A report on a workshop held in Terrat, Tanzania. 11th–15th December 1994*, 1995.

Potkanski, Tomasz. *Property Concepts, Herding Patterns and Management of Natural Resources among the Ngorongoro and Salei Maasai of Tanzania*, 1994.

Shivji, Issa. *A Legal Quagmire: Tanzania's Regulation of Land Tenure (Establishment of Villages) Act, 1992*, 1994.

Schoonmaker Freudenberger, Mark and Karen. *Pastoralism in Peril: Pressures on Grazing Land in Senegal*, 1993.

Lane, Charles, and Richard Moorehead. *Who should own the range? New Thinking on Pastoral Resource Tenure in Dryland Africa*, 1994.

Ecologist, The. *Reclaiming the Commons*, 1993.

Tenga, Ringo. *Pastoral Land Rights in Tanzania: A Review*, 1992.

IIED. *Haramata Bulletin of the Drylands*. (Magazine.)

Choksi, Archana and Caroline Dyer. *Pastoralism in a changing world: patterns of adaptation*

- among the Rabaris of Kutch, Gujerat, 1996.*
- Zeba, Souleymane NGOs and natural resource management policy in Burkina Faso, 1996.
- Scoones, Ian, Chris Reij, and Camilla Toulmin. *Sustaining the soil: indigenous soil and water conservation in Africa*, 1996.
- Scholte, Paul, Saidou Kari, and Mark Moritz. *The involvement of nomadic and transhumant pastoralists in the rehabilitation and management of the Logone floodplain, north Cameroon*, 1996.
- Al-Sayed Omar, Samira, Tareq Madouh, and Sarah Al-Sayed Omar. *Agricultural development in Kuwait: prospects and solutions for improving production and reducing land degradation*, 1996.
- Juul, Kristine. *Post drought migration and technological innovations among Fulani herders in Senegal: the triumph of the tube!* 1996.
- Hagmann, J. and K. Murwira. *Indigenous soil and water conservation in southern Zimbabwe: a study on techniques, historical changes and recent developments under participatory research and extension*, 1996.
- Sinha, Saurabh. *Resisting change? Adaptations by traditional pastoralists to the Rajasthan Canal Project*, 1996.
- Salem-Murdock, Muneera and Madiodio Niasse. *Water conflict in the Senegal river valley: implications of a "no-flood" scenario*, 1996.
- Myers, Mary with Rosalind David, Sarra Akarat, and Amani Awad Hamid. *The effects of male out-migration on women's management of natural resources in the Sudan*, 1995.
- Faure, Armelle. *Private land ownership in rural Burkina Faso*, 1995.
- Waters-Bayer, Ann, Wolfgang Bayer, and Annette von Lossau. *Participatory planning with pastoralists: some recent experiences*, 1995.
- Thébaud, Brigitte. *Land tenure, environmental degradation and desertification in Africa: some thoughts on the Sahelian example*, 1995.
- Toulmin, Camilla. *The Convention to Combat Desertification: guidelines for NGO activity*, 1995.
- Thébaud, Brigitte, Hermann Grell, and Sabine Meihe. *Recognising the effectiveness of traditional pastoral practices: lessons from a controlled grazing experiment in Northern Senegal*, 1995.
- Engberg, Pedersen, Lars. *Creating local democratic politics from above: the "Gestion des Terroirs" approach in Burkina Faso*, 1995.
- Ka, Awa. *Current natural resource management systems: landholding in the Gamaaji Saare rural community*, 1994.
- Manger, Leif. *Managing Pastoral adaptations in the Red Sea hills of the Sudan: challenges and dilemmas*, 1994.
- Kanté, Salif, and Toon Defoer. *How farmers classify and manage their land: implications for research and development activities*, 1994.
- Bruggeman, Hedwig. *Pastoral women and livestock management: examples from Northern Uganda and Central Chad*, 1994.
- Bara Guéye, Mamadou. *Conflicts and alliances between farmer and herders: the case of Goll*

- in *Fandène, Senegal*, 1994.
- Evers, Yvette, D. *Dealing with risk and uncertainty in Africa's drylands: the social dimensions of desertification*, 1994.
- Tiffen, Mary and Michael Mortimore. *Environment, population growth and productivity in Kenya: a case study of Machakos District*, 1993.
- Vedeld, Trond. *The state and rangeland management: creation and erosion of pastoral institutions in Mali*, 1993.
- Léye, Nohoune. *Writing from experience: grassroots in Senegal*, 1993.
- Lund, Christian. *Waiting for the Rural Code: perspectives on a land tenure reform in Niger*, 1993.
- Oloka-Onyango, Joe, Gariyo Zie, and Frank Muhereza. *Pastoralism, crisis and transformation in Karamoja*, 1993.
- Toulmin, Camilla. *Combating desertification: setting the agenda for a global convention*, 1993.
- Vira, Shiraz. *The Gujars of Uttar Pradesh: neglected "Victims of Progress,"* 1993.
- Painter, Thomas M. *Getting it right: linking concepts and action for improving the use of natural resources in Sahelian West Africa*, 1993.
- Lindskog, P. and A. Mando. *The relationship between research institutes and NGOs in the field of soil and water conservation in Burkina Faso*, 1992.
- Scoones, Ian. *Wetlands in Drylands: key resources for agricultural and pastoral production in Africa*, 1992.
- Bara Guéye, Mamadou. *Co-operation between Senegalese Non-Governmental Organisations and National Research Structures: constraints and perspectives*, 1992.
- Agrawal, Arun. *The grass is greener on the other side: a study of Raikas, migrant pastoralists of Rajasthan*, 1992.
- Guéye, Ibrahima, and Peter Laban. *From woodlots to village land management in the Sahel*, 1992.
- Stocking, Michael. *Land degradation and rehabilitation: research in Africa 1980-1990—retrospect and prospect*, 1992.
- Behnke, R. H. and Ian Scoones. *Rethinking range ecology: implications for rangeland management in Africa*, 1992.
- Mohamed Salih, M. *Pastoralists and planners: local knowledge and resource management in Gidan Magajia Grazing Reserve, Northern Nigeria*, 1992.
- ENDA-Tiers Monde. *Poverty and environment in Africa: which way ahead?* 1991.
- Murombedzi, J. *Decentralising common property resources management: a case study of the Nyaminyami District Council of Zimbabwe's Wildlife Management Programme*, 1991.
- Schoonmaker Freudenberger, Karen. *Mbengué: the disingenuous destruction of a Sahelian forest*, 1991.
- Pointing, J. and S. Joekes. *Women in pastoral societies in east and west Africa*, 1991.
- Maiga, A., P.N. de Leeuw, L. Diarra, and P. Hiernaux. *The harvesting of wild-growing grain crops in the Gourma region of Mali*, 1991.
- Parkipuny, M.S. *Pastoralism, conservation and development in the Greater Serengeti region*,

1991.

- Saint, Kishore. *Development Cooperation and the Development-Environment Crisis*, 1991.
- Mariko, Keletigui A. *Reforming land tenure and restoring peasants' rights: some basic conditions for reversing environmental degradation in the Sahel*, 1991.
- Scoones, Ian. *Living with Uncertainty: New Directions for Pastoral Development in Africa. Overview paper of the workshop on New Directions in African Range Management and Policy*. Woburn, UK, June 1993, 1994.
- Schoonmaker Freudenberg, Mark and Karen. *Fields, Fallow and Flexibility: Natural Resource Management in Ndam Mor Fadamba, Senegal. Results of a Rapid Rural Appraisal*, 1993.
- Scoones, Ian. (ed.) *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 1: Overview—ecological, economic and social issues*, 1991.
- Ingram, Julie. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 2: Soil and water processes*, 1991.
- Kolawole, Are. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 3a: Economics and management of fadama in northern Nigeria*, 1991.
- Hottenga, Folkert, Henk Peters and Sjoerd Zanan. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 3b: Potential of bas-fonds in agropastoral development in Sanmatenga, Burkina Faso*, 1991.
- Osman El Sammani, Mohammed. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 3c: Wadis of north Kordofan, Sudan—present roles and prospects for development*, 1991.
- Fre, Zeremariam. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 3d: Khor Baraka—a key resource in eastern Sudan and Eritrea*, 1991.
- Kokwe, Misael. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 3e: The role of dambos in agricultural development in Zambia*, 1991.
- Scoones, Ian and Ben Cousins. *Wetlands in Drylands: the agroecology of savanna systems in Africa. Part 3f: Key resources for agriculture and grazing: the struggle for control over dambo resources in Zimbabwe*, 1991.
- Scoones, Ian. (ed.) *Vivre dans l'incertitude: Nouvelles orientations du développement pastoral en Afrique*, 1997.
- Reij, Chris, Ian Scoones, and Camilla Toulmin. *Techniques traditionnelles de conservation de l'eau et des sols en Afrique*, 1996.
- IIED. *Réseaux MARP au Sahel: Missions et principes de fonctionnement*, 1996.
- Bara Guéye, Mamadou and Yéhia Haidara. (eds.) *Renforcement des capacités locales. Un processus participatif d'animation et d'auto-analyse villageoises. Rapport de l'atelier de formation d'animateurs villageois à la MARP, Bafoulabé, Mali, du 20 au 30 mai 1996*, 1996.
- Diouf, Waly, and Mamadou Bara Guéye. *L'apprentissage par l'expérience. Formation des formateurs à la MARP. Niamey, Niger 3–13 avril 1995*, 1995.
- Bara Guéye, Mamadou. (ed.) *Planification participative d'un projet de gestion des ressources naturelles - Atelier MARP: GTZ-PAGERNA, Toubacouta, Sénégal, 16–26 novembre 1994*,

1995.

- Bara Guéye, Mamadou. (ed.) *Rapport de l'atelier de formation des formateurs du réseau AFNETA-Cotonou, Bénin, 8-18 août 1994*, 1995.
- Bara Guéye, Mamadou. (ed.) *L'utilisation de la MARP dans le cadre de la Gestion des Terroirs: Rapport de l'atelier de formation sur la Méthode Active de Recherche et de Planification Participatives (MARP), Koudougou, Burkina Faso du 30 novembre au 09 décembre 1993*, 1994.
- Bara Guéye, Mamadou. (ed.) *OXFAM initie ses partenaires à la Méthode Accélérée de Recherche Participative: Rapport de l'atelier organisé à Ségou, Mali, du 14 au 23 juin 1993*, 1993.
- Bara Guéye, Mamadou. (ed.) *Rapport de l'atelier régional de formation de formateurs sur la Méthode Accélérée de Recherche Participative, Dakar, Sénégal, du 11 au 23 mai 1993*.
- Bara Guéye, Mamadou. (ed.) *Innovations méthodologiques et exigence de qualité.* (Relais MARP No. 3.)* 1996.
- Bara Guéye, Mamadou. (ed.) *Innovations méthodologiques et exigence de qualité.* (Relais MARP No. 2.)* 1994.
- Bara Guéye, Mamadou (ed.) *Outils, techniques et attitudes—le partage de quelques expériences. (Relais MARP No. 1.)* 1993.
- Bara Guéye, Mamadou and Mamdou Amadou Ly (ARED). (eds.) *Connaissances-Analyses-Choisissons*, 1996.
- IIED. *Haramata Bulletin de zones Arides (Magazine)*.
- Choksi, Archana and Caroline Dyer. *Le monde pastoral face au changement: schéma d'adaptation des Rabaris de Kutch, dans la région de Gujarat*, 1996.
- Zeba, Souleymane. *Rôle des ONG dans la réforme des politiques de gestion des ressources naturelles au Burkina Faso*, 1996.
- Reij, Chris, Ian Scoones, and Camilla Toulmin. *Techniques traditionnelles de conservation de l'eau et des sols en Afrique*, 1996.
- Scholte, Paul, Sadiou Kari, and Mark Moritz. *Le rôle des nomades et pasteurs transhumants dans la réhabilitation et la gestion de la plaine inondable de Logone, au nord Cameroun*, 1996.
- Al-Sayed Omar, Samira, Tareq Madouh, and Sarah Al-Sayed Omar. *Le développement agricole au Koweït: Perspectives et solutions pour améliorer la productions et atténuer la dégradation des terres*, 1996.
- Juul, Kristine. *Migration et innovations technologiques chez les peuls du Sénégal suite aux sécheresses: le triomphe de la chambre à air*, 1996.
- Hagmann, J. and K. Murwira. *Techniques traditionnelles de conservation de l'eau des sols dans le sud du Zimbabwe: évolution historique et développements dus à la recherche participative et à la vulgarisation*, 1996.
- Sinha, Saurabh. *Adaptations des pasteurs traditionnels au Projet du Canal du Rajasthan*, 1996.
- Salem-Murdock, Muneera and Madiodio Niasse. *Conflits de l'eau dans la vallée du fleuve Sénégal: implications d'un scénario "zero inondation,"* 1996.

- Myers, Mary with Rosalind David, Sarra Akkrat, and Amani Awad Hamid. *Les effets de l'exode masculin sur la gestion des ressources naturelles par les femmes au Soudan*, 1995.
- Faure, Armelle. *L'appropriation privée en milieu rural: Politiques foncières et pratiques locales au Burkina Faso*, 1995.
- Waters-Bayer, Ann, Wolfgang Bayer, Annette von Lossau. *Planification participative en milieu pastoral: Quelques expériences récentes*, 1995.
- Thébaud, Brigitte. *Foncier, dégradation des terres et désertification en Afrique: réflexions à partir de l'exemple du Sahel*, 1995.
- Toulmin, Camilla. *Convention de lutte contre la Désertification: Orientations des Activités des ONG*, 1995.
- Thébaud, Brigitte, Hermann Grell, and Sabine Mieke. *Vers une reconnaissance de l'efficacité pastorale traditionnelle: les leçons d'une expérience de pâturage contrôlé dans le nord du Sénégal*, 1995.
- Engberg Pedersen, Lars. *Démocratiser la vie politique locale de haut en bas: l'approche de gestion des terroirs au Burkina Faso*, 1995.
- Ka, Awa. *Systèmes actuels de gestion des ressources naturelles: Cas du foncier dans la communauté rurale de Gamaaji Saare au Sénégal*, 1994.
- Manger, Leif. *La gestion des adaptations pastorales dans les collines de la Mer Rouge, au Soudan: Défi et Dilemmes*, 1994.
- Kanté, Salif, and Toon Defoer. *La connaissance de la classification et gestion paysanne des terres: Rôle dans l'orientation des actions de recherche et de développement*, 1994.
- Bruggeman, Hedwig. *Femmes pastoralistes et gestion du bétail: Exemples tirés du nord de l'Ouganda et du centre du Tchad*, 1994.
- Bara Guèye, Mamadou. *Conflits et alliances entre agriculteurs et éleveurs: le cas du Goll de Fandène*, 1994.
- Evers, Yvette D. *Risques et incertitude dans les zones arides africaines: aspects sociaux de la désertification*, 1994.
- Tiffen, Mary and Michael Mortimore. *Environnement, croissance démographique et productivité au Kenya: le cas du district de Machakos*, 1993.
- Vedeld, Trond. *L'Etat et la gestion des pâturages: la création et l'érosion d'institutions pastorales au Mali*, 1993.
- Léye, Nohoune. *Travail avec les organisations de base au Sénégal*, 1993.
- Lund, Christian. *En attendant le Code Rural: Réflexions sur une réforme de la tenure foncière au Niger*, 1993.
- Oloka-Onyango, Joe, Gariyo Zie, and Frank Muhereza. *Pastoralisme, crise et transformation à Karamoja*, 1993.
- Toulmin, Camilla. *Lutter contre la désertification: Réflexions préliminaires à une convention mondiale*, 1993.
- Vira, Shiraz. *Des "victimes de progrès" bien négligées: Les Gujars d'Uttar Pradesh*, 1993.
- Painter, Thomas. *Trouver la bonne voie: Lier les concepts à l'action afin d'améliorer l'utilisation des ressources dans le Sahel ouest-africain*, 1993.
- Lindskog, P. and A. Mando. *Les rapports entre les instituts de recherche et les ONG dans le*

- domaine de la conservation des eaux et des sols au Burkina Faso, 1992.
- Scoones, Ian. *Les bas-fonds des zones arides: ressources-clés pour la production agricole et pastorale en Afrique*, 1992.
- Bara Guéye, Mamadou. *La Collaboration entre les organisations non-gouvernementales sénégalaises et le système national de recherche agricole: Contraintes et perspectives*, 1992.
- Agrawal, Arun. *L'herbe semble toujours plus verte de l'autre côte: Etude des Raikas, pasteurs, nomades du Rajasthan*, 1992.
- Guèye, Ibrahima and Peter Laban. *Des bois de villages à la gestion du terroir villageois en Afrique de l'Ouest*, 1992.
- Stocking, Michael. *La dégradation et la réhabilitation des terres: Rétrospective et prospective de la recherche en Afrique 1980-1990*, 1992.
- Behnke, R.H. and I. Scoones. *Repenser l'écologie des parcours: Implications pour la gestion des terres de parcours en Afrique*, 1992.
- Mohamed Salih, M.A. *Pasteurs et planificateurs: Connaissances locales et gestion des ressources dans la réserve de pâturages de Gidan Magajia, au Nigeria du Nord*, 1992.
- ENDA-Tiers Monde. *Pauvreté et environnement en Afrique: Que faire?* 1991.
- Murombedzi, J. *La décentralisation de la gestion des ressources de propriété commune: étude de l'application au district de Nyaminyami du programme de gestion de la faune du Zimbabwe*, 1991.
- Schoonmaker Freudenberger, K. Mbeguè: *L'habile destruction d'une forêt sahélienne*, 1991.
- Pointing, J. and S. Joekes. *Les femmes dans les sociétés pastorales d'Afrique orientale et occidentale*, 1991.
- Maiga, A., P.N. de Leeuw, L. Diarra, and P. Hiernaux. *La récolte des céréales sauvages dans la région du Gourma au Mali*, 1991.
- M.S. Parkipuny. *Pastoralisme, conservation et développement dans la région du Grand Serengeti*, 1991.
- Saint, Kishore. *La coopération au développement et la crise du développement et de l'environnement*, 1991.
- Mariko, Keletigui A. *La réforme foncière et la restitution des droits aux paysans: quelques conditions de base pour inverser la dégradation écologique au Sahel*, 1991.
- Ecologist, The *Pour une reconquête des communaux*, 1993.
- Organisé avec la collaboration du Ministère de Développement Rural et l'Environnement, Mauritanie. IIED. *Le Foncier Pastoral et le Développement au Sahel. Rapport de l'atelier sous-régional, Nouakchott, Mauritanie, du 30 octobre au 4 novembre 1993*, 1993.
- Scoones, Ian. *Vivre avec l'incertitude: Nouvelles orientations pour le développement pastoral en Afrique. Vue d'ensemble de l'atelier "Nouvelles orientations et politiques en matière de gestion des parcours."* Woburn. GB, juin 1993, 1993.
- Schoonmaker Freudenberger, Mark and Karen. *Champs, Jachère et Flexibilité—La gestion des ressources naturelles à Ndame Mor Fadamba, Sénégal. Résultats d'une Etude réalisée selon la Méthode Accélérée de Recherche Participative*, 1993.

Environmental Economics Programme

- IIED. *Towards a Sustainable Paper Cycle*, 1996.
- Knight, Peter. *A Changing Future for Paper*.
- Bishop, Josh and Ian Scoones. (Comps.) *Beer and Baskets: The Economics of Women's Livelihoods in Ngamiland, Botswana*, 1994.
- IIED. *Whose Eden?: An Overview of Community Approaches to Wildlife Management*, 1994.
- Barbier, Edward B., Joanne C. Burgess, and Carl Folke. *Paradise Lost? The Ecological Economics of Biodiversity*, 1994.
- Barbier, Edward B., Joanne C. Burgess, Timothy M. Swanson, and David W. Pearce. *Elephants, Economics and Ivory*, 1992.
- Pearce, David. W., Edward B. Barbier, Anil Markandya, Scott Barrett, R. Kerry Turner and Timothy M. Swanson. *Blueprint 2: Greening the World Economy*, 1991.
- Barbier, E.B. and T.M. Swanson. (eds.). *Economics for the Wilds: Wildlife, Wildlands, Diversity and Development*.
- Barbier, Edward B., Joanne C. Burgess, Joshua Bishop, and Bruce Aylward. *The Economics of the Tropical Timber Trade*, 1992.
- Eaton, Derek. *The Economics of Soil Erosion: A Model of Farm Decision Making*, 1996.
- Bishop, Joshua. *The Economics of Soil Degradation: An Illustration of the Change in Productivity Approach to Valuation in Mali and Malawi*, 1995.
- Kumar, Ritu and Yasser Sherif DP 95-01 *Economic Incentives for Pollution Prevention: A Case Study of Coal Processing Industries, Dhanbad, Bihar, India*, 1995.
- Young, Carlos E.F. and Ronaldo Seroa da Motta. DP 94-01 *Measuring Sustainable Income from Mineral Extraction in Brazil*, 1994.
- Aylward, Bruce A., Jaime Echeverría, Liza Fendt, and Edward B. Barbier. DP 93-06 *The Economic Value of Species Information and its Role in Biodiversity Conservation: Costa Rica's National Biodiversity Institute*, 1993.
- Aylward, Bruce A. DP 93-05 *The Economic Value of Pharmaceutical Prospecting and its Role in Biodiversity Conservation*, 1993.
- Brooks, David. DP 93-04 *Market Conditions for Tropical Timber*, 1993.
- Perez-Garcia, John M., and Bruce Lippke. DP 93-03 *The Timber Trade and Tropical Forests: Modelling the Impacts of Supply Constraints, Trade Constraints and Trade Liberalization*, 1993.
- Barbier, Edward B. DP 93-02 *Policy Issues and Options Concerning Linkages Between the Tropical Timber Trade and Sustainable Forest Management*, 1993.
- Barbier, Edward B., Joanne C. Burgess, Nancy Bockstael, and Ivar Strand. DP 93-01 *The Timber Trade and Tropical Deforestation in Indonesia*, 1993.
- Aylward, Bruce A., and Edward B. Barbier. DP 92-05 *What is Biodiversity Worth to a Developing Country? Capturing the Pharmaceutical Value of Species Information*, 1992.
- Barbier, Edward B. DP 92-04 *Valuing Environmental Functions: Tropical Wetlands*, 1992.
- Burgess, Joanne C. DP 92-03 *Economic Analysis of the Causes of Tropical Deforestation*, 1992.
- Burgess, Joanne C. DP 92-02 *Impact of Wildlife Trade on Endangered Species*. June 1992.

- Barbier, Edward B. Joanne C. Burgess, Bruce A. Aylward, and Joshua Bishop. *DP 92-01 Timber Trade, Trade Policies and Environmental Degradation*, 1992.
- Barbier, Edward B. *DP 91-07 Environmental Management and Development in the South: Prerequisites for Sustainable Development*, 1991.
- Markandya, Anil and Charles Perrings. *DP 91-06 Resource Accounting for Sustainable Development: A Review of Basic Concepts, Recent Debate and Future Needs*, 1991.
- Barbier, Edward B. *DP 91-05 The Role of Smallholder Producer Prices in Land Degradation: The Case of Malawi*, 1991.
- Büchner, Gregor, Joanne C. Burgess, Victoria C. Drake, Tom Gameson and David Hanrahan. *DP 91-04 Gender, Environmental Degradation and Development: The Extent of the Problem*, 1991.
- Swanson, Timothy. *DP 91-03 Wildlife Utilisation as an Instrument for Natural Habitat Conservation: A Survey of the Literature and of the Issues*, 1991.
- Barbier, Edward B., William M. Adams, and Kevin Kimmage. *DP 91-02 Economic Valuation of Wetland Benefits: The Hadejia-Jama'are Floodplain, Nigeria*, 1991.
- Southgate, Douglas. *DP 91-01 Tropical Deforestation and Agricultural Development in Latin America*, 1991.

Gatekeeper Series—Papers

- Johnstone, Nick *GK 96-01 International Trade and Environmental Change: Evidence and Implications for Developing Countries*, 1996.
- Aylward, Bruce A., Joshua Bishop, and Edward B. Barbier. *GK 93-01 Economic Efficiency, Rent Capture and Market Failure in Tropical Forest Management*, 1993.
- Southgate, Douglas *GK 92-04 The Rationality of Land Degradation in Latin America: Some Lessons from the Ecuadorian Andes*, 1992.
- Spurgeon, James P.G. and Bruce A. Aylward. *GK 92-03 The Economic Value of Ecosystems: 4—Coral Reefs*, 1992.
- Barbier, Edward B. *GK 92-02 The Nature of Economic Instruments: A Brief Overview*, 1992.
- Bishop, Joshua. *GK 92-01 Economic Analysis of Soil Degradation*, 1992.
- Pearce, David W. *GK 91-04 Afforestation and the Greenhouse Effect: The Economics of Fixing Carbon by Growing Trees*, 1991.
- Aylward, Bruce A. *GK 91-03 The Economic Value of Ecosystems: 3—Biological Diversity*, 1991.
- Bishop, Joshua, Bruce A. Aylward, and Edward B. Barbier. *GK 91-02 Guidelines for Applying Environmental Economics in Developing Countries*, 1991.
- Barbier, Edward B. *GK 91-01 The Economic Value of Ecosystems: 2—Tropical Forests*, 1991.
- Young, Carlos E.F. and Joshua Bishop. *CREED WP1 Adjustment Policies and the Environment: A Critical Review of the Literature*, 1995.
- Verbruggen, Harmen, Onno Kuik, and Martijn Bennis. *CREED WP2 Environmental Regulations as Trade Barriers for Developing Countries: Eco-Labeling and the Dutch Cut Flower Industry*, 1995.
- Aylward, Bruce, Jaime Echeverría, and Edward B. Barbier. *CREED WP3 Economic Incentives*

- for Watershed Protection: A Report on an Ongoing Study of Arenal, Costa Rica*, 1995.
- Kumar Ritu and Carlos Young. *CREED WP4 Economic Policies for Sustainable Water Use in Thailand*, 1996.
- van Beukering, Pieter, Edwin Schoon, and Ajit Mani. *CREED WP5 The Informal Sector and Waste Paper Recovery in Bombay*, 1996.
- Stone, Steven. *CREED WP6 Economic Trends in the Timber Industry of the Brazilian Amazon: Evidence from Paragominas*, 1996.
- Ramaswamy, K.V., R.R. Vaidya, M.J. Bennis, and J.G.M. Hoogeveen. *CREED WP7 Input Substitution in the Indian Paper Industry: A Variable Cost Function Approach*, 1996.
- Duraiappah, Anantha. *CREED WP8 Poverty and Environmental Degradation: A Literature Review and Analysis*, 1996.
- Janssen, Ron and Jose E. Padillo. *CREED WP9 Valuation and Evaluation of Management Alternatives for the Pagbilao Mangrove Forest*, 1996.