Part 2. Proceedings

Introduction / Mike Rock

This workshop is the consequence of conversations among a small group of people about building bridges between two cross-cutting kinds of issues and groups. The issues are along the development/environment continuum and the groups are research groups and advocacy groups. As many of you are aware, some in the research community, on the development side, and some in the advocacy community, on the environmental side, have been at loggerheads with each other. This manifests itself most clearly around the issue of dams, particularly big dams in the developing world. But, it also manifests itself at more micro-levels in real differences over values. I don't mean monetary values, but different values around the role of ecosystems and species.

While the debate at the Earth Summit in Rio last summer has moved us away from a view that saw environmentalists as stoppers of progress and developmentalists as destroyers of the environment, it is also clear that there is a continuing need for dialogue. That dialogue has to move away from macro issues to more micro-oriented issues such as water. No matter what you think about the World Bank 1992 environment and development report,[1] it put water scarcity and water quality at the absolute center of the debate around environment and development. We hope this workshop will begin a dialogue among groups with divergent views that are working on the issue of water and the environment and development, particularly, but not exclusively, in developing countries. What we hope at the grandest level will come out are answers to three simple questions: (I) Where do we agree? (2) Where do we disagree and why do we disagree? (3) Is there anything that we want to do collectively about either our agreements or disagreements? We hope that we can get some insights into these three questions.

Now let me turn to Bob Havener, who will set the stage.

Welcome / Robert Havener

You have left me a formidable challenge. It seems to me there are a few important issues that require the best minds that mankind can bring to the subject. One of these is conflicts over water. The riparian laws that used to guarantee rights and privileges of water that satisfied most of the people in the population, or at least appeared to, are breaking down as pressures for access to water and concern about the utilization of natural resources for the benefit of all mankind become imperatives in a modern society where communications and the press play such a prominent role.

[1] World Bank, *World Development Report* 1992: *Development and the Environment* (New York: Oxford Univ. Press, 1992).

Recently, in northwestern Arkansas we had a profound example that shook the agricultural community. A private individual bought 800 acres of scrub forest, which he intended to bulldoze and put into cattle pasture. His neighbors had an injunction placed against this particular use of his private property, saying that he was infringing their ability to enjoy the traditional views that they had become accustomed to and therefore he was impinging on their right to enjoy their environment, which he had just purchased a portion of. It is going to be an interesting situation to follow as they work themselves through that set of issues.

Those of us who were engaged in agriculture have long thought that we knew how to handle water relatively well. We knew if you could manage to use it where it fell and when it fell to produce an economic good or a productive crop for personal consumption, that was probably the most efficient use of water. If you could not use it where it fell and when it fell, then you would try to store it from one period or season until the next, where it fell-in the root zone of the crops that you wanted to grow. That was probably the second most efficient use of water. All other ways of using water somehow became more costly and less efficient and therefore less appropriate. So we spent a lot of time in research directed at capturing water, retaining water, and using water. Now, we are discovering that that was not done very well and that we are going to have to be more concerned about other people's access to water that farmers used to think of as being theirs - that, at least in the eyes of many, the water belongs to the greater community and that the community has a right to say how it is used, when it is used, and where it will be used. These are issues with which we are going to be dealing not only today but, I would judge, for the next 50 years. Winrock International is delighted to play a role in bringing together a group of people who don't normally talk with each other to see to what extent we can begin to codify and ameliorate those three challenges that Mike Rock gave us.

"There are a few important issues that require the best minds that mankind can bring to the subject. One of these is conflicts over water."

Water conservation and water development: Demand side / Deborah Moore

I split my time between "international issues and U.S. domestic water issues. In the Western U.S., I've found that there is more communication between what I would call the academic or research community and the advocacy community. For example, last fall Congress passed the Central Valley Project Reform Act, which makes some major changes in how that Bureau of Reclamation project will be managed. In the process of developing the legislation and getting it passed, there was a lot of interaction between people such as Bob Stavins at Harvard, an economist; Charles Wilkinson and David Getches at the University of Colorado Law School; Bonnie Colby, University of Arizona; and John Leshy, a law professor at Arizona State University. So my perspective

from the advocacy side is that support from objective and credible people and their research, the results of which really helped make our case, was very valuable. I haven't seen that same communication or interaction in my work on international policy issues. So my desire for getting this type of group together is to take a first step to start that communication process.

The challenge is to figure out how to meet human needs and human demands for water, including food production, drinking water, and electricity supplies, without sacrificing or mortgaging our water-dependent ecosystems. These ecosystems provide a foundation for many other services—flood control, wastewater treatment, subsistence food products, and watersheds, as the ultimate source of water. Certainly past history has placed human needs above ecosystem needs. That has probably been okay in many areas where water supplies have been sufficient. We are now approaching the point where demand exceeds supply in many areas and there is not enough water to go around. We need to start making harder choices about trade-offs in those areas. In the future not only are water supplies going to be scarce, but capital supplies will be scarce as well. Already many developing countries are severely in debt, so they don't have extra money to spend on expensive new irrigation projects and hydropower projects. Some new irrigation projects have been estimated to cost upwards of $15,000 per hectare. That is money that many countries don't have.

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The problem thus far is also that we have spent an enormous amount of money with some short-term gains in food production and increasing coverage for drinking-water supplies, but we still seem to be losing ground. The World Bank has spent about $40 billion, cumulatively, on water projects. Some people estimate that the total investments necessary over the next decade will be around $600 to $700 billion, but despite spending all that money we still see problems. Clearly, throwing money into new projects is not the only solution. A billion people in the world still lack access to adequate and safe water supplies. Per capita food production is expected to decline over the next decade and aquatic ecosystems are in danger of collapse in many areas. In the developing world, lack of information on ecosystems is a severe problem. We don't really know what is happening in many areas of the world.

In the U.S. where there *is* more information, we have seen fisheries decline 80 to 90 percent in many areas. In the Pacific Northwest, some species are being designated as endangered or threatened. In North America aquatic species like mollusks and fish may be more endangered than terrestrial species. In both the Atlantic and Pacific flyways, we have seen dramatic decreases in waterfowl and shorebird populations. So in places where we have information, we are seeing a collapse of certain ecosystems. Are we going to create that same situation elsewhere in the world?

By the year 2000, some estimates are that water demand will increase about 25 percent compared with 1990, up to about 5,200 cubic kilometers of water per year. Half of that increase is in the irrigation sector. Wastewater is expected to be about 2,300 cubic kilometers-slightly less than half of the total water demand. All of that wastewater requires a certain amount of dilution, particularly if it is not treated. In many areas there simply is not enough water to dilute the amount of wastes that are going back into the stream. Average losses can be up to half of water withdrawals. So we are taking a lot of water from the stream and returning it in a contaminated condition. Much of it is lost along the way through evaporation and seepage. Impacts of climate change may exacerbate these problems.

"We need to treat water conservation and efficiency as a new source of supply."

Imbedded in all of those estimates are various choices about how we are going to meet future needs - choices about the kinds of crops that we are going to grow, the industries, the types of technologies that we are going to use to meet those demands. I don't think many people, at least in this room, will disagree over the goals. Everyone wants to feed the world. Everyone wants to provide universal coverage for drinking water. Everyone wants to protect the environment. The question is, what are the best methods of meeting those different goals?

I want to talk about how far we can go toward meeting new demands for water without building major new infrastructure projects and without further degrading ecosystems. Similar to the energy efficiency discussion that has gone on, we need to treat water conservation and efficiency as a new source of supply. There are areas where we can actually cut water use and reallocate the saved water to meet new demands. With irrigation efficiency on average about 50 percent worldwide, the losses in the irrigation sector (recognizing that not all of them are irretrievable losses) are about 1,600 cubic kilometers per year. If we were able to recapture even a quarter of those losses, we could provide enough water to meet all the increase in municipal and industrial demand. The possibility of recapturing losses in irrigation and reallocating the saved water to other uses provides a new supply of water that we need to look at. Sandra Postel's book *The Last Oasis*[1] provides a variety of estimates about how much we can cut back demand in various sectors without sacrificing economic activity or quality of life.

In addition, conservation can reduce the amount of wastewater that we produce thereby again increasing the amount of useable supply. In conservation, I include other things like crop choices - are we going to grow sugarcane or tobacco or cotton in very arid environments? About 38 percent of total grain production is fed to livestock. Is that the kind of choice that we want to continue to make in the future as water supplies become scarce?

[1] Sandra Postel, *The Last Oasis: Facing Water Scarcity* (New York: W.W. Norton, 1992).

The second area of interest is in water transfers and the issue of allocation. Irrigation is the largest single water use worldwide. It accounts for about 70 percent of total water demand and 80 to 90 percent of total consumptive water use. So, clearly, if we want to increase water supplies for municipal and industrial use or increase water supplies for environmental protection and ecosystem maintenance, it is going to come from the irrigation sector. How do we match that with our other goals of increasing food supply? That is going to be the tricky one. Again some gross estimates: A 10-percent reduction in irrigation withdrawals could provide more than twice as much water as the new municipal and industrial demands. So if we can increase food production through rainfed and dryland areas, and cut back some on the irrigation, we can provide more than enough new water to meet these other growing demands. There are serious questions about doing that-the impacts on local economies, impact on groundwater recharge in some areas, the impact on other farmers in the region.

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Then, last, though not strictly conservation, are alternatives to new capacity, and this gets into the large-scale, small-scale debate. The primary point is that often the technologies and the know-how are available to implement effective small-scale irrigation systems or improved production in rainfed systems. The problems are often political or institutional. *The Last Oasis* documents many low-cost irrigation improvements as well as small-scale rainwater harvesting systems. I read in the 1992-93 world resources report[2] that water harvesting could increase agricultural production on 10 million hectares in Africa in the short term and 50 million hectares in the long term, which is fairly significant.

From my perspective, the goal is to supply water services not simply water supply. When we focus on the goal of water supply, we think about how to come up with a certain volume of water to allocate to a sector versus thinking of water services as the end result that we get from using that water. We grow food. If the goal is to grow food, irrigation is one means of doing that. There may be other means. Similarly, in industry there may be substitutions that we can make for more water whether it is new technologies or something else. I would like to focus on how to provide water services not just water supplies.

The obstacles to doing all these things that sound great are that many of them are political - political at the local level, at the national level, and at the international level in institutions like the World Bank. There are a lot of pork-barrel politics going on. Everyone wants to bring home a big new project and there are a lot of different industries that have grown up around those projects. If you look at World Bank procurement contracts, more money for IDA loans to developing countries, in some cases, is going back to industrialized - country contractors than stays in the country. If we are all interested in poverty alleviation, it is not clear to me that giving loans to a French or Ger-

[2] World Resources Institute, *World Resources* /992-93 (New York: Oxford Univ. Press, 1992).

man or American construction company is going to help produce local development in Cameroon.

I think political problems are our number one priority, but there are technical problems as well. Have demand-side alternatives been given adequate recognition in the project design process? Have we really looked at the true costs of wasting water and inefficiency over the long term as well as the true costs of environmental damage? Also, we don't always know what local communities want. We have tended to take a top-down approach, and I think we need information coming from the ground up. Last, we need to overcome all the institutional barriers for getting some of these new ideas through, whether it is about allocations, decentralization, or new technologies.

Water conservation and water development: Supply side / David Seckler

One of the disadvantages of having spent a lot of time in a field like water is you eventually start learning how complicated it is and you get more confused. At least, this is my experience. I find myself now writing papers that refute papers that I wrote 5 or 10 years ago. I say that because I am going to be a bit dogmatic in what I say here, but I am always open to argument and I can change my mind.

I would like to begin with some issues that we are going to have to address soon and mention some things that illustrate the problems. Along the Niger River in Africa, the population is growing at around 3 percent a year and the flow of the Niger has become low because of diversions of water for irrigation and urban use - you can literally walk across the Niger in the dry season now. The transportation facility that it used to offer is dead and fish production has diminished. The Niger feeds a huge wetland that begins at Mopti in Mali and extends to Timbuktu. With continued development of the Niger, we are threatening wetlands that are one of the most important bird sanctuaries of Europe.

Another one, you go across to the other side of Africa - Egypt has almost hit the absolute limit of its water development potential under existing conditions. Therefore, they want to build the Jonglei Canal in the Sudan, which would divert water from the Sudd, probably the biggest wetland in Africa, to replenish the Nile through the Aswan. That would harm one of the biggest bird sanctuaries in the world. The Egyptians are so sincere in that desire that two presidents of Egypt have declared that they were prepared to go to war with Sudan to ensure that they could get that water.

I just got back from Bangladesh. Peter Rogers, Peter Lydon, and I have spent 4 years fighting against this huge construction dream that the consulting firms have to train the Brahmaputra at a cost of several billion dollars of somebody else's money. It now seems that we have pretty well won that battle. That is a big relief. But, what you find happening there is shocking. Some time ago the Indians put a barrage on the Ganges right on the border with Bangladesh. For several years, they worked under an agreement that they would release so much flow in the dry season to Bangladesh. They let

that agreement expire 2 years ago and now they have reduced the release to Bangladesh by about half of what the normal flow is in the dry season. The World Bank and everyone else there believes that 5 years from now the Indians won't release any flow from the Ganges in the dry season into Bangladesh. This is causing tremendous sedimentation on the Bangladesh side of the Ganges and blocking the entrances to the rivers that go down the western part of Bangladesh and causing saltwater intrusion. It threatens the Sunderbunds, which depend very much on the water supply in that area.

The intensity of such problems is increasing rapidly. We are going to have major problems, maybe erupting into wars, over some of these water issues. We have to figure out rational ways to address these problems.

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Let me give you an idea. There is a good study by Pierre Crosson and Jock Anderson on world supply and demand for cereals.[1] They find, on very conservative grounds, that the demand for cereals is going to double by 2030. Interestingly enough, about 80 percent of that increased cereal demand is going to be for coarse grains - maize, sorghum, millet - for livestock feed. Ninety percent of that increased demand is going to be in the less developed countries, primarily in Asia because of high income growth. Where is the doubling of production to meet this demand for grain going to come from? Well, there is, in fact, about twice as much potential agricultural land in the world as is now being cultivated. It is all in forests and rangeland, of course. If you developed all those forests and rangelands, you could meet that demand without any increases in yields. One of the problems is the distribution of that land. Forty-five percent of that land is in Africa and 49 percent of it is in South America. Most of the demand is in Asia. So what kind of a world is going to emerge under this scenario? Can we say, well, we are going to increase the yield on the existing land to meet this? Or are we quickly going to wind up in a world where Brazil and parts of Africa that have infrastructure are going to become major coarse grain providers to Asia? It could be a massive development in international trade with terribly destructive consequences to environmental and ecological interests.

In Asia, the situation even gets grimmer from a supply standpoint because Asia by 2030 could lose 50 million hectares of agricultural land to urbanization. Those of you who know Asia know that it is much worse than that because almost every town or city in Asia is in an irrigated area. That is the way history determines things. Most of the 50 million hectares that is going to be lost will be irrigated land. That is one-third of the total irrigation that now exists in Asia.

What are the alternatives? One idea on which I would differ with many of my colleagues here is what I call the illusion of water efficiency. Ten years ago I thought there was almost unlimited potential for satisfying agricultural and industrial demands

[1] Pierre Crosson and Jock R. Anderson, *Resources and Global Food Prospects: Supply and Demandfor Cereals to 2030,* Technical Paper 184 (Washington D.C.: World Bank, 1992).

by improving water efficiency. Today, I believe there is very little potential. The illusion is that, when we talk about efficiency in irrigation, we say that if we put water on a piece of land with 55 percent irrigation efficiency, what that really means is 55 percent of it is used for evapotranspiration by the crop and the other 45 percent is lost (that is, not used for evapotranspiration, which is ultimately the only use the plant has for water). The question is what happens then? It implies of course that the 45 percent of that water that is lost could be recaptured by improving irrigation efficiency and then used for some other purpose.

The fundamental question that we haven't asked is, what really happens to that 45 percent of nonevaporated water that is being inefficiently used? In most systems of the world that are highly developed, that water goes into subsurface or surface return flow. It flows somewhere and somebody downstream picks up that water and reuses it. Then, some evaporates and they let some go and somebody further downstream picks up the residual and some evaporates and they let it go. Through this cycle, you get a water-multiplier effect in which much more water is beneficially used than the amount you started with. If you add up all the uses, you find that you might have two times more water being used than you actually had to begin with, because of this recycling. Therefore, when an irrigation engineer or somebody says, I am going to improve the first person's irrigation efficiency from 50 percent to 75 percent, they can do that very easily and look like a hero. What they don't understand and they don't see, because it is invisible, is the decrease in water that some other person downstream is experiencing because of the improved efficiency upstream.

Gil Levine did some interesting work a few years ago on recycling in the Nile. Recently Jack Keller and I did some more work and we found that the entire irrigation system of the Nile runs at around 40 to 50 percent irrigation efficiency at the on-farm level. The farmers are only half efficient. But if you add up all the return flows and all the flows to the industrial and municipal sectors, you find that the Nile Basin as a whole below Aswan is running at around 93 percent efficiency. It may be at 100 percent efficiency because you still have to release water into the Mediterranean to take care of the fisheries and keep out saltwater intrusion. So for all practical purposes, the Nile is completely used. Egyptians cannot service any more water demands without taking that water away from somebody else. There is no room at a basin level for any gains due to improved water efficiency. The Nile is perhaps the most extreme case, but I think most of the highly developed water basins on the earth today are in that same position. They may have a few percentage points left to gain through efficiency at a global level, but it isn't enough to talk about seriously.

Jack Keller tells me that California hydrologists realize you have to make sure that if you think you are saving water you are really saving water. Now they talk about the difference between "wet" water and "dry" water in efficiency. There are two kinds of efficiency. That is, if you just create efficiency that takes return flow away from somebody else, that is dry water, since you are not saving anything. If you create efficiency that actually does give somebody else some more water, that is wet water. They are

finding that the wet water to dry water ratio is plummeting. That is why I am skeptical about the potential gains from efficiency.

A good example, again in California, is the transfer of water from the Imperial Valley Irrigation District to the Metropolitan Water District of Los Angeles. That is one case where you can get real efficiency because they were overusing the water, and the water was flowing to the Salton Sea, a sink that started to form at the turn of this century due to excess irrigation. In that case, there was no chance for people to get return water and it was so highly polluted that nobody wanted it. Now, with some efficiency, they can make a gain. I think the Salton Sea is the exception to the rule, rather than the rule, of the water picture that we are facing in the world.

After agricultural demand, which is 80 to 90 percent of all the water used in the world, probably the next largest demand for water is environmental demand for water. I think it is much higher than the demand from industrial and urban sectors. The consumptive demand for water for wetlands, for flowing rivers, for scenic uses, and so on is particularly high. You have large bodies of water totally exposed to the surface with high evaporation rates, so that the consumptive use demand (evaporation) in these environmental uses is very high. If you combine that with environmental demand for water in the preventive sense-that we don't want to develop water because it will drown this valley or something like that-I am quite sure that the environmental demand for water is the second largest demand sector. It is a demand that almost didn't exist until 10 to 20 years ago. When you go to developing countries, people often say, we have plenty of water, look at how much is being "wasted to the sea." Nowadays waste to the sea means wetland habitats at the interface with the estuary. We have this demand explosion and the supply side, in my opinion, collapsing because of inability to gain anything from efficiency.

In considering both feeding people and environmental protection, we have to start thinking how we can develop additional water supplies in order partly to protect the environment. I personally don't like the idea that the world is going to go pell-mell into extensive agriculture to meet this exploding cereal demand, that we are going to rush into Africa and South America and clear the existing ranges and forests to meet it. I doubt we can increase yields substantially on the existing irrigated land and I am particularly skeptical about big yield increases on the existing rainfed land. That has been tried for 100 years and it is a miserable experience. People just haven't been able to get it done.

The question is, can we irrigate more land to relieve this tension? We then get the classic question of large dams versus small dams and water conservation techniques and so on. My answer is that we need to do all of those things. We need to have water conservation technologies wherever we can get them to work. The record on that score has been bad. In India people have since the last century tried to improve rainfed agriculture through terraces and water conservation, almost to no avail. But, we can do things like small tanks. I have spent a lot of time doing small tanks and I love them. We can do groundwater development. All that nice small-scale stuff.

But we also have to realize that we are going to need some more large dams. Large dams and small dams and water consumption are not substitutes for each other. They perform different functions. Large dams store water over periods of years. Small dams can only store water for 3 to 6 months and meet interseasonal droughts. More important. large dams and river diversion schemes transfer water from areas with high rainfall to areas with low rainfall. Small water-conservation technologies can't do that. If we did every thing we possibly could, building all the big dams we could that meet environmental standards and do water conservation and everything else, we would still have a hell of a time meeting a doubled cereal demand over the next 20 to 30 years. The big challenge is how to get together people interested in the environment, people interested in production, engineers, and ecologists to find the technologies and the designs for dams and other technologies that will enable us to go ahead with some production and at the same time to keep the environment from being damaged by extensive agriculture.

Rock: I think the issue has been well cast by Deborah and David.