Discussion

Gleick: The Pacific Institute has a project called Research and Activism in which we bring together researchers and activists under this kind of round table format. I want to make a couple of points about such meetings and how to make them successful. The most important is to understand definitions to make sure that we are talking about the same things. To give an example, this morning the question of conservation efficiency versus new supply came up. An additional distinction might be useful. New supply is one issue and increasing the efficiency with which we use water in a particular sector is another issue. A third issue is transfers of water from one sector to another. For example, changing the crop we grow - instead of growing alfalfa or cotton or rice in California, growing something that requires less water and shifting that water within the agricultural sector or shifting the water from the agricultural sector to the urban sector - is not necessarily the same thing as conservation or not necessarily the same thing as increasing the efficiency of water use. I think we could talk a little more about those kinds of definitions.

Another point: I am not sure anyone here would argue that under no circumstances should we develop new supply. Perhaps some people would say under no circumstances should we build any more large dams, and I think that question is worth pursuing. Perhaps, instead, the question is, under what conditions should new sources of supply be developed? And a subset of that might be, under what conditions should new large dams be built? New large dams tend to be in a category by themselves, and that might be worth discussing. Everyone here probably would agree that some new large dams are going to be built, and the real question is, under what circumstances, under what conditions of environmental assessment, under what financial and economic situations? That might be worth pursuing as well.

First, the question about goals. Everybody has different goals on the water side. Is the goal long-term food security? In which case the question is, do we want to increase irrigation water and if so how do we do it? Is the question supplying water for urban centers and does that mean taking water away from irrigation? If our only concern is urban supplies, then surely we can take water away from irrigation by either shifting the crops we grow or improving the efficiency with which we use water. However, as David Seckler said, ultimately the food question may be a more difficult problem to solve than the urban problem. Is the generation of electricity and hydroelectricity - and supplying the water to generate energy - basic human needs?

Finally, I have a question about the wet versus dry concept. I understand the concept, I think, but I find it difficult to believe that in Egypt there is not in fact a lot of wet water that could be achieved by increasing the efficiency with which it is used in the agricultural community and inserting another user.

"Perhaps the question is, under what conditions should new sources of supply be developed? And a subset of that might be, under what conditions should new large dams be built?"

Seckler: Let Gil Levine comment on that.

Levine: With respect to the question of definition, there are three words that we have to have clear. One is requirements. The second is demands. The third is wants. They are not the same. We keep talking about water requirements for crops, and there are very few water requirements for crops. There are ways in which crops respond to different amounts of water. You have response functions. Depending upon what yields you want and what crops you grow, you make decisions about how much water to put on. It is not a question of requirements. There are other factors that influence how much water you put on in addition to the basic physical requirements of survival. The same thing is true with respect to human beings. The water that is required to survive is relatively modest. We use much more water than we require for a variety of reasons. So we need to keep in mind those differences and recognize that there are many factors other than basic survival.

With respect to the question about the Nile. I agree with David Seckler that there is an overestimation of what can be saved when we see relatively low water-use efficiencies in irrigation. In the Nile, when you look at the upstream irrigation systems, they have relatively low efficiencies in classical engineering terms. When you look at it on a watershed basis going down to the ocean, there is practically no waste. There is no excess water going to the sea. How many times you can reuse it in that process depends on how much consumptive use takes place and what happens to water quality. The paper that Jack Keller did showed that as the water was reused for agricultural purposes, the quality of the water decreased so you get salt accumulation problems.[1]

[1] Jack Keller, *Implications of Improving Agricultural Water Use Efficiency on Egypt's Water and Salinity Balance,* Center for Economic Policy Studies Discussion Paper 6 (Arlington, Virginia: Winrock International, 1992).

That is what we have seen in Pakistan, too. When you look at the land that is being irrigated in one 250-mile part of the system that supposedly has fresh groundwater and that is being used, the overall salt balance shows there is no way to sustain that area in agriculture because the salt will accumulate in the soil. The only way to have sustainable agriculture in that area is to reduce the amount of land that is growing crops. There is much less water available in many of the systems than people think. That is very disturbing.

Seckler: I mentioned the Salton Sea example for a specific reason. The Imperial District is one of the few cases that I know in a highly developed water system where you actually did have water going into a sink and not being used - except now there are some environmental benefits to the Salton Sea. There, you actually could improve on-farm efficiency and take the improved water saving and offer it to the Metropolitan Water District, which is what they are doing. That case is a notable exception. In most cases water does not run into some sink. It just flows down the river basin and is continually recycled until the water quality business stops it or it hits the sea, which is another water quality problem. That is the end of it. So if you think you are going to gain anything by efficiency, you won't do it because you will lose down below what you picked up above. You can always transfer from low to high value uses. But, that isn't going to accomplish a lot if you don't have any wet water to transfer.

Rogers: The All-American Canal in the Imperial Valley is a fascinating case. The most successful agriculture in that area doesn't actually take place inside the U.S. It takes place over the border in Mexico from seepage from the All-American Canal. So these people are going to be wiped out by the lining of the canal to save water for Los Angeles. We can say it all depends on where you draw the boundary. So there goes your example: If you don't count the Mexicans, fine; if you count the Mexicans, it ain't fine.

Seckler: I count them. I guess you are right.

Yudelman: The relationship between efficiency in a particular area and overall efficiency raises an important issue in evaluating projects. Many projects have been condemned for being inefficient. On the other hand, if you look at it from a water-basin point of view, then, of course, the projects may not have been as inefficient as we thought they were. Had I known more about this when I was running things at the World Bank, we might have looked at some of these issues quite differently.

On the macro issue, I have also been doing some work on demand and supply for food. What isn't emphasized in the study by Crosson and Anderson is that there has been a tremendous change in demand because there has been a fundamental change in the demographic situation of the world. Thirty or forty years ago, we could see how food supply could be increased, but we felt we would always run up against this tremendous barrier of demographic pressures. What we see now in this strange way is that the Green Revolution did buy time. That time has been well spent because there has been a demographic transition, notably in Asia and Latin America, but far less so in most of Africa. One shouldn't lose sight of that. My own projections of demand, reflected to

some extent in the Crosson and Anderson study, show quite a sharp decrease in the rate of growth of demand. That is very important because if much of this increase in demand is going to be satisfied in Asia, it will have to come from increases in yields. So in Asia we come to the question, at what rate can yields increase? In the course of the last decade or so, they have been increasing very rapidly.

The next point is, what about the increase in the grains grown in the dryland areas? The basic assumption in the study by Crosson and Anderson is that people will continue to eat meat. As incomes rise, the demand for meat will rise rapidly and the derived amount of grain will increase. But, will people eat meat 25 years from now? What kind of meat? This is what this issue hinges on. We can look at the consumption patterns and see how they are changing. I am far less pessimistic about the ability to provide food enough for the world, except for two regions. One is Africa (for a large number of reasons that aren't relevant here) and the second is the Middle East, where I do think that the grave constraint is going to be water.

That brings me to the last issue, efficiency. I am somewhat bemused by the argument that you cannot raise the efficiency of water use in agriculture because what you gain on the swings you lose on the roundabout. Look at Israel for instance. It is absolutely stunning how they have raised the efficiency of water use and had overall demand management, with a system that allocates water between competing sectors. By 2020 it is estimated that all the water for agriculture will be recycled from waste use.

Blake: I look at this from a less technical point than Monty Yudelman. Assuming we can get the technologies that use less water, I find a terrific lack of political will in countries to face up to these problems. I was in India not long ago talking with Indian officials. The problem was the blocking of effective action to reorganize irrigation by middle-level bureaucrats for their own reasons - a lot of other things they want to use the money for, some of them good and a lot of them not so good. There is a great need to generate the knowledge or fear or something that is going to move people that have to take big investment decisions. Somehow we have to help people come to grips with these problems, support them with investment, support them with necessary research, and so forth. But, the most urgent need is raising the knowledge and the will to make the tough decisions that the deteriorating situation requires.

Svendsen: Monty Yudelman and Ambassador Blake have pointed us in a direction that I would like to go. That is, to move away from the question of irrigation efficiency calculated in hydrologic terms and to look more at the question of the productivity of water. There are ways to increase the output from the amount of water that is being used now in agriculture without necessarily bringing new land into production and without necessarily changing the overall basin efficiency. Those basin efficiencies that we see are already clearly high. That gets us into the question of how do you take a quantum of water and make it more productive in terms of either crop output or in terms of value of output. That raises interesting institutional questions about property rights, allocational mechanisms, and intervening institutions, irrigation departments for example. That is where a good deal of the potential that we have for getting more from the irrigated agricultural system lies.

Meinzen-Dick: Ambassador Blake said something about people problems. We are starting to think about water as a system and looking at it as a hydrologic system or as an ecosystem, but we also need to look at human systems. There is a need for food production. What isn't produced on irrigated lands is going to be produced on rainfed lands, which may be pushing into marginal areas and fragile ecosystems. There is also the need for livelihoods, and people who are not supported in one area will need to be supported by industrial development and then food imports, perhaps. We can't just draw boundaries around a plot of irrigated land or even around the water and soil system. We have to look at what is happening to people and to support them.

"The worst nightmare is that we go to alternative dispute resolution methods, and we try to re-create the market by having everybody sit around the table and talk."

Rogers: Water gets very complicated. We talked about people problems and how messy they are. We do have some powerful tools for dealing with these types of issues. Certainly pricing is an important way of getting the signals right. How do you price water? It is hard if water belongs to God or the water belongs to the state. There are ways of bringing it down to the realm of ownership rights or access rights in the developing water markets. This has happened in the United States beyond the wildest expectations of the water experts who thought about these things and proposed it for years but never believed it would actually happen. As long as we don't assign value to water and don't price it in some way, we will never solve these arguments because it is going to be the individual evaluation of the individual group that is doing this. I think lots of the economic uses can be dealt with directly by some sort of pricing. Where we run into problems is in the in-stream uses - the uses by the ecosystem of this valuable resource. There are even approaches to that. In our country we have chosen to do it politically by saying, take 800,000 acre-feet from the Central Valley and give it to the fish. We have just done that. It is not necessarily the best way, but it is one way. I think that you can get good economic and environmental outcomes by making sure the water is allocated properly because it then will take a lot of water away from agriculture and put it to more valuable use.

The issue about people building on valuable irrigation land: People do that because land for urban use is much more valuable than irrigated land. You would be crazy not to. In fact, I would urge people to do so. The development of these countries is not going to come through irrigated agriculture; it is going to come through other economic activities. We have to remember that it is a trade-off between values explicitly stated through market mechanisms that is going to provide a much easier way than having every little group saying, we can arbitrate it, or, we can do these things. The worst nightmare is that we go to alternative dispute resolution methods, and we try to re-create the market by having everybody sit around the table and talk.

Gleick: We need to consider communities that perhaps don't have economic power and that would lose water in situations where we rely entirely on economic pricing.

We are running into such debates in the western U.S., not just with ecosystems, but with farm communities that depend entirely on subsidized water. We have to debate whether we care about the community as an entity at all for other reasons.

I'm suffering from the definitional problem that I raised. I find that when I asked about wet water in Egypt and the possibility of increasing efficiency, Gilbert Levine shakes his head very sadly, and then when Mark Svendsen says we need to talk about increasing productivity, Gilbert nods his head and says, yes, that is a good thing to do and that would free up wet water, I gather. I am trying to think about the Nile in this context - a system that I know a bit about. I'm not sure what I am missing here.

Perhaps we should come back to this question of wet water. We are debating this in California, the wet water versus dry water with the water banks, and whether we are buying real water when we do that.

Seckler: I want to respond to the two Peters. Peter Rogers and I have worked together for a long time. It is an interesting example of familiarity breeds contempt in the sense that I am an economist, and I get hypnotized with all these hydrologic things and Peter is an engineer and hydrologist who is hypnotized with the economics. He has a lot of faith in the price system and I don't have much. I have a lot of faith in engineers and he doesn't have any. This is a continuing saga for us.

"If you are going to use the market system to improve productivity of water, we have to see that it isn't just a matter of economics. We have to see the physical potential down there below the economic system - where is the improvement physically going to come from?"

If you are going to use the market system to improve productivity of water, we have to see that it isn't just a matter of economics. We have to see the physical potential down there below the economic system - where is the improvement physically going to come from? That's my problem with the pricing business. Pricing is just going to shuffle the water around and not substantially change the amount of water. It is the amount of water that matters.

In the Nile, for example, we transfer water from agriculture to the industrial and urban sector, which we should do. That should be the first priority because it is a higher value use. It doesn't solve Egypt's problem of feeding its people. And there is a problem if you say, let them import food. It is the problem of getting the foreign exchange to do that-and then we would also displace the problem to perhaps Brazil or North Africa. I always like to see the physical consequences of price policies. In the Nile, I think it is perfectly demonstrated in Jack Keller's paper. There's your dry water. Jack spelled it out step-by-step right through the Nile. What happens is as you go through these iterations along the Nile from the Aswan north, you evaporate a bit of that water and then you pass a bit down, increasing the salt concentration every time, even if it isn't picking up salt on the way, until finally you converge to a position near the Mediterranean where the salinity loads are so high that you can't use it for anything. Then, you pass it on into the sea. If you could improve water quality through these

transfers, you can gain. You are not going to gain water by improving the efficiency of the use upstream.

Gleick: So you are saying that it is a quality limitation in the Nile?

Seckler: Yes, and even that is not a big deal.

Gleick: We have that problem in the Colorado. There are things that you can do to deal with that problem.

Seckler: Yes.

Gleick: What you have said is only true if you are telling me that nothing can be done to increase the productivity of agriculture with the same amount of water and deal with quality as well.

"There is no question that if cotton production in Central Asia had been in drip irrigation rather than in flood or furrow irrigation, the Aral Sea would be in much better shape."

Seckler: You can gain some if you could keep the water from becoming more salty as it goes down. But, even that is small potatoes in the Nile because the discharge into the Mediterranean is already not even 20 percent of the Aswan outflow. So that discharge isn't very much. The big fear is that if you reduce that discharge a bit more you are going to get a lot more saltwater intrusion, so you don't have much gain. You don't have much room to do anything. That's the important lesson of the Nile. You can't do much.

Moore: There are environmental advantages to efficiency. If you can reduce the amount of water diverted, you can leave some of the water in the stream at a higher quality and not simply rely on getting the water back again and then in a degraded state. The argument that other people depend on the waste, and so we have to institutionalize waste because people depend on it, is a bit of a straw man. If we leave more water in the river, that can help supply the downstream users who were previously depending on the waste. Meanwhile, it stays in the river for a longer stretch, and you have also maintained the river environment. Now, there are groundwater recharge questions, but I think that we can deal directly with some of those if we have greater efficiency. Just saying, the way it cycles through from surface to subsurface now and the way it gets degraded along the way is basically okay because of this multiplier effect is misguided. There are things that we can do. You both seem to be saying that in the case of the Nile there is nothing we can do. If that is true, it is very disturbing.

Sklar: Are we saying that there are no gains to be made by reducing evaporative losses that do not contribute to the physiology of plant growth, and so forth, in the Nile or other systems? My understanding is that there are tremendous opportunities to reduce evaporative losses.

Yudelman: I want to make one general point. Egypt is the only country that relies entirely on external sources of water. The Nile is the only source of water for agriculture. With the rapidly increasing population, the problem is how to feed the country. In

Egypt yields have gone up greatly. There have been huge investments to improve the efficiency of agriculture and the efficiency of water use. The world's biggest drainage project is in Egypt. There have been tremendous investments in improving secondary and tertiary canals and so forth. The issue that interests me is one of both economic and hydraulic efficiency. That is, how can we make the use of water more efficient? How can you raise the productivity of agriculture? Egypt is the classic case. There you have to see the water constraint more than anywhere else simply because everything they grow is irrigated. The issue that you have to address in this purely irrigated society is, what are the limits on production? That is the relevant issue, given a big supply of water, unless you are going to change and divert the Nile and get water from somewhere else. In this context I am not sure whether it is wet water or dry water.

One last point I would like to mention is about pricing. I have had engineers and economists working for me and the one thing that they disagree about is water pricing. Economists all say that it has to be done for a whole range of reasons. If you look at the Dublin water conference,[2] the first point they make on water is that you have to attach a value to it. As an economist I can't see how you can argue with it. When we deal with the engineers, they say, yes but how are we going to do it? What system are you going to use for measuring if you don't have volumetric meters? I think over time different ways of pricing water have been developed. I agree with Peter Rogers that this issue is number one - the value of water. When I was at the World Bank, the most favored projects were multipurpose projects that served urban areas and rural areas because you could charge water in the urban area at about 5 or 10 times what you charged in the rural areas. This made them economic.

Postel: I would agree about the efficiency potential being more real in more cases than David Seckler implies. I think not just in terms of absolute quantity of water saved but where the water is and what other services it is providing. There is no question that if cotton production in Central Asia had been in drip irrigation rather than in flood or furrow irrigation, the Aral Sea would be in much better shape. You might say that that is another case of a sink, where there was basically water flowing into a closed water system, but I think there are more cases like that - not just in terms of an absolute sink but where you are servicing a wetland or some other ecological function by way of not manipulating the basic hydrology as much as you would if you are not investing at all in efficiency.

To respond to Monty Yudelman's point about Israel and Egypt, Israel has succeeded in increasing water efficiency and water productivity dramatically, but what I find sobering is that they have not done much since about the mid-1970s. They achieved a lot of these gains in the 1960s and they haven't been able to do much more since. So what is the next technological or agricultural leap to be made? Who is going to find it? I find that particularly of concern because the Israelis certainly have invested more thought, energy, and financial resources into researching this than almost any other

[2] International Conference on Water and the Environment, Dublin, January 1992. Sponsored by the United Nations.

country. They are now beginning to shift fresh water from agriculture and supplying agriculture with treated municipal wastewater. That is their next strategy, and it will last for a while. It looks to me like the solutions are getting thin.

That relates as well to Egypt and the broader question of whether the extent of irrigated agriculture as we see it in some of these very dry regions is really sustainable. In Egypt population is growing by a million people every 8 months and yet the government is still spending an extraordinary amount of money per hectare to reclaim desert land west of the Delta. Some of this land is not producing anything. They have drip irrigation lines and the fields aren't being really used. Yet, 20 or 30 years down the line, that water is not going to be there for those fields. There is a broader economic development question of whether continued goals of increasing food self-sufficiency make sense in some of these dry regions.

"An important research question is, how much of our current food production is being achieved through ecological deficit financing?"

An important research question is, how much of our current food production is being achieved through ecological deficit financing? How much of it is through drawing down water supplies or relying on water supplies that are being used unsustainably. If you start subtracting the amount of production in the Punjab of India that is drawing down groundwater or the 4 million tons of wheat in Saudi Arabia that are dependent on mining of a fossil aquifer, or, if you add up all those tons of grain that are being produced through the unsustainable use of water and subtract that from the food supply, you get an even gloomier picture than you would get from the Crosson and Anderson report.

Seckler: The Aral Sea is an interesting example of what I was trying to talk about. If you are inefficiently irrigating cotton in the Aral Sea basin, then that water you are wasting by low efficiency irrigation, as far as I know, can only come back into the Aral Sea.

Peabody: But there is another lake forming.

Seckler: Then we have another Aral Sea. It isn't like you have a different deal. That water, if it is lost underground, is just going to wind up coming back into the river and going back to the Aral Sea.

Peabody: It goes in different places.

Seckler: Then you are trading Aral Sea for Aral Sea. It might be a gain now, I don't know.

Moore: That's the environmental point - what are you trading and do you want it in the sea or do you want it in the ground or what?

Seckler: You're not wasting it. There are two basins involved, evidently, so that it is draining to another sink over there. If it were just one basin, it would go back to the Aral Sea, so you wouldn't gain. But if there is another one, you can talk about that.

Postel: Much is lost through evaporation in a climate like that and if you were using a more efficient technology like drip where you lose very little, more water would stay in the basin and flow into the Aral Sea ecosystem.

Levine: The figures in Israel typically show about a 20 percent saving in evapotranspiration by using drip in contrast to flooding. So that is your upper limit, assuming that there is no salt accumulation problem. That is a big assumption that you can't make all over.

Gleick: Twenty percent is a substantial number.

Levine: Twenty percent. That's where you are. Even when the efficiencies are on the order of 50 percent. That is the maximum. That represents a substantial investment. It is useful for tomatoes or for certain fruit crops. It certainly is not 'appropriate for most field crops unless the price of all the agricultural products is going to go up very substantially.

Gleick: We've moved from zero to 20 percent.

Levine: For Egypt, there are possibilities to gain certain environmental benefits in the stream if you exercise more control over the root of the reuse. How much that really will represent, I don't think anyone knows. But, the question is really efficiency, which has two parts. One is the numerator and the other is the denominator. When you talk about saving the water, you are talking about the denominator. That is very difficult to do. You physically have to do lots of things. The numerator is whatever you are using as your efficiency measure - the yield or the value and so on. That's where, in effect, the greatest gains have been made. That is the Green Revolution. The amount of water used by traditional rice is essentially the same as that used by modern varieties. But if you get three times the yield, you have tripled your efficiency in terms of the use of that resource.

Now one of the empirical issues is, in a given situation, where is your option? Do you get the most for your effort by looking at the numerator or looking at the denominator?

Gleick: When I talk about increasing efficiency and increasing productivity, I'm talking about both the numerator and the denominator. In some cases I actually think there are gains to be made in the denominator, but I will tentatively accept your premise that the greatest gains can be made in the numerator. Nevertheless, those gains will increase over all the things that you can produce with the same amount of water in Egypt. I would argue elsewhere, but you are saying that Egypt is the toughest nut to crack at the moment. I think there is still enormous potential there.

Moore: If 20 percent is an upper limit on gains to be made in the denominator through serious financial investments and capital and infrastructure, drip irrigation, etc., even if there are 5 or 10 percent gains to be made, if it is during the right time of the year, especially during dry season, the environmental gains from that 5 to 10 percent may be more in terms of the ecosystem. There are various thresholds for low flows, where if you can increase low flows at critical times in the year, you may get a

greater environmental gain. Again it goes back to other choices about crops and other activities you choose to do.

Levine: The discussion points out an inherent difficulty that as soon as you start talking about the water, you are dealing with site-specific situations. It is difficult to generalize about site-specific situations. In every case, nothing is perfect so there is always going to be some opportunity either on the denominator side or the numerator side. That is not the issue. The issue is, is there something generic in the way the problems have to be addressed? That does raise institutional issues and broad policy issues and is much less about specific physical situations.

Moore: We have made generalizations in the past that large-scale irrigation systems will work anywhere and everywhere, and we have used them in some ways as a blueprint around the world. We have maybe made that mistake in the past and perhaps we should try to avoid it in the future.

Groenfeldt: We talk about the water that we can see and about some that gets evaporated and some that goes into seepage. I would be more comfortable in this discussion if we had a sense of where is all the water going and traced it until it disappears from our system. Let's expand the system to include seepage water - how much of it is going to shallow aquifers and how much is it going to deep seepage where it can't be recovered? Even when it can't be recovered, what does that mean? Does it serve any useful purpose environmentally? Do these deep aquifers matter to us? Or, in the fairly shallow subsurface area does water that seeps down from surface irrigation matter environmentally? Or if not, then it sounds like we would be much better off using drip irrigation and trying to minimize how much water we lose from the root zone of the crop. I would even like to know what happens to the moisture in the crop when the crop is drying. That moisture eventually comes back into the atmosphere and becomes rain somewhere. Is there an argument to be made that we should maximize evaporation as far inland as possible to increase the chances of recapturing some of it as rainfall rather than having the rain fall in the ocean? I worked in northwest India along the Bhakra Canal system where everyone claimed that there is more rainfall. I never checked the figures. Certainly, the local environment had been changed in terms of dust storms and microclimatic conditions. That might be another benefit from sloppy irrigation. The water that is wasted in evaporation might serve some purpose. Ten years ago we might have scoffed at the idea of releasing water for fish. Maybe 10 years from now we will be concerned about maximizing evaporation under certain airstream conditions so we can pick it up later on.

Castro: The reason we are discussing the efficiency issue versus the increase in supply is we are assuming there is going to be more demand for food in the future. Population is going to double in 30 years; therefore, we need more food and we need to use more water. We will then face the situation where there is really no more land to be developed and therefore the only solution, if the population keeps going up, will be efficiency. That seems to suggest that right now might be the time to focus on the problem of efficiency as opposed to increase in supplies so that we don't destroy whatever natural ecosystems we now have.

If we said that the demographics is an integral part of this, then we better focus on pricing because that will obviously allow us to allocate water. But some things don't have a price. In many natural ecosystems you can give values and prices and there can be trade-offs, etc., but for some things in some ecosystems, some wetlands, because they are unique and cannot be replaced, there is no way that you can put a price on them. We have to take that into account when we let the pricing system allocate water freely.

I am surprised that we haven't touched climate change yet. The effects of climate change in water are going to be serious, and we have to take that into account.

Meinzen-Dick: I am worried that putting too much faith in the markets is going to lead to real problems. I heard somebody from the World Bank relate an argument that was presented to him in India that we might need to reduce the irrigated area that is currently serving subsistence cultivation and put it into higher value commercial crops. This sounded good until you understand the political economy of the area, which means that there is a large sugarcane lobby. Sugarcane industrialists in India receive much more than the world price of sugar. Large farmers are favored in being able to grow sugarcane because of the links to the mills. So this lobby argues that water should be concentrated and given to them for growing sugarcane rather than "unimportant" subsistence crops like wheat, rice, grains. Isn't there something in economics about the law of second best - that if you have price distortions in one area, then going to a free-market system on another commodity is not necessarily going to lead where you want. It is very important in a lot of these changes to look at the political economy. Who is behind this? Who is going to benefit? Who is going to lose? In this case, many small farmers are going to lose access to water, if this argument goes through.

Sklar: If we look at the larger picture to see where are the greatest constraints and at the same time where are the greatest opportunities for change, it is at the political, institutional level. We should be concentrating more in this discussion on how we are going to change the way we do business. We have many good policies. All over the world, we have talented people who are thinking about these questions. We have innovative technologies. We have a real commitment toward some of the same goals that we are looking at. At the same time, we have an embarrassing record of implementation of the thinking, of the policies, and of the designs that we come up with. The World Bank is now taking a look at why its portfolio suffers from so many deficiencies. And the irrigation sector is doing the worst. We have enough experience to be able to identify where we have gone wrong and where we need to make changes in a technical sense, but what we lack is a feedback loop so that experience influences future decisions. The problem is that there are many vested interests who have a short-term interest in keeping things pretty much the way they are. Unfortunately the middle bureaucrats in India or wherever have a vested interest in seeing that certain projects go ahead whether or not they are likely to achieve their stated goals.

We have the same incentives here in this country. We need the World Bank to keep moving money out the door. We have procurement needs that are built into the way

our foreign aid is distributed and designed. We have to change this equation. Perhaps the biggest impact that we could have on this is to bring people who are currently disenfranchised into the decision-making process. This could be disenfranchisement due to economic reasons, due to political reasons, due to the scale of decision making and the level of democracy in a given country, or whatever. The local people who are directly affected, the users, are not actors. In a sense, we need to have some of them here at this table. I don't pretend to speak on their behalf, but I do have opportunity to deal with NGOs that represent many of these people in my daily work.

An example of how this can make a difference, and how also there is a built-in institutional bias that makes it difficult to bring about greater openness in decision making, is the World Bank's new water resources management policy. We have been pushing the staff developing the policy to listen to NGOs. At first they said water management is a technical issue, and NGOs don't really know about this stuff. They said, we want to hear from engineers. We want to hear from economists. But International Rivers Network obtained copies of the draft of the policy and sent it out to hundreds of NGOs and received a strong response. People from many different countries, many different types of organizations, grassroots groups, and national organizations had substantive things to say not just about environment but about all aspects of the policy. In fact, many of their ideas now appear in the latest draft. Unfortunately, they don't appear as much in the "implications for the bank" section of the draft, but I think many of the World Bank staff have realized that it actually was a valuable experience.

These people have a different perspective that would cut across some of what I believe are artificial divisions between advocates and researchers, divisions between environmentalists and developmentalists. For example, many of the NGOs that work directly with people who are affected by proposed large dam projects for which it is questionable whether the benefits outweigh the costs don't see a difference between environment and development. They are one and the same. Essentially, water-dependent ecosystems are human needs. Communities that are dependent upon freshwater fisheries don't see the ecosystem as something separate and apart from them that needs to be protected. They don't see the birds as belonging to some place else. The human community is part of the ecosystem from this perspective. That is something I think we lose at the macro-level, policy-making, boardroom setting.

We need to be thinking about how to change the way decisions are made, how to communicate to those vested interests that currently are benefiting in a short-term sense that they are also in a long-term sense at risk by continuing business as usual, and how we can make a requirement in terms of the conditions that Peter Gleick was talking about. Under what conditions are we going to build new supply projects? This is one of the rock bottom conditions that we need to have participation by the beneficiaries, the users, the people affected by the project. The people actually have more experience on a certain level than can be gained by reading the research literature. This can be done, and it doesn't necessarily alienate borrowing governments or require a political revolution. We are talking about something that will benefit all of us in the short and the long term.

Ellis: Just an observation about what we have been talking about and what we haven't been talking about, which I find encouraging. We started out with Gil Levine and Dave Seckler saying our existing irrigation systems are limited. Then they talked about the technical reasons why they are limited. They didn't say it, but I think that means we have to think about more irrigation. If we are going to increase food production, it is going to be with an expansion of irrigation. Peter Gleick and Deborah Moore took them up on that and said, no, we can increase efficiency through technical means and so on. There are institutional and political things that we need to think about, like pricing mechanisms. We don't necessarily need to expand but we need to improve what we have. I am pleased that nobody is talking about the need to expand food production in terms of rainfed agriculture and marginal lands. This group seems to be focusing on how to deal with irrigation as a means of increasing food production and not on how to expand food production into what I would argue are marginal areas.

Groenfeldt: I want to shift the discussion to another part of cutting demand and talk about other crops and other agricultural practices, as well as other foods. There are a lot of ways to decrease demand rather than increasing efficiency. I'm thinking about agroforestry, other varieties of existing crop species, such as wheat, rice, maize, and traditional or low status crops, maybe coarse grains, millet in India, finger millet in Sri Lanka, jackfruit - traditional crops that are usually relegated to: "Oh, that's what we used to eat but we don't eat those things any more." The conventional research emphasis is on high input crops - high water-input as well as high other-input crops - which leads back to water quality problems of pesticide residues.

Those things deserve to be discussed in this forum. How much potential is there for reducing water demand or increasing the food output for a given quantum of water through research that emphasizes water potential, focusing on crops that have been ignored in the past? It could also stretch to an issue of not only policies but programs - social marketing to enhance the perceived status of foods that are now considered of almost no value. In Sri Lanka you can have jackfruit for free. You have to buy rice.

So there is a lot in terms of where research is headed and what decisions we are making or foregoing in the research agenda and also in terms of what lifestyle-related policies governments adopt that have implications for water demands.

Warren: Bill Adams, a geographer at Cambridge, has done some remarkable work on African water systems. He has beautiful stuff on indigenous knowledge. One striking set of data he has shows that most irrigation users are traditional and indigenous irrigated system users - hundreds of thousands of small-scale farmers primarily in Egypt who have nothing to do with large-scale national and international intervention systems such as those we have been talking about. In Nigeria, 97 percent of the irrigation users are operating in indigenous systems and have nothing to do with dams. These systems may not look impressive from the air, but when you put them all together you have something we really have to deal with.

Second, there is a video called "The Goddess and the Computer," produced by the University of Southern California, about a thousand-year-old irrigation system in Bali that came in conflict with the Asian Development Bank. It demonstrates how an indigenous knowledge and decision-making system can be tested with a computer program. It shows the different options that come from this system and that it does optimize the water resource, soil fertility, crop-pest management, and conflict over water rights. Then the video shows what happened when a $58-million ADB project came in that completely ignored the local system, even though they tried hard. We had a conference at USC a couple of years ago with the ADB and World Bank representatives. They finally admitted, man, we have screwed up a system that is so fine tuned. Here, you can argue that the ADB came in and folks like us came in to do the environmental impact and we said there is no relationship between religion and rice, whereas there is a 100 percent relationship. Now we are trying to turn that around. It should be Indonesians taking a look at their own dam systems, recording these systems. They are now starting to do that through the Indonesia Resource Center for Indigenous Knowledge. That is what we are about - trying to get a grip on what the structure and functions of existing systems are, how people at the local level are evaluating the problems they recognize within these systems, how they would like to see these systems evolve, and how we can capitalize on the millions of creative people around the world.

"The environmental community has come quite a way in thinking about efficiency and trying to rely on the price system or some allocative system to deal with efficiency problems."

Rock: Let me close with a few reflections on answers to questions about where we agree, where do we disagree, and what we are going to do about it. The presentation by Deborah Moore, I thought, along with Sandra Postel's book, has shown that the environmental community has come quite a way in thinking about efficiency and trying to rely on the price system or some allocative system to deal with efficiency problems. That is a move that has been a long time coming. Deborah focused on what can we do to meet new demands without building new structures. David Seckler, Gil Levine, and Peter Rogers, on the other hand, looked at the problem from a hydrological perspective and essentially argued that there is not much to be gained by trying to improve efficiency in the system and it seems to me that that was one of the clear points of disagreement that emerged.

On the agreement side, there was remarkable agreement that human needs, particularly basic human needs and food, were going to have to be met. How is maybe not so clear, but there wasn't much sentiment that we are going to have to move back to rainfed techniques and marginal land. So there was agreement that if we could improve irrigation efficiencies, we could have agricultural intensification rather than extensification.

Finally, we began to get some discussion on the role of participation and decision making, on distributive impacts of the way in which water is actually allocated, and on what the distributive impact of moving to water markets might be. Ruth Meinzen

Dick's comment around vested interest and crop needs and distribution and the ownership of land was well taken.

Now we are going to break into three groups. Each group is meant to focus on what are the priority areas of concern in both advocacy and research that comes out of this discussion.

Group reports

Walker: We didn't get very controversial because we were looking for areas that we had an interest in and thought would be important. The most difficult areas to penetrate are the local institutional levels of policy and ways of doing things. It was brought up that our goal is not to dominate projects or to influence, in a forced way, the management of water resources within institutes, but to provide good data and good suggestions, based on research and experience, of reliable ways of approaching water scarcity - whether it is irrigation, supply, demand, or large or small systems. The main constraint in coming up with an agenda like that was the question of making the water have some price or value to provide accountability and responsibility on the part of the users.

Water rights came up as another major issue, partly because there is some ongoing research, and property rights are linked to that. Again, these institutional issues are difficult to penetrate. It would be beneficial to do research in areas where flexibility in transfer of water rights exists, for example, to see how that is working and whether it can be a model for others to use. In situations where there are very tight property rights and few opportunities institutionally, there may be internal flexibilities. One example is the exchanging of water rights for land rights. This kind of opportunity arises in certain instances where land ownership is a problem because there is no incentive to invest in crops or irrigation, but water rights can be given to some of the disenfranchised and then they are in a position to exchange. So there are areas for flexibility within the institutional constraints.

Another priority is to use the ecosystem as the unit of analysis - rather than parts of it or certain species, certain land areas, certain people - to see the whole project, or development, or use of water, in terms of the whole ecosystem.

Indigenous cultures should be studied, not as a model or to idealize them, but to benefit from their strengths and to determine what can be applied and used today that would not be disruptive and that could be incorporated into modern systems.

Rather than focusing on the actual scarcity issue, we were focusing on better use of the resources already available. Does anyone else in my group want to comment?

Sklar: We need to be able to present alternatives both in the actual techniques for designing projects and technologies to apply and in the methods of implementation - lending instruments, management structures, management strategies.

Rock: Who has the report for the second group?

Meinzen-Dick: Our group tended to be a bit dominated by the researchers, so things tend to be phrased in terms of questions rather than things that we are advocating. The first one was, what are the health impacts of water quality, especially drinking water and sewerage in urban areas?

Next, how can agricultural goals, either food security or value of output or foreign exchange generation, or whatever those goals are, be achieved with the least water? This includes advocating other varieties, high-value crops, less-water-demanding crops. use of agricultural research and use of other inputs like more labor, more fertilizer. more chemical inputs. And, what are the implications of changing the cropping system for local food security? What are the implications of higher fertilizer and chemical usage?

Then, in terms of the need for attention to property rights and the social implications of the transfer of water, what are the losses to some groups? What are the gains to others? And, what are the equity implications of those?

"Indigenous cultures should be studied, not as a model or to idealize them, but to benefit from their strengths and to determine what can be applied and used today that would not be disruptive and that could be incorporated into modem systems."

How can irrigation development be managed to maximize the positive environmental consequences? We discussed things such as that irrigation development can provide alternatives of employment or take pressure off extensive agriculture. There may be other specific management techniques, for example rice cultivation in such a way that it provides artificial wetlands for migratory birds at critical times, or rules within the irrigation system management that control rises of water tables or that specifically manage environmental concerns.

Another question was, how do you define the proper system boundaries? Sometimes even the nation-state isn't broad enough. So it includes both the physical boundaries of the ecosystem, if you like, and also what components fall within that boundary - people as well as wetlands, fish, other things that often are not valued.

Rock: Other comments from group two?

Larson: Another key issue is urban water supplies. In Latin America, 70 percent of the population is urban. In Africa, urbanization is going to be 50 percent of the population in 25 or 30 years. Whether or not drinking-water supplies and sanitation systems get put in for urban populations remains to be seen. The human health impacts of poor urban water and sanitation supplies are substantial.

Groenfeldt: There was also discussion about planning of water resources development, going beyond the irrigation sector in water resource planning and going beyond the water sectors to bring in implications for forestry, for the full farming system including livestock or even industrial uses downstream. Narmada is a good case of not quite going beyond the irrigation sector until forced to do so in the planning.

Rock: The third group?

Moore: We spent a lot of time talking about two priorities and gave short shrift to the rest. The first one was primarily a research question aimed at determining whether significant biological fixes or quantum leaps to increase crop productivity are possible from stabilizing crop output, by reducing the impact of pests and by introducing drought-resistant crops, or from increasing photosynthetic efficiency.

The second major area we talked about was how to change the culture of institutions, like the World Bank and other regional development banks, to get them to focus more on project quality as opposed to project quantity - some of the things that came out of the Wapenhans internal review of the World Bank's portfolio. People seemed to agree that major changes needed to occur. There is possibly less agreement about *how* those changes could occur. The pressure needs to come both from inside the institutions as well as outside, and the role of nongovernmental organizations on the outside is fairly clear.

"Two major areas you need to look at when evaluating darns: The need to compensate affected parties and the need to address downstream environmental effects."

The role of researchers and how they can interact in that sense was sensitive, particularly since many researchers have to have good relations with borrowing governments where they are doing the research. We didn't resolve the issue of sensitivity toward countries' sovereignty and their need to make their own decisions versus the pressure that is being brought to bear in donor countries on aid, but we raised it as a flag. Overall, there needs to be greater transparency in decision making so that when problems occur in project design, they can be identified early, and people can do something about them rather than cover them up.

A third priority area was developing criteria for assessing dams. How can we tell a good big dam from a bad big dam and are there conditions that we need to look at? David Seckler suggested two major areas you need to look at when evaluating dams: The need to compensate affected parties and the need to address downstream environmental effects. We then also talked about how to deal with uncertainty and lack of information. Gil Levine brought up the notion of making your case for a dam based on possibilities versus probabilities - that possibilities tend to promote wishful thinking about what is going to happen and that perhaps we should look more at probabilities and risk assessment so that we don't choose options that have major and irreversible consequences.

A fourth one that I am going to stick in is that in assessment of dams we want a level playing field, where the supply options as well as the alternatives that we spent this morning debating are given equal consideration in the evaluation stage, so that we have more information that we can give to decision makers.

The fourth and the fifth points are related - that there is a lack of good information and data on the extent and condition of irrigated lands and water resources. Also there is lack of information about performance and performance monitoring. That is something

we can say in any field - we don't have enough information. There was a notion that in the area of water resources, the data may even be worse than in other subject areas. In forestry, if the tree is there, you can see it and you know it is there. Water is never in one place and it is hard to monitor. The related point being that there is a serious lack of public awareness, that although there are serious problems over global food supplies and water resources, there is not a sense of urgency or fear the way there is, say, about chloroflurocarbons or the ozone hole or climate change or things like that and that we should be better at portraying that the situation isn't hopeless. These two points provide some area where we should all be able to work together to get the word out better.

"There is general agreement that water needs to be valued and that pricing is a tool to get more accurate and better allocation of scarce water supplies. The question is how to implement it, how to ensure that the poor are protected and that basic needs are still met."

The sixth point is the potential for increasing productivity in rainfed areas. This morning there seemed to be a tendency to say there may not be very significant gains to be made in rainfed agriculture, that we have been trying to do that for a long time. But Sandra Postel pointed out that since there are a lot of dry land and rainfed areas (83%), a small increase in yield spread over a large area will still make a significant contribution to increasing agricultural productivity, given a set amount of water. That is maybe a research question at this stage but also an advocacy question in terms of getting institutions to shift to looking at it and making it a priority.

The seventh is making access to clean water and sanitation a priority. There may be opportunities to have more multipurpose projects, such as irrigation systems that can also provide rural drinking-water supplies, as well as making sure that gains in water saved in the irrigation sector or transfers of water from the irrigation sector are used to provide greater access to drinking-water supplies.

The last thing we talked about was pricing and the value of water. There is general agreement that water needs to be valued and that pricing is a tool to get more accurate and better allocation of scarce water supplies. The question is how to implement it, how to ensure that the poor are protected and that basic needs are still met, and how to change the politics, particularly with vested interests. It goes back to the issue that Ruth Meinzen-Dick brought up this morning about sugarcane growers and who has control of the water now and how do you get them to accept paying a higher price and the political will that goes along with that. Many of these issues are both research and advocacy questions.

Seckler: One thing on Sandra Postel's point that it is good to get a little yield increase over a gigantic area: That has always been the thing that drives everybody to rainfed agriculture. But the basic problem that I have encountered in trying to do anything in rainfed agriculture is that it is so location-specific that while you can get something to work quite well in perhaps one 50-hectare spot, it isn't generalizable over the vast tract of rainfed lands. One of the advantages of an irrigation system is you

kind of impose a homogeneous ecological situation over large tracts of land. Then you can start doing things that will have a broad effect. The thing that perplexes me in this rainfed business is that local specificity: You have to reinvent the game every time you move a kilometer or two.

Havener: That is generally true, but it is not universally true. There are some things that lend themselves to broad-gauge solutions even under rainfed conditions, for instance the disease barley yellow dwarf in wheat. Eighty percent of the world's wheat area is rainfed. And barley yellow dwarf is a serious disease in rainfed conditions as well as irrigated conditions. If you can solve barley yellow dwarf virus susceptibility for rainfed varieties, then you make a real difference in a rainfed situation. Tolerance of wheats or maize to acid soils is the same kind of thing. They do affect rainfed conditions and can have very high leverage.

Seckler: In a way, that makes my case, too, because you can do a lot on the existing rainfed area that is pretty productive. It's when you get out of the productive rainfed into the more marginal rainfed that you get into these problems.

Havener: That was going to be my final point. You have to be working on rainfed areas with relatively high water regimes or you are not going to make it.

Rock: I want to make a few remarks about the overlaps that exist among the discussion groups. In at least two of three instances, water pricing and valuation was mentioned as a priority. In at least two of three of the groups, defining water rights and property rights was mentioned as a priority. In at least two of the three groups, there was concern about what we really know about the numerator: For every unit of water what do we know about output and how big the increase in output can be? In at least two of the three groups, there was agreement that institutional change is likely to play an important role. Finally, in at least two of the three groups there was concern about the impact of water quality in urban areas on health and labor productivity. So there are six areas where at least two of the three groups identified a list of priorities in which there were overlaps.

What we want to turn to now is those areas of overlap and begin to ask, what does this mean for strategy?