SESSION IV. FUTURE SCIENCE AND POLICY CHALLENGES

October 19, 2007 – 10:00 – 11:30 a.m.
Moderator: **Margaret Catley-Carlson**
Speaker: **David Molden**

Margaret Catley-Carlson
Chair, Global Water Partnership
World Food Prize Council of Advisors

Our next speaker is David Molden. He is the Deputy Director at IWMI, which is the International Water Management Institute. I'm on their board, so I'm very biased in favor of this organization, so I declare that from the beginning.

His field, and the field of IWMI, is looking at water in agriculture. And if you're going to read one book this year, it's called *Water for Food, Water for Life.* It is a summary of 700 researchers who spent about seven years looking at how much water is required if we're actually going to support a planet of nine billion people.

And you will have noticed in the last two days everybody has described to you yields in terms of bushels per acre or ton per hectare. Nobody has talked about what the water input is in terms of how much crop, how much yield you're getting for the water that goes in. And yet it's water that we are going to be very short of. The land stays the same, the water says the same, but we're using so much more of it.

If this isn't enough for you, you can have this book, but this one you can pull down from the Web, and it will make you informed about what is going to happen.

The link between this and bioenergy is very clear. You know, the agricultural historians say to us that when Caesar and the Romans colonized Britain, that on the farms there they were getting about a ton per hectare. And there's lots of places in the world where that's still the yield. If you could quadruple that yield in those places in the world, then the competition between food and fuel takes on an entirely different aspect. So, therefore, the importance of yield and the water that is the backstopping of that yield is primordial.

David has been looking at questions like this in Lesotho, Egypt, Botswana, India and Nepal. He got his PhD from Colorado State, and his background is in groundwater, hydrology and irrigation. This is the book you have to read this year; you can pull it down from the Web. This is David.

David Molden
Deputy Director General, International Water Management Institute, Sri Lanka

Thank you, Maggie, and thanks to the Borlaug Dialogue to give me a chance to talk about my passion, water – and it doesn't work in the gas tank – I know that.

The big question: Will there be enough water? It's a question that I think people in Atlanta, Georgia, are asking these days with drought. It's a question that in fact I think millions of people ask every day of their lives – Is there enough water to survive?

But what we did is we posed that question – Is there enough water for food and drinking? – to a group of about 700 people that come up with solutions for the future. And that was documented in the book that Maggie was showing you.

So let's just set the water scene and first of all establish a link between water and food. And of course one of the big reasons why we're here is the huge success story in food production. So the world now produces enough calories basically to feed everybody, and we all know that the problem is too much and too little, so in sub-Saharan Africa not enough calories for food.

But the length there with water is, as a rule of thumb, for every calorie you produce it takes about a liter of water. So when we go out producing more and more food, what happens, we take more and more water for food production.

One of the big ways to do this has been through irrigation, and this is a graph of the Bank's investments in irrigation, the World Bank's investment, kind of as also a proxy for government's investment in larger irrigation projects.

And what you see there kind of coinciding a little bit later than the Green Revolution was large investments in irrigation infrastructure. And they've tapered off quite a bit. There was a World Commission on Dams report that questioned a lot about the sustainability of these practices.

Interesting. In spite of investments in large-scale infrastructure going down recently, irrigated area keeps going up. It keeps going up because people invest in water. They need it so bad for agriculture that people, individuals and communities invest in water. And actually the figure is much bigger than that if we look at it from remote sensing images.

Another great gain from the Green Revolution fueled by water has been the huge decline in prices. Okay. What we see recently now are the prices coming back up – great for consumers, great for people in the city consuming food, making it difficult for farmers. Now, of course, the prices are coming back up but from really an all-time low.

At the same time, coinciding with that big dam construction area, WWF has an index, the Living Planet Index for Freshwater. And it also plummeted in about 1990, and I think it's not a coincidence that a lot of that has to do with the way we're managing water for agriculture.

So water and food are also very much related to poverty. So if we look at areas where there is malnutrition, a lot of that is in arid, semi-arid areas of the world. So water is a problem where the 850 million malnourished people live today.

One interesting graphic that came up is – if we look at the rainfall in a country like Burkina Faso and plot that against food production, I mean, it makes good sense. In a good rainfall year you get good yields, and in a lousy rainfall year you get bad yields. The thing is, the variability in a country like Burkina Faso is so high, so it's very hard for farmers to find a stable environment to make investments in agriculture.

It's also interesting that you can also trace the GDP of a country by rainfall. Rainfall patterns in a country like Burkina Faso are a good predictor of GDP.

It's striking – say in Australia or North America the amount of water storage per person is around 4,000-5,000 cubic meters per year, compared to the situation in Ethiopia, about 38 cubic meters. Ethiopia is the source of the Nile River, so there's water there. People dependent on rainfall, high variability. So you have to ask the question – in one sense there's not enough storage for water, not enough irrigation, and in another sense there's almost too much. Asia has benefited greatly by a lot of water development; very little storage in the Africa setting.

Moving on to another topic – what's happening now are rising energy costs. That impacts water resources in many different ways.

Hydropower becomes an option people think about more. Bioenergy – the reason we're here today. People spend a lot more money pumping water, and one of the reasons that irrigated area went up so fast is how many pumps are actually in agriculture.

People have looked at desalinization as a source of water, but now it's just out of reach to grow crops, especially with the rising input costs. And then fertilizers and other ag inputs go up, making it hard to increase productivity.

So over time from the 1960s to about present, a lot of very, very important limits are now reached or even breached. So for example what we find is rivers that don't flow to the sea. The Yellow River in about 2000 didn't reach the sea for about 220 days. Groundwater overdraft – some water tables in the world are falling at a meter every year.

Two other limits are fisheries. Okay. We've kind of overfished the oceans. Freshwater fisheries are peaked out. What that means is – to eat more fish, people have to rely on aquaculture, which requires water.

And livestock – how much more grazing land can we do? The implication of this is more livestock production will have to come from industrial process growing grains and feeding the livestock, which takes more water.

So if we put that together, we can draw a picture of water scarcity as it exists, say, in 2000, as it exists today. The red areas are places where people use too much water. They build hydraulic infrastructure, irrigate, use water for cities. The symptoms of physical water scarcity in

those areas are: very intense competition for water, falling water tables, high pollution with little water to dilute it, and very little water for environmental flows going out to the coastal ecosystems.

Over one billion people live in river basins that face that kind of physical water scarcity. And it's not just a problem of developing countries, it's an issue in the U.S., say in the Colorado River, in the Ogallala Aquifer. It's an issue in Australia in the Murray-Darling River Basin.

But there are two very different water worlds. And the other side is the purple. You see that in Africa, a lot of India, South Asia and some in the Andes. These are areas where women have to walk hours to fetch water. There is water in nature, but those people are feeling water scarce because they can't tap it – not like we do in the U.S.

So we have another 1.6 billion people living in these, what we're calling economically water-scare areas where people are feeling the pinch of water scarcity.

So the question is then – let's go back – "Will there be enough water to grow food and, for this conference, to produce the biofuels we need?" No.

The way we do business now, it'll be more than 2.6 billion people that will have to deal with water scarcity. We just have to change the way the water business is done. But luckily there's an "unless" in there – unless we really change our policies and actions and the way we think about water.

So let's take a glimpse then into the future. What does this hold for us? A lot of the discussion is around, say, biofuels and food. In a way, a lot of the actions outside of agriculture impact how water is used in agriculture. So, for example, trade impacts water use; our response to climate change impacts water use.

But interesting, two big things drive water use. One is our diets and the other one is energy. So it's not a question of food versus fuels. It's sometimes a question of cars versus carnivores. Let me get into that a little bit more.

Think about how much water it takes to eat. So if we think on a daily basis, to drink, we need about two to five liters of drinking water. For household use about 20 to – 20 is an absolute minimum; we probably use 500 liters of water for household use.

But if we look at how much water crops convert into evaportransporation, liquid into vapor, it's about 500 to 2,000 liters to produce 1 kilogram of grain. Okay, that's about a ton of water to produce 1 kilogram of grain. Then if you feed that grain to livestock, the conversion, depending on how you do it, is about 5,000-15,000 liters per kilogram of meat products.

So what happens is – you can put these things together, and on average your diet takes about 3,000 liters of water, thinking about that water converted into evaportransporation to produce food, very much depending on the type of diet. So if you look on the left-hand side of the photo, that's one, that's probably about a 5,000-liter a day diet. In the middle, more vegetarian is about 2,000-liter a day diet.

On the right hand there are some refugees in Chad; clearly, just an unacceptable situation. That's their food in one week, and we don't even want to talk about how much water that takes or doesn't take. By the way, these are from a book called *Hungry Planet.* I find them very great and interesting photos on diets.

So then if we look ahead at consumption of animal products coming out today, the USA eats a lot of beef. Seemed like there was a turning point in about 2000 where the level – and that's animal products – the level of consumption leveled off. But that's when my house, my wife and daughter, turned vegetarian in about 2000. But don't tell them that I enjoyed that beef last night – it was pretty good.

In China, consumption of animal products is taking off like anything. And so we see this steady increase in the world of animal products. And India – maybe it's not beef in India, but it is dairy products and eggs.

Okay, so then let's go on to water use per liter for biofuels. So we use that same logic of how much water it takes for the grain of crop, added a little bit to that the processing – which is far less than the amount for the crop typically – especially with a lot of the processes we've seen. And I notice a lot of people are saying they're recycling the water in the production of biofuels, which is great. I guess the bigger concern here in Iowa might be the pollution from fertilizers.

But, for example, in China and India, the liter of biofuel we estimate at about 3,800 liters of water per liter of biofuel, U.S., way low – I think that's because the yields in the U.S. are so high. But the big difference is in how much irrigation water it takes. So a lot of the biofuels in India and China are grown off irrigation water.

And I was actually quite interested in Professor Chen, who spoke the other day, saying that China had actually shut down some of the biofuel plantations. Part of the reason was competition for water. India uses a lot of sugar cane, irrigated sugar cane. A lot of times people pump aquifers to grow that sugar cane. So much more water is used for irrigation in the production of biofuels.

So if we look into the future to about 2050 and look at the food and animal feed need, we see in developing worlds a lot more of the grains go into animal feed. In sub-Saharan Africa it's used for food, but there is a trend then because of that increase in consumption of livestock products for more animal consumption.

And basically that food/grain needs, population by change in diet, what happens is the food demand will double over the next fifty years – a huge problem. We haven't got the food problem licked, and there are serious water constraints to that. If we don't change the way that crops are grown, then basically what happens is the water required will double.

So if we look today how water is used for agriculture, and the blue part is irrigation water that has evaporated, the white is how much irrigation water is applied, so about 2,700 cubic kilometers of irrigation water are applied. We use over 7,000 cubic kilometers of water converted into evaportransporation. By the way, about a hundred thousand cubic kilometers of rain falls on the earth's surface, to put it in a little bit of perspective.

So without any improvement in water productivity gains, what happens is – if food demands double, the water requirements double. So how are we going to deal with this situation of water scarcity as it is today, unless we change the way we do things?

What we did in the assessment is try to answer that question – How do we do things differently? And what we found is a combination of things, policies that really go after productivity gains but productivity gains looking at water, yield per unit of water. We know that a lot of times yield going up means more water. Somehow we have to make it, yield going up but using less water, growing more food with less water.

Look at rainfed areas. Take a serious look at rainfed areas, especially in sub-Saharan Africa. Try to upgrade those with a little bit of irrigation practices. Trade can make a huge difference. And the way we govern and manage water can make a huge difference. So that impact does not have to be so big for future water needs if we can take the right actions.

Let's look at biofuels. What's the impact then looking at the land and water globally now. What our projection shows is right now the additional land for biofuels is a little bit – In 2030, with the projections of the IAE, the biofuels will also just take a little bit more land.

And in a way this is a relief. And in fact it's the same for the water issue too. Globally there's just a little bit more land and water required for biofuels. It's a relief to see that, because sometimes you just expect that these things add up and go off the roof.

But what happens with water, the problems are local, so even though globally it's a little bit, locally these can be a big issue. So again, in India and China, what happens with the policies that we understood they set out, the percent of additional irrigation water is 7 and 5 percent more, a lot of that from that red zone where practices aren't sustainable.

So if we look at India, that's the amount of water for food and feed today. In the future we're entering this red zone of water scarcity. Then on top of that adding the biofuels – it's not sustainable; it can't be done in certain places in India.

By the way, I read a report for the U.S. from the National Academy of Sciences, and they had a similar point for the U.S. For the country as a whole, the additional amount of water is not so great, but there are areas. For example, the plants in Texas that take water from the Ogallala Aquifer may not be the best use of the water resources.

So to end, we came up with eight big things to do, but I'll just give three:

One is to increase the productivity of water – get more food with less water. So we've done a great job of intensifying land and halting land expansion through yield, but that's been at the expense of water. So what we now have to do is stop the water use in agriculture. And improved biofuel technology and practices play a big role in that.

Second, especially for poverty, is to get more value per unit of water for wealth promotion, especially in places like sub-Saharan Africa, and there is where I think the biofuels present an opportunity.

This is the growth in yields of maize in the U.S., and it's interesting in the forties and about the time Dr. Borlaug started work, it just jumped up. The Green Revolution, sixties and seventies, in China and Latin America – somehow the corner was turned, and somehow in sub-Saharan Africa, we just, it's in a way, we just haven't turned that corner. It's just a corner we need to get over. And we know a lot of the ingredients in there, and I think every effort has to look at sub-Saharan Africa to get the productivity up.

Thinking of the water angle, if I want to increase water productivity, the best place to do that is not in U.S. It's in sub-Saharan Africa to get more food per less water.

A second agenda item when we do that, is to make sure that we get water to poor people. Water flows to money, and somehow we have to reverse that trend and make sure that poor people get access of that water. And they can be extremely good at increasing water productivity.

Third is to recognize that poverty, hunger and gender inequality are not really because of our technology here. It's because of the way we manage water. It's our policy and institutional failings.

I'm finished. And then finally just to think about water.