WATER WORKING GROUP, UNIVERSITY OF CALIFORNIA, BERKELEY

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Peter H. Gleick

"Anticipating Future Demand and Supply"

I'm going to try not to talk too much, although I can talk about water forever. So, what I'd really like to do is just raise some issues related to the title of my talk which is *anticipating future demand and supply*, and throw out some concepts and issues, and some trends, perhaps.

It's way over due that Berkeley has had a water discussion, a water group. There really hasn't been a focus, there really hasn't been a center for water. There are some very good water people here in Ag Economics, or there are some in the Engineering department or in ERG, who have water as an interest but there really hasn't been much of a focus on water on campus, and I think it's overdue so I'm hoping this might turn into something.

Making predictions about the future is very difficult. That's been said in a number of different ways by another…it's been attributed to all sorts of people. Some said Freeman Dyson said making predictions is very difficult, especially about the future. Somebody else had attributed back to Casey Stengel. I don't know whether it's physics or baseball philosophy or what. But the truth is it's hard to predict the future and it's especially difficult with something like water supply and demand. What I'd like to talk about is some of the difficulties in doing that and also the importance of doing it, because as difficult as that is it's really important that we be able to think about, in a coherent sense, what demand and supply of water will be. That in turn drives water policy in the U.S., in California, and internationally. The reality is that predictions about demand and supply of water resources really *drives* what happens in the water world, whether or not those predictions have any basis whatsoever in reality -- and the truth is they often don’t have any basis whatsoever in reality -- and that leads to a whole series of bad things, which I’ll raise briefly.

Now, how are water scenarios or futures typically derived? The simplest method, and by far the most common method, is the simple assumption that there are a very small number of drivers that determine water demand -- and I’m actually going to focus on water demand rather than water supply to begin with, for reasons that I think will become apparent. Those drivers are population and economic activity, or well-being, or standard of living. Speaking simply, the assumption is that future water demand is a function of population and economics, GNP or GNP per capita, or something like that. And that as population grows and as our wealth or standard of living grows the demand for water will grow. Often it’s linear, sometimes it’s not exactly linear, but usually it’s pretty close.

Now, the next level, which is much more uncommon, is a fairly simple modification of that. Modest corrections for efficiency or changes in productivity. Those are the most typical but they take the simple assumptions and they make some minor modifications. At various levels of regional detail, I should say, various levels of sectoral detail, we do this in California. By law every 5 years we produce something called the California Water Plan; the Department of Water Resources produces this, and it stated in 1957 and they’ve done 7 or 8 of them now. The last one came out in 1998, I’ll come back to that.

Now the most sophisticated approach, which is extremely rare but on the positive side, increasingly less rare, if you will. We’re doing it more and more often. What do we want to use water for? Just as in the energy debate in the ‘70s the goal of using water is not to use water, the goal is to accomplish things. It’s to flush toilets or actually more accurately to get rid of human wastes. It’s to produce automobiles or widgets. It’s to grow calories that are consumed by people and livestock. And so the most sophisticated kind of water planning in theory, and increasingly in practice, goes to the end use and disaggregates the end use and says, what do we want to do and how much water does it take to do it. If what we really want to do is: we want to eliminate, we want to separate human waste from the active human environment, how can we do it? And then there are a lot of ways to do that. I mean you can flush toilets with 6-gallon per flush toilets or you can flush toilets with 1.6-gallon per flush toilets, or, you can build latrines that don't use any water, or you can use a composting toilet. The goal is to get rid of the waste. The goal is not to use water, *per se*. Then you can build up demand from the bottom based on what you want to do as a society.

Now my personal opinion, which might be obvious already, is that that's the right way to do water planning but the reality is that's not the way it's done. I want to show a few pictures … A lot of this is just information but there are some graphs here that show some things that are interesting. [WW1.1]. This is very simply world population, world water withdrawals -- it says water use in the title but I hate that term, even though I made this graph, and irrigated area. World population is from 1900 to the present so we've gone from about 1.5 billion, you probably all know, to just over 6 billion last fall. Irrigated area is on this side *(shows chart)*-- we've gone from about 50 million hectares of irrigated land to about 270 or so million hectares of irrigated land today. Water withdrawals in cubic kilometers per year have gone from about 500 cubic kilometers withdrawn to today about 3500. A quick comment on this issue of withdrawals vs. use. Use is a really ambiguous term. If you see somebody whose says we use a certain amount of water, that doesn't mean anything. Is that the amount of water *withdrawn* for use? Is it the amount of water that's *consumed* by a process? Those numbers are very different but the distinction that I usually make is between withdrawal and consumption, and that's an important distinction but not so much for this talk. Anyway, these numbers are withdrawal figures.

Now, the only thing you might note on this graph is in fact this exponential increase in population is not being matched anymore by water withdrawals. If you actually look at this, and I have better graphs, which I'll show you in a minute, water withdrawals seem to be maybe leveling-off, and that's an interesting point to talk about.

Now, I talked about projections and let me show you some projections for global water withdrawals over time. [WW1.6]. These are projections that have been made since the 1960's and there are a lot of them. What this graph shows in red, *(showing chart)* are projected water withdrawals made before 1980. The projection, the forecast, was made in the 60's or 70's for the year 2000 or sometimes the year 2025. The blue ones are projections made between 1980 and 1995 (and there weren't very many) for the year 2000. The ?? ones are projections that were made after 1995, but basically projections of future water withdrawals globally, made within the last 5 years, 4 years. None of these are year 2000 projections. And this ?? line is the actual water withdrawal number. This is actual global water withdrawal. Now, if you just look at the red ones what you can see is in the 60's and 70's the projections were not only for continuation of increases in withdrawals but for an acceleration of increases and withdrawals. Every one of those projections was based only on population projections and economic growth. And typically economic growth is what's driving this. Not only does the population grow but more of the world's population is richer and is using more water as people do in the industrialized nations. And so here you have a certain number of people in the developed world using a lot of water and a lot more people in the developing world using not using nearly as much water per person. More of the developing world gets richer and uses more water like we do, and population grows and you get huge numbers, I mean, 10,000, 12,000 cubic kilometers of withdrawals here; that's a lot of water. The total annual runoff of the globe is about 47,000 cubic kilometers per year so that's a lot of water.

You can see that over time these projections have been coming down. Now, they're coming down for a lot of reasons. They're coming down because population growth projections now are lower. They're coming down because it turns out the richer you get; you don't necessarily use more water. And they're coming down because people are starting to be a little more sophisticated in both the regional analysis and the economic analysis. And recently we've actually got a couple of projections below current use. In other words, not only might be leveling-off but there's possibility, under some of these crystal ball analyses, that water use can go down, in some scenarios. Now, I have to say that one of these (projections) is mine, but there are other people who think that it's not fated that the larger the population is, and the richer we get, the more water we have to use.

We do the exact same thing in the U.S. That's global, these are projections for the U.S. along with actual withdrawals.*(shows chart).* Let's see, the blue ones are from the 1960's, projections made in the 1960's when water use was going up exponentially. The 1970's are the green ones; they're coming down a little bit, some of them. The purple ones are the 1980's and then there actually were 2 in the 1990's done by a guy named Brown with the U.S. Forest Service, just published last year. We might hold level here. But look, more interesting curves here, look at the actual water withdrawals in the U.S. [WW1.4]. They peaked 15 years ago. We're using less water in the U.S. today then we used 15 years ago, which was a front page New York Times story when this data came out about a year ago. The reasons are many, I'll come to them in a second, but the economy is certainly larger, much larger. The population is much larger, so something else is going on here.

Here's part of what's going on. *(shows chart).* This shows U.S. GNP, in 1996 dollars, in blue, and that's U.S. water withdrawal, from 1900 to 1999, basically. Up until 1980, or '77 or somewhere around here, GNP and water withdrawals moved in lock-step. This was the classic (pattern), I mean you can see energy curves that look exactly like this too. The richer you are, the hotter the economy, the more energy you use, the more water you use. Well, Amory Lovins in 1977 said this doesn't have to be the way it is, this doesn't have to be the future, we can break this link between GNP and energy use. And, of course, 25 years later, I mean, he looks brilliant. He was brilliant! He was right. Well, the same thing happens in water and since 1980 – 1977 -- there's been this separation between GNP and water withdrawals. This is another way to show it *(shows chart)* -- This is basically 1996 U.S. dollars, per cubic meter of water withdrawal. It's a measure of economic productivity of water in dollars per cubic meter. Now, what it shows is ups and downs, and this down here is the Great Depression, when the U.S. GNP figures plummeted, and then WWII and the economic recovery. But, you know, it's basically between, I don't know, $6 and $8 dollars, of economic productivity produced -- if you're ignoring the problems with GNP as a measure of that – for one cubic meter of water withdrawn. Until this breakpoint and now the economic productivity of water is going way up.

The trend is pretty clear here, something has changed, okay? U.S. water withdrawals per unit of economic activity shows the same thing. Basically, we are producing the same amount (=value) of economic output with less and less water. Now, to give an example, a real world example, it used to take about 60 tons of water to produce a ton of steel. Now it takes about, I think, 20 tons of water or 10 tons of water to produce a ton of steel, simply because of changes in the process of making steel. Okay, so that's part of what's going on. But it takes less than 10 tons of water to produce a ton of aluminum for example, and we're making cars more out of aluminum than we are out of steel and so the amount of water involved in making a car has gone way down; partly because we've gotten better at making steel and partly because we're not using steel anymore. So, those are some of the factors involved in this changing dynamic.

[Question: Don't you also have a big change in industry, period? A lot less consumptive industries in general in the country?]

Yeah, that's partly what I was trying to get out of this… you can make steel much more efficiently from the water point of view, but you may also no longer want to make steel, you may want to make aluminum (for cars). Well, in fact, we may not want to make cars, ultimately. We may make computers and not telecommute! And you know the water required to make a computer, per dollar (of output), is less. In fact, in California between 1980 and 1990 industrial water use went down 30% in total terms. Industrial GNP went up 30% and that was due in part to getting better at what we do, and in part to changing what we do. The nature of industry in California shifted enormously from steel making and petroleum refining, chemicals manufacturing, which were very water-intensive, to the service industry, in electronics, in communications and computers, which were much less water intensive -- yes, that's absolutely true.

In the first chapter of my book I talk about a changing paradigm and the way we think about water, in the way water planning is done. Partly (because of) this set of issues that I've been talking about, but it's driven by a lot of other things as well, it's also driven by environmental issues and it's also driven by social issues. In the past these projections of constantly increasing demand for water led to inevitable gaps between water supply and water demand, and the California plan is the classic example of that. We have a fixed amount of water in California. There's a fixed amount of water everywhere pretty much, unless you want to build dams and move water form one place to another, and ignoring the issue of climate change. But if the amount of water is fixed, demand is constantly increasing. Sooner or later you get to a situation where demand, theoretical demand, exceeds supply; what do you do? Well, the traditional approach is you figure out how to make supply bigger. You build another dam, you capture the flood-waters that run off in the winter so you can use them in the summer. You build a 4000 mile aqueduct from Canada and Alaska to Mexico and siphon water everywhere in between. You build things, concrete things, big things. Because of that water planners are, for the most part, engineers. Not to knock engineers, I have an engineering degree, but the reality is that water planning and water management is done mostly by engineers, world-wide, historically, that's the way it is. The response is build something new. And so the focus is supply, not demand.

What's changing, I think, as we enter a new century, I see a change in that concept. We're really moving away from this focus on new supply and we're moving away from it for economic reasons. It's really expensive to build new supply options now, for most places. For environmental reasons, building new supply options really mucks up the environment. And for social reasons, building big supply options has social impacts. Now, I don't mean to suggest that this transition is going very rapidly, or is going to necessarily be successful, although I think it will be, or easy, which I don't think it will be. But I do think it's happening. Certainly, if you look at California we (already) built all the good dams and lots of the bad ones here. And there's enormous public opposition to new dams in California, of any kind, or aqueducts. In addition, the federal government is no longer going to be paying for it. In the 60's and 70's and the 50's, the U.S. government paid for them, the tax payers paid for them, not the users. That era is over so economically it's harder and harder to do that. And socially there's a whole series of reasons why it's increasingly difficult as well. Now, this is a graph of a cumulative number of dams, large dams, defined as a certain volume, built in the U.S. from 1960 to the present and we built a lot of dams in the 60's and 70's *(shows chart).* But the curve's leveling off, in fact it's flat. We're not adding new volume almost anywhere now. And it's because of environmental, economic and social reasons.

The other side of it is this issue of demand management. For the first time people are really seriously thinking about, not the supply side -- partly because of the difficulty in building the supply options -- but the demand side. There's an old economic joke, which we've all heard, so pardon me, but I'm going to do a little modification about the $20.00 bill on the ground. This economist and his daughter are walking along the street and she says Daddy! Daddy! Look! There's a $20 dollar bill on the ground. He starts dragging her along the street and says don't be silly if it was a $20.00 dollar on the ground somebody would have found it already, so it can't be. Well, that's the demand side argument, that there's all of these savings out there to be gleaned but we haven't figured out how to get it yet. Now, the reality is that it's not a $20.00 bill -- it's 2000 pennies and it's hard, perhaps, to get. It's much easier to build a dam and to supply water to a million people, than to deal with a million peoples' end use patterns. To deal with a million toilets or 1 million faucets or farmers' behavior, those things are a horror (I'm not suggesting that it needs to be), but the potential is enormous.

Just my last view graph here…*(shows chart).* We're doing a project now looking at the potential for demand management for water in California and it's looking at every sector and we've only finished the urban residential sector. But this is a graph that shows the amount of water used for toilets in California. Now, why toilets? It turns out toilets are the single largest user of indoor water, residential water. More than showers, more than dishwashers, more than washing machines; happens to be toilets. The red line, starting in 1980, is how much water California would have used without conservation. That means that the toilets that were available in 1980, which at the time were 6-gallon per flush toilets. Starting in 1980 California started implementing programs to install water saving toilets, 3.5-gallon per flush toilets and passed a state law requiring those, and they started to get installed. In 1994 the federal law changes requiring all toilets sold in the U.S. to be 1.6-gallon per flush toilets, and that's what's available now. This blue line is our best estimate of the current statewide use of water for toilets. So, basically this is where we are today. This is what the savings has been. If there were no conservation efforts, we'd be using 1.2 million acre feet a year about. Instead we're only using about 780 or 760,000 acre feet a year. If everybody in California had a 1.6-gallon per flush toilet, which they don't yet, this is how much water we'd be using for toilets, about 300,000 acre-feet. _ of what we would be using with no conservation.

[Question: Does the green line reflect population changes? Why's it so flat?] Yes, it's flat but it's actually going up. It's going up because of population. If everybody used a 1.6 –gallon per flush toilet in 1980, and if everybody used a 1.6 gallon per flush toilet in 1998, that's what this curve is. So, in fact the only difference between 200 and whatever and about 300 is population growth. But this is the additional savings to be captured somehow through natural replacement or aggressive utility programs and these kinds of curves can be drawn for every water use in the state, or in the nation, or globally. Thank you.

(*Note*: This is a transcribed talk. It has been only minimally edited, so that the speaker's individual "voice" still comes through. In the text, "WW1.6" means Figure 1.6 in *World's Water* by Peter Gleick (Island Press, 1998). -- Isha Ray.)