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How Water Pricing, Human Rights, and an International Perspective Can Help to Provide Water For the Growing California Population

Dr. Peter Gleick*

Thank you for that very generous introduction and thank you to the Witkin Legal Institute for having me here. I'm delighted to be back at Pacific McGeorge. I've been here a few times and it's always exciting. I did, as Professor Sprankling mentioned, some early work on the human right to water. I'm a scientist by training, I'm not a lawyer. That work was probably the closest I've ever gotten to any sort of legal work, but it ended up being useful for the United Nations. And it is great to note that the United Nations formally declared a human right to water in 2010.

The work that I did in this area was itself built on work done by Steve McCaffrey. His earliest work on the human right to water has been very influential in my career and I think very effective at bringing this issue to a close at the UN in 2010.

I am going to talk about the future of water. Water is an issue for science and economics and law but it's also connected to sociology, politics, ecology, and to everything we care about. Really, it's hard to think about a resource issue that is not more fundamental to anything that we have to deal with—land use planning, the things we've talked about here this morning, population dynamics, energy policy and strategy and so on—there's a connection between all fresh water resources and all of those things.

I give a lot of talks on global water issues, climate change, and sustainable water management but I was really looking forward to the opportunity today to talk about some of these issues because it gave me an opportunity to sit back a little bit and think a little more broadly than I usually do about the complex and controversial challenge around water both here in California and globally as well and to think about some of the parallels between what's going on worldwide and what's going on here in the state.

Let me begin by observing that as a scientist or a conservationist or an advocate, or as an attorney, I think working on environmental issues can sometimes be a little bit depressing. Everyday there's bad news. Everyday there's

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some step in the wrong direction or another battle that's lost or pushback from vested interests, economic interests or political interests. Sometimes, one might argue there's distressing ignorance in Congress about science issues or worse than ignorance, lack of interest. Maybe that's not worse than ignorance, I'm not sure.

There are worries sometimes that our political allies on the left or the right, whatever side you are on, aren't strong enough or aggressive enough to take steps that many of us believe are necessary to move in the direction of sustainable use of our resources. All of that is true and all of that is somewhat disheartening but I'd like to offer a different perspective.

I actually believe that science and public opinion and continued efforts on the part of communities and citizens and academics are slowly but surely moving us in the right direction, in the direction of a sustainable future. Bad things that we used to do or proposed doing a quarter of a century ago or half a century ago or longer without thinking or without understanding the true implications of some of those actions, we no longer do or we chose not to do. Some of the good things that we knew we ought to be doing, we are now beginning to do. Let me give you some examples.

We don't have fifty or 100 nuclear power plants along the coast of California but, some of you are too young to remember this, we had plans to build fifty or 100 nuclear power plants along the coast of California or big LNG terminals, liquified natural gas terminals. There were serious public discussions about the value of the coast of California and about energy policy and about ecosystem health and protection along the coast and so we didn't do that.

We put in place instead some pretty comprehensive coastal protection policies. We didn't develop the Marin Headlands or Point Reyes and again, some of you are too young to remember this but there were plans, development plans for thousands or tens of thousands of housing units on the Marin Headlands and in Point Reyes. We didn't build dams to flood the Grand Canyon and yet there were proposals to build massive sets of dams in the Grand Canyon, in the national parks for power generation and for flood control and for recreation and we didn't do that. Okay, we built some of those dams but we didn't build all of them.

We didn't build fleets of supersonic aircraft that would have destroyed the ozone layer because we had a scientific conversation about the risks to the ozone layer and then an economic conversation about the advantages of flying to Europe in three hours instead of five hours from the east coast of the United States, not to mention sound problems and other issues associated with that. This was also at a time when we were discovering what the threats to the ozone layer really were and we passed bans on ozone depleting chemical at the global level and bans on DDT when we learned what DDT was doing to ecosystems.

We saved the whales, or at least some of them, and this year we saved a few more with the international legal court decision against "Japanese research" about whaling. We saved the redwood or some of them. I would argue overall,

there is fundamental and growing support for the environment among the general public and that support is expanding not shrinking and it gets better with every generation.

We have to accept first of all that we are in this for the long haul. There is never going to be a shortage of bad ideas or inappropriate development plans—we heard some this morning. Vested interests that favor short-term economic gains over long-term issues and interests but I think a century from now, future generations are going to look back at the environmental movement of the 20th century—the late 20th century and the early 21st century—the way we today look back on the antislavery movement or the suffragette movement or the civil rights movement or the gay rights movement or other examples where social and societal mores and values have changed and are continuing to change.

That's the good news. I think all of these arguments and observations apply in the world of water. Now the title of my talk is *The Future of Water*. It could have been: *Will We Have a Water Future or Will We Solve Our Water Problems or How Do We Solve Our Water Problems or A Sustainable Vision for California Water*. I'm going to try and give a talk that touches on all of those things.

We hear all the time about the California water crisis or the global water crisis or the climate crisis or the coastal crisis or the energy crisis. Others criticize the environmental community for making everything a crisis but we do have a global water crisis in many ways and I'm going to touch on some of that. There are also many different ways of looking at our water problems. I, and the Pacific Institute—I work at the Pacific Institute, which is an independent nonprofit in Oakland California—we work at the local level, we work at the global level, much of what we do is fresh water related, water and climate, water and energy, water and international conflict, there are many pieces to this puzzle.

What is the worst aspect of the water crisis? Is it the very severe current drought that we are in? Is it the problems with the Sacramento San Joaquin Delta? Is the biggest problem really whether we should build a couple of more reservoirs in the state of California or a pair of tunnels? It used to be the Peripheral Canal—now it's the Delta Tunnels. Or a desalination plant in San Diego?

The worst water problem in my opinion is none of those things, it's a bigger issue. It's the failure to provide safe water and sanitation for everyone on the planet. I'm not going to talk much about global water problems; I'm going to talk mostly about California. But at the highest level, it's the 21st century and there are still 800 million people worldwide that don't have access to safe drinking water. There are two and a half billion people worldwide, maybe 40% of the world's population that don't have access to adequate sanitation, something everyone in this room probably pretty much takes for granted because we grew up with those advantages.

That's not a problem that requires new technology—it's not a problem that requires a lot of money. It's not a problem that we don't know how to solve but

it's a problem that we've failed to solve. If there is a single big global water crisis, it is the failure to meet basic human needs for water and sanitation, which is tied to this issue of the human right to water, because it leads to bad things: It leads to water-related diseases, approximately two million deaths a year, mostly of children under the age of five, from cholera and typhoid and dysentery and the diseases you get when you don't have access to safe water and sanitation. We got rid of these diseases in the richer developed countries of the world 100 years ago.

It leads to miserable lives for young women who spend countless hours in drudgery carrying water long distances, often contaminated water from distant water sources, to their homes because we haven't provided safe water. We—the world population, the world community—hasn't provided safe water and sanitation. That's a real water problem but it's very different than the problems that we face here in California.

We do have serious unresolved contentious water problems in California. Even in California, there are populations that don't have access to safe drinking water. We did some work at the Pacific Institute looking at local communities, small rural communities in California without access to high-quality water or in particular with access only to nitrate-contaminated water in the Central Valley. Water is contaminated by nitrates from animal feeding operations or agricultural fertilizer or bad septic systems. In many of those communities, we've known the concentrations of nitrates were too high for a decade or more and yet we've failed to meet basic human needs for those communities as well. In many ways that is even more inexcusable in a place like California.

Different groups, different organizations, different communities, different interests dealing with California water have different perspectives and perceptions on the nature of the problems that we face and on the priorities that we ought to be tackling. The reality is California is a big state in a lot of different ways. We have a large absolute number of people. We have a vast land area and a very diverse climate. We have many different kinds of populations. We have different backgrounds and different interests and different priorities so in some ways, it shouldn't be a surprise that our interests around water are different. Let me offer some examples of these different perspectives.

Agriculture: 80% of the water that humans use in California goes to agriculture. Interestingly about 80% of the water that people use on the planet goes to agriculture, mostly irrigated agriculture. The agricultural community feels that their use of water is the most important because it produces food and not just our food but very large quantities of food that go to the rest of the United States and much of the rest of the world. Changes from their perspective to water rates or allocations, risk overturning a very complicated water rights system that was set up over 100 or 150 years, which provides them with some of the resources they feel is critical to grow the food that we want. Some farmers also feel that losing agricultural water to urban development or ecosystem restoration threatens their communities and their way of life. They say with some justification that 100 acres of farmland is a far more beautiful thing than 100

acres of suburban sprawl or MacMansions. We talked about some of these things this morning.

There's an environmental perspective. Many environmentalists argue that humans use too much of the water in the state of California and that leads to, and has led for a long time to, a whole series of critical environmental threats to the quality of our water, to wetlands and the few remaining natural wetlands in the state, and aquatic ecosystems and fisheries, and devastated bird populations on the Pacific Flyway and much more. The environmentalists see current water policies around the state as threatening a big part of what makes California a pretty wonderful place to live.

There's an urban perspective. Urban water users believe that they produce far more value with the water that's used in the urban center, such as dollars, economic productivity, and services to people than is produced by that same amount of water used in the agricultural sector. They note that only a small fraction of our water use goes to the urban sector so why pick on the cities? (20% of the water goes to urban use in California.) Urban use includes residential use indoor and outdoor and commercial use and industrial use and institutional use.

Rational water policy, many urban water users feel, would meet their demands for water as a top economic priority. They worry about the future reliability of urban water supply to meet current needs and growth because the cities are growing much faster than rural populations. They worry about future water quality because the quality of water is threatened by all sorts of our activities around the state. They worry about the cost of water delivery and water services and water bills going up.

There's an environmental justice perspective as well. The social justice movements including in the environmental justice community have long felt that their voices are not being heard in decision-making about water policy and that they disproportionately bear significant costs from our water policy. My earlier comments about poor communities in the Central Valley exposed to nitrates is one example of that. They are uneasy about historical and continuing lack of concern for social and cultural and equity implications of our water policies.

Scientists often think, "Well, we just don't have enough data and information. If we just knew more about fish biology or climatic variability or the human health impacts of pharmaceuticals in our water then the rationality of knowledge and science would make policy makers move in the right direction and do the right thing."

Economists believe, "Well, if we just priced water properly and had markets then the rationality of economics would lead policy makers and individuals and groups to make the right decisions. We just need to get the economics right.

Lawyers . . . okay, I'm not going to say lawyers. There's clearly an issue about water law and water rights and our regulatory systems and sometimes lawyers feel that if we just properly got those systems in order and applied them effectively that would lead to the right decisions.

Technological optimists think we just need to build desalination plants on the coast or develop some other brilliant simple silver-bullet technology. There are lots of other perspectives out there: Southern California versus Northern California, rice growers versus almond growers, Northern Sacramento Valley farmers versus Southern San Joaquin famers, eastside farmers with senior water rights versus west-side farmers with junior water rights. Environmentalists who favor wilderness and wildlife may have different priorities than those who favor small-scale sustainable farming operations or local agriculture or public health issues. You get the idea, we are a complicated state and that hasn't helped us when it comes to making rational water policy.

I raise this issue of perspectives because I think it helps explain the lack of progress in many California policy areas, not just environmental areas and certainly not just water. Maybe given all those differences, it's not a surprise that we find it so difficult so often to find common ground. We all want to reach solutions. We just can't always agree on what those solutions ought to be and sometimes not even what the problems are. Rather than trying to pick among these different perspectives, maybe I can say a few things about what the water crisis *isn't* from my perspective. That's what you are going to get today.

I believe that California's water problem, indeed the global water problem, is not the result of a lack of resources or money or brains or infrastructure. I think absolute scarcity of water is not our problem. Yes, we have serious regional problems with scarcity. There are wet areas, there are dry areas, that's the nature of the hydrological cycle around the world. I know that we are currently in a very severe drought and that makes allocation and distribution of the water that is available to us even more problematic and contentious.

But overall, California actually has a pretty large amount of renewable fresh water available to it—on average on the order of 2,500 cubic meters per person per year. That's our average hydrologic endowment, 2,500 cubic meters of water per person per year. Now that probably doesn't mean much to you but for perspective, the traditional measure of serious water scarcity worldwide is a region that has less than 500 cubic meters of water per person per year. Under 1,000, you're considered water stressed, under 1,700, you may have domestic challenges growing all the food you need with agricultural systems and irrigation but again, California has about 2,500.

By comparison, Kuwait's average renewable water availability is 10 cubic meters per person per year, which is why . . . it's effectively zero, which is why they are completely dependent on desalination. The United Arab Emirates is 100, Singapore is 220, Israel is about 450, again, we are 2,500. I mentioned Kuwait, United Arab Emirates, Singapore, Israel, those are places that really ran into the wall of water scarcity long before we did and have done things that we still haven't discussed doing in terms of water policy. They already made decisions about investment and agricultural policy and recycled water and some of the things I'll talk about towards the end of my talk.

Our problem is not absolute water scarcity. There are enormous issues about distribution of water, how we distribute it, about variability and time, wet years and dry years and especially about how we use water. I'll come back to that also.

Poverty is not our problem either. We are a rich state. We are rich in money and we're rich in education and we're rich in ingenuity. We're a little less rich in good will but politically again, we're better off than many other parts of the world that have serious disputes over water.

Part of the problem is that those things aren't well distributed or fairly or equitably distributed. I know we have serious budget problems but the truth is we have plenty of money properly spent to deal with the water-related problems that we have. Lack of intelligence isn't our problem either. We've decoded the human genome; we manipulate substances at the subatomic level. We've eliminated some diseases permanently. We are using smart machines and technologies to explore the universe around us. Just in the last few weeks we discovered a lot of water on a moon of Saturn, Enceladus. There's another significant amount of water on another moon of Saturn, Europa. I'm sure somebody right now is planning the pipeline.

Lack of infrastructure is not our problem either in California; we have a lot of water infrastructure, in fact, more than just about any other place in the world. I think the recent proposals for a couple of more big dams or the pipelines or the tunnels through the Delta result in part from an old way of thinking about our water problems: the idea that we need infrastructure to solve our water problems. That's what we've always done, we've built infrastructure to solve our water problems so let's do more of it.

I'd like to challenge the assumption that a few more dams or a pair of tunnels through the Delta will finally solve our water problems. We might build them, we might build the tunnels, we might build a site reservoir north of the Delta, we might build one more reservoir on the San Joaquin River squeezed between existing reservoirs there. I would argue that even if we do those things, even if we can figure out the politics and the environmental challenges and the economics, at the end of the day, our water problems will pretty much look exactly like they do today because I don't think those are the solutions to our problems.

Each new investment in traditional water-related infrastructure comes at a higher and higher economic and environmental and political price. Ultimately, if not already—and maybe this is what part of the debate is—those costs are going to be too high to bear. I do think there's an infrastructure problem. In the rest of the world, there are places we've under-invested in infrastructure. In California, we've under-invested in maintaining some of the infrastructure we have. I do believe there's a role for some new concrete. I actually think what they're doing at Folsom Dam right now—very expensive retrofit to the spillway system—is a very smart idea at an existing dam. It's going to enhance our ability to reduce the risk of floods and at the same time capture more water on average. I'm not

opposed to infrastructure: I'm opposed to bad, poorly thought-out infrastructure that isn't really going to solve our problems.

I think we need to invest more in infrastructure to fix water quality problems. We build really high-quality tap-water systems in the United States and yet we're not investing in the modern technology to keep those systems up to date to deal with new water quality contaminants. There is plenty of new smart technology that's already being applied in places like Singapore that we could apply in the United States and in California. I'll come back to a couple of more examples of that too.

If our water crisis is not the result of a lack of water or money or brains or infrastructure then what is it? I think it's two things. I think it's a lack of vision for where we want to be, for what a sustainable water future looks like. I think it's a lack of a clear path from here to there, from where we are today to where we want to be. I think it's complicated by a morass of old law and policy and thinking and management institutions that developed over the first 150 years of the state's existence. I think that set of infrastructure in the broadest sense, including institutions, doesn't help us.

For the remainder of my talk, I'd like to offer an alternative future, a positive future for the state of California and where we are going to go. It may be an audacious plan for the future but before we do that, I wanted to read a couple of things. These aren't new issues. I've been asked to write an introduction to a special issue of *Scientific American* that's bringing together a collection of old essays in *Scientific American* going back 120 years about California water infrastructure. As part of that—it's shorter, it's like 800 words—but as part of that, they've sent me a dozen articles from old issues of *Scientific American* and I've been reading them.

They're really interesting; they talk about the construction of the Los Angeles aqueduct and the Hetch Hetchy system and the Colorado River aqueduct and the crisis with the Salton Sea when the Colorado River broke its bank and the amazing engineering feats that they did to seal it. These are great old stories but I want to read to you one . . . I was thinking I would read to you one and not tell you when it was from but the language is . . . it's interesting how the English language has changed.

This is from 1901, it's 113 years old and it talks about the chief obstacles to agricultural development and rational water policy in the state of California. You understand first of all, 1901 is before any of the big dams were built in California, before the major irrigation laws were put in place, before the 1914 senior water rights were adjudicated. It was really before modern California water in any sense of the word. This is what this 1901 article says are the chief obstacles to smart water policy.

“Unremitting production of low-value crops, unwise investments, over-appropriation of streams resulting in confusing uncertainty as to the number and extent of valid appropriations, the conflicting nature of water laws, private ownership of water” (and this is a quote) “in the face of the fact that all leading

countries where irrigation is necessary recognize only the rights of use.” Finally, and this is still a quote, “and most importantly of all, the absence of any state control over streams or of any state administration of rights of their use.”

I read that and I thought, “All right, so maybe we haven’t come that far.” How many of those problems do we still have that we still have not quite adequately resolved despite an enormous investment in infrastructure, despite smarter institutions that effectively deal with some of those things? One-hundred thirteen years later, where are we? More importantly, what do we want? I think we need to ask what we want.

Here are some things that I think we want. We want a strong economy that equitably allocates water and uses water efficiently. I’m going to pretend that left, right, ag, urban, environmentalists, that everybody is going to agree with me on these things that what we want but maybe not. I think we want healthy agricultural communities and agricultural production with less uncertainty. California is a great place to grow food. The soils in the Central Valley are fantastic, the climate is fantastic. There’s plenty of water for certain things and so I think we want healthy agricultural communities as a part of that state, despite the argument that agriculture provides only four or five percent of the GDP of the state.

I think we want urban water reliability and high quality service in our cities. I think we want successful restoration and protection of California’s ecosystems, aquatic ecosystems, and fisheries. I think we want collaboration and public participation in decision making over water.

How do we get those things?

Let me offer seven ideas. This is partly related to something we at the Institute call the Soft Path for the water. It’s an effort to develop a comprehensive overview of strategies for water worldwide. Much of what I’m going to say is related not just to California but the world.

First of all, we have to rethink the concept of supply. Water policy has traditionally been supply-oriented. How do we find the water that we want to do the things that we want to do? We build another reservoir, we build an aqueduct and move water from where we have it to want it, from the Sierra to the coast, from north to the south, we tap another groundwater well, we look to the next river basin, that’s sort of the traditional approach.

I think we are reaching what we call peak water. I think we are reaching the limits of traditional supply, certainly in California, but in many other parts of the world as well. But that doesn’t mean there aren’t new supply options. I do think we have to rethink the idea of supply and what we mean by supply. Let me give you a few examples.

First, new surface reservoirs may not be a good idea but groundwater storage may be a great idea. We over pump groundwater in California now. But if we could better integrate surface and groundwater systems together, we can store a significantly larger amount of water than we do currently in wet years that we can use in dry years. We don’t do that now. At the moment, even in dry years we

over pump groundwater. The idea of conjunctive use—managing surface and groundwater use together—is a new way to think about managing supply.

Second, we collect an enormous amount of wastewater and we treat it to a very high standard and we throw it away. Probably four or five million-acre feet of water a year of treated wastewater is thrown into the ocean. That's a source of supply. We can use treated wastewater for any purpose. We can produce treated wastewater of any quality we want including potable water. Even if we don't produce potable water with it, there are plenty of uses in California for non-potable water, for groundwater recharge, for ecosystem restoration, for power plant cooling, for watering landscapes. There are plenty of uses for treated wastewater, that's a source of supply.

The truth is, we've already collected that water. We've spent a lot of money getting it to us and using it and then collecting it again and treating it to a reasonable standard and then we throw it away. That's an asset not a liability; it's a source of supply.

Third, desalination is a potential source of supply. It's extremely expensive, it's probably the most expensive source of supply California has, but in the long run I think for some uses we may see more desalination plants once we've done some of the smarter cheaper things first. Tomorrow's cities are going to include numerous local sources of supply and sophisticated options for the collection and distribution of not just the traditional sources of water that we've tackled but new ones.

Another "soft path" strategy is to properly apply economic tools. Water has to be properly priced. The failure to price water properly leads to overuse of water. It leads to under-investment. It leads to poor economic decisions.

Most of us don't pay enough for our water. But water also has to be fairly priced to reflect the true costs of using that water, to encourage efficient use and to protect the poor who may have challenges and economic challenges in meeting their water needs. And so that means eliminating some subsidies for water. It may mean new subsidies for water in different areas. It means comprehensive monitoring and metering of all of our water use because if you don't meter water you can't charge for it. Tomorrow's water utilities will have smart water meters for everyone and smart pricing systems that cover all costs and investment needs and encourage efficient use.

We have to protect water quality and do a better job of matching quality and water demands. I've touched on this already in the new supply discussion. But we need to develop real time, inexpensive water quality monitoring technology and we need more serious and comprehensive efforts to protect water from contamination. The Clean Water Act and the Safe Drinking Water Act need a 21st century reboot. They're two of the nation's most important water laws. They're great but they need updating. They need to be brought into the 21st century. Different water uses require waters of different qualities. I've already mentioned that but the truth is, we can meet a lot of our needs with a lot of the water we already have if it were differently allocated and managed. Often the

best way to deal with wastewater is to figure out how not to produce the stuff in the first place.

The fourth “soft path” criteria is to restore and protect ecosystems. This is another issue that's at the heart of the current debate about California water. What's the value of natural ecosystems? What water rights or water resources or water allocations are available to ecosystems? What amount of water at what time of year is really required to improve the health of ecosystems? Where should that water come from? This is a tough one but again, going back to these old articles in *Scientific American*, not one of them talks about ecosystems or the impacts on streams or fisheries of these engineering miracles. It just wasn't part of the conversation then, but it is part of the conversation now. We may not agree among all the different interests how much water is required for ecosystems, but the answer is no longer zero.

Fifth. We have to expand our concepts of water management and regulation and we ought to develop some new institutions to deal with water management. We have to address growth in a responsible manner. Again, like we ignored ecosystems, we can't pretend that land use planning and water planning are different things. They're not. They're tied together. We have to move from federal and state water management to local water management where appropriate or to integrated regional water management. And there are efforts to move in this direction already. We ought to complement our extensive investment in centralized infrastructure with investment in decentralized infrastructure and small-scale facilities. And we need to bring local communities into decision making about water policy because they've often been excluded from our institutional structures in the past.

We've got to figure out what to do about groundwater. It's ridiculous that we don't have groundwater law in this state. We sort of squeaked by, but not really. I mean the truth is our groundwater problem is at the core of our water problem. As I said already, during an average year, even a wet year in California, we overdraft groundwater. That is we pump it out faster than it's naturally recharged, especially in the southern San Joaquin Valley. And it's allowed because we pretend there's no connection between surface water and groundwater and when surface water is scarce or allocations are limited, groundwater's available. That's a classic tragedy of the commons and we're heading for a disaster with our groundwater.

Six. Perhaps most importantly, we have to rethink demand. We have to do more with less water. We have to grow more food with less water. We have to wash our clothes and flush our toilets with less water. We have to produce more energy with less water. We have to do everything that we want with less water and that's this question of demand management and efficiency. Again, in the 20th century we took demand for granted. The assumption was, however many people we have and whatever water they want, we'll provide it. We'll build the systems to bring water to us and there was no questioning about demand. It was fixed. It was immutable. It was assumed. But our goal is not to use water, our goal is to do

things. It's to produce the goods and services we as a society want and most of those things require water but less water than we're currently spending to do those things. And that's this question of efficiency and demand management.

I actually think that in a place like California, where supply is really badly constrained, demand management offers the greatest opportunities for moving in the right direction. And in the best possible sign that this is actually already happening, more and more individuals and water districts and agencies and corporations and countries are doing this. The United States uses less water today than it used thirty years ago for everything, for power plant cooling and irrigation and commercial and industrial use. We use less water today for everything than we used thirty years ago. Our population is much higher. Our economies continue to grow exponentially, but our demand for water has not grown exponentially and there are many reasons for that, but one of them is we're getting more efficient at doing the things we want to do. And California uses less water than it used thirty years ago. And Los Angeles and San Francisco use less water. Communities around the country are doing this. And on a per capita basis those improvements have been even greater because population has grown.

On a per capita basis the U.S. uses less water, 20% less water than it used thirty years ago. And work done at the Pacific Institute suggests that the potential in California for continuing to improve efficiency even more, on top of the gains we've already made, is very substantial. We could really do a lot more with the water we already are using.

Seventh and last, finally, we have to integrate climate change in to all of the aspects of our water system and design, and use and management. We have to do what we can to reduce greenhouse gas emissions. That's the mitigation piece of this. But we also have no choice but to adapt to climate changes that we're not going to be able to avoid and a fact that we already see happening around us. So we have to mitigate emissions and we have to adapt to the unavoidable consequences of climate change. And some of the most important unavoidable consequences of climate change are actually on water resources, because the hydrologic cycle and the climate cycle are pretty much the same thing.

Higher temperatures are already increasing the demand for water in evaporative losses from our reservoirs and agricultural water needs. We're already seeing the loss of snowpack and the change in the timing of runoff from the Sierra Nevada. Earlier winter runoff and less summer runoff because what's falling is falling more as rain than snow. What falls as snow is melting earlier and running off faster and that's a water management problem for the existing infrastructure that we already have. We worry about changes in storm frequency and intensity off the Pacific or the likelihood of, or intensity of El Niño events and La Niña events, which determine the amount of water California gets and so on.

Rising sea level is going to affect the coastal ecosystems and push more saltwater into the Sacramento/San Joaquin Delta. And sea level is nine inches higher than it was over a hundred years ago and is going up faster and faster. So

we have to integrate climate change into all of these questions that I've already addressed.

All of these strategies together form a new way of thinking about the future. A new path. A soft path for water. And I think we're already on that path. We are rethinking supply. We are investing in conservation and efficiency. We're having a conversation about groundwater. That one's going pretty slowly. We're having a discussion about new management structures at the local level. There is a greater voice for local communities in water policy. I do think we're moving in the right direction.

The transition may be too slow. It's certainly slower than I would like. It may be too slow to avoid some of the impacts that I think we could avoid and in the long run I don't think we can wait another 113 years. Thank you very much.

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