



*Opening Session Keynote Address  
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## Leading Through a Time of Extreme Uncertainty

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I am very pleased and honored to have been invited as your keynote speaker this morning. I view this jointly sponsored conference of the Water Environment Federation (WEF) and the American Water Works Association (AWWA) as one of the most important leadership forums in our industry. Moreover, I also appreciated the encouragement to go beyond a purely technical discussion and reflect on the personal dimensions of leadership and decision-making in times of deep uncertainty and perceived vulnerability.

For about 35 years, I've worked with many of you as a water resources and infrastructure planner and project manager. You can be the judge, but what I think I'm good at is built around three skills: (1) communications, (2) project management, and (3) rational analysis and decision-making.

Communications has helped me understand the people and the problems I work with. Remember I am not an engineer and started working at an engineering company in 1975 as a technical editor. I needed to know what engineers, planners, and scientists were talking about. So that I could make sure the people they were talking to understood them. That's what good editors do.

I learned project management as essential knowledge in an engineering and construction firm, where nothing is accomplished without teams of people who understand how a project is structured, what the deliverables are, when they're due, and what resources (both human and financial) are available to produce the finished product. For the young professionals here, you must learn these skills.

But it was the rational decision-making and planning that really excited me the most. Answering the question: "What should we do next?" How do you manage the values, interests, objectives, and analysis-of-alternatives that are fundamental to deterministic decision-making regarding the future? And when I use the word "deterministic," I mean

decisions based on relationships that are causal and outcomes that are repeatable – all supported by reliable past data.

It's enough to say that my education had prepared me for all three. But honestly, I loved rational problem solving – particularly problems about the future. I became CDM's strategic planner in 1983, and helped persuade my management to invite the Wharton Professor who taught me strategic planning, Peter Lorange, to serve on our Board of Directors. I got to work directly with Peter and five CEOs of the firm over a period of from 1983 to through 2012. I was always interested in the future. Thinking that if we could predict what was likely to happen next, our business could be positioned to be "lucky" – and I mean that definition of luck, where opportunity meets preparation. And our clients could be positioned as well.

*What does leadership look like in a world where rational policies and management decisions are harder and harder to make – in the context of a future that is increasingly uncertain and change is occurring at an evermore rapid pace?*

But today, I really struggle with the challenges associated with predicting the future in water management. And I am increasingly conscious of how much our industry depends on being able to do that rationally. I ask you, what does leadership look like in a world where rational policies and management decisions are harder and harder to make — in the context of a

future that is increasingly uncertain and change is occurring at an evermore rapid pace? It feels like putting your foot down on the accelerator, while driving on a highway straight into dense fog — going faster and faster, while seeing nothing in front of you.

We are so steeped in the belief that we can quantify the outcomes and probabilities associated with our decisions – that the implications of non-stationarity (that is conditions that depart from stable historic patterns) as it relates to climate struck me as baffling. Because the foundations of our success rest, in large measure, on our ability to predict the future. And for many of the most important elements of decision-making (not all) we have lost our ability to reliably and prudently do that.

On top of that, the analytic computer-based modeling tools we use may give us a false sense of security regarding the answers they provide. They are still spitting out simulations and predictions based on historical data and extrapolated past trends. Just as concerning, the decision-makers we work with are uncomfortable drawing conclusions without these forecasts firmly in hand. I've never found that "We don't know" or "I'm not sure" is an acceptable answer to the councils, commissions, boards, and governing bodies we work for.

So, how serious is the problem I'm describing? And what's causing it? Because the loss of deterministic tools and reliable probabilities does not eliminate the need to make decisions, establish policies, and take action.

In fact, I'm sure that decisive and bold action **can** be taken in the face of extreme uncertainty. But the solutions we employ must not be based solely on predicted outcomes and probabilities. They will need to be based on appropriate decisions made in the context of a disorderly world, where insight and innovation emerge from creativity and imagination – a different place in the brain from where most management decisions stem.

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Why is this the case? Because, in my view, we are confronted with the convergence of at least two forces which will require a level of leadership and innovation unprecedented in our history – one is the deep uncertainty of climate change, and the other is the extreme complexity of our radical transition to one-water-solutions – and all of this while trying to maintain aging and outdated infrastructure.

It's unprecedented, in part, because each of these realities is accompanied by a significant breakdown in our traditional management tools and rational methods. But again, deep uncertainty can't be allowed to lead to inaction or denial; and extreme complexity shouldn't be mistaken for one more complicated problem that can be deconstructed, simplified and solved.

### **Complexity of the One-Water Vision**

Let's start with the extreme complexity of the one-water vision. We are in the midst of a revolutionary rethinking of how we view water management and infrastructure – the One Water concept. While our mental paradigm may have shifted, the implementation is enormously complex. And when I say that, I am not talking about the proliferation of technologies, urban landscape design, and societal changes that can theoretically replace our reliance on the expropriate, use once, and dispose of water infrastructure that dates back 2000 years. No doubt, like you, I'm optimistic about our technical ability to achieve a one-water vision. We are already seeing that transformation happening in California and around the world.

What I am talking about is the intrinsic complexity and chaotic evolution of the systems solutions that will lead to sustainable water management. It is not a command-and-control response to our future water needs. It feels more like an unwieldy proliferation of competing, uncoordinated, and disconnected efforts across radically different geographic and temporal scales.

It doesn't add up to a clearly articulated, top-down model of organized problem-solving and decision-making. And that's OK. But it's basically unmanageable in our traditional sense of management. It imposes very difficult choices for utilities regarding what's good for their direct customers, what's good for citizens who pay for services from multiple agencies, what's good for regions and watersheds where external one-water

initiatives may seem to interfere with local one-water strategies – where it seems like we are competing against one another to get there first and do the most – even though the sum of all we can do together still may not be enough. I can point to specific instances where these conflicts exist in the urbanized watersheds of Southern California. And it's likely, you have confronted these challenges yourself.

They leave decision-makers with a very difficult job. What are the appropriate boundaries within which plans should be drawn-up? Institutional boundaries, geopolitical boundaries, topographic boundaries, and temporal boundaries (that is how long is this plan expected to perform?).

Ultimately, as utility leaders you will need to set the boundaries yourself. And they will be based as much on your perception of both what's needed and what's possible than on the clearly defined borders established by your historic service area limits and responsibilities.

I would guess that almost all of you are participating in efforts that create benefits beyond the traditional boundaries of your predecessors' actions. How did you decide how far to go? When have you gone too far? Our rational decision-making models will not be able to answer those questions – because they almost always require boundary conditions to be established as the first step in the process, and your stakeholders won't agree on where they should be drawn – the very definition of what is described as a “wicked” problem (Kwakkel et al. 2016).

### **Deep Uncertainty of Climate Change**

And as if this complexity wouldn't be enough to make life difficult for managers, let's explore the deep uncertainty presented by climate change, as well as our ingrained desire to translate that uncertainty into something we define as “risk.” My first real awareness of the problem resulted from reading a bold statement that appeared in the February 2008 issue of *Science* entitled, “Stationarity is Dead: Wither Water Management?” The authors state that:

“In view of the magnitude and ubiquity of the hydroclimatic change apparently now under way . . . we assert that stationarity is dead and should no longer serve as a central, default assumption in water-resource risk assessment and planning. Finding a suitable successor is crucial for human adaptation to changing climate.” (Milly et al. 2008)

Most practitioners have acknowledged and accepted this concluding assertion, but few of us have been able to do much about it. Why is that so difficult? Well, we are not well equipped to deal with the uncertainty that a lack of stationarity in climate and hydrology impose on our planning, analysis, and decision-making. What to do when past data cannot be trusted to serve as the basis for predicting our water future.

For the record, I want to define my terms when describing “uncertainty” versus “risk.” These are definitions that go back to terminology introduced in 1920s by economist Frank Knight and adopted by the Intergovernmental Panel on Climate Change, the IPCC. “Risk” is applied to variables where a probability distribution can be defined reasonably well based on available historic data. That enables people to say things like “most often this will happen and very rarely these extremes will occur.” “Uncertainty” on the other hand refers to variables where the data or theories do not exist to apply a reasonably defensible probability distribution for future events. That is “I don’t know how often something is likely or not likely to happen, and I don’t know how benign or catastrophic it will be when it does.” This is sometimes referred to as “ignorance” (Ben-Haim 2006, 12) – but unfortunately for all of us that’s a term rarely employed by people who like to think of themselves as “professionals.”

### Sources of Uncertainty

What are the sources of uncertainty that are embedded in the IPCC’s analysis of climate change? They can be divided into three primary categories:

First and (in the long-run) foremost, we don’t know how the people of the world will respond to increasing green house gas emissions. The IPCC employs several green house gas emissions scenarios reflecting plausible societal responses to climate change together with resulting differences in the radiative forcing that drives increased temperatures. In this first step, there is no historical data or theory that can be used to credibly assign probabilities.

Second, it's not easy to simulate global weather over long periods of time, even if you could predict future levels of greenhouse gas emissions. Consequently, the IPCC relies on widely varying results from 20 global climate modeling teams.

And finally, these compounding uncertainties are increased again by the imprecision of downscaling climate modeling results for use in local and regional planning. The consequence of this is a wide range of possible futures that illustrate the immensity of the challenge, the inevitable upward direction of changing temperature, and the plausible severity of its planetary impacts. But when it comes to the question of what will it be like in Southern California over the next 20 years? There’s no way to predict that with any certainty. And yet today, we’re spending significant amounts of money on projects that are expected to work for at least 50 years or more.

### What can be done about it?

So what can be done about these problems of extreme complexity and deep uncertainty? They are not the kind of problems that left-brain analytics and computer modeling tools can solve. And as a reminder of what I mean by “left-brain” thinking let me quote a popular book on the topic by Daniel Pink, entitled *A Whole New Mind*.

“In general the left hemisphere participates in the *analysis* of information,’ says a neuroscience primer. ‘In contrast, the right hemisphere is specialized for *synthesis*; it is particularly good at putting isolated elements together to perceive things as a whole.’ Analysis and synthesis are perhaps the two most fundamental ways of interpreting information. You can break the whole into components. Or you can weave the components into a whole. Both are essential to human reasoning. But they are guided by different parts of the brain.” (Pink 2006, 22)

So, trying to use our whole brains in a professional way, my friend and colleague Enrique Lopezcalva and I developed some practical recommendations for addressing the complexity and uncertainties I have described.

1. **Make sure that extreme uncertainty is a fundamental consideration throughout the entire planning process**  
If the predicted effects of climate change have been reduced to a single probabilistic hydrologic forecast, then the most basic dilemma regarding how to deal with deep uncertainty has been simplified out of the decision.
2. **Ensure that decisions are robust and flexible under a wide range of possible scenarios developed by a widely diverse group of stakeholders**  
Three good examples of analytical approaches that do not rely upon predictive models are *Info-Gap Decision Theory* (IGDT) developed by Yakov Ben-Haim, *Dynamic Adaptive Policy Pathways* (DAPP) developed at Delft in the Netherlands, and *Robust Decision Theory* (RDT) developed by the RAND corporation.
3. **Correctly value flexibility in the analysis of costs and benefits**  
Quantify real savings that result from the ability to rapidly expand or shed capacity, as well as quantifying the benefits associated with the timing of expenditures, and the resolution of some uncertainties over time for better or worse (new technologies and extreme events).
4. **Encourage real options and future flexibility in the development of alternatives being considered**  
Be creative in the solutions that are identified. Large scale, centralized, single purpose, barrier-based solutions are an excellent response to highly predictable future conditions. Unfortunately, in water resources planning, highly predictable outcomes are a thing of the past. Find new approaches in solutions that provide redundancy, are modular, have rapid response times, distributed functionality, and offer increased levels of immunity to the hydrologic cycle. And be less concerned about the apparently chaotic proliferation of these distributed solutions at multiple scales in overlapping geographies. Remember, proactive investments to increase preparedness

and flexibility must be proposed before they can be evaluated and decided-upon. Don't leave them out as alternatives.

5. And finally, draw on your own inventiveness and creativity as a leader rather than your training as professional manager

The analytics of orderly thinking are not enough in the disorderly context of extreme complexity and uncertainty. Leaders who can bring their whole brain (left and right hemispheres) to the decision-making process will be far more effective than those who are limited to divide-and-conquer, command-and-control approaches – which happen to work splendidly in managing most utility functions, but fail us miserably when tackling the wicked problems of the world.

### What does this mean for you?

And it's this last recommendation that I want to end on. The most important challenge that faces you in addressing these issues may require a fundamental shift in your approach as a leader, and a much greater reliance on the so-called right-brain characteristics that we all possess. And this is difficult in an industry that relies almost entirely on left brain skills that make us sound managers and dependable decision makers.

In his book entitled *On Becoming a Leader*, Warren Bennis begins the chapter called "Operating on Instinct" with a citation from Mark Twain's *Life on the Mississippi*:

"Two things seemed pretty apparent to me. One was, that in order to be a [Mississippi River] pilot, a man had got to learn more than any one man ought to be allowed to know; and the other was, that he must learn it all over again, in a different way, every 24 hours." (Bennis 1994, 101)

That rapid relearning of everything every day could be called acting on "instincts." If you have been trained as an engineer, this might just drive your left brain crazy. This is an appeal to a whole brain approach that is informed by – but not enslaved by – the need to fully apprehend and understand outcomes before taking any action. If you have been trained as a Marine, this whole brain approach is what is expected of you in battle. If you are my brother-in-law, a decorated officer retired from the Massachusetts State Police, it's what you do the second after breaking through the door during a drug bust. It's not that you don't plan, but you realize that your planning is only there until reality takes over and it goes out the window.

Does it mean you don't try and obtain every bit of intelligence and plan for every contingency you can dream-up prior to taking action – of course not. But it recognizes that in the "fog of war" leaders make decisions without knowing exactly what the consequences will be ahead of time. Decisions that can be easily second guessed by

critics with the same information and intelligence that you have – but without your authority, your responsibilities, and your instincts.

The U.S. Marine’s training publication called *Warfighting* describes it this way:

“Because we can never eliminate uncertainty, we must learn to fight effectively despite it. We can do this by developing simple, flexible plans; planning for likely contingencies; developing standing operating procedures, and fostering initiative among subordinates.” (U.S. Marine Corps 1997, 8)

“A military action is not the monolithic execution of a single decision by a single entity but necessarily involves near-countless independent but interrelated decisions and actions being taken simultaneously throughout the organization. Efforts to fully centralize . . . operations and to exert complete control by a single decision maker are inconsistent with the intrinsically complex and distributed nature of war.” (U.S. Marine Corps 1997, 13)

The challenges I have cited seem overwhelming only if we continue to rely solely on the decision-making tools and traditional solution set that has served us for hundreds of years. Adding a dimension to our plans and actions that is driven by the need for preparedness, flexibility, options, and rapid response to unforeseeable circumstances can dramatically reduce our vulnerability.

But the tools that created our traditional management responses will never produce the change we need. Your leadership can and will if you realize the fog which impairs our ability to see what's ahead of us is the fog of war. It requires action not acquiescence. It demands leadership not indecision and procrastination. Waiting for the answers to present themselves invites definitive, but potentially disastrous outcomes.

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This is one of the most unteachable characteristics of leadership – because it is not based on rational decision-making, it’s based on your talent, imagination, and creativity in times of crises. It doesn’t look back at a plan that will tell you what to do. It looks forward in the moment to everything that will happen

next. It’s deep instinctive understanding of context and the complex systems that surround us. It draws on the part of the brain that tells you “this is too good to be true” in spite of claims and evidence to the contrary; or conversely “all we have to fear is fear itself,” – blatantly denying the facts that have us terrified. Where does this knowledge come from, and how do you find the extraordinary courage to act on it? To know it’s so and ask others to follow your lead.



The German military strategist and philosopher Claus von Clausewitz, who first described the fog of war in his 19<sup>th</sup> century classic *On War* wrote:

“Finally, the general unreliability of all information presents a special problem in war: all action takes place, so to speak, in a kind of twilight, which like a fog or moonlight, often tends to make things seem grotesque and larger than they really are. Whatever is hidden from full view in this feeble light has to be guessed at by talent, or simply left to chance. So once again for lack of objective knowledge one has to trust to talent or to luck.” (Clausewitz 1993, 161)

*Warfighting* concludes that:

“The conduct of war is fundamentally a dynamic process of human competition requiring both **the knowledge of science** and **the creativity of art** but driven ultimately by the power of human will.” (U.S. Marine Corps 1997, 19)

These characteristics of leadership are the appropriate response to the deep uncertainty, extreme complexity, and daunting challenges facing our industry. We must never abandon the analytical rigor of our decision-making methods and tools – they will continue to support the management of our utilities day-in and day-out. But it simply isn’t enough. You must lead us to where those antique navigational tools will never point – because they are fundamentally anchored in the past and are incapable of guiding us on a safe and secure voyage into the future. Like Twain’s Mississippi River pilot, you must learn more than any single person ought to be allowed to know, and be prepared to relearn it all over again, in a different way, tomorrow – always driven by the power of human will. You can do it.

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