Climate Change and Reservoir Water Supply Planning
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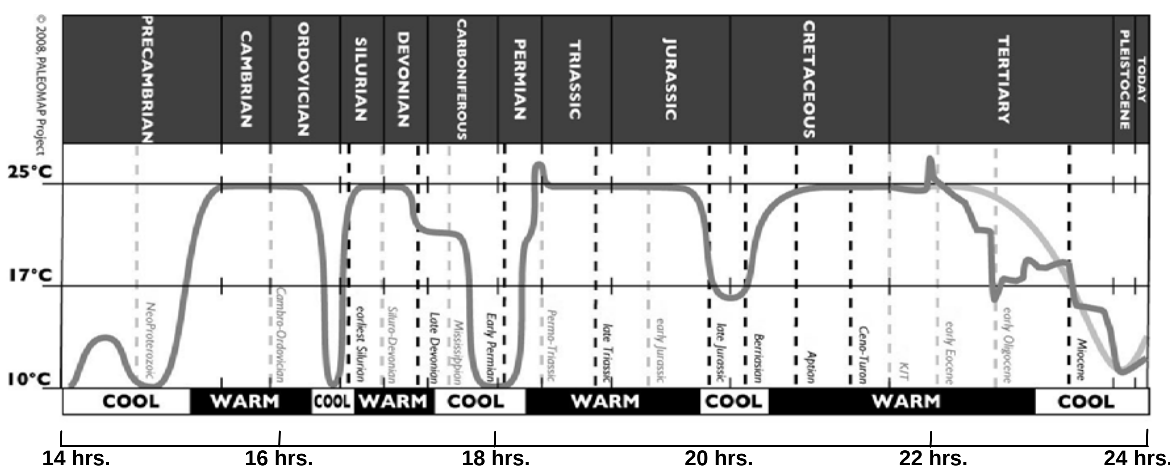
We are immersed in media coverage and concerns related to global warming, climate change and climate variability, which represent a range of perspectives and time scales. In general, discussion of the non-fixity of climate was gaining in volume and urgency until the current economic crisis. It will no doubt return. Prevailing attitudes and beliefs include Al Gore "inconvenient truthers" certain of a 20-foot rise in sea level this century. It also includes conspiracy theorists believing the climate change movement is solely a left wing scheme to wrest power and dollars from people and businesses in order to expand the influence of government over our lives.

Global warming and climate change are discussion points that have attained political momentum and become a major pop culture theme. However, if one takes the long view of the situation – say around 4.5 billion years - the purported age of our planet – it is easy to see that change has been with us from the very beginning, and there is no reason for us to believe that things have somehow settled out. The non-fixity of climate becomes a brilliant statement of the obvious.

The land we stand on was once in intimate contact with Europe. The seas have risen and fallen mightily, in concert with growing and shrinking ice caps. If the age of the earth is shrunken to represent a single day, there appear to have developed fairly regular two-hour supercycles of fluctuating greenhouse and icehouse conditions, each carrying shorter term variations to add a touch of complexity. Continuing the 24 hour earth history analogy, the last ice age ended 0.2 seconds ago - and a Medieval Warm Period occurred about 0.02 seconds ago.



We can't dispute that the activities of man have and will continue to have an effect on terrestrial, aquatic and atmospheric conditions. With the human population of the world approaching 7 billion, how can it be otherwise. Mankind's impact on the planet is clear at the local level, especially in and around cities. It is much more difficult to define globally, and even more difficult to establish defensible cause and effect relationships that separate out man's activities from a plethora of naturally occurring conditions related to global temperature.

A portion of my skepticism regarding the magnitude of human influence comes from personal pushback to what I call 'global warming enthusiasts' – those that for a range of personal reasons find the idea of man-induced climate change suited to their purposes and, therefore, deem to make it so.

Jennifer Marohasy, an noted Australian biologist wisely stated:
"A consensus of 60 or 60,000 scientists is not science. Consensus is the business of politics. Science, on the contrary, requires only one investigator who happens to be right, which means he or she has results that are verifiable with reference to the real world. There is a need to take environmentalism out of science. This is going to be even harder than moving beyond politics, because religion can be even harder than politics to deal with."

Now for some much shorter-term historical perspective and practical wisdom from an old civil engineer: Civil engineers are practitioners that plan, design, build and manage infrastructure. Work in the water resources arena relies heavily on climatological data. Major water supply projects are generally planned and sized on the basis of 50 year projections in demand, which is itself an empirically developed process with a great deal of uncertainty. In practice, we tend to do what we do based on practicality and reason. What better approach exists for modeling a river's flow conditions for the next fifty years than to use the immediate past fifty years of accumulated flow data. And while we plan for a finite period (typically 50 years[1]), many owners and much of the public expects these facilities to continue to serve unabated for much longer time frames.

Over the past several decades, there has been steady movement in the water supply planning regulatory process. Over time, permitting for reservoirs has required the applicant to jump through more hoops, the hoops are higher off the ground and they are getting smaller. Twenty years ago, there was limited scrutiny of population projections, per capita demands, yield analysis parameters, water system operations and drought contingencies. Some additional scrutiny has been merited to cull out those that would otherwise abuse the process. Engineering parameters and analysis processes are now thoroughly scrutinized and questioned on an individual basis. The pre-minimized individual considerations are then merged into the overall analysis framework to derive the outcome. The integration of a set of minimized elements provides a minimum solution – one with a marginally small probability of meeting the need being addressed.

Engineers recognize that there are many variables beyond our control and typically apply 'factors' to estimate their effects or to provide a margin of protection from bad outcomes. Historically, the planning process incorporated a fudge factor to projected population, or a bump in expected per capita demand, or added reservoir storage; each in recognition that analyses cannot fully articulate every consideration and projections of future conditions include considerable judgment and guesswork. These factors are applied to enhance the probability that the planned outcome would actually be obtained. Until very recently, we have not given serious consideration to the effects of climate non-fixity on our projections, nor would we have had a chance of securing approval for such a proposition.

[1] While some stations do provide stream flow data for 50 years or more, it is recognized that many do not. Also, in many cases, stream flow data must be obtained from other regional locations and calibrated for local use.

In today's world, regulatory agencies, resource agencies and environmental advocacy groups, at the local, state and federal levels, have become more technically adept, better funded, more broadly supported and more zealous in questioning every step within the process. Parameters and analysis processes are thoroughly scrutinized and questioned. Each consideration now has to withstand individual scrutiny and stand alone. The victim in all of this has been the factor of safety, the engineer's trusted sidekick for dealing with unknowns and unknowables. There hasn't traditionally been a separately identified, discrete factor of safety applied to population projections, demand forecasting, streamflows, reservoir evaporation, or reservoir yield analysis.

Climate considerations (streamflows, evaporations) have always been tacitly adopted as a predefined constant within the planning phase, and arguments related to unforeseeable risks and factors of safety have been quietly eliminated from the process. In response to environmental activism, we have allowed ourselves to be bullied into accepting a minimalist approach, while knowing that this will translate into projects that won't meet the sponsor's needs over the adopted planning period. The time has come to reassert a recognition of the 'art' of water resources planning. Recognition of the variability and unpredictability of climate (non-fixity) by the environmental community provides an opportune vehicle for engaging permitting and resource agencies regarding reestablishment of both reason and caution to the planning process.

Even if climate is assumed to be unchanging, development of 50-year projections and execution of capital programs to effectively serve for 50 years or more demand factors of safety to cover a multitude of unknowns and unknowables. In 1960, we had little idea of what our world would look like today, and we today have little idea of what it will look like in 2060. Despite the obvious reality of this, we currently find themselves badly in need of traction regarding factors of safety related to water supply development. Knowing that climate does drift, the need to prepare protective 50 years projections require that we include even more significant factors of safety.

Whether man-induced or not, the recognition of climate change provides leverage in that climate change is broadly believed by and supported by the environmental community. While it is doubtful that we will be able to recreate stream flow variations from sediment samples, ice cores or tree rings, there is great leverage in advancing our understanding of historic climate variations and applying good science in developing justifiable forward looking indicators. Climate change allows us to bring these issues to the table and have them heard, and it opens the door for restoring responsible levels of conservatism appropriate for these critical long-term infrastructure projects. It is imperative that we take advantage of this opportunity to reinstate a healthy factor of safety into the planning and design of critical water supply facilities.

All interested parties need to recognize that many of these critical, costly and vitally important source of supply development programs are to serve the needs of small to mid-sized water providers that work with moderate revenue bases, and have limited breadth and depth of staff expertise to direct towards these type of disruptive, infrequent and costly capital program considerations. For growing communities confronted with major economic and population growth, demand growth within a typical planning horizon can be from several times to an order of magnitude increase over current deliveries.

Planning, permitting, funding and implementation of a source of supply development program for these utilities is an overwhelming process that is further intensified by a complex of layered regulatory requirements. It is not a process to be taken on lightly, and it is not one that many water utility managers would choose to have repeated within their careers. It is therefore incumbent on all involved in the process to partner for thoughtful protection of both the impacts to the environment and the needs of the applicants, including the impacts on the citizens and communities that they represent. Failure of a water supply due to under-sizing presents unacceptable consequences to public health, fire safety and the economies of the communities the water system serves, while a moderate over-sizing of a source of supply merely defers the timing of need for an additional water supply source and provides the opportunity to better assist in serving a neighboring community during critical drought periods.