OPINION PIECE

California Water Governance at Risk:
Losing Ground to Climate Change at the Operational Level

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With growing predisposition, perhaps no other term in contemporary water resources management invokes the diversity of perception, opinion, and conviction as *climate change*. Once a topic of relative anonymity, it has become a regular part of our modern day lexicon carrying with it the various advantages and disadvantages that go along with such notoriety.

The central thesis of this opinion paper expands upon that presented earlier this year at the 27th Annual California Water Law & Policy conference in San Francisco. That paper, titled, "*Accelerating Climate Change: How a Shifting Flow Regime is Redefining Water Governance in California*" attempted to demonstrate how a rapidly shifting hydrologic baseline is not only changing the way we practice water resources management but also warned of how our complex governance structure has not kept pace with such rapid changes -- with little indication, in fact, that it can without a deliberate commitment by our water leaders, practitioners, and stakeholders. By *governance*, I am referring not so much to overarching legislation that recognize climate change, since even in a non-Kyoto nation like the U.S., such legislation exists. Rather, I call attention to the static nature of our existing water-related regulatory benchmarks, and in particular, focus on the need to update these long-standing laws, the paucity of operational on-the-ground detail to help water managers decide what to do today, and the genuine risks of maintaining the status quo. Climate change, regardless of causation, is affecting our hydrology in ways never before experienced or contemplated. Conscious intervention is what is needed now. For us to remain effective, *The old must remain compatible with the new*.

The earlier paper, by necessity, devoted considerable attention to presenting evidence of recent climatic trends and discussing some of the implications of this prodigious shift in California hydrology. For this current paper, it is assumed that the reader accepts this hydrologic reality, with this paper focusing more on specific examples of how our long-standing water governance structure can and will likely continue to lose ground to a shifting hydrologic baseline. A statement in my earlier paper declared somewhat daringly;

From a hydrological perspective, the fundamental baseline upon which we have developed our entire water resources management framework is shifting – governance needs to shift along with it or risk regulatory irrelevancy

While the legitimacy of this outlook may seem obvious, the challenge lies in convincing a still skeptical public and more importantly, our collective governance leaders that indeed, not only is this change occurring rapidly, but the speediness with which these changes are occurring is outpacing the relevancy of many of our existing laws, regulations, and rules. Moreover, the very compliance, approval, and enforcement-related measures that were developed to safeguard against undesirable environmental effects are becoming increasingly ineffective under a changing hydrologic regime. At some point in the future (and perhaps this point has already been reached), many of the permits, licenses, Biological Opinions, and operating rules, to name but a few, if left unattended, will simply not be able to appropriately account for the current conditions of the day. Their relevancy will have become compromised.

There is certainly no shortage of scientific evidence that these changes are occurring, and while there is a growing assemblage of agency policies, mission statements, and strategic visions directed towards climate change *per se*, this same level of commitment has not manifested itself into timely changes in legislative governance *operationally*. Prevailing substantiation notwithstanding; failing to learn from our past mistakes, we seem destined to remain reactive.

Many reasons lie at the root of our apparent institutional and legislative idleness; suffice to say many factors -- political, economic, socio-cultural, and administrative all play a role. Most are notably provincial in their influence. Such insularity acts to undermine the prescient need to address governance changes comprehensively and with a greater sense of urgency. An upcoming paper will explore some of the societal and socio-cultural aspects of climate change, including discussion of the definition itself -- how the term not only represents a modern-day misnomer and is, therefore, partly responsible for much of the anxiety, passion, and possible resentment associated with its use.

Let us turn to some examples of how we are currently addressing climate change and how a shifting hydrologic baseline is increasingly inhibiting our ability to accurately meet our water resources planning, implementation, and enforcement obligations given our existing governance structure.

Interestingly, now in the second decade of the new millennium, many environmental documents today still treat climate change as if it were some uniquely separate resource category. Typically, climate change gets shuffled into a separate chapter or section in various environmental documents; such as EIRs. As is often the case, it remains an afterthought, decoupled from the critical analyses that directly affect many of the document's salient impact conclusions. However, climate change is not an isolated resource, nor is it some ancillary topic. A few sidebar paragraphs can never hope to adequately capture its overall implications. Rather, it is a prominent *physical driver* affecting all resources and arguably no more so than its effects on hydrology. Climate change must, therefore, at a minimum, be *applied* universally across all water-related resources and be employed *a priori*.

What is the most effective way of accomplishing this? By incorporating it into the hydrologic baseline. For it is against this baseline that all water-related resources are ultimately assessed. Resources such as water quality, flood control, hydropower, riparian health, fisheries, water-related recreational activities, groundwater, levee stability, wetland/refuge function, etc., all must be evaluated against a standard environmental baseline. What better (and arguably easier) way of addressing climate change than to incorporate it into a singular hydrologic baseline before any impact analyses are undertaken? Climate change is not a separable physical process that can be correctly represented by post-processing modeling output data or through subjective narratives.

In other words, today's environmental documents must carefully and fully explain up front, how the environmental baseline, take hydrology for example, has been bias corrected and accounts for climatic forcings. It need not attach causality to the shifts, but must acknowledge and describe the assumed forcings. Discussion should include explicit explanations of which forcing models (GCMs) were adopted, the range of perturbation across applied GCM ensembles (i.e., the climatic forcing sensitivity), how such climatic forcings were downscaled, the spatial acuity of that downscaling, which translatory models were used to convert forced hydroclimatic data into adjusted runoff response, and the assumed limits of those forcings. Only then can we be assured that the potential effects of climate change have been acceptably integrated into our effects analysis. Accordingly, it stands to reason that before system-wide operational models (e.g., CALSIM) are implemented, properly adjusted inputs (as a result of climatic forcings) must be made. We need to verify how much water will be available in our upstream reservoir systems and when such fluxes will become available before attempting to run any system-wide routing simulations.

Unfortunately, few environmental documents today do any of this with rigor or consistency. Without proper guidance (in say, the CEQA Guidelines or CEQ adaptations), this is somewhat understandable. Investigators are left to their own devices and typically address the quantification of climate forcings in an *ad hoc* manner at best or, at worst, omit this vital detail altogether.

In my previous paper, I discussed the need to significantly reduce if not discard our long-standing (and perhaps irresistible) urge to rely on historical hydrology. For in some ways, a subtle disjunctive syllogism is perpetuated when we do so -- *yesterday's hydrology must be a reflection of tomorrow's*. However, such *modus tollendo ponens* while perhaps convenient, ignores the fact that hydrologic stationarity never was. Hydrologic variability is an incontrovertible truism, redundant in its expression, almost as sure as if one were to use the phrase "wet water" or "round earth". Our perception that climate should be stable and, therefore, predictably respond according to our limited experiences (past observations) has led to the growing disconnect between what has happened in the past and what we think will happen in the future. There is unanimity regarding our past (and in many still lingering instances) exclusive reliance on historical hydrology. As Julie Kiang, of the U.S. Geological Survey recently stated, "*We are riding a bicycle backwards if we look only at the historical record*".

The earlier paper identified several examples of where a shifting hydrologic baseline is affecting our ability to properly manage today and plan for tomorrow given our current and largely static water governance structures. Examples were provided for water rights, federal/State allocations, reservoir operations, Delta management, etc. Here, we expand on some of those discussions and water supply is a convenient place to start. We might ask ourselves, "*When was the last time a water right or federal contract was amended or re-opened for negotiation due to a changing hydrologic regime?"* Contractors and water right holders, entering into long-standing agreements assumed a level of delivery and accepted inter-annual reliability variances but, and this is the crux, did so based on the *anticipated* hydrology of the day. There was a presumption, based on computations at the time of what their likely deliveries would be on an average annual basis. The contractors accepted this as part of the *quid pro quo*. These results of course, were derived from calculations based on the historical record. With that fundamental hydrology now changing, so too will the expected future yearly reliabilities.

While new regulations, directives, and policies continue to surround various defining aspects of annual allocations, no similar investment has been made to re-assess how those contracts will be affected by shifting yield availability, the quantification of those shifts, and their geographic differentiation. More importantly, little has occurred in taking the necessary steps to revise those contracts to address these obvious changes in gross environmental conditions. We expend considerable effort in constraining contract deliveries due to "environmental" needs but, do not devote the same level of effort evaluating the fundamental baseline upon which those environmental needs are based. In other words, while listed species needs generate considerable attention and, in fact, represent a primary factor in constraining deliveries, little or no attention is given to a shifting hydrology. Both, however, are part of the natural hydrologic environment. The water contracting *playing field* has clearly changed; yet the rules are still the same. This inequity will impose increasing adversity to water contractors across California in the future.

From a water rights perspective, similar challenges exist. Any new water right applicant is required to undertake a Water Availability Analysis to confirm the availability of yield from those watershed(s) upon which their water right would be exercised. A proper analysis today would seemingly imply that climate-adjusted hydrology be factored into any such study. On the one hand this could bias a new applicant, relative to pre-existing water right holders since they would be obligated to prove "availability" under climate change, while others, who preceded them would not. But is it completely skewed against new applicants? Not necessarily. Long-standing water right holders who, have not taken the time to investigate how a shifting hydrologic regime may impair their own long-held water delivery expectations, could find themselves increasingly less likely to acquire their full entitlements based on their permitted periods of diversion. As demonstrated in the earlier paper, a rapidly shifting hydrograph may soon obviate long assumed diversion potential for many water right holders.

Throughout California over the years, many watershed agreements or compacts exist where negotiated water allocations have been developed between interested parties. Locally, the Sacramento Water Forum Agreement serves as an excellent example. This landmark agreement essentially ended the long-standing fight between local water users, exporters, environmental groups, business interests and other stakeholders that, over time, each laid claim to the vital water resources of the lower American River. Essential to the agreement was the negotiated water

allocation provisions under each of the purveyor-specific agreements (PSAs). Annual allowable diversions were based on a metric defined by the March through November unimpaired inflow into Folsom Reservoir (UIFR) with allocations derived on a sliding scale for the UIFR (and defined what was termed, the "dry-year wedge" or, simply, the "wedge"). The UIFR was based on an analysis of the historical runoff from the upper catchment of the American River watershed. Under a changing hydrologic regime, with much of the volumetric response in the American River watershed and, in fact, most Sierra Nevada catchments coming earlier in the year, this metric may no longer be reasonable -- as it may increasingly truncate a larger portion of the peak runoff period (e.g., January and/or February). If left unattended, the current application of the UIFR-based "wedge" could increasingly underestimate its intended objective of gauging primary watershed runoff into the reservoir. Accordingly, Water Forum purveyors may find themselves progressively more challenged to realize benefits from defined "above wedge" year diversions as the hydrograph node migrates outside of the March through November period. Again, this example demonstrates the fundamental issue that serves as the central theme of this paper; namely, that today's governance *instruments*, whatever they are, were all based on a historic hydrology -- one that will no longer adequately represent current, let alone future conditions.

Perhaps the best example of California's complex water regulatory *instruments* is the well known compilation of water quality objectives contained in the Bay Delta Water Quality Control Plan. Key water quality, flow, and habitat objectives are included with many having gained colloquial recognition -- Delta outflow, X2, E/I ratio, etc. Each objective is established and regulated through a variety of hydrologic parameters (e.g., WY type, current month, geographic location, etc.), and based on the assumed combined operational, ecological, and biological needs of the system. Most importantly, however, the fundamental hydrologic metrics were originally developed at least in part on an analysis of the historical record -- and therein lies the problem. For we can ask, how representative are these objectives today of current Delta inflow conditions when we know that system hydrology has changed and continues to change? Having ascribed certain minimum in-Delta flow conditions by month, we did so with the understanding that historical inflow to the source (i.e., upstream) reservoirs together with mandated operations would, or at least could, continue to provide the vital hydrologic flux necessary to meet those objectives. We assumed upper basin storage supply would always be there when we needed it. But what happens when the source reservoirs no longer possess accumulated storage on a *schedule* we once assumed would always be present?

Such potentialities compel us to inquire even further. Not only are we obliged to ask whether these objectives are being adjusted in light of the primary changes occurring in upstream source area watersheds, but how that analysis (assuming it is being performed) is being integrated with other known critical operational mandates such as flood control? Reservoir operations, as we all know, not only involve maximizing carryover storage for supply purposes, but also requires delicate timing in maintaining vital empty space during the flood season. While the magnitude of the encroachment curves may decrease in the future (owing to a reduction in the effect of spring freshets with a diminishing snowpack), the earlier availability of incident precipitation (no longer distributed as snowfall) may require a more protracted encroachment curve and one with an earlier onset date.

The above discussion demonstrates the complexity and risk even when focusing only on changes to upstream supply sources. Consider the potential effects from the *other* direction. Tidal dynamics, storm surge frequency, and ambient salinity migration due to changing sea levels can exert an equally adverse effect on the Bay Delta and significantly inhibit the ability to meet current water quality objectives. Simplistic assumptions related to global average sea level rise are not sufficient. One must look carefully at nearshore current dynamics, eastern Pacific circulation, and ENSO-related cyclicality, as local sea level change can deviate considerably from the changes in global mean sea level. Even at its most rudimentary level, avoiding inland saline intrusion will require additional outflow from the inland areas across all months. Current operating rules (e.g., Operations and Criteria Plan) for Delta water quality, however, do not account for such systemic and empirical processes associated with sea level rise.

Admittedly, in some governance documents, change is being acknowledged. In Biological Opinions for example, re-initiation of consultation, as defined under the Endangered Species Act (ESA), is available where, "*...new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent <u>not previously</u>*

considered....". [Emphasis added] Clearly, however, this ESA provision is directed towards possible changes in an agency's action. The same weight or probability that the natural environment may change does not appear to be given equal credence. Anyone reading the recent Biological and Conference Opinions for the Long-Term Coordinated Operation of the CVP and SWP will know that the RPA Actions are notable in their attempt to address certain biologic requirements. As an example, regarding Shasta end-of-September storage at or below 1.9 MAF, the RPA Action I.2.2.C states, *"...Reclamation should take additional steps in the fall and winter months to conserve Shasta storage to the maximum extent possible, in order to increase the probability of maintaining cold water supplies necessary for egg incubation for the following summer's cohort of winter-run."* While the biologic validity of such statements is not argued, we may question whether they consider the operational challenges facing reservoir operators as they struggle to contain a new hydrologic winter flow regime where inflows are expected to increase, relative to past conditions? For Shasta Reservoir, how will the need to "conserve storage", as stated in the RPA Action, be countered with increasing flood encroachment from anticipated inflow increases from the Pit and McCloud watersheds, both of which are anticipated to experience significant snowpack reductions in the future?

From this example, one may step back and formulate a broader inquiry, "*Is there a regulatory provision in the ESA that even provides re-consultation based on a changing baseline*?" A good question. When, for example, was the last time a Biological Opinion or its RPA Actions were re-opened for discussion due to important changes in baseline hydrology? Surely, with the accepted notion that baseline hydrology has changed say, over the last decade, such queries would now seem legitimate. The pioneering 1992 Winter Run Biological Opinion for example, was completed at least a decade before climatic shifts were recognized in California water resources management and almost two decades before any deliberate attempts were being made at including climate modeling in ESA-related hydrologic analysis. Are the fundamental prescriptions in that Biological Opinion still appropriate? And moreover, has there been any attempt at re-opening that specific consultation? Again, interesting questions. To be sure, Biological Opinions, such as the CVP-OCAP, referenced earlier, contain adaptive elements or working groups (e.g., WOMT, B2IT, and HSG) that consider seasonal adjustments and help ensure that the intent of the Opinion(s) are met. While such adaptive measures are certainly notable, consider that an updated hydrologic baseline would undoubtedly improve the ability to assess whether current provisions are adequate and reduce the likelihood of, and requirement for, large seasonal adjustments by the working groups.

The preceding few examples demonstrate how our traditional reliance on historical hydrology and long held perception on hydrologic consistency have been embedded in many governing approvals, permits, agreements, and environmental assessment documents. The inconvenient truth is that we still devote much of our investigative efforts on various new water resource initiatives, impact analyses, water quality protection, and species recovery endeavors without perhaps paying equal attention to the intrinsic hydrologic baseline upon which those and other actions depend. While challenging enough, just given inherent natural system variability, forced climatic shifting is presenting us with a moving target. While there is no assurance that we can effectively update our antiquated governance instruments so as to conceivably *catch* that moving target, we have by and large opted to not even try. Left unattended, the unfortunate result is that there will be losers on all sides. The water users (or those being regulated) will likely become increasingly frustrated as they are bound to meeting regulatory constraints that, under a changing hydrologic regime, will no longer be relevant or achievable. From the regulators perspective, an equally impracticable situation develops as they will likely expend more effort monitoring irrelevant standards, negotiating variances, or prosecuting avertable infractions. It is clearly a no-win situation for all involved.

To be fair, those of us on the analytical side also have a genuine responsibility on this issue. We need to question the legitimacy and accuracy of the data we are analyzing and so, offer up a collective voice of what is expected (in order to properly address the effects of climatic forcings on hydrology). Currently, however, this is rarely practiced with any consistency. Consider, for example, that most of our analytical efforts hold the presumption of some *future* application. In other words, when we undertake an analysis, it is with the clear intent to have those findings represented in a future-applied context. After all, we rarely perform analyses for historical edification only. This implies that our data must be sensitized to *both* current and future conditions. But how often, when provided with a dataset on something as simple as flow, as one example, do we ask, "*Is this bias corrected for long-term shifts in*

future climatic response?" Typically, we choose instead to plunge headfirst into our noted specialties (e.g., fisheries, toxicology, hydrodynamics, etc.) without first questioning whether the data for what we are being asked to opine is climate adjusted. For any analysis that has a future connotation (which would include virtually all analyses), investigators must account for climatic shifting and possess a solid understanding of how the baseline data were developed. Without such knowledge, we accept baseline hydrology generation as simply a "black box".

Take reservoir inflows for example. It is one thing to employ standard routing models on reservoir carryover storage to simulate reservoir releases and downstream flows but, do we question how the original reservoir inflows were computed? Under a shifting hydrologic regime, the timing, volume, intensity (e.g., sediment load implications), pathways (e.g., water quality implications) will all differ from before. Without reassessing these fundamental input assumptions, are we properly capturing the differing proportion of runoff contributing processes under a new hydroclimatic regime and are those processes appropriately accounted for in our modeling platforms? This potential oversight may be partly attributable to geography. For example, water quality practitioners working in the lower Sacramento River, may not feel it is in their purview to evaluate inflows into upstream reservoirs -- such processes may be deemed too distant and disconnected. So long as the operational rules for reservoir releases are acceptable, then seemingly, there is no need to look at the processes contributing to reservoir storage gain. But this is a fallacy. Downstream flows are primarily generated by releases from carryover storage propagated from the upstream source areas. If that carryover potential is inaccurate (volumetrically or temporally), then it matters little, how accurate the environmental evaluation may be. Even with the best forensic science, downstream analysis will only produce acceptable results *if* the interconnected upstream reservoir inflows (and reservoir operational rules) are also accurately portrayed.

As noted earlier, numerous policies, mission statements, "action" plans and strategic visions of various detail exist today regarding climate change. Yet very few provide the kind of thorough and meticulous direction necessary to really help guide on-the-ground water resource managers and operators. We use phrases like "adopt integrated approaches", "use best available science", "apply ecosystem-based approaches", and many others. We encourage the inclusion of these principles into our core policies, planning, practices, and programs whenever possible. But the necessary detail is all but omitted. We remain fixated on addressing climate change at a very broad level. To this day, we have not yet provided the operational practitioner with the technical guidance necessary to address these threats in a real-time or contemporary context. For example, how meaningful is it to a reservoir operator who, provided only with a policy statement that reads, "*...prioritize options to reduce vulnerability to potential environmental, social, and economic implications of climate change*" is expected to make discretionary, real-time, and possibly critical decisions in the face of a changing environment? While we certainly better understand the implications of hydroclimatic forcing effects today, we have not yet fully committed to re-examining our long-standing governance structure to see what still works, what will likely continue to work, and what will clearly no longer work.

As a vital first step, and as alluded to previously, what is needed is a comprehensive, singular database of verifiable bias-corrected and spatially downscaled hydrologic response that all agencies can support. One that properly represents California's shifting hydrology *writ large.* This should represent the initial step in any contemporary Statewide water resources management undertaking since this new baseline represents the foundation, the backbone of all water resource management actions. Currently, however, each agency, within their own silos of expertise, develop and rely on their own hydrologic assumptions and databases. The level of coordination between other agencies whether at the local, regional, State or federal levels is not what it perhaps could be. Utilizing a singular hydrologic response dataset could provide significant technical enhancement, strengthen consistency across documents, improve management efficiency, and increase transparency that might help boost public awareness and reduce the uncertainty and skepticism often associated with the many highly technical studies and reports that are generated involving water resources.

Armed with a new *climate-sensitized* baseline hydrology, we can proceed with added confidence towards re-assessing and resetting many provisions within our complex water governance. In some cases, only minor effort would be required, in others, a more substantial undertaking would be necessary, possibly even necessitating a

complete re-evaluation of existing permits and/or approvals. The latter would represent no less than a daunting undertaking. But do we really have any choice? We could maintain the status quo and let the reliability gap further widen or, allow the continued divergence between compliance and non-compliance. For obvious reasons, none of these are desirable and so, inaction is clearly not the preferred option. The salient question, as is often the case, revolves around whether we have the courage and commitment to take on what is clearly an immense, highly politicized, costly, yet critically necessary undertaking. The continuing shift in hydrology is real, whether we choose to await the opportune moment to respond is up to us -- but the longer we wait, the larger the gap will be.

All of our best efforts today at addressing vital water issues will be diminished (perhaps to the point of irrelevancy) if we do not also pay heed to long-standing governance provisions and cast a critical eye to ensure that these well-established measures remain valid. Water governance issues, as discussed in this paper, is clearly influencing our ability to effectively plan for and manage California's changing water resources landscape. Now is the time for water leaders, water users, resource managers, and all stakeholders with an interest in this precious, yet rapidly changing public trust resource, to give serious thought to making sure that these deep rooted governance provisions can continue to meet both contemporary and future challenges. While revisiting past governance may not hold the same interest and allure as new water initiatives, it is one without which effective, long-term water resources management in California will be hard pressed to succeed.

About the Author

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