

Climate Change Ushers in New Era of Uncertainty for Water Resource Management

By [Douglas MacDougal](#) and [Dustin Till](#)

November 30, 2011

Scientists are seeing more climate change impacts on water availability – particularly in those areas dependent upon glacial and snow meltwater for agriculture. As water becomes available at different times of the year (or grows more scarce), controversies over water allocation will grow more common. This is particularly true in the arid west, but also in the plains states and many other parts of the country. Water resource agencies will increasingly struggle with how to protect senior water rights, preserve agriculture and other economic activity, manage flood events, and provide instream flows for fish habitat and other ecological purposes. This article details some of the difficult trade-offs that decreased flows will require to be made.

History is No Guide to the Future of Water Rights

Most agencies are accustomed to dealing with historical data over a “period of record” which is used as a basis for analysis and development of agency responses. It is hard to think of a single area involving hydrology or fisheries biology where the record of past flows in rivers and streams is not relevant in some way. But the climate context from which the past record was obtained is changing. Hence the practice of using a period of historical record to evaluate and justify future agency actions must be called into question. Indeed, the International Panel on Climate Change (IPCC) has warned that past hydrological data is an unreliable predictor of future conditions for purposes of water management decisions:

Climate change challenges the traditional assumption that past hydrological experience provides a good guide to future conditions. The consequences of climate change may alter the reliability of current water management systems and water-related infrastructure. While quantitative projections of changes in precipitation, river flows and water levels at the river-basin scale are uncertain, it is *very likely* that hydrological characteristics will change in the future. Adaptation procedures and risk management practices that incorporate projected hydrological changes with related uncertainties are being developed in some countries and regions.[\[1\]](#)

Exactly *how* a resource agency is to adapt is the fundamental challenge, since it is an uncomfortable position for an agency to acknowledge that the solid data, reliably developed over decades of measurement, may not be the best predictor of the future behavior of the system in question.

Accepting Climate Change Impacts on Water Resources

Accepting the reality of climate change impacts on water resources is a necessary first step to good planning, and many states are working to do so, backed by some very good scientific research.

Regionally, one of the most focused studies of watershed-specific water scarcity due to climate change is a 2010 [report](#) (the Nolin Report) published by researchers at Oregon State University. The Nolin Report concerns the impact of glacial recession (*i.e.* diminished volumes of glacial ice resulting from climate change) on streamflow in the Middle Fork Hood River – a river that provides critical water for agricultural activity.^[2] The Nolin Report focused on the Upper Middle Fork Hood River, which is primarily fed by glacial melt from the Eliot and Coe glaciers.^[3] Based on current recession rates, the Eliot Glacier will reach 50% of its 2007 extent in approximately 50 years.^[4] If there is a 1° C increase in temperature and a 50% reduction in glacial mass by that time, the Nolin Report found that glacial water feeding the Middle Fork of the Hood River will decrease by 42% in the month of August (as compared to 2007), and by 34% in September.^[5] Stating the obvious, the Nolin Report concludes that “[t]he implications of continued changes in late summer streamflow are significant for water resources policy and management.”^[6] Other studies in the Northwest have reached similar conclusions.^[7]

Oregon has been proactive at the planning level in responding to climate change warnings. In December 2010, Oregon released the [Oregon Climate Change Adaptation Framework](#) (the Framework). The study was commissioned as a interagency project to identify likely changes in Oregon’s climate conditions and the likely consequences of those changes over the next 40 to 50 years, including impacts on irrigators.^[8] The work group compiled a survey of various consequences of climate change in Oregon. Among the risks that the work group deemed “very likely to occur”^[9] over the next 50 years are changes in hydrology and water supply. The Framework found that the long-term effects on hydrology in the region will be complex and significant:

Climate change will likely impact the hydrology in Oregon in terms of water quantity, water quality, water supply, snowpack, and water availability in some areas. Increasing winter temperatures will affect snowpack in the Cascades, which will affect the timing of runoff and water availability in large areas of the state.

A study completed by the Climate Impacts Group at University of Washington indicates that approximately fifty percent of Oregon water users are located in areas of the state that are “snowpack dependent.” This means that water use significantly depends on the use of natural storage, with water becoming available during heavy use periods as a result of snow melt. Loss of natural storage will mean less water will be available for users during summer and fall months. This issue will be compounded by warmer summer months and a longer growing season (Climate Impacts Group, 2009; Elsner et al., 2009). Significant declines in snow water equivalent (SWE) in the Pacific Northwest and a shift in precipitation from snow to rain coinciding with increases in air temperature since the 1950s are well documented (Mote, 2003b; Mote et al., 2005; Knowles et al., 2006, Chang et al., 2010).^[10]

The Framework further found potentially profound impacts on flows from loss of snowpack:

Cascade snowpacks are projected to be less than half of what they are at the beginning of the 21st century (Leung et al., 2004).

Hydrologic patterns vary annually and seasonally throughout the state. In general, however, basins are either snow-dominated, where the hydrologic pattern is marked by the majority of runoff occurring as a function of spring snowmelt, or rain dominated, where the hydrologic pattern closely reflects the seasonal precipitation pattern. In other words, in snow-dominated basins, the peak runoff lags behind the period of the peak period of precipitation, since much of the precipitation occurs as snow, and is stored until springtime temperatures rise above freezing.

As average temperatures increase across the state, the amount of precipitation that falls as snow will decrease, and timing of the peak runoff period will begin to shift to earlier in the year. Lower elevation snowpacks are expected to show the greatest differences in timing and magnitude of snowmelt; much of the snow in the Cascades accumulates close to the freezing point (Hayhoe et al., 2004; Payne et al., 2004; Nolin and Daly, 2006; Oregon Climate Change Research Institute, 2010).[\[11\]](#)

The Framework concluded that irrigators would be among the parties most impacted by changes in hydrology: “[r]educed water availability will reduce water available for junior irrigators and change water supply planning in many basins.”[\[12\]](#) Indeed, the Framework concluded that:

Water users suffering the most adverse consequences will be irrigators. Irrigated agriculture is a primary economic driver in Oregon, so without careful planning for the consequences of climate change, the Oregon economy may well suffer significantly.[\[13\]](#)

The Oregon Water Resources Department (OWRD) echoed the findings of the Framework in its Draft Recommended Actions to its Integrated Water Resources Strategy.[\[14\]](#) Specifically, [Bulletin 5](#), addressing climate change, stated that:

The change in timing and availability of water as a result of climate change may affect whether or not water users are able to utilize their water rights for the amount allowed. Less water may mean that junior users are more frequently regulated to meet the water needs of senior water right holders.[\[15\]](#)

This, of course, suggests that there will be increasing disputes over the use of ever-scarcer water supplies.

Incorporating Climate Change Realities into Agency Decision-making

Given all this, what is an agency to do? It is well established that agencies must take the environmental effects of climate change into account in their decision making. This is particularly true with respect to changes to hydrology attributable to climate change, such as the example given above in the Hood River basin. Failure to do so in the face of mounting evidence of the effects of climate change can lead to a conclusion that an agency’s decisions are arbitrary and capricious.

For example, the U.S. District Court for the Eastern District of California’s decision in *Natural Resources Defense Council v. Kempthorne* is instructive. 506 F. Supp. 2d 322 (E.D. Ca. 2007). That case involved challenges to a determination under the Endangered Species Act (a biological opinion or BiOp) that the

continued operation of federal and state water diversion projects in California would not jeopardize the continued existence of certain fish species or adversely modify their critical habitat.

The court concluded that the evaluation, which was based on, among other things, 72 years of historic hydrological and meteorological records, was flawed because it assumed that neither hydrology nor climate would change. *Id.* at 370 (“[The agencies] acted arbitrarily and capriciously by failing to address the issue of climate change in the BiOp. This absence of *any* discussion in the BiOp of how to deal with climate change is a failure to analyze a potentially ‘important aspect of the problem.’”).

The court specifically rejected arguments by the defendant agencies that they properly declined to engage in “guesswork” about the impacts of climate change in light of the uncertainty of climate change predictions. The court acknowledged that “[w]hile the precise magnitude of [climate and hydrologic] changes remains uncertain, judgments about the likely range of impacts can and have been made.” *Id.* Thus, the fact that there may have been some uncertainty concerning the site-specific impacts of climate change did not absolve the agencies failure to address climate change; climate change was an important aspect of the problem that required some analysis in the agencies’ decisionmaking. *Id.* 368-69. Both federal and state courts have similarly found that agencies must consider climate change impacts under environmental review statutes such as the National Environmental Policy Act (NEPA) and its state-level counterparts. In 2008, a federal appellate court held for the first time that “climate change is precisely the kind of cumulative impact analysis that NEPA requires.” *Center for Biological Diversity v. Nat’l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1217 (9th Cir. 2008). Since then, dozens of cases have been filed and decided concerning the extent to which climate impacts must be evaluated under NEPA and state environmental review statutes. Many of these cases focus on the extent to which reviewing agencies must take the environmental effects of climate change (*e.g.*, hydrological changes, rising sea levels) into consideration. For example, in *Natural Resources Defense Council v. Reclamation Board*, a California trial court ruled that the environmental review of a proposed 4,900 acre mixed-use development failed to adequately respond to information concerning whether rising sea levels would exacerbate the project’s anticipated environmental impacts. *See* Tentative Ruling on Petition for Writ of Mandate, *NRDC v. Reclamation Bd.*, Case No. 06CS01228 (Sacramento Super. Ct. Apr. 27, 2007). The court also observed that “[a]s the projected effects of climate change become clearer and can be related to specific sites, there is little doubt that those effects *will have to be factored into the analysis* of many projects” (emphasis added).

Federal and state regulators are also imposing requirements to consider climate change impacts as part of the project review process. The White House Council on Environmental Quality (CEQ), which is responsible for implementing NEPA, has issued draft guidance on how climate change should be taken into consideration under NEPA. In addition to requiring a quantification of greenhouse gas emissions, the draft guidance makes clear that agencies must project evaluate how the existing environment will change as a result of climate change for the “reasonably foreseeable” future.[\[16\]](#)

Similarly, many states have, by legislation or regulation, imposed affirmative requirements that agencies consider climate change impacts when reviewing proposed projects.[\[17\]](#) The Washington Department of

Ecology has issued guidance on how agencies should evaluate climate impacts in environmental review documents.^[18] Ecology's guidance makes clear that agencies must consider the effects of a changing environment on the proposal's new infrastructure as the result of, among other things, changes in water availability. As Ecology explains, "[c]limate change will also affect future water availability and should be considered for projects that will be large water users."^[19]

Conclusion

As researchers continue to publish watershed-specific analyses of how climate change will impact water availability, water resource agencies will no longer be able to exclusively rely on past records, and will need to adapt their management and planning practices to reflect the changing baseline of water availability. At the same time, irrigators and other water right holders will need to remain vigilant as resource agencies struggle to reconcile past practices (irrigation, instream flows, etc.) with changes in water availability.

For more information, please contact [Douglas MacDougal](#), [Dustin Till](#), or any member of Marten Law's [Water Resources](#) practice group.

^[1] IPCC, *Technical Paper No. 4 – Climate Change & Water* (June 2008).

^[2] Anne W. Nolin, et al., *Present-Day And Future Contributions Of Glacial Runoff To Summertime Flows In A Pacific Northwest Watershed: Implications For Water Resources*, Water Resources Research, Vol. 46 (2010).

^[3] *Id.* at 3. The Nolin Report observes that the Upper Middle Fork Hood River "is heavily utilized for irrigation in the region, and highly relevant for water management purposes," and that water from the system is "especially important for late summer as the harvest period for apples and pears approaches." *Id.*

^[4] *Id.* at 10. The Nolin Report also observes that this is a conservative projection, and that rates of glacial recession are likely accelerating. *Id.*

^[5] *Id.* at 10 at Table 8.

^[6] *Id.* at 12.

^[7] E.g., Julie A. Vano, et al., *Climate Change Impacts on Water Management and Irrigated Agriculture in the Yakima River Basin, Washington, USA* (2009).

^[8] Framework at Appendix 2.

^[9] The Framework follows conventions established by the IPCC for describing the likelihood of a risk impacting the state through 2050. A risk that is "very likely to occur" is "almost certain to occur in Oregon" (translating to a greater than 90% chance of occurring). This designation "reflect[s] the best judgment of the scientific community related to the risk." Framework at 4.

^[10] Framework at 20.

^[11] *Id.*

^[12] *Id.* at 21.

^[13] *Id.*

^[14] *Id.*

^[15] Integrated Water Resources Strategy, Draft Recommended Actions Bulletin No. 5.

[16] CEQ's draft guidance is *available at*

http://ceq.hss.doe.gov/nepa/regs/Consideration_of_Effects_of_GHG_Draft_NEPA_Guidance_FINAL_02182010.pdf.

[17] Oregon does not have an environmental review statute analogous to NEPA. However, as discussed herein, Oregon has developed guidance addressing climate change adaptation, including issues surrounding changes to hydrology.

[18] Ecology's guidance is *available at*:

http://www.ecy.wa.gov/climatechange/docs/sepa/20110603_SEPA_GHGinternalguidance.pdf.

[19] Ecology guidance at 6.

Robert A. Levite, Esq.

UMASS Extension

237 Chandler Street

Worcester, MA 01609

508-831-1223, Ext 244(Voice)

508-831-0120 (Fax)

email: boblevite@hotmail.com

www.umassextension.org/NREC

The Massachusetts Watershed Coalition

....Creating a Network of Watershed Partners.