AWRA newsletter
Washington Section
AMERICAN WATER RESOURCES ASSOCIATION

APRIL-MAY 2014

# PRESIDENT'S NOTES

**By Megan Kogut, AWRA-WA President**

As part of my ongoing effort to showcase AWRA-WA, I offer a tour behind the scenes. Some of you are former AWRA-WA board members and volunteers, and many more of you volunteer for other organizations. So, much of what is below may be familiar to you. But, there is always news to share.

We are an all-volunteer organization that does a lot, which is especially remarkable considering most of us are busy professionals with family, sports and hobbies (with the exception of one semi-retiree who is probably busier now than he was before he sort-of-retired.)

It helps that our goals are clear and our tasks relatively routine: we have a newsletter, state conference, dinner meetings, scholarship awards, membership management and communications and corporate sponsorship recruiting. We do look at ourselves beyond that occasionally: we revisited our mission/vision three years ago, created a new website two years ago, and streamline duties and improve documentation frequently. But mostly, we have a predictable routine and we have our bases covered very well.

However, the board currently lacks diversity of several types. Some types are familiar and some are more specific to our focus on water resources in the state of Washington.

Our gender balance is good. But, we currently represent a relatively thin slice of ethnicities and socioeconomic statuses, which is largely a reflection of the larger community of water resources professionals we serve. As a board, we remain sensitive to all these issues, although to some extent we are constrained by forces much larger than us.

We also do not represent the entire state of Washington as well as we would like. Washington is large, with a much celebrated mountain range separating it into eastern and western sections; and an equally renowned deep water sound dividing northwestern Washington into the inland and peninsula.

Most Washington residents are in Seattle and the surrounding area, so it is not surprising that most board members are in Seattle, with three more regularly calling in to board meetings from eastern Washington (Spokane, Yakima, and Ellensburg.) But, many of the most pressing water resources issues are in eastern Washington. Seattle meetings are inconvenient for many of the people working on those issues.

Finally, our current board members are mostly environmental consultants. This is mostly because new board members are often recruited by word of mouth, so vacant board positions are often filled by someone else from the same company. Of fifteen board members, all are consultants except one each from the nonprofit, academic research, and energy utility sectors, plus one student chapter representative and one semi-retired member. We are missing representation from regulatory agency personnel, municipal policy makers and planners, economists and many other types of professionals involved in water resources.

But, we're always trying to reach out. Our state conference planning for this year is a case in point. We often stick to our own resources, but this year we are focusing on water resources infrastructure, a particular specialty of none of us.

Armed with our huge collective Rolodex, we seek to assemble the best speakers to present the overall situation of infrastructure in Washington and emphasize understanding of the economics as well as the science and engineering aspects of future infrastructure decisions.

Another example of us thinking bigger is the recent screening of Return of the River, an upcoming film focusing on the history and the culture impacts of the Elwha Dam removals. Last year we had one dinner meeting in Tacoma and one in Ellensburg. Dinner meetings in Spokane continue, and planning is underway for a second annual conference in Spokane with a focus on eastern Washington and Idaho. And, we're trying to rally students at Central Washington University to start a second student chapter.

Ultimately, we seek people from new locations and backgrounds to fill board vacancies as they occur. The process for filling board vacancies begins in early fall. There is always at least one vacancy since the outgoing president fills a non-voting past president slot for a year. New members are nominated by the board for membership vote at the December dinner meeting.

Are you interested in adding a new perspective to the board? Board meetings are the first Monday of the month at rotating locations, and they are open to all members. And, we also have ongoing committee volunteer opportunities. Both of these opportunities are a great way to try us out and get involved!

Contact me at mbkogut@gmail.com if you have questions or suggestions.

**IN THIS ISSUE:**

# DOING HYDROLOGY BACKWARD TO ESTIMATE MOUNTAIN PRECIPITATION PATTERNS FROM STREAMFLOW

**By Brian Henn[1], Martyn P. Clark[2], Dmitri Kavetski[3] and Jessica D. Lundquist[1]**

**[1]University of Washington, Seattle, WA [2]National Center for Atmospheric Research, Boulder, CO, [3]University of Adelaide, South Australia**

## ABSTRACT

Precipitation in mountain watersheds, whether falling as rain or snow, is critical for human water supply and ecosystems across the western United States and elsewhere worldwide. However, precipitation is difficult to measure accurately over these watersheds, due in part to its strong spatial variability which is not captured well by the very sparse network of gauges located at high altitudes. In fact, the vast majority of precipitation gauges are located at low elevations and those at higher elevations may have accuracy problems due to the difficulty of maintaining them during the snow season.

As a result, predictions which rely on measurements of precipitation over a large area, such as flood forecasts and runoff volume forecasts for water supply, often suffer from serious errors. However, two other types of observations are made more frequently in mountainous areas such as the Cascades and Sierra Nevada: snowpack measurements (snow depth and/or snow water equivalent) and streamflow measurements. These measurements indirectly reflect precipitation through snow accumulation and runoff, respectively. Therefore, we propose a method to improve estimates of precipitation in mountain watersheds by using snowpack and streamflow observations to correct errors in the precipitation gauge record.

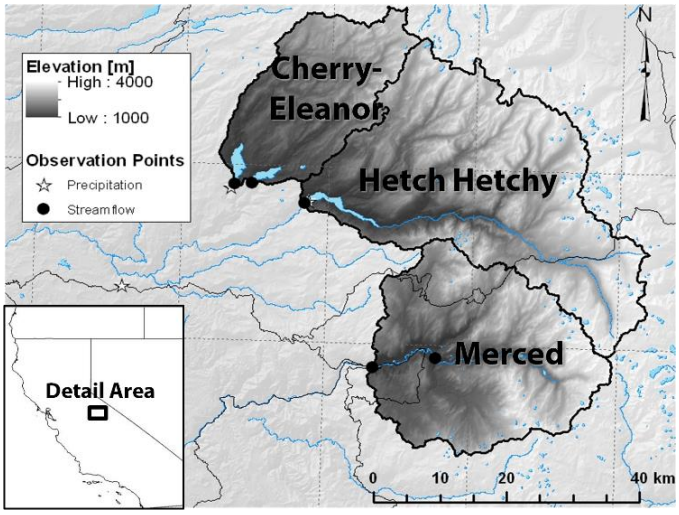


**Figure 1.** Topographic map of the Yosemite, Calif. region showing the Hetch Hetchy, Merced, and Cherry-Eleanor watersheds. Stream gauges (circles) are located at the basin outlets, while meteorological observations come from foothill stations (stars).

## SIERRA NEVADA TEST BASINS

We examine watersheds in the Sierra Nevada mountain range, where the orographic effect enhances precipitation and supplies many California river systems. The long-term orographic precipitation gradient is fairly well understood. However, year-to-year variations in the precipitation distribution between high- and low- elevation stations have been observed, and these variations impact the accuracy of streamflow forecasts.

We use streamflow observations to estimate basin-averaged annual precipitation for three Yosemite National Park watersheds (Figure. 1). This includes the Hetch Hetchy basin, which provides water and hydroelectric power to millions of San Francisco-area customers. The basins are located in the High Sierra and contain steep granitic valleys and peaks; their climate features heavy winter snowfall and relatively dry, sunny summers. Thus, these basins are an ideal testbed for inferring precipitation from streamflow, because snowmelt and rain tend to exit the steep, impervious basins quickly.

We assume that errors in streamflow observations are small in comparison with those in precipitation measurements. Thus, given our observations of streamflow, we can assess the likelihood of the precipitation observations being representative of the basin. This approach makes use of the statistical axiom known as Bayes' Theorem, which calculates an event's likelihood given that we have observed another related event. In this context, we use streamflow as the "known" event and then estimate the most likely precipitation amount that we would expect to generate the runoff.

To do this, however, we need to understand something about the basins' rainfall-runoff response, which means that we need a hydrologic simulation model of the basin. We apply FUSE (Clark et al. 2008), a conceptually-simple model of snowpack, soil water storage and runoff, in order to determine how the basin translates rainfall and snowmelt into streamflow. Then, we use a Markov Chain Monte Carlo (MCMC, Kavetski et al. 2006) routine to sample the rainfall probability density function (PDF), which is the relatively likelihoods of different amounts of precipitation. The updated PDF provides an improved estimate of basin-average precipitation and its confidence bounds, as compared to the uncertain gauge record alone.

## INFERRING LONG-TERM BASIN AVERAGE PRECIPITATION

Our first question was whether precipitation inferred from streamflow could identify the basins' long-term average (climatological) precipitation. Long-term average precipitation should be the most robust characteristic of a basin, since unusual storms and evapotranspiration events should average out over a period of many years.

We test the period 1981-2006, when reliable daily low-altitude meteorological and streamflow records were available. By correcting modeled streamflow using observations under

the Bayesian framework, we can infer the basin-mean precipitation for each basin during this period. We find that the Hetch Hetchy and upper and lower Merced basins have similar basin-mean precipitation values of 1520, 1410, and 1460 mm per year respectively, while the Cherry-Eleanor basin is much wetter, with an inferred precipitation rate of 1880 mm per year. This suggests a precipitation maxima in the northern end of the region highlighted in Figure 1.

In order to check whether our results match other estimates of basin-average precipitation for this area, we make use of the PRISM (Parameter Estimation on Independent Slopes Method, Daly et al. 2008) 4 km 1981-2010 precipitation dataset.

PRISM is a gridded precipitation climatology interpolated from topography and available precipitation gauges, and is widely used by hydrologic modelers for its spatial patterns of precipitation selected basins. However, while our method agrees fairly well with PRISM for the Hetch Hetchy and Merced basins, it does not for the Cherry-Eleanor basin, which received a comparatively low precipitation estimate of just over 1400 mm per year. This constitutes a reduction of about 25 percent from our estimate.

To investigate further, we use a simple mass-balance check for each basin. Assuming that one third of the basin's precipitation is evapotranspired, we can generate another estimate of basin-mean precipitation for the Cherry-Eleanor basin of 1885 mm per year, which is much closer to our estimate than PRISM's. At this point, the discrepancy suggests a potential problem at this location in the PRISM dataset.

## CONTRASTING PRECIPITATION PATTERNS

Water managers noted a particular difference between the snowpack patterns of water years 2005 and 2006. While both years had above-average snowpack statewide, the spatial pattern of snow appeared to be very different between the two. In particular, the snowpack water equivalent (SWE) was greater at Gin Flat than at Tuolumne Meadows in 2005, while the opposite was true in 2006 (Figure 2a).

This pattern also appears in streamflow records. In 2005, the Merced and Hetch Hetchy basins had similar annual streamflow volume, but in 2006 the Hetch Hetchy basin had about 15% more streamflow (Figure 2b). The Tuolumne Meadows gauge is located in the Hetch Hetchy basin, and so the greater streamflow in 2006 would be expected given the greater SWE in the basin that year.

We test our method by inferring basin-averaged precipitation in both the Hetch Hetchy and Merced basins in 2005, and again in 2006. We find that in 2005, the Merced basin had slightly more precipitation than Hetch Hetchy, but that in 2006, the Hetch Hetchy basin received more (Figure 2c). Our results corroborate the independent snow measurements, suggesting that the inferred precipitation is a robust estimate.

## DOING HYDROLOGY BACKWARD: METHOD SKILL AND EVENTUAL GOALS

The results indicate that it is possible to infer precipitation patterns over a watershed from seasonal streamflow quantities and timing. We are able to infer both the climatological basin-average precipitation and examples of year-to-year deviations from the average in the Yosemite region.

Many stream gauge records are available for the Southern Sierra Nevada, a region of very high-elevation basins stretching from Yosemite to Mt. Whitney. Precipitation gauges are very sparse here, and so the stream gauges will allow us to create a substantially more robust spatial map of precipitation patterns at the annual scale. Each basin, in effect, can act as a very large precipitation gauge, providing retrospective information about precipitation falling the watershed. A similar approach could be applied to critical high-altitude basins in the Cascades of Washington and Oregon.

For weather forecasters and water resource managers, annual scale spatial deviations from precipitation climatology are currently difficult to identify. This problem is particularly true, and particularly important, in the high-elevation basins of the western United States. Our approach could help identify storm patterns that lead to such deviations, and thus improve future forecasts.

## REFERENCES

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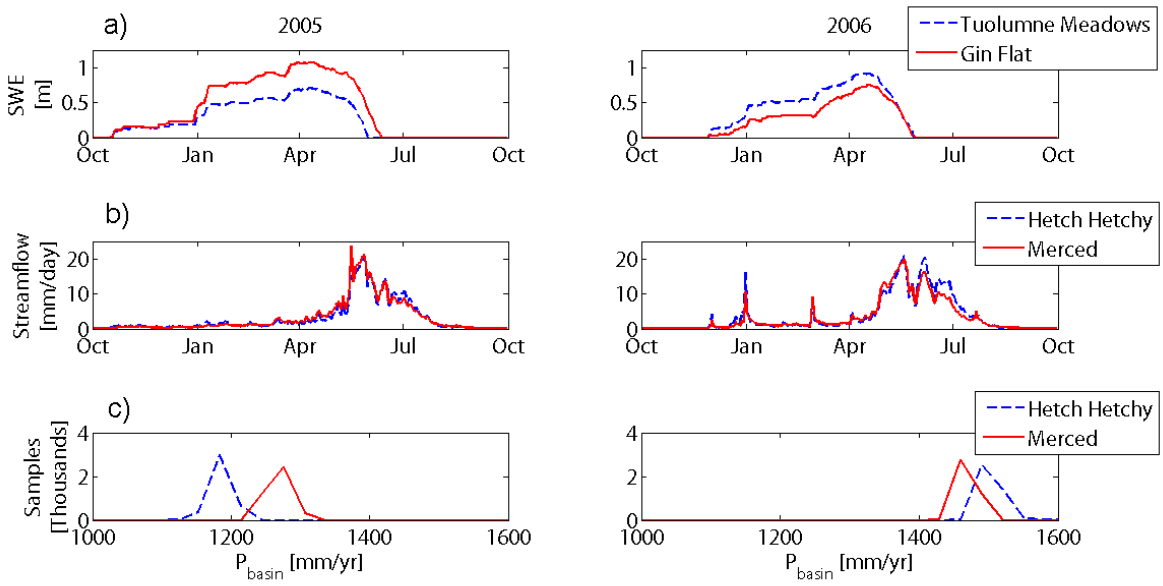



**Figure 2.** 2005 vs. 2006 comparison of snow water equivalent (a), streamflow (b), and inferred precipitation (c). The inferred precipitation in (c) is shown as a probability distribution based on Monte Carlo sampling of possible values.

# GET INVOLVED IN THE 2014 STATE CONFERENCE!

Planning for the 2014 AWRA-WA Section conference on **Water Resources Infrastructure** is now underway! Our annual conference will be held October 23, 2014 at the Mountaineers Event Center. Is this a topic that interests you? Participation in the **Conference Committee** provides a good opportunity to interact with members of the AWRA Board and other AWRA Washington Section members in a fun and collaborative setting. There are numerous different ways to help out and we welcome you to contribute your skills and expertise to support this event. If you are interested in joining our team, contact **Allison MacEwan**, Conference Committee Chair, at aam@shanwil.com or at 206-695-6691 to learn more.

# CALL FOR WATER RESOURCES ARTICLES

Do you have a great idea for a newsletter article? There's no need to ask us if we are interested, the answer is yes! Article submissions and water-related announcements are welcome for the June 2014 newsletter. The deadline for submissions is May 15, 2014. The newsletter editor reserves the right to make changes for reasons of length, grammar, legality, or clarity.

Contact **Jenny Saltonstall** at (425) 827-7701 or send submittals direct via email at jsaltonstall@aesgeo.com. We look forward to hearing from you!

## What this State Section is All About!

The Washington State Chapter of the AWRA fosters educational and professional development. **Student support** is provided in the form of two annual student fellowships, sponsorship of a student chapter at the University of Washington (and hopefully soon at Central Washington University), underwriting of a special meeting in Winter Quarter hosted by the student chapter, and other subsidies. **Inter-organizational support** is fostered with local, interstate, national, and international organizations. A **newsletter** is published several times per year containing in-depth analysis and editorials on current issues. Several **dinner meetings** are held throughout the year providing good food and good company followed by a presentation by featured guests. **Brownbags** are organized on special issues as they arise. And of course don't forget the **Annual Section Fall Conference** (see above)**.** The Conference is the principal funding vehicle for many Section activities, including providing financial support to the Section's Student Fellowship program. A **dedicated board** meets regularly to plan, organize and facilitate events. If you wish to learn more about your Section and/or wish to participate more in Section activities, you will be warmly welcomed. Please contact any of the board members listed on Page 11.

# WATER YEAR 2014: AN EARLY REVIEW

**By the Office of the Washington State Climatologist**

Washington State (WA) has enjoyed relatively wet weather in recent years. Mountain snowpacks have typically been ample, especially by the end of winter, and the last four water years (October-September) have had above normal precipitation from a statewide perspective. But this year started off much differently. The climatologically-wettest part of the present water year (October-January) was dry enough to raise doubts about the sufficiency of summer water supplies. The U.S. Drought Monitor designated virtually the entire state to be experiencing a "moderate" drought, and the WA State Department of Ecology convened the Water Supply Availability Committee (WSAC) for the first time since early 2010.

A notable switch in the weather occurred in February to frequent drenching rains and heavy mountain snows that lasted into March. Was it wet enough during this period to alleviate worries, and is there precedence for such a whipsaw of a wet season? These points are elaborated upon below in our review of the water year to date.

## WHY SO DRY?

The dry start to the water year can be blamed on a large, upper-level ridge of high pressure off the west coast of the Pacific Northwest that acted as a block to our typical parade of winter storms. This blocking ridge was quite persistent, and essentially lasted through January. Averaged statewide, the October through January period ranked as the 6th driest October-January on record, with total precipitation 8" below the 20th century long-term average. The first meeting of the WSAC occurred in early February, and while some relief was anticipated during the next couple of weeks, concern was high. The snowpack was below normal nearly everywhere in the state at that time, and the Olympic Mountains and the southern WA Cascades were the worst off, with a basin average of 33% of normal in the Olympic Mountains and 49% of normal in the western slopes of the south WA Cascades on 4 February.

## FEBRUARY IMPROVEMENTS

A significant change in the weather pattern occurred during the second week of February, however, with copious rains and mountain snows over the following 4 weeks. This caused remarkable comebacks in snowpack and improvements in precipitation deficits. Figure 1 shows the season snow water equivalent (SWE) at Stevens Pass in the central Cascades, showing an approximate 18" jump in SWE from February to early March, and snowpack returning to normal. Snow depth on Hurricane Ridge in the Olympic Mountains, one of the regions that caused a lot of early concern, doubled from 32" on February 1st to 64" on March 1st. As of March 12th, snowpack throughout WA State is near-normal to above normal, except for the Olympic and Lower Columbia basins, where the basin average snow water equivalent is 78 and 80% of normal, respectively.

## HISTORICAL CONTEXT

So has a water year played out like this in the past? A survey of the historical record reveals that the year of 1978/79 resembles, if not matches, the current water year. Figure 2

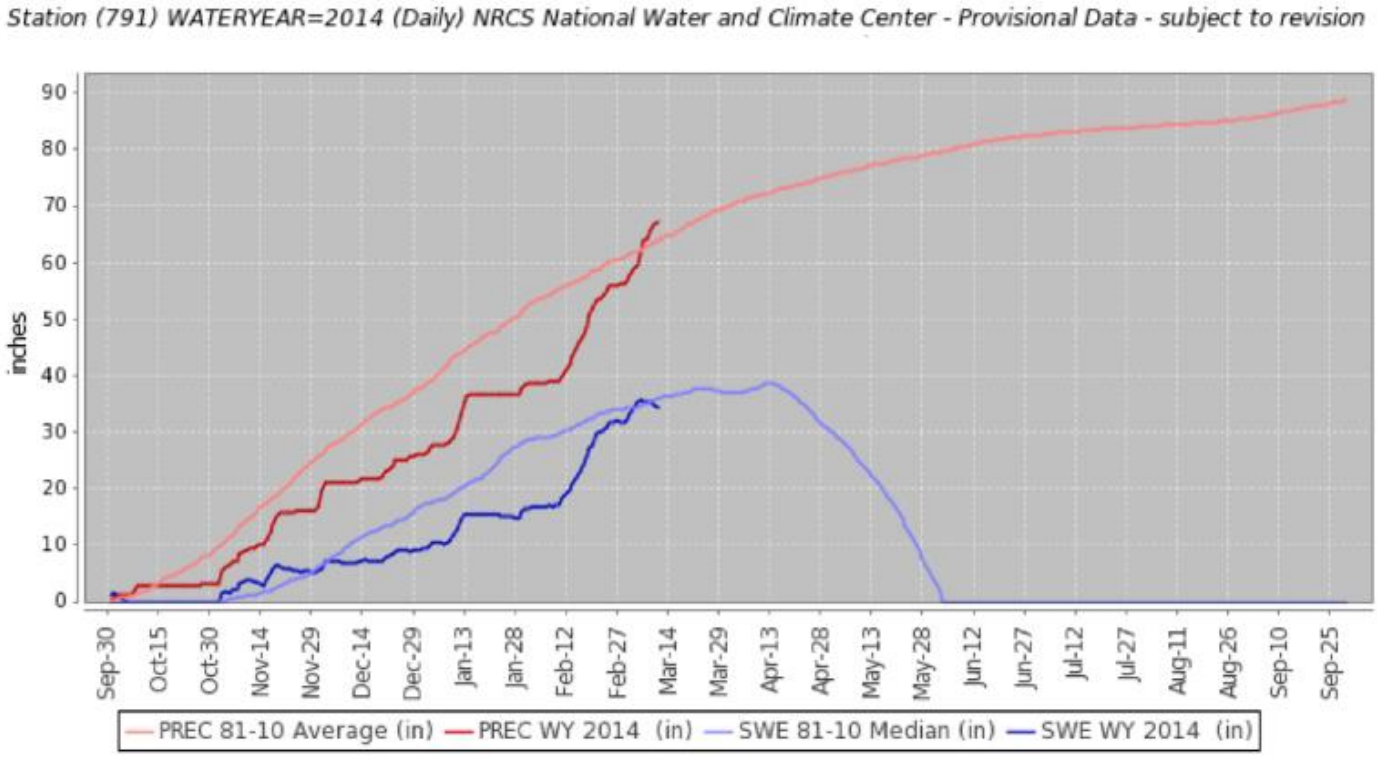



**Figure 1.** The precipitation (dark red) and snow water equivalent (dark blue) for water year 2014 compared to the 30-year average precipitation (light red) and snow water equivalent (light blue) for Stevens Pass. Data Source: National Resources Conservation Service

shows the statewide average precipitation for the current water year, the 1979 water year, and the 2001 water year – which is the most recent year that is on par with the present year in terms of statewide precipitation deficits in fall and early winter.

The biggest difference between this water year and the one in 1979 is the January precipitation. Otherwise, the similarities, including the wet February, are striking. WA State is well on its way to a wetter than normal March, so that may be where the correspondence ends.

Both water year 2001 and 1979 saw near-normal spring (March through May) precipitation, so it will be interesting to see how the remainder of the wet season plays out this year. NOAA's Climate Prediction Center is calling for higher chances of below normal precipitation for April through July, especially west of the Cascade Mountains. So we may have really caught a lucky break with the wet spell near the end of winter.

The average precipitation for the state does not tell the entire story. Notably, much of eastern WA is still drier than normal for the water year to date. The rain shadow effect was prominent much of the time as the storm systems moved through during February and early March, leaving locations east of the Cascade Mountains with considerably less precipitation to make up the deficits.

There should be enough water from the mainstem rivers for irrigation this summer, barring unusually rapid melt off from an early warm spell. On the other hand, the soil moisture content in the lower Columbia basin is still extremely low (in the 5th percentile at the time of writing in early March).

This is liable to lower the yields of dryland crops such as wheat and hay. Conditions are still closely being monitored, and a follow-up WSAC meeting is scheduled for mid-May.

In the meantime, local impacts from the dry conditions can be reported to either the Office of the Washington State Climatologist[1] or to the Drought Impact Reporter[2] directly to assist in monitoring the conditions.

[1] climate@atmos.washington.edu

[2] http://droughtreporter.unl.edu/

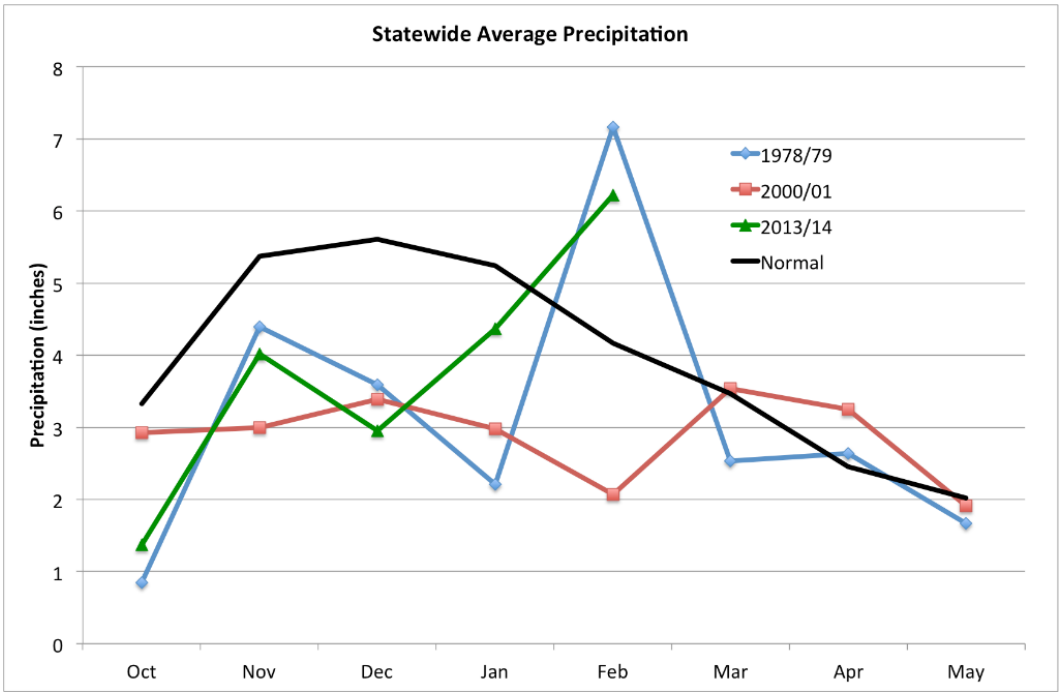



Figure 2: The statewide averaged precipitation from NCDC's climate division dataset for water year 2014 and two years for comparison – 1979 and 2001. The long-term, 20th century average is also plotted in black.

# REVIEW OF THE JANUARY 2014 STUDENT CHAPTER MEETING WITH DR. JOESEPH COOK

**Review by Megan Kogut, UW School of Oceanography, AWRA-WA Board President**

The AWRA-WA UW student chapter January dinner talk was attended by about 50 students and professionals. As usual, it was held at the UW Waterfront Activities Center, with a view of Lake Washington and pizza, beer, and pop provided by the AWRA-WA state section. After socializing and eating, everyone settled down for a talk by UW Professor Joe Cook on The Role of Economic Analysis in Water Resource Management.

Dr. Cook started with some economics basics using water as an example. He illustrated the inverse relationship between the value of water for household use and the amount of water available. He also outlined a few historical efforts to apply cost-benefit analysis to flood control projects and other projects.

He then highlighted many reasons that water is different than other commodities in ways that make it difficult to value accurately. It is both a public and a private good; return flows and re-use complicate pricing; the supply varies in time and space; it's expensive to move; and it has cultural and non-consumptive values (recreation, wildlife, aesthetics) that are difficult to translate into economic value. For these, as well as historical reasons, the current price of water often mostly reflects only the cost of maintaining supplies, not its scarcity.

One of the projects that Dr. Cook is involved in works with municipalities interested in introducing a billing scheme for households that encourages water conservation. The WaterSmart program shows a scoreboard of a household's use compared to the municipality's average use and the use of "efficient neighbors." It also includes eligibility for a cash prize drawing if you reduce your water use. This project is focused on what economic incentives work best for households.

Regarding irrigation and water supply, Dr. Cook reviewed markets for water rights. His first point was determining what was the best goal of a water market. Is it to focus more on the welfare of current users, to use water at a rate less than or equal to the recharge rate (or less than the recharge rate if reservoirs are already depleted), or something inbetween?

He then talked about reasons why water right trading for agricultural and municipal uses is so rare in Washington, focusing on a poll he conducted of farmers in the Kittitas Valley exploring the type of buyer (developer, WA Department of Ecology, irrigation district), full or split season lease, operator of water bank (Ecology or new non-profit) and price.

Dr. Cook finished his talk with some statistics about the repayments for water supply projects in the western US, keeping in mind that water storage is only a fraction of the true cost of water. From 1902 to 2004, $21.8 billion was spent on 133 projects. Irrigation users were to repay $7.1 billion, of which only $950 million has been paid (as of 1995) and $3.7 billion was subsequently waived.

Join us in May for the second student mixer, also at the WAC. And stay tuned for more from AWRA-WA about water resources economics. Our state conference will be related to this topic, and we may have a dinner talk or two leading up to the conference about water resources infrastructure and economics.

An aerial view of Hoover Dam, one of many water storage projects built by the Bureau of Reclamation. (Photo Credit snakefisch, public domain license)

*Megan Kogut is a research scientist at UW School of Oceanography and ARWA-WA Board President. She is currently studying applications of isotope chemistry to evaluate coral growth and the impacts of ocean acidification.*

# REVIEW OF THE FEBRUARY DINNER MEETING: RETURN OF THE RIVER

**Presented by Jessica Plumb, film director, producer, and chief editor**

**Review By Felix Kristanovich, PhD; Environ International, Seattle**

Our February meeting was devoted to the premiere of the film "Return of the River". The film's director, producer and chief editor Jessica Plumb presented an abbreviated version (1/2-hour) of the film. The full-length (70-minutes) feature movie can be seen at the Seattle International Film Festival this spring.

Jessica Plumb came to live on the Olympic Peninsula a decade ago, and has been working on this film for the last four years. She is the filmmaker and writer whose work focuses on the relationship between people and the places they call home. John Gussman, the film cinematographer, was unfortunately not present at the meeting.

This groundbreaking film documents the construction and removal of the Elwha and Glines Canyon dams on the Elhwa River, and the return of the salmon to middle reaches of the Elwha River. The filmmakers interviewed about 70 people, including scientists and engineers working on dam removal, and Native Americans from Elhwa Tribe affected by dam removal. The film started with showing a glimpse of a historic Elhwa River surrounded by trees and un-impeded salmon runs, and Elhwa Tribe stories about numerous salmon runs and big salmon caught in the river. The Elhwa River was historically one of the most productive streams in the Pacific Northwest, and all five species of the salmon were observed in the river.

The film chronicles settlement by white immigrants in the 19th century, removal of trees and rise of timber industry, founding of the City of Port Angeles, and the rise of Mr. Thomas Aldwell. In 1890s, Mr. Aldwell saw the river and its narrow gorges as an economic opportunity. He sought to harness this raw, massive energy source, and so he formed plans to build a hydroelectric dam.

With financial backing from Chicago investors, the Olympic Power Company was formed, and the plans for the first dam were materialized when construction of Elhwa Dam began in 1910. In 1927 the second dam -- Glines Canyon Dam -- was built eight miles upstream.

Removal actions at Elwha Dam. Photo courtesy of the Seattle Times and Steve Ringman.

Power generated by the dams helped fuel the local Port Angeles economy, but the failure to build fish ladders left the Elwha River with a mere five miles of available habitat for returning anadromous fish. Despite the Washington State law to protect the fish, the ladders were not built. The dams had a number of other serious impacts including sediment and silt blockage behind the dams, erosion of the river banks, and other impacts on a huge ecosystem that previously relied on the anadromous populations for sustenance.

However, the City of Port Angeles did not expand as originally expected, and by the 1980s, perspectives had changed. Legal challenges and policy questions arose about licensing a dam in the Olympic National Park. After several years of political maneuvering, Congress settled the issue in 1992 by passing the Elwha River Ecosystem and Fisheries Restoration Act. This act initiated numerous scientific studies on the river with the purpose of gathering monitoring data in order to document impact of the dams' removal.

The removal of the Elhwa Dam finally began in 2011 and was completed in 2013. The removal of Glines Canyon Dam is currently in progress. Increased salmon runs have already been recorded several miles upstream of Elwah Dam site. Parts of the former Elhwa Dam reservoir were re-vegetated, helping to augment the Olympic National Park ecosystem.

The river is transforming a formerly stripped-down ecosystem into a more complex one with huge amounts of woody debris that were previously held back by the dam. At the river mouth, the beach is literally coming back due to an increased sediment supply that was previously impounded behind the dam.

More information about the film is available at www.elhwa-film.com.

*Felix Kristanovich is an AWRA-WA board member and Senior Water Resources Manager with ENVIRON in Seattle. He has worked on numerous watershed analysis and streamflow restoration projects.*

# WATER RESOURCES NEWS ROUNDUP

**By Eric Buer, Ridolfi Inc., AWRA-WA Board Member**

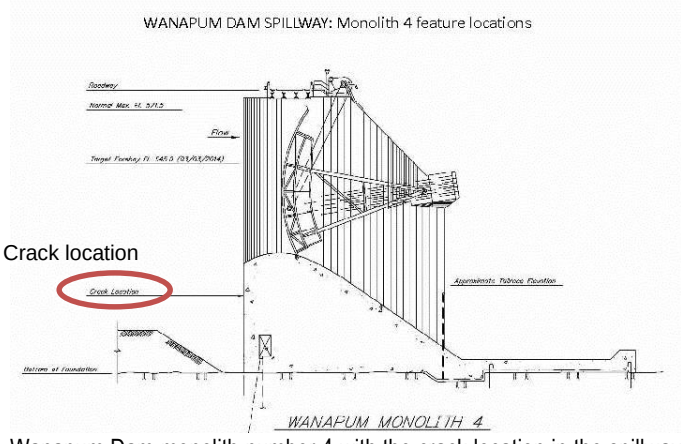
Our interest in water resources is one of the common elements that draw us together as a professional organization. And with that in mind we at the newsletter committee thought we would try something new for our members by offering a roundup of water resources news stories from the west coast and the Pacific Northwest in particular. If you're reading online, links to the original stories are embedded in the text so you can follow your interests back to the source.

Rex Block with the National Weather Service in Spokane reported that what started off as a bleak winter snowpack in January 2014 saw a dramatic turnaround in many parts of the northwest by mid-February when a series of winter storms swept through and dumped between 2 and 3 times the monthly average snowfall in a period of about two weeks. Snow telemetry sites as far east as Montana and Wyoming received similar dumps. (See our article from the Washington State Climatologist in this month's newsletter for all the details)

As of this writing, the Northwest River Forecast Center ensemble prediction system for water supply was reporting water supplies ranging from 80- to over 100-percent of average throughout most of Washington and northern Idaho. The Natural Resource Conservation Service reported surface storage in the central Cascades hovered around 100-percent of average for every reservoir that was tracked except Ross Lake. Unfortunately supplies to the south in the Snake River Plains and northern Oregon remain leaner, ranging from 30- to 70-percent of average.

Worse still are the conditions in California, where seasonal supply volumes in all but a few locations are currently at less than 50-percent of normal. In many locations snowpack storage is now at less than 20-percent of normal levels, suggesting this will be a very rough drought season for one of the Nation's top agricultural producers.

Drought related problems in California were identified as early as January this year, when Governor Jerry Brown declared a state of emergency regarding water shortfalls throughout the State. At least 500,000 acres of farmland are already anticipated to be left fallow this growing season, and prices for many consumer-favorites ranging from beef to strawberries are either rising or already at near-record prices as supplies are squeezed. Beef prices in particular have taken their own bite out of consumer's wallets due to the reduction in available pastureland combined with rapidly rising feed prices for grain, hay, and of course the very water-intensive alfalfa.




Wanapum Dam monolith number 4 with the crack location in the spillway called out. Lowering the pool behind the dam by approximately 30 feet closed the crack by an inch. (Schematic from Grant PUD Board presentation, March 4, 2014)

The San Francisco Chronicle reports that in anticipation of dwindling water supplies, San Francisco Public Utilities Commission is already making contingency plans to increase its drinking water supply with updated taps to Lake Eleanor and Cherry Reservoir, neither of which has been used as a drinking water source in more than 20 years. Necessary repairs to the dams and water delivery system are anticipated to cost as much as $10 million.

While most of the Central Valley is fretting about a summer of watching cattle bones bleach on fallow farmland, at least one rose is blooming in the desert: the Imperial Valley. Thanks having some of the most senior water rights in the Colorado Compact and its own water supply system using the All-American Canal the Imperial Valley irrigation district is swimming in 3.1 million acre-feet of cold clear Colorado River water, 97 percent of which will go to agricultural use. Imperial's neighbor to the north, the Metropolitan Water District, which serves 19 million urban users in Los Angeles, San Diego, and Riverside will be metering out approximately 1.1 million acre-feet this season.

Closer to home the February 27 discovery of a 65-foot long, 2-inch wide crack in Wanapum Dam on the Columbia River has garnered a lot of attention since it was announced by Grant County Public Utilities District. The crack was discovered approximately 91 feet below the normal maximum water surface by divers inspecting the concrete monoliths between spillway gates. Based on a presentation to Grant PUD Commissioners released March 4, the crack in Monolith 4 (the fourth pier from the shoreline on river-right) is located in the upper third of the spillway at elevation 480 feet above sea level, just below the approximate elevation of the dam tailrace.

Discovery of the crack resulted in GPU drawing down the storage behind the dam by approximately 30 feet (as of March 4, 2014). While the drawdown closed the crack by nearly an inch it has led to a host of other complications including stranding around 100 irrigation intakes in Rock Island Reservoir; closure and policing of several miles of reservoir shoreline; potential stranding of fish ladder facilities that may become critical as soon as April; and of course reductions in power production.

The Oregonian reported that Wanapum Dam has a normal generating capacity of 1,000 megawatts, and that flows during this time of year typically generate approximately 700 MW, but the head reduction has slashed power production in half. A second "shock" to the system followed when Chelan County PUD took Rock Island Dam upstream – capable of generating another 629 MW – off-line as well

to protect the turbines from damage for the duration of the drawdown.

Grant PUD announced it had initiated a forensic analysis of the fracture on March 12 that included drilling into Monolith 4, and imaging using both ground-penetrating radar and echo-imaging technology. The investigation intends to determine the crack's full extent and geometry. Once that information has been obtained a panel that includes utility experts, the Federal Energy Regulatory Commission, and a board of independent consultants will work towards determining an approach to repairing the dam and possibly raising the reservoir elevation to an interim level.

In the meantime other agencies including Washington Ecology and Chelan County PUD are working with Grant County PUD to evaluate how water users (a group including both agricultural and domestic users) will be affected by the prolonged lowering of both the Wanapum and Rock Island pools.

*Eric Buer is a hydrogeologist at Ridolfi Inc. and AWRA-WA board member. He enjoys recreating on both frozen and liquid water and is thinking about making this a regular feature. Email your thoughts on why this is a bad idea to him at eric@ridolfi.com.*

# STATE AGENCY POSTINGS

**From the Department of Ecology's Water Resources Advisory Committee:**

- 2014 Legislative session bills being tracked by Ecology Water Resources Program.
- Skagit Instream Flow Rule: Ecology's response to the *Swinomish* decision and discussion of current efforts for stream flow enhancement and mitigation.
- Petition for Rulemaking – Dungeness Water Resources Management Program Discussion of the Olympic Resource Protection Council petition to amend the Dungeness Instream Flow Rule (WAC 173-518) received by Ecology on January 21, 2014.
- Rural Water Supply Strategy Discussion of Ecology's Strategy to address rural water conflicts, including an update on Guidance to Counties on making legal water supply determinations.
- Drought in Washington State Discussion of the latest information about the potential for drought, and Ecology's preparations in response. See also our article in this newsletter from the Office of Climatology.

**From the Department of Ecology's Office of the Columbia River:**

- Construction projects and contracts deliver water to Odessa area farmers Columbia Basin farmers relying on declining groundwater supplies in the Odessa Subarea are getting good news. Contracts signed today will deliver water through the new Weber Siphon to some irrigators as early as this year. Plus, construction now underway at the East Low Canal will deliver more water to others down the line thanks to a water permit just issued by the Washington Department of Ecology.

**Other Postings:**

- Instream Flows: 2013 Report to the Legislature: Statewide Progress on Setting Instream Flows
- Department of Health, Office of Drinking Water forms Drinking Water Advisory Group
- Stormwater Work Group: Regional Stormwater Monitoring Program update from Puget Sound Ecosystem Monitoring Program

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# CALL FOR STUDENT MENTORS AND INFORMATION FOR STUDENTS

**STUDENT MENTORING**

Perhaps you saw in our January newsletter that AWRA Washington Section is looking for professionals and others to mentor graduate students in the AWRA student chapter. We are still looking, and want you to get involved!

Perhaps you were concerned such commitments might cramp your schedule? Not to worry, students are busy too, so the commitment to mentor may consist of nothing more than a cup of coffee or lunch once a month or even once a quarter.

Providing a little perspective on studies and career choices is extremely valuable to students looking at career options. If you are interested in mentoring a student or just want to know more about the program, email Megan Kogut at mbkogut@gmail.com with questions or a short biography for posting on the AWRA website.

**STUDENT DINNER SPONSORSHIP**

AWRA-WA is pleased to present students the opportunity to attend our dinner meetings **free of charge**. Our meetings feature an informative presentation by a guest expert on a timely water resource issue. The events are well-attended and offer lively conversation and professional networking opportunities.

Student sponsorship will be offered on a first come first serve basis and the number sponsored seats will depend on the number of corporate sponsorships obtained for each dinner meeting.

# AWRA EVENTS

The Washington Section of AWRA holds regular dinner meetings, including a social hour, dinner, and a speaker. Visit our website calendar of events (http://waawra.org/Events/Calendar) for the most recent postings.

Washington State University is looking for a stormwater management/low impact development extension specialist located in their Puyallup Research Center. . The position's primary responsibility is to lead the WSU Extension outreach programs in green infrastructure Washington. For more information please follow this link: https://www.wsujobs.com/postings/9846

**DON'T FORGET!** Article submissions for our next AWRA-WA Newsletter are due by May 15, 2014. Contact Jenny Saltonstall (jsaltonstall@aesgeo.com) with your ideas.

**SAVE THE DATE!** AWRA-WA State Conference will be held **October 23, 2014** at the Mountaineers Center in Seattle, Washington. We are preparing an exciting full-day conference program, focusing on issues critical to water resources infrastructure in Washington State and we hope to see you there!

**AWRA State Events – http://waawra.org/** **AWRA National Events – www.awra.org**

# OTHER EVENTS

**SAVE THE DATE!** The Washington Stormwater Center is pleased to announce the inaugural Washington State Municipal Stormwater Conference will he held **November 5-6, 2014** in Puyallup, Washington. This unique conference will focus specifically on addressing high-priority issues and challenges faced by municipal NPDES permittees statewide

**Links to Other Local Water Resources Related Associations**

American Fisheries Society-Washington
British Columbia Chapter: http://wabc-afs.org

Center for Environmental Law and Policy: http://www.celp.org/

Northwest Environmental Business Council: http://nebc.org

Pacific Rivers Council http://pacificrivers.org/

Puget Sound Partnership http://www.psp.wa.gov

River Restoration Northwest http://www.rrnw.org/

Society of Inland Northwest Environmental Scientists
http://www.spokanesines.org/

Seattle ASCE Water Resources:
http://seattleasce.org/committees/water_resources.html

USGS Tacoma Water Science Seminars:
http://wa.water.usgs.gov/seminar/seminar.html

Washington Water Research Center:
www.swwrc.wsu.edu/conferences.asp

Washington Hydrologic Society http://wahydro.org

Washington Water Trust: http://washingtonwatertrust.org

The Water Report: http://thewaterreport.com/

The Board of AWRA-WA seeks to provide through this newsletter a full range of views on water resource issues. Opinions expressed in this newsletter do not necessarily reflect the views of individual Board members, the section membership, or their employers.

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***Special Thanks to Associated Earth Sciences, Inc. and Ridolfi Inc. for word processing support on this newsletter.***

# 2014 MEMBERSHIP / CHANGE OF ADDRESS FORM

( ↖ please circle, as appropriate ↗ )

Annual membership in the state chapter costs $35.

Name _____Position _____ Affiliation _____

Street Address _____City _____State _____Zip_____

Phone (_____)_____Fax (_____)_____E-mail _____@_____

- ❑ Please indicate if you prefer to receive your newsletter electronically.
- ❑ Check if you would like to be actively involved on a committee. You will be contacted by a board member.

2014 Membership Dues: $35.00.

**Preferred Method: Pay via Paypal on our website: http://waawra.org/.**

**For Checks:** please make payable to **AWRA Washington Section**.

Mail to: American Water Resources Assoc. WA. Section
P.O. Box 2102
Seattle, WA 98111-2102

The American Water Resources Association is a scientific and educational non-profit organization established to encourage and foster interdisciplinary communication among persons of diverse backgrounds working on any aspect of water resources disciplines. Individuals interested in water resources are encouraged to participate in the activities of the Washington Section.