Willamette Water 2100
Spring 2014 Workshop Summary

Chemeketa Eola Events Center, Salem, Oregon—March 18, 2014

About this Summary

The WW2100 research team appreciated the time and involvement of 70 people at our Spring 2014 workshop in Salem, Oregon. This document:

1) recaps the meeting,
2) summarizes comments participants made during roundtable discussions and in a post-meeting survey, and
3) summarizes the research team's response to these comments.

This is a preliminary report and the information shared here is subject to change.

About the Project

The Willamette Water 2100 project is a collaborative research effort by Oregon State University, Portland State University and the University of Oregon to evaluate how climate change, population growth, and economic growth will alter the availability and the use of water in the Willamette River Basin on a decadal to centennial timescale. The project team has developed a computer model of the Willamette water system that integrates aspects of hydrology, ecology, and human systems, and allows scientists and stakeholders to explore the interaction between land and water management policies, economics, climate, and ecology. The project is supported by grants from the National Science Foundation.

Workshop Purpose and Participants

This workshop was an opportunity for researchers working on the Willamette Water 2100 (WW2100) project to meet with water managers, policy makers, and other stakeholders. The research team described their computer model of the Willamette Water system and shared early findings from an initial modeling scenario of future water availability in the basin. The purpose of the workshop was to:

- Receive input on the model design, assumptions, and early findings.
- Receive feedback on metrics and illustrations used to share results.
- Introduce the project's next steps, including plans for policy analysis and the development of alternative scenarios.
- Provide Willamette Basin water managers, scientists, and consumers an opportunity to learn from each other.

The participants at the workshop represented many different organizations and regions of the Willamette River Basin. They were recruited from previous WW2100 events (see *water.oregonstate.edu/ww2100/stakeholders*), the professional contacts of the research team and their collaborators, and other persons who expressed interest in the project at regional conferences, association presentations, or after learning about the project online.

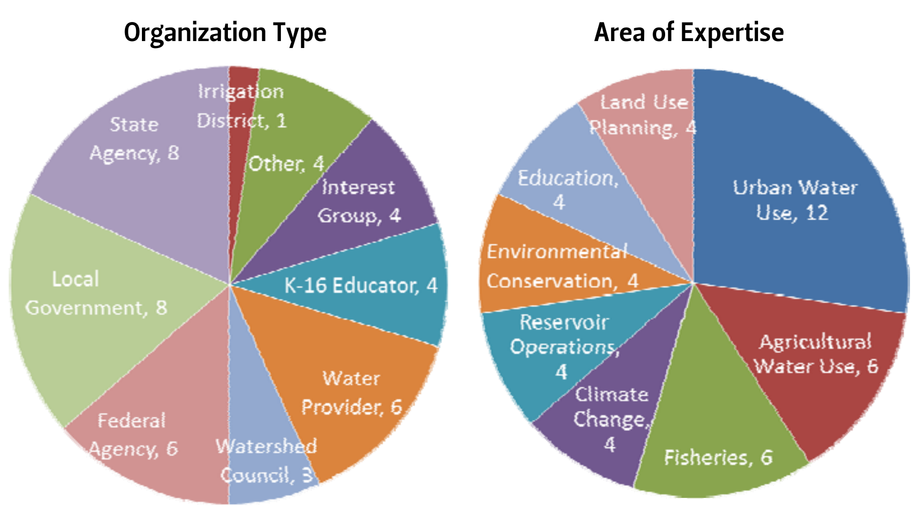

Figure 1. Meeting participants according to organization type (a) and by area of expertise (b). In addition, 20 project researchers and six graduate students attended the meeting. In total, 70 people participated.

Synopsis of Presentations

During the morning session, project scientists provided background about the Learning and Action Network (LAN), and introduced the Willamette Water 2100 computer model and preliminary results. Here we summarize key points from the presentations and provide links to online materials.

Introduction to the Learning and Action Network

WW2100 Broader Impacts Team leader, Dr. Sam Chan, and graduate student, Laura Ferguson, reviewed activities of the Learning and Action Network (LAN). Since 2010 the project has hosted field trips and workshops designed to encourage knowledge sharing between the research team and Willamette Basin water managers and decision makers. The goals for the LAN are (1) to enhance scientific discovery and understanding by incorporating regional and practitioner knowledge, and (2) to provide educational, training, and networking opportunities that help inform water management in the basin.

Model Overview

Dr. John Bolte described the computer model the team is developing of the Willamette water system. It combines biophysical models of hydrology and ecology with economic models of land and water use. It generates "futures scenarios" of how the water system might change, given assumptions about climate change, population and income growth, and land and water management. Dr. Bolte also described key assumptions for the "Reference Case Scenario" - an initial model run that depicts future water availability under expected trends in population and income growth, existing policies and institutions, and a mid-range climate change scenario. The Reference Case assumes a summer temperature increase of 0.57˚C/decade, and growth of population to 5.8 million people in the basin by 2100 with a mean annual household income of $242,000(in 2005 $).

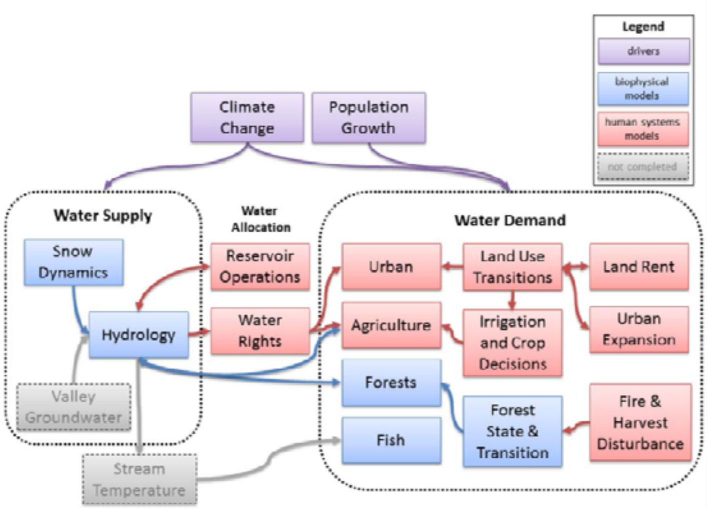

Figure 2. The conceptual framework and component models that make up Willamette Water Envision. At the March 2014 meeting, scientists presented posters on each of the component models. The posters and a "primer" document describing the model is available online (see link above).

Online Resources

- *Introduction to the Willamette Water 2100 Model and the Reference Case Scenario*. This is a 10 page "primer" that was given to workshop participants in advance of the meeting. It includes a glossary of WW2100 terms.
- PDFs of workshop presentations and posters.
- FAQs—Answers to questions posed by stakeholders at the meeting and in the post-meeting survey.

http://water.oregonstate.edu/ww2100/workshops

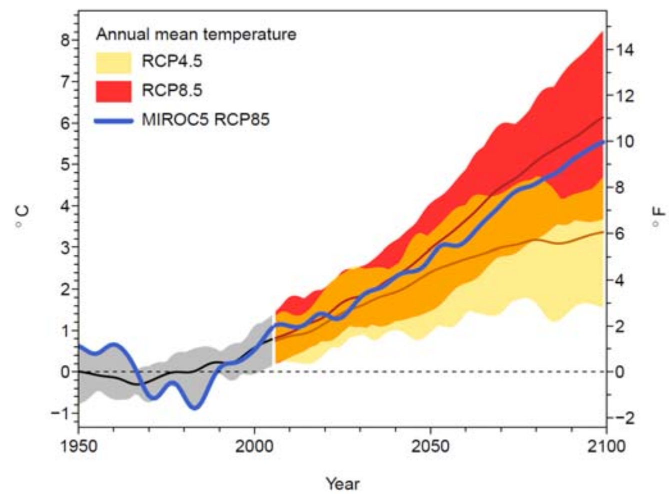

Figure 3. Increase in average annual air temperatures for the Pacific Northwest from statistically downscaled simulations by global climate models (GCMs). The dashed line indicates no change from the historical average (1950-1999) and positive values indicate warmer temperatures than observed in the past. The red and yellow shaded areas show the range of temperature differences simulated by 20 different GCMs using two different assumptions about future concentrations of greenhouse gases (RCP 4.5 and RCP8.5)). The heavy blue line is the temperature increase simulated by a GCM called MIROC5. We used climate data downscaled from this simulation as one of the drivers for the WW2100 Reference Scenario.

Preliminary Results

Dr. Roy Haggerty presented some initial results of the Reference Case Scenario. Some of the key points he made were the following:

- We are sharing preliminary results that may change as we continue to adjust models and calibrate the core hydrology model.
- The largest effect of climate on water scarcity in the Willamette Basin may be earlier peak flows and a longer period of summer low-flow.
- This effect may alter tradeoffs for reservoir management between flood control and storage.
- Changes in water temperature may become a significant driver of scarcity in the Willamette Basin over this century.

Poster Session

After the introductory presentations, Dr. Haggerty invited participants to interact with the developers of the WW2100 Envision sub-models (Figure 2) during a poster session. The posters described assumptions, parameters, and preliminary results for the Reference Case Scenario. Dr. Haggerty encouraged attendees to ask questions and provide feedback to the principal researchers. Copies of all presentations and posters can be viewed online. Two poster stations invited comments regarding the model output metrics and illustrations used to present results.

Next Steps

At the end of the meeting Dr. Haggerty and Dr. David Hulse introduced the project's next steps. During Spring and Summer 2014 the research team will continue to refine the model and the Reference Case Scenario. They will also run alternative scenarios that will explore the effect of alternative assumptions such as a high change climate scenario, or explore policy changes. In addition, in Fall 2014 Dr. Hulse will convene a Technical Advisory Group (TAG) of 12-15 stakeholders to review scenarios run to date, and select model settings and assumptions for an additional alternative scenario that reflects key priorities and interests of water managers and other stakeholders.

LAN Feedback

During the afternoon of the workshop, the project team led eight concurrent self-selected roundtable discussions. They focused on the six questions listed below. In addition, most stakeholders provided feedback through a post-meeting survey (n=31). The survey revisited the discussion questions and gathered feedback on the meeting format.

Table 1 highlights key themes that emerged in the roundtable discussions and in the post-meeting survey responses. They are listed here with a summary of the response from the research team. The research team also created a "Frequently Asked Questions" page on the WW2100 website to answer questions and comments in more detail.

Roundtable Discussion Questions

1. What elements of the modeling framework and WW2100 terminology need clarification?
2. Are there large magnitude influences on supply or demand that we are missing?
3. Do the assumptions of the reference case adequately represent your understanding of the Willamette water system?
4. What is your first reaction to the initial Reference Case Scenario results?
5. How might the figures presented be improved for your understanding?
6. Who are your colleagues and stakeholders and how would you communicate this project to them?

Table 1. Summary of feedback received in roundtable discussions and post-meeting surveys.

LAN Comments	Response from the Researchers
Many stakeholders requested better explanations of the connectivity among Envision's drivers and sub-models and for detailed documentation about the model design and assumptions.	The model "primer" document, the meeting posters, and the FAQs (all on the project website), provide more details about the sub-models and the connectivity between them. The questions and requests for clarifications from the LAN are helping us to understand what information needs to be added and clarified. Supporting documentation for the sub-models is still in development, but will ultimately be shared through scientific publications and the Web.
Participants found the Reference Case Scenario to be logical but almost every group expressed a desire for a better description and representation of uncertainties.	We recognize the need to represent uncertainties better. The barrier that we face is computational. Envision is a unique and relatively complex piece of software, and runs of Envision take approximately 24 hours. Most methods used to investigate uncertainty either require several completely different models that describe the same processes (this is one of the approaches used in the global climate modeling community), or hundreds of thousands of model runs with alternative parameter sets. Neither of these approaches is feasible right now for WW2100. We have discussed this problem within the project, but we do not yet have a feasible solution. In the end, we will probably do a modest number of runs with alternative parameters, all within Envision, and we will be able to get a sense of some of the uncertainties with our model. However, this approach may remain unsatisfying to some.
Several asked about coordination with other projects — specifically Oregon Water Resources Department and US Army Corp of Engineers water reallocation and climate change studies.	We are not collaborating directly with the projects mentioned, but we welcome input to the scenarios, particularly through the Technical Advisory Group (TAG), that Dr. Hulse will lead in Fall 2014 (see Next Steps section above). Project scientists have also attended some agency meetings and personnel from these agencies have attended WW2100 LAN meetings.

Table 1. (continued from page 3) Summary of feedback received in roundtable discussions and post-meeting surveys.

LAN Comments	Response from the Researchers
Many commented that mean income projected for 2100 ($242,000 in $2005) did not seem credible.	Future income is extrapolated from historical trends and projections by Woods and Poole (woodsandpoole.com). While projected income may seem "high" in 2100, it is important to consider that 85 years is a long time from now. For comparison, consider how much lower the standard of living would have been in the Willamette Valley in 1930 compared to today (Figure 4). In fact, our projections assume a lower growth rate in income (1.13%) in the next 85 years compared to the previous 85 years (1.63%).
There was concern that the urban water demand model projects an increase in per capita use for the Reference Case Scenario, while most cities have observed a decrease in per capita use in recent decades. Participants also asked why the model did not have a way to adjust for the effect of water conservation measures or future changes in water reuse or wastewater management.	The urban water demand model is a generalized model designed to estimate water demand in all urban areas of the basin using a limited number of variables that can be estimated over the long time horizon of the project. The most important variables in the model are income and price. In the Reference Scenario, the upward model trend in per-capita water use results from the increasing trend in income (+1.17% per year on average, Figure 4) and a very slight decreasing trend in water price reflecting economies of scale as cities grow. In alternative scenarios we can explore the effect of increasing water prices. As explained in the online FAQ, there is mixed evidence in the economics literature about the effect of non-price water demand management policies. Because of this, and given the difficulty of projecting conservation attitudes or development of new technologies over the study period, we opted to omit the non-price management effect from the water demand model. To the extent that this component would be expected to have a negative impact on demand, we are being conservative by slightly over-predicting residential demand for water.
Several raised questions about how water demand from the Portland Metro area is modeled and satisfied. The population is within the basin but key water sources (e.g., Bull Run) are outside the basin.	We estimate an aggregate water demand for the entire Portland Urban Growth Boundary (UGB) within the basin. That demand is then satisfied by withdrawing water based on water rights with places of use within the UGB. Thanks to stakeholder critique, we have revised the water rights model to include rights to critical out of basin water sources such as Bull Run. We provide more details about this issue in the online FAQ.

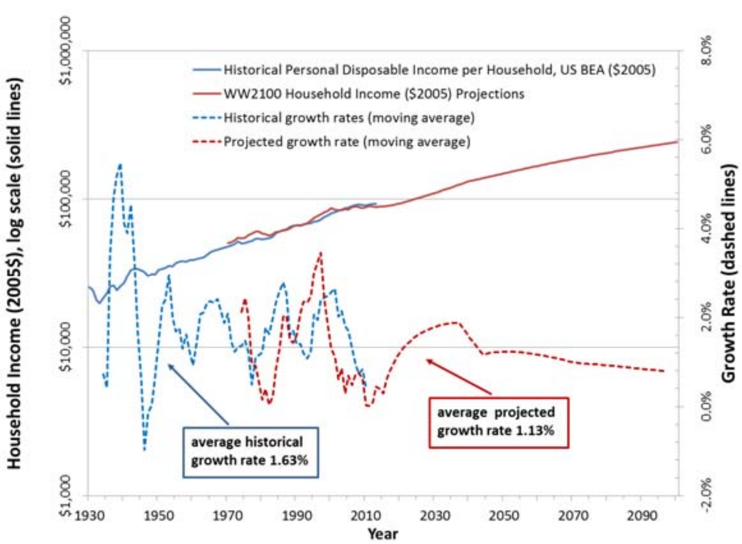

Figure 4. Household personal income for the Willamette Basin, historic patterns and WW2100 projections.

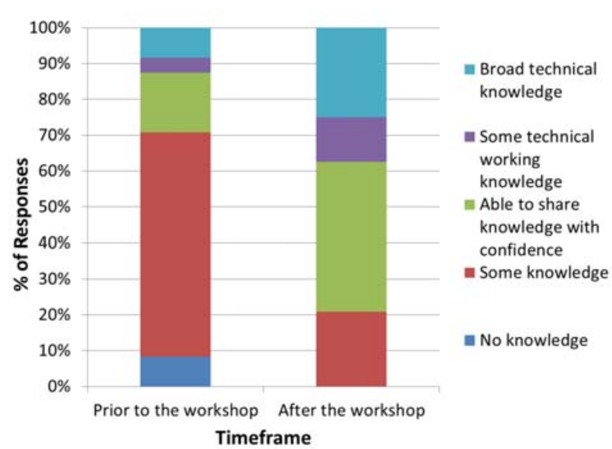

Figure 5. Reported participant knowledge of WW2100, prior to the workshop and after the workshop (based on survey responses).

Table 1. (continued from page 4) *Summary of feedback received in roundtable discussions and post-meeting surveys.*

LAN Comments	Response from the Researchers
Several made comments reflecting their knowledge of key data sets and systems—for example about missing records in the water rights database or specifics about reservoir rule curves.	We appreciated these comments and have acted on some suggestions. For example we continue to develop the water rights model and are working to add omitted irrigation districts.
There was criticism of the regression-based stream temperature model described at the meeting and questions about why the sophisticated stream temperature model, called CEQUAL-W2, was not integrated.	The CEQUAL-W2 model is computationally intense and we cannot efficiently incorporate it into Envision with current computing resources. The requirements for modeling the stream temperature of the main stem of the Willamette (for use by the fisheries sub-model) is a precision of one degree Celsius. We are developing an energy balance stream temperature model that we hope will achieve this precision. We did not have that model completed in March 2014.
Participants also wanted to know how final project results will be shared and offered specific comments about figures and graphs. Many thought that cascade plots should be used sparingly and that less similar colors and averaged lines would be easier to read and be more informative. Many commented that the maps and simplified graphs were easier to understand.	As is typical for National Science Foundation funded projects, results will be shared through peer-reviewed journal articles in scientific publications. In addition, the Broader Impacts Team will work with fellow researchers to communicate findings through outreach events and through the Web. We will continue to work on data visualization methods and value the specific feedback received at the meeting.
There were questions about whether individuals and agencies would be able to use WW2100 Envision directly. Some commented that it appeared too cumbersome and expensive to explore a wide variety of possible scenarios, for example with regards to water rights litigation and policy.	The model will ultimately be available for download; however, it is correct that it would be difficult for individuals to run WW2100 Envision in its current form without training. However, groups could work with the Envision team to develop future projects that apply and adapt WW2100 Envision to specific questions.
Participants showed excitement about the potential to test policy alternatives through modeling scenarios. Many shared ideas for specific scenarios, even though that was not one of the discussion questions.	This summer, the research team is beginning to run alternative scenarios that explore the effect of specific policy changes—many suggested at previous LAN meetings. Also, in Fall 2014, we will form a Technical Advisory Group (TAG) of 12-15 stakeholders who will design an alternative scenario (see Next Steps section on page 3).
Comments about the meeting format were generally positive and most felt that they left with a better understanding of the project (Figure 5). Participants enjoyed the diverse opinions and potential for collaboration that emerged from the round table discussions but some suggested that future groups be assigned to ensure a diversity of perspectives where all can participate equally. Some also thought that the poster session needed more time and space to allow for meaningful dialogue.	We appreciated the comments about format and will take them into account as we plan future LAN events.

This summary was prepared by Laura Ferguson, Maria Wright, and Sam Chan.

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Acknowledgement and Disclaimer:
This project is supported by the National Science Foundation under Grants No. 1039192, 1038925 and 1038899. Any opinions, findings, and conclusions or recommendations expressed in this document are those of the authors and do not necessarily reflect the views of the National Science Foundation.

7/2014