Willamette Water 2100

A project managed by the OSU Institute for Water and Watersheds.

RESPONSES TO QUESTIONS ASKED AT AND AFTER THE MARCH 18, 2014 LAN MEETING

Below is a list of questions and answers about the Willamette Water 2100 project. Most of these questions were asked at and after a workshop we held in March 2014 with Willamette Basin water managers, policy makers, and other stakeholders that are part of our Learning and Action Network. This is a living document and we will periodically update it to include new questions posed to the research team.

Please note that Willamette Water 2100 is an active research project. The answers provided here are subject to change and should not be considered final work. We are posting information here as part of our effort to be transparent with our research approach and responsive to inquiries from regional stakeholders.

This document was last updated: July 14, 2014

Related Documents

Most of the questions and suggestions listed here were asked by stakeholders who attended our March 2014 workshop in Salem, Oregon. These FAQ's may be most informative when read in companion with documents from the March 2014 workshop including:

* A "primer" about the WW2100 model design and assumptions of the Reference Case Scenario. This was given to workshop participants in advance of the meeting and includes a glossary of WW2100 terms.

* May 2014 Workshop Posters and Slides

* May 2014 Workshop Summary – narrative summarizing workshop purpose, participants, and key comments and responses. A table in this document summarizes many of the questions and answers on this FAQ page.

SECTION 1. GENERAL QUESTIONS:

1. Question (Q): **Who funds WW2100 and to whom does WW2100 report?**
   Answer (A): WW2100 is funded by the US National Science Foundation under grants to Oregon State University, Portland State University, and the University of Oregon. We report to the Vice President for Research or their equivalents at each of these institutions, and to the US National Science Foundation.

2. Q: **How do you define water scarcity and why do you define it in this way?**
   A: We define water scarcity as the marginal value of a unit of water (see Jaeger et al, 2013). In a given location, at a given point in time, and for a given use, one additional cubic-meter of water may have a very high value or a very low value, and that value (e.g., dollars per acre-foot) is an indication of its scarcity. During a LAN event and with your collaboration, we also defined water scarcity as a situation in which there is not an affordable, attainable and reliable source of clean water when and where it is wanted or needed by humans, animals and plants, currently and in to the future.

3. Q: **How can the model be used to inform policy decisions?**
   A: We are developing "alternative scenarios" where one or more policy levers or other interventions are introduced into the model. By comparing outcomes from different scenarios, we can explore the potential effects of different policy changes. In Fall 2014, we will form a Technical Advisory Committee (TAC) of 12-15 stakeholders who will review results from future scenarios run to date by the science team, and select model settings and assumptions for an additional alternative scenario that reflects key priorities and interests of water managers and other stakeholders.

4. Q: **What about the possibility that the future will be very different from the past?**
   A: The future could be very different from the past - this possibility cannot be ruled out. The scenarios explore alternatives that seem possible, based on our scientific judgment. Surprises can happen, however.

5. Q: **What scale of decision-making is supported by the various parts of the WW2100 project?**
   A: The model will be best to inform decision-making at spatial scales close to that of the Willamette Basin itself. The models may be used to inform decision-making at the city or county level. However, the model certainly should not be used to guide decision-making at the scale of square miles or smaller.

6. Q: **How do you represent uncertainty?**
   A: 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. 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.

7. Q: **How is WW2100 considering other efforts such as the Willamette Biological Opinion (BiOp), reallocation discussions, and issues identified in the state water strategy?**
   A: We are using some parameters from the BiOp. We are not formally considering other efforts, but we welcome input to the scenarios and we will be happy to share our results. The stakeholder engagement process, through the Learning and Action Network, is the main way that communication with federal and state agencies is happening.

8. Q: **Are there plans to transfer the model to different places?**
   A: No plans have been made to directly transfer the model elsewhere. However, elements of the model (some of the sub-models

and sets of the sub-models) are being used elsewhere, including in other states.

9. Q: **Are there plans for maintaining and adapting the WW2100 Envision model after this project finishes?**
   A: Yes, the model will continue to be used on other projects. Modifications and adaptations are very likely to happen. For more information on this, contact John Bolte.

10. Q: **Are there any data input features of the project or ways that stakeholders can provide information to support the model?**
    A: Participation in the stakeholder-driven scenarios would be an excellent way to ensure that the results are as responsive as possible to particular concerns.

SECTION 2. ENVISION:

1. Q: **How long does it take to complete a model run?**
   A: 24 hours are required for a complete model run.

2. Q: **Are there feedback loops within Envision?**
   A: Yes, there are many feedback loops within Envision.

3. Q: **Is the WW2100 Envision model intended to be a decision support tool?**
   A: A better description of the WW2100 Envision model is that it is a discussion support tool.

4. Q: **What is the stationarity or non-stationarity of model parameters? How will non-stationarity be addressed?**
   A: While this is model-dependent, most parameters are fixed values. However, most processes are dynamic, and respond to changing inputs and conditions in the landscape.

5. Q: **Is there a simple layout available to help visualize how all of the pieces fit together?**
   A: The best diagram for this is the WW2100 model components slide we have used in various presentations (Figure 1).

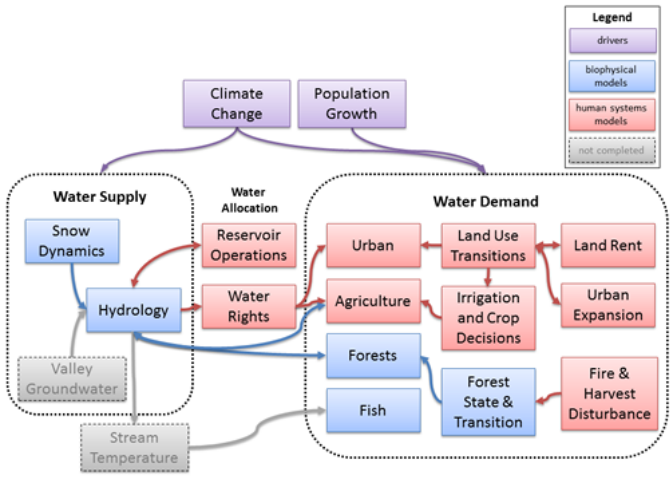

Figure 1. The conceptual framework and component models that make up Willamette Water Envision. Many of the questions posed here relate to these component models.

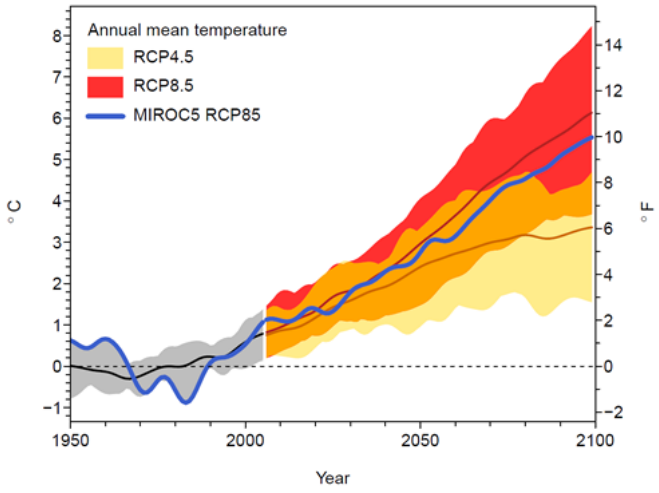

Figure 2. Increase in average annual air temperatures for the Pacific Northwest from statistically downscaled simulations by global climate models (GCMs). The dashed line indicates no change from the historical average (1950–1999) and positive values indicate warmer temperatures than observed in the 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 MIROC. We used climate data downscaled from this simulation as one of the drivers for the WW2100 Reference Scenario.

SECTION 3. CLIMATE:

1. Q: **How and why were the chosen climate scenarios selected?**
   A: Because of practical limitations, we selected three scenarios out of hundreds which span a range of simulated futures and which come from global climate models (GCMs) that adequately simulate historical climate in the Pacific Northwest. These were

selected through a process evaluating sensitivity (plotting temperature and precipitation) and ability to reproduce the observed climate. In this way, we selected accurate models to simulate three scenarios: HAD, a high-impact scenario, MIROC, a medium impact scenario, and GFDL, a low impact scenario. The Reference Case climate scenario uses the MIROC which represents a "middle of the road" case of climate change (Figure 2).

2. Q: **In the reference scenario run, why is 2020-2040 so much warmer than other decades?**
A: A reexamination of the reference scenario climate shows that temperatures during 2020-2040 are not warmer than the decades that follow. However, climate is variable at decadal scales with or without human influence, so any single decade may be warmer than the one that follows it even in the presence of an overall long-term warming trend.

3. Q: **How is the statistical downscaling conducted for the climate modeling?**
A: The Multivariate Adaptive Analog Method (MACA) is a statistical method for downscaling Global Climate Models (GCMs) from their native coarse resolution to a higher spatial resolution that captures both the scales relevant for impact modeling while preserving time-scales and patterns of meteorology as simulated by GCMs (See short lecture videos on statistical downscaling and MACA at http://maca.northwestknowledge.net/). This method has been shown to be slightly preferable to direct daily interpolated bias correction in regions of complex terrain due to its use of a historical library of observations and multivariate approach (Abatzoglou and Brown, 2011). Variables that are downscaled include 2-m maximum/minimum temperature, 2-m maximum/minimum relative humidity, 10-m zonal and meridional wind, downward short wave radiation at the surface, 2-m specific humidity, and precipitation accumulation all at the daily time step.

4. Q: **Will the sensitivity analysis be done on MIROC (the climate scenario that is used in the Reference Scenario) or on all climate scenarios modeled in WW2100?**
A: A sensitivity analysis will be done on the MIROC climate scenario. Basically, the other climate scenarios are a sensitivity analysis of the MIROC scenario since they assume greater or lesser changes in climate over the next century.

SECTION 4. POPULATION GROWTH AND LAND USE CHANGE:

1. Q: **Do land values respond to the changing climate?**
A: The value of land in agriculture depends on the annual farmland rent, which itself depends on precipitation and temperature. For agricultural lands with irrigation water rights, the land value will depend on whether that water right is likely to be satisfied or "shut off" due to water scarcity.

2. Q: **Can the method for calculating land values change as the landscape and climate change?**
A: The values of land in developed, agricultural, and forest uses are calculated with equations that depend on parameters estimated with historical data and variables such as household income, farm rent, and distance to urban growth boundaries. The parameters stay the same throughout the simulation, but the variables change with landscape and climate change.

3. Q: **Why is predicted mean income so high in 2100?**
A: Future income is extrapolated from historical trends and projections by Woods and Poole (https://www.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. In fact, our projections assume a lower growth rate in income in the next 85 years compared to the previous 85 years (Figure 3). References: (2012 State Profile: State and County Projections to 2040 (Idaho, Oregon, and Washington). 2011. Woods and Poole Economics, Washington D.C.)

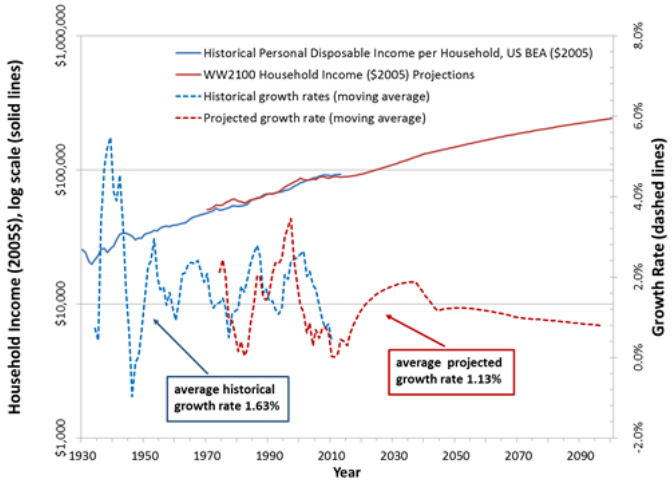

Figure 3. Household personal income for the Willamette Basin, historic patterns and WW2100 projections.

4. Q: **What are the drivers of land use change and how is this reflected in the resultant maps?**
A: The drivers of land use change are changes in the values of land in developed, agricultural, and forest uses. These values depend, in turn, on numerous factors, including population, income, climate, hydrographic features of land parcels, and land use policies such as urban growth boundaries and zoning designations.

5. Q: **Do land use change maps indicate where transitions will happen or where they might happen given other drivers?**
A: Of course, the model cannot predict with complete accuracy where land-use change will occur in the future. Maps showing future land use are best thought of as potential outcomes that are consistent with the underlying drivers in the model, though no particular outcome is unique.

6. Q: **How is income a good predictor of increased water demand?**
A: Numerous empirical studies show that residential water consumption increases as income rises. When people have more income, they spend it -- and the data show that some of this spending is on more water. In our model, water consumption also depends on the price of water, population, population density, climate, and other factors.

7. Suggestion (S): **Include densification of urban areas - not just Portland but developing suburbs are built with smaller lots.**
Response (R): Our model accounts for densification of all areas within urban growth boundaries.

8. S: **Consult an appraiser rather than an assessor for the price of land rent. $700/acre seems low and possibly is $10,000 - $15,000/acre.**

R: We collected historical data on thousands of land parcels at multiple points in time. The use of assessor data was the only practical approach. It is also worth noting that our land value data are based on real market values (RMVs), which are meant to represent the price a parcel would retrieve in an arm's length market transaction. These values come from county assessment offices, but are distinct from the values used in determining property taxes.

9. S: **Include potential thresholds for population growth, income, land rent that may be crossed.**
   R: Upper limits are included for land values.

10. S: **Climate change outside of Oregon may lead to even greater population growth within Oregon as a climate refuge.**
    R: For the reference scenario, our population projections are based on the Oregon Office of Economic Analysis projections. Higher population growth could be considered as an alternative scenario.

11. S: **Update Population Growth and Land Use transitions with legislative "rezoning" in the Metro area.**
    R: We account for zoning changes when urban growth boundaries expand.

SECTION 5. WILLAMETTE HYDROLOGY MODEL (WHM):

1. Q: **How are floodplains/wetlands and riparian zones modeled?**
   A: These areas currently are not in the hydrological model.

2. Q: **How is groundwater recharge modeled?**
   A: In the long term, the goal is to include MODFLOW groundwater simulations, though this will not occur until the end of the project, and may require the development of additional funding. The simpler approach currently included is based on a Swedish hydrological model called HBV. HBV is a conceptual model that includes calibrated parameters, one of which represents groundwater recharge.

3. Q: **Can various models be recalibrated during a run?**
   A: Calibration of the hydrological models is an important component of the project. We are still in the process of refining the calibration that will be used for the reference case scenario, and while the project will likely stick with a single calibration, the models themselves certainly could be recalibrated. In particular this would be useful if/when new observations are available, or if the models themselves are modified.

4. Q: **Why can't the variable infiltration capacity model be used for the Willamette Hydrology Model?**
   A: It could be. The Willamette Hydrology Model is set up as a model framework. We elected to start with the HBV model as the basis for the rainfall/runoff calculations. But other models could also be used, and VIC certainly could be a useful alternative.

5. Q: **Will optimization of the hydrologic model be documented? It was mentioned that software will be used to optimize model parameters. What process is followed to check whether the optimal values are realistic and make sense?**
   A: A variety of researchers are involved in the calibration of the model, which is our first step in model evaluation. The primary mechanism for the calibration is a standard parameter estimation strategy called PEST. The optimal values must acceptably capture the observations they are optimized against (either stream discharge, or Snow Water Equivalent) and they must be realistic. Both of these constraints are built into the parameter estimation strategy.

6. Q: **One impression I had from the meeting is that the Coast Range tributaries will not be as affected by climate change as other areas of the basin (e.g. Cascades snowmelt basins); is that the case?**
   A: Potentially, because the Cascades are more influenced by the seasonal snowpack, which is more sensitive to changes in climate. But these analyses have yet to be completed. Stay tuned.
7. S: **Include wastewater treatment and groundwater return flows.**
   R: Return flows are being incorporated.

8. S: **Make a graphic/map of the rates of how water is cycled throughout the Willamette River Basin.**
   R: This is a good suggestion. Some version of it will be available towards the end of the project.

9. S: **Incorporate storm water management as it changes in the future - including green strips, bioswales, rainwater harvesting.**
   R: This is a great suggestion. The current version of the model is too coarse to explicitly incorporate these features, though it may be possible to include them in a future version.

SECTION 6. RESERVOIR OPERATIONS:

1. Q: **What are the assumptions that drive the model?**
   A: The model is based on the US Army Corps of Engineers' ResSim model, which simulates prioritized releases from reservoirs based on meeting targets for downstream control points. Since this is simply a water balance model, it has few assumptions, the primary ones being associated with relevance and appropriateness of the policies that drive the release decisions and of the method for routing of water.

2. Q: **Are reservoir rule curves sensitive to climate change?**
   A: The rules themselves don't change with climate change. The performance of the reservoirs in meeting objectives (e.g. summer and spring flow targets, refill, etc.) may change, but current results indicate that these changes will be minimal.

3. Q: **Why is the Detroit Reservoir not included in the reservoir operations model?**
   A: The reservoir operations model includes all 13 projects operated by the US Army Corps of Engineers, including Detroit.

4. Q: **What is the interaction between recreation and reservoir operations? How is this modeled in Envision?**
   A: Reservoir recreation is not currently included directly in the WW2100 model, however we have estimated the relationship between a drop in the reservoir fill levels and changes in the number of visitors to a given reservoir. This evidence will make it possible to estimate the cost (in terms of decreased recreation benefits) if reservoirs are drawn down.

5. Q: **What are the economic impacts from different strategies of reservoir operations?**
   A: The economic analysis related to reservoir operations includes a) estimating potential flood damage, b) estimating lost benefits from reservoir recreation, and c) potential lost benefits if insufficient stored water is available for agricultural and urban uses.

6. S: **Address how federal/state regulation of reservoirs may shift in the coming decades.**
   R: Some alternative scenarios may include changes to the reservoir rule curves dictating reservoir releases.

7. S: **Represent USACE special operations to improve temperature control through location of releases (Fall Creek, Detroit, Lookout Point). Adopt current management of USACE .**
   R: The model replicates the rules in the 2011 USACE ResSim model and thus does not incorporate special operations at those reservoirs. Modifying the model to accommodate the special operations would require acquiring operations information from the USACE and further modification of the reservoir operations. At this point in the project, it appears that this is unlikely to happen because of time and budget constraints.

8. S: **Willamette Reservoir operations should consider the US Army Corps Willamette Basin Reallocation Study project**.
   R: Unfortunately, the results of the reallocation study were not available in time for us to incorporate them into the model.

9. S: **The conceptual diagram on the reservoir operations poster shows refill beginning on March 1 but it actually begins on February 1.**
   R: The diagram was intended to illustrate a rule curve conceptually. The WW2100 model has the correct rule curves modeled for each reservoir.

SECTION 7: WATER RIGHTS:

1. Q: **What was the process for choosing the instream flow requirements represented in the model?**
   A: Instream flow requirements in the model (still a work in progress) reflect Oregon instream water rights obtained from OWRD, and also minimum flow targets that guide reservoir operations by the US Army Corps of Engineers. The appropriated flow rates are accounted for in each pertinent stream reach, and are not available to junior appropriated water rights for out of stream uses.

2. Q: **What is the demand for instream water rights for fish?**
   A: Fish habitat is one of the considerations that has resulted in instream water rights (OWRD) and minimum flow targets that guide reservoir operations.

3. Q: **Is there a way to represent a recent trend where people acquire agricultural land only to purchase the water right but not to farm?**
   A: We have looked at the historical trends in the number of irrigation water rights (acres irrigable) and the number of acres actually irrigated. There has been very little change in either in the past 20 years.

4. Q: **Is there a mechanism within the model for transferring water rights?**
   A: We are working on a mechanism that will reflect the ways that irrigation water rights are either "retired" or transferred to urban use when lands change from farming to urban development. Modeling other forms of water right transfers or creation of new water rights are being discussed.

5. Q: **Why are some irrigation and water district water rights omitted from the water rights model?**
   A: These are currently being researched and will soon be added to the model.

6. Q: **How will climate change affect the use and regulation of water rights? I believe this is THE critical aspect of the project.**
   A: Climate change is likely to mean reduced water availability at some times of the year. Oregon water law has an automatic "trigger" for situations where there is a growing water deficit. In the case of agriculture, if there is insufficient water available for all water rights to be satisfied, the irrigators with the most "junior" water rights will be shut off for the remainder of the growing season.

7. S: **In addition to irrigation water rights, model livestock and fish rights.**
   R: OWRD prior appropriated instream water rights for fish are accounted for in each pertinent stream reach, and are not available to junior appropriated water rights for out of stream uses. Livestock watering accounts for a relatively small portion of the overall usage in the Willamette basin. The research team's main focus is on accurately estimating irrigation, municipal, and instream water uses.

8. S: **Include "Places of Diversion" even if there is no "Place of Use".**
   R: Our modeling efforts only simulate OWRD prior appropriated water rights in cases where detailed information exists for both the point of diversion and corresponding place of use.

9. S: **Include transfers of tribal rights.**
   R: We currently do not simulate transfers of tribal rights. However, a mechanism exists in the Envision framework so that they could be included in future projects.

10. S: **Include the possibility of new in-stream water rights currently "held behind" reservoirs.**
    R:The team realizes the significance of these water rights. How to best incorporate them into our research efforts is currently under discussion.

SECTION 8. URBAN WATER DEMAND:

1. Q: **What is the definition of the urban water demand model? Is it deterministic? Is it a regression model?**
   A: The urban water model was calibrated using regression parameters from the peer-reviewed economics literature on water demand estimation and recent data from water utilities in the study area.

2. Q: **Is the urban demand model based on national data sets and is that appropriate for local modeling?**
   A: The urban water model is based on water use and water price data from water utilities in the local study area.

3. Q: **How does the model incorporate water conservation and efficiency?**
   A: Incentives for water conservation are captured in this model through the effect of pricing. Model validation exercises suggest that changes in price capture a sufficiently large proportion of historical variation in water consumption. As explained below in more detail, there is mixed evidence in the economics literature about the effect of non-price water demand management policies. Because of this lack of reliably measured impacts, 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 (assuming rebound effects are smaller than direct impacts), we are being conservative by slightly over-predicting residential demand for water.

4. Q: **Why does the model predict an increase in per capita use when Willamette valley cities have observed a decrease in per capita use in recent decades?**
   A: Our model of urban water demand does not make any particular assumption about the trajectory of per-capita water use. Urban water demand will rise with a growing population and also with rising income per capita (growing at 1.17% per year; see Figure 3); it will decrease if population density increases, and it will decrease if prices rise. Prices are assumed to continue to rise in the current decade, but then stay constant, reflecting our estimated cost function, for a given sized city. As cities grow, however, and their water utilities serve more customers, economies of scale will produce a slightly decreasing average cost (relative to a city that is not growing), and this will be reflected in water prices in the model. Whether per capita water use rises or falls will depend on all of these factors.

5. Q: **Why doesn't the urban water use model account for water reclamation or higher water conservation standards?**
   A: Despite engineering estimates and anecdotal evidence about the effect of non-price water demand management policies, there is mixed evidence of the impact of such measures in the literature. We found only one peer-reviewed economics paper that systematically measured the effect of non-price management policies on water demand. That study found small but statistically significant effects for public information and subsidized retrofit-types of programs in California, but no statistically significant effects for low-flow toilet rebate programs. Because of the lack of research in this area, 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.

6. Q: **How do you model water demand for Portland, when Bull Run, one of its key water sources, is outside of the Willamette Basin?**
   A: We estimate an aggregate water demand for the whole Portland Urban Growth Boundary (UGB). This includes areas served by different water sources, some within the Willamette Basin and some outside of it (e.g. Bull Run). Our water rights model satisfies the aggregate demand for the UGB by withdrawing water at "points of diversion" (as defined by the water rights available to urban areas). Because it is such a critical water source, the water rights model includes Bull Run, even though it is outside of the Willamette Basin. Our modeling of urban water demand could be refined in future projects to estimate demand separately for different parts of the UGB served by different water providers and water sources, but at this time it does not.

7. S: **Incorporate relationship between population and income growth with energy and water use.**
   R: The effect on water use is already incorporated. Effects on energy use are tangential to this study.

8. S: **Incorporate re-use of treated wastewater (driven by water scarcity).**
   R: Not feasible in our model at this time.

9. S: **Account for rural urban development.**
   R: We account for rural urban development with a separate model for rural residential water use.

10. S: **Look to online city water consumption data for calibration/verification.**
    R: This is precisely how the model was calibrated. We used price and quantity data from water utilities in the study area.

11. S: **Users of Bull Run may switch to Willamette water sources in the future because of cost.**
    R: The feedback we have received indicates that the major user of the Bull Run does not intend to switch to Willamette sources.

12. S: **Re-evaluate predicted declining costs in light of costs of aging infrastructure.**
    R: Replacing aging infrastructure would increase total costs, largely through the fixed costs associated with building new infrastructure. However, the data and our model predict that average cost (cost per unit) decreases with population as utilities take advantage of economies of scale generated largely because those fixed costs can be spread out among additional consumers.

SECTION 9. AGRICULTURAL WATER DEMAND:

1. Q: **Does the crop choice model change with a changing climate?**
   A: The probability that a given crop will be grown on a particular piece is an empirically-estimated model that depends on 14 variables including the climate variables of minimum temperature and precipitation (during the growing season), as well as the existence of a water right.

2. Q: **What drives the economic models with respect to climate change?**
   A: Climate change mainly affects the availability of water for diversions onto farm fields. If spring and summer stream flows decrease, or if groundwater levels decline, farmers will make different decisions and these may mean lower profits and higher costs.

3. Q: **How is water demand for each crop identified?**
   A: For each crop we have modeled there are specific biological water demand estimates (evapotranspiration) that depend on the growth stage of the plant, the temperature, the soil moisture, the time since planting date, etc. These are calculated for each crop on each day of each year.

4. Q: **How are irrigation requirements for crops, particularly grass seed, likely to change with climate climate?**
   A: With higher summer temperatures and earlier planting dates the model predicts increased biological water demand and a shift toward needing more water earlier in the summer.

5. Q: **How does the model represent crop choice and irrigation?**
   A: We have two models, one for crop choice and one for irrigation decisions. The irrigation decision involves a change in the probability of certain crops being grown; the crop choice decision depends on whether an irrigation water right exists and is likely to be usable (not restricted due to water scarcity).

6. S: **Incorporate re-use of treated wastewater (driven by water scarcity).**
   R: Not feasible in our model. Also, the quantitative importance is likely very small at the scale of our model.

7. S: **Consider conversion of forest to vineyards.**
   R: Our model allows for forest to agriculture transitions; we have a fixed area for vineyards.

8. S: **Consult with Extension people for data on crop choice in order to more accurately represent current and future trends in crop choice.**
   R: We have done this.

SECTION 10. STREAM TEMPERATURE:

1. **Q: Why was the sophisticated stream temperature model CEQUAL-W2 not incorporated into Envision for the Reference Case Scenario?**
   The computational demands of the CEQUAL-W2 model are too great for it to be integrated and run within Envision with currently available computing resources. Instead, we are developing an energy balance stream temperature model that can be feasibly integrated and run within Envision. However, CEQUAL-W2 can be run offline (outside of Envision), and it can be used very effectively to calibrate the energy balance stream temperature model.

2. Q: **Will a simple model be adequate given its importance in future decision-making?**
   A: Our current focus for stream temperature modeling is to be able to connect the hydrologic modeling to the fisheries modeling. The fisheries sub-model estimates the likelihood of observing different fish species in the Willamette mainstem as a function of stream temperature (see more below). It requires a precision of one degree Celsius. We are developing an energy balance stream temperature model that we expect to be able to achieve this, and that we will be able to run successfully within Willamette Envision.

3. S: **Extend model to include people living on tributaries affected by temperature requirements.**
   R: Envision won't be modeling stream temperature in the tributaries due to time and resource constraints.

SECTION 11. FISHERIES:

1. Q: **Does the model predict a two degree water temperature increase or was that increase an assumption made to explore potential climate impacts on fish?**
   A: This was an initial assumption used to explore the fisheries sub-model at the March 2014 meeting. This assumption will be replaced with results from a process-based stream temperature model when it becomes available.

2. Q: **Where are key habitat areas within the Willamette for native and exotic fish? Where do their habitats overlap?**
   A: In Spring 2014, Josh Williams, an MS student working with Dr. Stan Gregory, completed a thesis on habitat relationships of native and non-native fishes on the Willamette River. Over three years, Josh and his team caught 36,586 fish on the Willamette River between its confluences with the McKenzie and Columbia Rivers. He writes that, "Overall, native fish represented 93% of the total fish sampled. Higher numbers of fish were collected in the upper river, and higher proportions of those fish were native species. Though non-native fish were more common in slough habitats than mainstem sites, the majority of fish collected in both habitat types were native." Link to Josh's thesis for more details.

3. Q: **Can the model address how fish micro-habitats (e.g. cold water sloughs) can be maintained?**
   A: No. The model does not have sufficient spatial resolution.

4. S: **Consider how fish may be affected by parameters beyond stream temperature like hydrology.**
   R: Josh William's thesis (mentioned above) contains a detailed analysis of associations between fish community composition and habitat characteristics such as velocity, depth, and substrate.

5. Q: **Would it be possible to define 5-6 key habitat areas that are now being used by fish and that are being protected under conservation easements, and assess how these areas change under future climate/hydrological and anthropogenic scenarios?**
   A: The model does not consider habitat quality factors beyond stream temperature, due to lack of sufficient datasets available for the Willamette mainstem at appropriate levels of spatial resolution. Nor have we been able to incorporate maps of existing conservation easements into our landscape representation, primarily due to resource constraints. Stream temperature has been shown to be a significant factor in the distribution of native and non-native fish species in the Willamette, and is considered in the fish community model.

SECTION 12. OUTREACH:

1. Q: **How will stakeholders interact with the Envision model and output?**
   A: In Fall 2014, we will form a Technical Advisory Committee (TAC) of 12-15 stakeholders who will review results from future scenarios run to date by the science team, and collaborate to develop an alternative scenario that will be analyzed by the science team. Individuals would need extensive training to run and analyze WW2100 Envision, in its current form, on their desktop computers. Stakeholders could also work with the Envision team to develop future projects that apply WW2100 Envision to answer other specific questions.

2. Q: **Are there plans to offer trainings so that anyone can manipulate the model and/or use data?**
   A: We will be seeking agencies or groups to co-host outreach events where the WW2100 team can work with stakeholders to share and apply project findings.

3. Q: **How will results be shared?**
   A: 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 the research team and members of the LAN to communicate findings through outreach events described above and through the Web. We will also be seeking resources to produce a "summary to action" digital report, similar to the National Climate Assessment outreach website, and related products for use with stakeholders and in classrooms.

4. Q: **How might rural residents be able to use the results of Envision?**
   A: Rural residents should be able to use results from Envision by participating in the stakeholder engagement process and using the documents that result from the project.

5. Q: **How can information/outputs for each sub-model be accessed online?**
   A: The model and its supporting documentation is still in development, but will ultimately be shared through scientific publications and the Envision website. The raw outputs for each model run are posted on the Envision website as they become available and are constantly changing as the model is refined. Please contact the research team if you would like to study and work with this data directly.

6. S: **Coordinate e-mail notification of project updates to the LAN**
   R: Good idea! As new things are added to the WW2100 website, we will send out notices to the project listserv.

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