CW3M White Paper

Ideas for a Community Willamette Whole Watershed Model

12/11/18

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# CW3M concept

## A different kind of community model

CW3M stands for Community Willamette Whole Watershed Model. The “Willamette Whole Watershed Model” part is a generic term for the series of whole watershed models developed by the WW2100, OUWIN, and Willamette INFEWs projects. The “Community” part is inspired by the community models maintained by the National Center for Atmospheric Research: the Community Earth System Model (CESM), and the Whole Atmosphere Community Climate Model (WACCM). NCAR’s “Community” is the community of scientists who develop and use the NCAR models. The “Community” in CW3M is made up of the analogous group of scientists from the research projects, but includes also the community of policy makers, land managers, reservoir operators, NGOs, government agencies, utility operators, farmers, and others who can make use of the model outputs (the stakeholder community). CW3M is especially for that larger community. It retains, however, some of the key features of NCAR’s community models: open access to source code, the opportunity for qualified people to contribute to model development and data, and rigorous version control.

## What CW3M is for

The intent for CW3M is to flesh out the Willamette basin regional results with more details at the scale of the Willamette's tributary rivers. As of November 2018, models of the whole Willamette River basin and of a dozen tributary subbasins and smaller watersheds are included in the CW3M prototype. Ultimately CW3M would include detailed models of all the major subregions in the Willamette River basin.

A second objective of the CW3M project is to improve the model's skill through reconciliation with available independent datasets. This is a continuation of work already started at the regional scale, comparing simulated streamflows with USGS gage records for the actual weather of recent decades. Results of that work were reported at the 2018 NW Scientific Association conference this past spring. This effort is expected to improve the calibration of many of the constituent submodels: not just streamflow but also urban water use, irrigation, population, crop choice, land use change, expansion of urban growth areas, and so on. Opportunities for better calibration increase as the spatial focus narrows from the whole WRB to tributary subbasins.

The goal is to produce an open source model and an accompanying collection of datasets which are useful to agencies and organizations involved in planning and management of lands in the Willamette River basin, especially in the context of the stresses and uncertainties arising from climate change and population growth. The model, if successful, will provide process-based and data-driven conjectures in response to some of the essential what-if questions.

# Management and maintenance

Unlike for NCAR’s community models, there is no large organization behind CW3M. Oregon Freshwater Simulations is a tiny consultancy in Portland, but it has been the keeper of the Envision-based models for WW2100, OUWIN, and Willamette INFEWS, acting as a vendor to Oregon State University and using repositories located on a server at OSU. Freshwater is now developing CW3M, without outside funding and with due regard for the professional interests of the investigators on the original projects, for the benefit of the stakeholder community.

To address longer term questions of management and support for CW3M, Freshwater is organizing an ad hoc steering committee with representatives from both the stakeholder community and the universities. As of 12/10/18, Dave Turner (OSU College of Forestry, retired) and Rebecca McCoun (executive director, North Santiam Watershed Council) have accepted invitations to participate in the ad hoc committee. We anticipate that the committee will meet for the first time in December 2018 or January 2019. Interested parties may contact Dave Conklin (CW3M@freshwatersim.com). It is expected that the ad hoc group will eventually be replaced by a somewhat more formal but still mostly voluntary group hosted by a larger organization within the stakeholder community.

# Documentation: the Digital Handbook

Freshwater is assembling a set of documentation as computer files in a folder named “CW3M Digital Handbook”. As of 12/10/18, the folder contains a Microsoft Word document file and several Excel spreadsheet files. The folder is kept in the CW3M Subversion repository, so it is under version control like the source code itself. The intent is to gather all our information about CW3M into that one folder, and to make the folder publicly available in compressed form as a single .zip file.

# Support from the stakeholder community

As of 12/10/18, the CW3M project has been discussed with

Rick Bastasch, Oregon Water Resources Department, retired

Rebecca McCoun, North Santiam Watershed Council

Kathleen Guillozet, Bonneville Environmental Foundation

Esther Lev, The Wetlands Conservancy

Karl Morgenstern, Eugene Water and Electric Board

All have expressed support. Rick Bastasch sent two emails about CW3M, which he has given permission to quote here.

## Response from Rick Bastasch on 9/20/18 and 11/12/18

“I've long thought it very desirable to extend WW2100/UWIN-type understanding and approaches up into the Willamette's major tributaries. I'm encouraged by your saying some preliminary work along these lines is already being done.

Having open source community models should be ever more important for all manner of decision-makers in the Willamette. I say "should" because I continue to be concerned that the (to me) incredible efforts of WW2100 and UWIN seem a bit isolated from our extant decision-matrices. Put another way, it seems doubtful the state (Governor’s Office, OWRD, ODFW, LCDC, etc.), the feds (USFS, USACE, etc.), cities, counties and utilities know of and/or appreciate how recent efforts can inform preparations for climate and population change.

Which to me both makes the case for open source community models, as well as for somehow designing a more well developed bridge to decision-makers as your project progresses.”

# Support from the research community

As of 12/10/18, the CW3M project has been discussed with

Anne Nolin, professor, University of Nevada – Reno (P.I. for WW2100 5th year)

Dave Turner, professor, Oregon State University, retired

Chad Higgins, professor, Oregon State University (P.I. for INFEWS)

David Hulse, professor, University of Oregon

Majdi Abou-Najm, professor, University of California – Davis

Mary Santelmann, professor, Oregon State University (P.I. for OUWIN)

Anne Nolin has had an email conversation about CW3M with

Roy Haggerty, Dean of the College of Science, OSU (P.I. for WW2100 yrs 2-4,

original P.I. for OUWIN)

As did the stakeholders, all these members of the research community have responded favorably. Mary Santelmann was supportive, provided that we respect whatever intellectual property rights may be associated with the models as developed in the WW2100, OUWIN, and INFEWS projects. Chad Higgins had a similar concern and has been in contact with David Dickson, OSU’s licensing manager. Chad is considering including the novel elements of the INFEWS model in CW3M, and identifying CW3M as resulting in part from the INFEWS project. Mary Santelmann is considering a similar thing for the OUWIN project.

Anne Nolin gave permission to quote her emails about CW3M here.

## Emails by Anne Nolin on 10/25/18 and 11/25/18

**From:** Anne W Nolin <anolin@unr.edu>   
**Sent:** Thursday, October 25, 2018 9:51 AM  
**To:** david.conklin@freshwatersim.com  
**Subject:** Re: WW2100 -> community Willamette basin model ?

Hi Dave,

I fully support the idea that you propose, creating a community Willamette basin model. I would add to this that part of the work should be a study to determine the most parsimonious set of variables and model parameters needed to achieve acceptable results. This of course will require developing some metrics to determine what is meant by “acceptable” (or some other term).

I think that a second goal would be to use the parsimonious model in another location. The value of a community model is that it can be applied to different locations.

I will be glad to help with this effort!

Thank you and kind regards,

Anne

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Anne Nolin  
Director, Graduate Program of Hydrologic Sciences and  
Professor, Department of Geography  
University of Nevada-Reno

**From:**Anne Nolin <[anne.nolin@gmail.com](mailto:anne.nolin@gmail.com)>  
**Date:**Sunday, November 25, 2018 at 7:04 PM  
**To:**"Haggerty, Roy" <[Roy.Haggerty@oregonstate.edu](mailto:Roy.Haggerty@oregonstate.edu)>  
**Subject:**request for your opinion on transitioning Willamette Envision to a Community model

Hi Roy,

…I’m writing to ask your opinion on the idea of transitioning the Willamette Envision model to a Community model. As you know, Oregon Freshwater Simulations (Dave Conklin et al.) has made great strides in creating a common core of the model to use in WW2100, OUWIN, and INFEWS. There has been interest in creating an open source version of the model with a collection of relevant data sets that would allow agencies and organizations the ability to run the model. The goal is to provide decision support for managers and practitioners in the Willamette River basin (and eventually, more widely) so that they can explore policy and management alternatives on their own. The idea is to create a highly functional yet parsimonious model that is “fit for purpose” and eventually transferable to other watersheds. I’m thinking that it could become something like NCAR’s WRF model that has wide community acceptance and support.

As a former PI on the WW2100, I would appreciate your perspective on this idea. I think we also need the blessing of the OSU intellectual property office but that’s a different question that what I’m asking here.

I hope to hear from you soon,

Thank you and kind regards,

Anne

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# Current status

A CW3M Subversion repository has been set up on the same OSU server that holds the repositories for the WW2100, OUWIN, and Willamette INFEWS models. The CW3M repository includes code and data from the WW2100 project, which was completed at the end of 2016, but does not include the major additions to the model still under development in the OUWIN and INFEWS projects. As of 12/10/18, the CW3M repository is not publicly accessible.

As of 11/17/18, CW3M simulations can be executed for 13 watersheds:

Willamette River (Figure 1)

Tualatin River (Figure 2)

Chicken Creek (part of the Tualatin basin; Figure 5)

North Santiam River (Figure 3)

the upper Willamette basin (McKenzie + Middle Fork + Coast Fork; Figure 4)

Calapooia River

Clackamas River

Long Tom River

Luckiamute River

Marys River

McKenzie River

Molalla River

Pudding River

Compilation of documentation into the CW3M Digital Handbook has begun. The figures in this white paper are from the main prose document, “CW3MdigitalHandbook.docx”, in the Digital Handbook file folder. As of 12/10/18, that document is 15 pages long.

CW3M has been used on an informal, volunteer basis by Dave Conklin at Freshwater to assist in the review of ECONorthwest’s draft report, “Importance of Water in the North Santiam Basin”. Conklin has been working with Rebecca McCoun at the North Santiam Watershed Council (NSWC) on this review. ECONorthwest itself had first contacted Conklin in spring 2018 for information about WW2100 output data for the North Santiam basin, and subsequently referred Freshwater to NSWC.

# Potential projects

1) Freshwater’s informal work with the NSWC on the review of the ECONorthwest draft report has prompted thoughts of a more formal study of the North Santiam. CW3M’s representations of agricultural land and existing water rights in the NSW would be updated for better accuracy. CW3M would be calibrated specifically to the NSW, using whatever historical datasets are available: stream gage records, snowpack records, municipal water use records, possibly records of irrigation withdrawals from cooperating irrigation districts, etc. On completion of calibration, CW3M would be used to simulate future conditions using future climate projections. Assuming collaboration of the Willamette INFEWS project, future stream temperatures might also be simulated, which would allow use of the WW2100 fish model to project climate change effects on native fish.

2) Building on their experience from other projects prior to WW2100, Dave Turner and Dave Conklin have a mutual interest in quantifying the carbon budget of the Willamette River basin. The basic questions are: Given that 2/3 of the basin is upland forest, and that several of the dams in the basin generate hydroelectric power, is it possible for the WRB to be carbon neutral? If so, how many more people could live in the WRB while maintaining its carbon neutrality? There is a forest carbon model in the CW3M code, a legacy of the WW2100 project although it wasn’t used in WW2100. For this carbon budget project, an anthropogenic carbon model would have to be added to CW3M, and the upland forest data and state-and-transition model would need to be updated.

![A close up of a map

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Figure 1. Willamette River basin study area; embedded study areas are colored other than gray. The 2 lighter blues together make up the upper Willamette basin study area.

![A screenshot of a video game

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Figure 2. Tualatin basin study area; Chicken Creek watershed is highlighted.

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Figure 3. North Santiam watershed study area.

![A screenshot of a map

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Figure 4. Upper Willamette study area.

![A close up of a map

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Figure 5. Chicken Creek watershed study area.