

Exhibit A
INTERGOVERNMENTAL AGREEMENT
AGREEMENT NO.:

This Intergovernmental Agreement (IGA or Agreement) is entered into by and between the City of Portland, Oregon, acting by and through its Water Bureau, hereafter called "City" and the State of Washington acting by and through the Board of Higher Education on behalf of the University of Washington hereafter called "UW". This IGA is authorized pursuant to ORS 190.110 and Revised Code of Washington (RCW) 28B.20.130 and becomes effective upon full execution of this document.

RECITALS

1. The City desires to improve and update the climate change study completed by the University of Washington in 2002.
2. As a member of the Water Utility Climate Alliance under the Pilot Utility Modeling Application project, the City, is one of five case studies advancing the state of the science of climate change by improving prior work on climate change impacts on the Bull Run watershed. This work will be accomplished by working with the University of Washington to assess hydrologic models and their performance against downscaled global climate model outputs. The UW will recommend, develop, and train Water Bureau staff in the use of the best-fit hydrologic model as applied to the Bull Run watershed. This work will be included in the WUCA PUMA project products.
3. The City desires to ensure that the impacts of climate change are understood, modeled, and monitored in order to adapt to these potential impacts. The City feels that best way to obtain and apply "actionable science" to the issues of climate change is to work with the premier academic institutions as coordinated by the Climate Decision Support Consortium housed at Oregon State University.

NOW, THEREFORE, THE PARTICIPANTS AGREE AS FOLLOWS:

1. STATEMENT OF WORK

- A. See Exhibit A for a detailed scope of work for this IGA.
- B. Two IGA's will be necessary to fully implement the work contemplated to update the climate change assessment on the Bull Run watershed. The use of two IGAs is recommended by the Climate Impacts Research Consortium head, Dr. Philip Mote, in order to reduce overhead costs. This is the first of the two.

2. BILLING PROCEDURES AND COMPENSATION

- A. The CITY has authorized a total not to exceed amount of \$75,000 to fund the program and enter into a formal agreement for the period between the effective date of this IGA and December 31, 2013. Funding of \$75,000 is available in the Fiscal Year 2012/13 Budget. The CITY's Fiscal Year is defined as July 1 through June 30 of each year.
- B. By the 15th of every other month following the end of the previous two months after the effective date, UW shall submit to the CITY an invoice for work performed during the previous month. Each invoice shall identify the tasks that have been completed per the terms of Exhibit A of this agreement.
- C. Invoices shall be submitted electronically to wbaps@portlandoregon.gov or to:

City of Portland Water Bureau

Attn: Accounts Payable
1120 SW 5th Avenue
Room 609
Portland, OR 97204

D. UW shall fully cooperate with a CITY Audit of the records at any time. UW shall also fully cooperate with an audit to account for all expenses if necessary.

3. TERMINATION

This agreement may be terminated by either party. The CITY on thirty (30) days written notice may terminate this Agreement. UW on ninety (90) days written notice may terminate this Agreement. Failure to produce work products or services on the scheduled timeframes listed in Exhibit A shall be grounds for termination unless both parties agree to shifts in the timeline for delivery of work products and services.

4. NON-DISCRIMINATION

In carrying out activities under this contract, neither party shall discriminate against any employee or applicant for employment because of race, color, religion, sex, age handicap, familial status or national origin. Either party shall take affirmative actions to insure that applicants for employment are employed and that employees are treated during employment, without regard to their race, color religion, sex, age, handicap, familial status or national origin. Such action shall include but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

5. ACCESS TO RECORDS

Both parties and their duly authorized representatives shall have access to the books, documents, and records which are directly pertinent to the specific IGA for the purpose of making audit, examination, excerpts and transcript.

6. INDEMNIFICATION

In accordance with the Revised Code of Washington 28B.20.250, 253 and 255 and UW's standing orders (<http://www.washington.edu/admin/rules/policies/BRG/SOCh5.html>), UW shall indemnify, defend and hold harmless the CITY from and against all liability, loss, and costs arising out of or resulting from the acts of UW, its officers, employees and agents in the performance of this agreement.

Subject to the conditions and limitations of the Oregon Constitution, Article XI, Section 9, and the Oregon Tort Claims Act, ORS 30.260 through 30.300, the CITY shall indemnify, defend and hold harmless UW from and against all liability, loss and costs arising out of or resulting from the acts of CITY, its officers, employees and agents in the performance of this agreement.

7. INSURANCE

UW as an agency of the State of Washington is self insured through a self insurance revolving fund established by the Regents of the University of Washington in accordance with the Revised Code of Washington (RCW) 28b.20.253. All UW personnel, officers and employees, acting within the scope of their employment are covered by worker's compensation insurance

pursuant to RCW Title 51 and this insurance shall be maintained for the duration of this agreement.

8. SUBCONTRACTING AND ASSIGNMENT

UW shall not subcontract its work under this Agreement, without the written consent of the other party. UW shall assure that all subcontractors used to perform the services under this Agreement, meet the CITY'S Codes pertaining to permits, workmen's compensation, licensing, and all other requirements.

9. OREGON LAWS AND FORUM

The Parties expressly remain silent on jurisdiction and venue.

10. FUNDS AVAILABLE AND AUTHORIZED

The CITY certifies that at the time the Agreement is written that sufficient funds are available and authorized for expenditure to finance costs of this Agreement within current appropriation and limitation. In the event of any extension or non-appropriation, the CITY shall notify UW its intent to terminate this Agreement.

11. CAPTIONS

The captions or headings in this Agreement are for convenience only and in no way define, limit or describe the scope or intent of any provisions of this Agreement

12. COMPLIANCE WITH APPLICABLE LAW

Both parties shall comply with all federal, state and local laws, regulations, executive orders and ordinances applicable to the Work under this IGA. Without limiting the generality of the foregoing, parties expressly agrees to comply with (i) Title VI of Civil Rights Act of 1964; (ii) Section V of the Rehabilitation Act of 1973; (iii) the Americans with Disabilities Act of 1990 and ORS 659.425; (iv) all regulations and administrative rules established pursuant to the foregoing laws; (v) Any applicable sections of ORS Chapter 279, and (vi) all other applicable requirements of Federal and State civil rights and rehabilitation statutes, rules and regulations.

13. FORCE MAJURE

Neither Party shall be held responsible for delay or default caused by fire, riot, acts of God and war which are beyond it reasonable control. The affected party shall, however, make all reasonable efforts to remove or eliminate such a cause of delay or default and shall, upon cessation of the cause, diligently pursue performance of its obligation under the Agreement.

14. NO THIRD PARTY BENEFICIARY

The CITY and UW are the only parties to this Agreement and such are the only parties entitled to enforce its terms. Nothing contained in this Agreement gives or shall be construed to give or provide any benefit, direct, indirect, or otherwise to third parties unless third persons are expressly described as intended to be beneficiaries of its terms.

15. MERGER CLAUSE

This Agreement constitutes the entire agreement between the parties. No waiver, consent, modification or change of terms of this Agreement shall bind either party unless in writing and

signed by both parties. Such waiver, consent modification or change, if made, shall be effective only in the specific instance and for the specific purpose given. There are no understandings, agreements, or representations, oral or written not specified herein regarding this Agreement.

16. AMENDMENTS

The CITY and UW may amend this Agreement at any time only by written amendment executed by the CITY and UW. The CITY's Water Bureau Administrator shall be authorized to approve amendments for the City to this Agreement that do not increase the total contract amount above 15% of the original Agreement amount.

17. AGREEMENT PROJECT MANAGERS

- A. The CITY Project Manager shall be Lorna Stickel or such other person as shall be designated in writing by the Portland Water Bureau. All notices to CITY shall be directed to:

Lorna Stickel, Project Manager
City of Portland
1120 SW 5th Ave 6th floor
Portland, OR 97204
Phone:
Email: lorna.stickel@portlandoregon.gov

- B. The UW Project Manager shall be Dennis Lettenmaier or such other person designated in writing by UW. All notices to shall be directed to:

Name: Dennis Lettenmaier
Address: 201 More Hall, Seattle, WA 98195
Phone: (206) 543-2391
Email: dennisl@uw.edu

18. OWNERSHIP

- A. The CITY and UW shall jointly own any and all data, documents, plans copyrights, specifications, working papers, and any other materials the produced in connection with meeting the requirements of the Scope of Work, Exhibit A of this Agreement. UW grants a nonexclusive royalty free license for governmental purposes to CITY.
- B. UW upon request by the CITY shall provide the CITY copies of the materials referred to above in Ownership, Section 18.A, including any electronic files containing the materials.
- C. The CITY understands that UW project investigators may want to seek publishing of the work completed under this IGA in academic peer-reviewed journals and/or presentations at conferences. The CITY supports this objective with caveats:
1. Such publishing and/or presentations will be conceptually discussed with CITY Water Bureau Administrator or their designee early in the development.
 2. Opportunities for co-production of publishing and/or presentations are explored, and
 3. Draft documents or presentation products will be presented to the CITY for review and comment prior to submission.

4. The purpose of these caveats is to ensure that the CITY has the opportunity to characterize the impacts of climate change on the water systems that the CITY is responsible for managing.

19. SEVERABILITY/SURVIVAL

If any of the provisions contained in this IGA are held unconstitutional or unenforceable, the enforceability of the remaining provisions shall not be impaired. All provisions concerning the limitation of liability, indemnity and conflicts of interest shall survive the termination of this IGA for any cause. If any term or provision of this Agreement is declared by a court of competent jurisdiction to be illegal or in conflict with any law, the validity of the remaining terms and provisions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the Agreement did not contain the particular term or provision held to be invalid.

20. CONFLICTS OF INTEREST

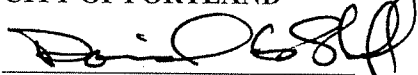
No City Officer or employee, during his or her tenure or for one year thereafter, shall have any interest, direct, or indirect, in this IGA or the proceeds thereof. No board of director member or employee of UW, during his or her tenure or for one year thereafter, shall have any direct financial interest in the IGA or the proceeds thereof. No City Officer or employees who participated in the award of this agreement shall be employed by during this IGA.

21. EFFECTIVE DATE AND DURATION

This Agreement shall be effective upon final date of execution and terminate on December 31, 2013 unless otherwise agreed to by both parties under the provisions of this Agreement.

Dated this _____ day of _____, 2012

CITY OF PORTLAND

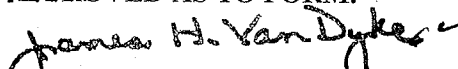


David G. Shaff
Portland Water Bureau Administrator

01.23.2013

Date

APPROVED AS TO FORM



James H. Van Dyke
CITY ATTORNEY

1/11/13
Date

UNIVERSITY OF WASHINGTON



Carol Rhodes
Interim Director, Office of Sponsored Programs, University of Washington

12/21/12

Date

Matthew T. Hawkins
Senior Grant & Contract Administrator
Acting for Carol Rhodes

Exhibit A
Scope of Work for the Portland Water Bureau
PUMA Project Phase I – Hydrologic Model for the Bull Run Watershed for
Climate Change Analysis
University of Washington, Climate Impacts Group

Key participants: Dr. Dennis Lettenmaier, Dr. Bart Nijssen, Dr. Homero Cervantes, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Ocean, Climate Impacts Group (CIG) University of Washington, Coordination roles with the Pacific NW Climate Impacts Research Consortium (CIRC) Dr. Phillip Mote, Kathie Dello, Meghan Dalton Oregon State University.

Overall budget: \$75,000

Phase 1. Overall Project Intent for Hydrologic Model - To assist PWB in the selection, setup, and implementation of future climate change assessments, six subtasks are identified to explore the best fit of hydrologic models to assess climate change through downscaled global climate model outputs within the Bull Run watershed. The final product will be recommendations for the best option(s) for developing a hydrologic model, develop that model at the Portland Water Bureau (PWB), and to train Bureau staff in the use of the model.

Subtask (1) Select 3-5 possible hydrologic models

Staff:

Lettenmaier (Professor) (.33 months)

UW Research scientist (Post Doc) (1 month)

The PWB does not currently have a hydrologic model of the Bull Run watershed. In order to process downscaled climate data into useful information as hydrologic outputs to place within the Bureau's integrated planning model (WEAP), a watershed model or some related platform is needed.

Hydrologic models have been developed for many purposes in many locations. Often the model that is selected is simply one that has been used before and is thus most familiar to those doing the work. Although this rationale is logical, we feel this project offers an opportunity to look beyond the obvious, especially because models used in a research context (e.g. DHSVM) are not necessarily the most applicable in practice. UW will, therefore, work with PWB to select 3-5 hydrologic models that could be run in house at PWB (ultimately, UW project managers will set up one at PWB as outlined below). UW project managers/staff will consider the following criteria in the selection and evaluation of prospective hydrologic models:

- i. Non-proprietary software
- ii. Able to process multiple runs through scripting (important in climate change assessments)
- iii. Simulates hydrologic processes at appropriate spatial and temporal scales
- iv. General ease of setup and use
- v. Model reputation
- vi. Cost to the utility including initial cost, setup, and operation

As an important first step in the project, UW will have discussions with PWB and a site visit to further understand and prioritize PWB's needs and general possibilities

for model implementation. In these discussions, we will revise and prioritize the above criteria.

PWB will conduct a brief survey of which hydrology models are used by other utilities in the region and other PUMA participants (e.g. Vancouver, Seattle, Tacoma, San Francisco, Tampa Bay) which may be partly based on examination of past research/information. This work will be provided to UW project managers.

A brainstormed list of possible models to explore include but are not limited to: NWS Sacramento model, HSPF, VIC, USGS PRMS, DHSVM and other models utilized by the utilities listed above if feasible and appropriate. The final work product of this subtask will include a brief report on the work done and a recommended short list of models to be carried forward into the next subtask (2).

Deliverable: Tech memo #1 outlining the work completed.

(2) Apply/calibrate the selected models to the Bull Run watershed

Staff:

UW Research Scientist (Post Doc) (1 month)

Nijissen (Research Scientist) (.5 months)

This sub-task will be done primarily off-site at the University of Washington, working with PWB to gather datasets for parameter setup and model testing. The PWB will provide some of the information sets desired and those our current data sets can provide. It is an outcome of this task to demonstrate the ability of the models tested to reproduce a) past observed streamflow variations (classical calibration/validation) and b) their ability to reproduce observed interannual variations in streamflow that are climatically sensitive (e.g., interannual variations in centroid of timing, and summer low flows in response to precipitation and temperature variations).

Deliverable: Tech memo #2 outlining the work completed.

(3) Conduct a hydrologic model intercomparison

Staff:

UW Research Scientist (Post Doc) (1.5 months)

UW project managers will work with PWB to develop a suite of model performance metrics that are already commonly used as well as metrics specific to how well the hydrologic model captures changes in climate. Climate sensitivities are being evaluated across the entire

Columbia River basin and in the Willamette Basin in other project by the CIRC and this information may be able to be leveraged to provide a regional context for the Bull Run watershed. A tentative list includes evaluation of:

- i. general magnitude and timing of flow
- ii. peak of hydrograph and how it changes with increasing temperatures
- iii. changes in the centroid of timing,
- iv. baseflow recession
- v. temperature sensitivities (how much streamflow changes per degree increase in temperature)
- vi. precipitation elasticities (how much streamflow volume changes per percent change in precipitation)

Deliverable: Tech memo #3 outlining the work completed.

(4) Select the most appropriate model from intercomparison results to run at PWB

Staff: UW Research Scientist (Post Doc) (.5 months)

The model selection will be done in collaboration between PWB and UW/CIRC, ideally through another site visit. An overview of the models and intercomparison results will be presented to PWB and subsequent discussions will result in a selection.

(5) Set up selected hydrologic model at PWB and train PWB staff on model operations

Staff: UW Research Scientist (Post Doc) (1 month)

Set up and training will occur over multiple days at PWB facilities. Special attention will be given to setting up the model in an environment that is conducive for running climate change scenarios. Training will be provided to PWB staff on operating the hydrologic model and how to apply downscaled climate change data to be developed as Phase II of the PUMA project to produce hydrologic outputs that will capture the range of impacts of climate change on flows.

(6) Further evaluate land-surface sensitivities to changes in temperature and precipitation to help bound hydrologic uncertainties Staff: UW Research Scientist (Post Doc) (.5 months)

As mentioned in sub-task 3, climate sensitivities are being evaluated across the Columbia and Willamette basins. If resources allow, the Bull Run watershed could become a case study for how these sensitivities could be used in water management applications to bound uncertainties of global climate models (outside of the more commonly used downscaled scenario approach). This would involve more rigorously exploring climate-related observations to better understand how the watershed has historically responded to changes in temperature and precipitation.

Deliverable: Tech memo #4 outlining the work completed in Tasks 4-6.

Final Product –

Staff: UW Research Scientist (Post Doc) (.5 months)

Other than any final products listed in the above Sub-tasks

UW with assistance from the CIRC staff will provide a summary that clearly details methods, results, and conclusions. This report will be in a format, and with content similar, to a journal article or articles that will be submitted for publication following completion of the project. This report will differ, however, from any journal publications (those outlined in the IGA section X)

in that the primary audience for this report will be the utility and other non-academic audiences. This report will be drafted by UW project manager and reviewed and commented upon by PWB staff before finalization.

BUDGET CATEGORY

Year 1

Total

Salaries		
Dennis Lettenmaier ^a	\$5,098	\$5,098
Bart Nijssen ^b	\$4,600	\$4,600
Research Scientist ^c	\$24,000	\$24,000
Exempt Staff ^d	\$3,174	\$3,174
Retirement and Benefits ^e	\$10,470	\$10,470
Travel ^f	\$1,200	\$1,200
Total Direct Cost	\$48,542	\$48,542
Indirect Cost ^g	\$26,458	\$26,458
GRAND TOTALS	\$75,000	\$75,000

Budget Explanation:

^aD.P. Lettenmaier .33 month/year

^bBart Nijssen .50 month/year

^cResearch Scientist 6 months/year

^dExempt staff (computer systems analyst, computer support) .50 month/year

^e26.90% faculty, 34% professional and exempt staff

^fProject meetings, 4 round-trips to Portland, OR from Seattle

^g54.5% on direct cost (travel + salary and benefits)

TOTAL COST = \$75,000

References

Hamlet, A.F., and D.P. Lettenmaier, 2005: Production of Temporally Consistent Gridded Precipitation and Temperature Fields for the Continental United States J. Hydrometeor., 6, 330–336.

Maurer EP, Hidalgo HG, Das T, Dettinger MD, Cayan DR. 2010. Assessing climate change impacts on daily streamflow in California: the utility of daily GCM output. Hydrology and Earth System Sciences 14: 1125–1138, DOI:10.5194/hess-14-1125-2010.

Exhibit B
INTERGOVERNMENTAL AGREEMENT
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RECITALS

1. The City desires to improve and update the climate change study on Bull Run completed by the University of Washington in 2002.
2. The City as a member of the Water Utility Climate Alliance, under the Pilot Utility Modeling Application project is one of five case studies advancing the state of the science of climate change by improving prior work on climate change impacts on the Bull Run watershed. This work will be accomplished by working with the University of Idaho to provide downscaled global climate model (GCM) climate variable output for the area of the Bull Run watershed. This work will be included in the WUCA PUMA project products.
3. The City desires to ensure that the impacts of climate change are understood, modeled, and monitored in order to adapt to these potential impacts. The City feels that the best way to obtain and apply "actionable science" to the issues of climate change is to work with the premier academic institutions in the Pacific Northwest as coordinated by the Climate Impacts Research Consortium housed at Oregon State University (RISA).
4. The City intends that as the second of two Phases, this IGA for Phase II will provide downscaled global climate model (GCM) outputs from the most recent iteration of these models for application to the hydrologic model developed as part of Phase I of this work with the University of Washington.

NOW, THEREFORE, THE PARTICIPANTS AGREE AS FOLLOWS:

1. STATEMENT OF WORK

- A. See Exhibit A for a detailed scope of work for this IGA.
- B. Two IGA's will be necessary to fully implement the work contemplated to update the climate change assessment on the Bull Run watershed. The use of two IGAs is recommended by the Climate Impacts Research Consortium head, Dr. Philip Mote, in order to reduce overhead costs. This is the second of the two.

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- D. UID shall fully cooperate with a CITY Audit of the records at any time. UID shall also fully cooperate with an audit to account for all expenses if necessary.

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6. INDEMNIFICATION

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loss and costs arising out of or resulting from the acts of UID, its officers, employees and agents in the performance of this agreement.

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7. INSURANCE

UID's liability coverage is provided through a self-funded liability program administered by the State of Idaho Office of Insurance Management. Limits of liability, and this indemnification are \$500,000 Combined Single Limits, which amount is the University's limit of liability under the Idaho Tort Claims Act. UID is a subject employer under the Idaho Workers' Compensation law I.C. 72-203/205, and shall maintain workers' compensation insurance through the duration of this Agreement.

8. SUBCONTRACTING AND ASSIGNMENT

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Lorna Stickel, Project Manager
City of Portland
1120 SW 5th Ave 6th floor
Portland, OR 97204
Phone: (503) 823-7502
Email: lorna.stickel@portlandoregon.gov

- B. The UID Project Manager shall be Dr. John Abatzoglou or such other person designated in writing by UID. All technical notices to shall be directed to:

Name: Dr. John Abatzoglou
Address: Geography Department, University of Idaho, Moscow, ID 83844-3021
Phone: 208-885-6239
Email: jabatzoglou@uidaho.edu

For all other matters the UID contact shall be:

Name: Vicki Russell
Address: 875 Perimeter Drive MS 3020, Moscow, ID 83844-3020
Phone: (208) 885-4984
Email: postaward@uidaho.edu

17. OWNERSHIP

- A. CITY and UID shall jointly own all data, documents, plans copyrights, specifications, working papers, and any other materials produced jointly by one of more employees of CITY and one or more employees of UID produced in connection with meeting the requirements of the Scope of Work, Exhibit A of this Agreement . UID grants CITY a perpetual, irrevocable, and royalty-free license to use all data, documents, plans copyrights, specifications, working papers, and any other materials produced under this agreement for City's purposes.
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If any of the provisions contained in this IGA are held unconstitutional or unenforceable, the enforceability of the remaining provisions shall not be impaired. All provisions concerning the limitation of liability, indemnity and conflicts of interest shall survive the termination of this IGA for any cause. If any term or provision of this Agreement is declared by a court of competent jurisdiction to be illegal or in conflict with any law, the validity of the remaining terms and provisions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the Agreement did not contain the particular term or provision held to be invalid.

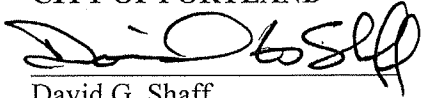
19. CONFLICTS OF INTEREST

No City Officer or employee, during his or her tenure or for one year thereafter, shall have any interest, direct, or indirect, in this IGA or the proceeds thereof. No board of director member or employee of UID, during his or her tenure or for one year thereafter, shall have any direct financial interest in the IGA or the proceeds thereof. No City Officer or employees who participated in the award of this agreement shall be employed by during this IGA.

20. EFFECTIVE DATE AND DURATION

This Agreement shall be effective upon final date of execution and terminate on December 31, 2013 unless otherwise agreed to by both parties under the provisions of this Agreement.

Dated this _____ day of _____, 2012

CITY OF PORTLAND

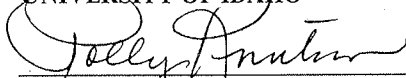
David G. Shaff
Portland Water Bureau Administrator

01.23.2013

Date

APPROVED AS TO FORM:**APPROVED AS TO FORM**
James H. Van Dyke
City Attorney**CITY ATTORNEY**

1/11/13
Date

UNIVERSITY OF IDAHO

Polly Knutson 1/8/13
Director, Office of Sponsored Programs

1/8/13
Date

**Scope of Work for the Portland Water Bureau
PUMA Project Phase II – Downscaled Global Climate Model Data for the
Bull Run Watershed for Climate Change Analysis
University of Idaho, Geography Department**

Key participants: Dr. John Abatzoglou, University of Idaho, Geography Department. Coordination roles with the Pacific NW Climate Impacts Research Consortium (CIRC) Dr. Phillip Mote, Kathie Dello, Meghan Dalton Oregon State University. Overall budget: \$25,000

Phase II - PUMA downscaled MACA data base development

Selection of suite of downscaled climate scenarios suited to operate hydrological models at spatial and temporal scales are needed to resolve local meteorological factors within the Bull Run watershed and the hydrologic sensitivity of the basin to climate change. The development of downscaled climate scenarios suited for applied use will involve three subtasks:

Subtask A – (\$4,000, Post Doc)

Selection of appropriate set of global climate models (GCM) from the state-of-the-art models developed for the Coupled Model Intercomparison Project 5 (CMIP5), UID will work with PWB to select a group of 8-12 CMIP5 models and selected emission scenarios in coordination with other CIRC efforts for the Pacific Northwest.

Subtask B - (\$5,000, Post Doc)

Identification of the highest-quality observational datasets for the Bull Run Watershed. To foster improved applicability of the downscaled climate scenarios UID will consult with PWB on the appropriate observational meteorological datasets needed for downscaling. UID will consider both gridded meteorological data (e.g., Hamlet and Lettenmaier, 2005; updated to ~6km resolution) as well as available station data (e.g., SNOTEL, PDX, Headworks) used operationally by PWB. This effort will be coordinated with Phase I by the University of Washington to ensure interoperability between downscaled climate scenarios and selected hydrologic models.

Subtask C - (\$8,000, Post Doc)

Statistical downscaling to bridge the gap between GCMs and representative spatial and temporal scales within the watershed. Using the observational datasets selected for the basin and the set of climate scenarios, UID will statistically downscale CMIP5 runs using the Multivariate Adaptive Constructed Analog (MACA) method (Abatzoglou and Brown, 2011). The MACA methodology is reasoned to be well suited to application within the Bull Run watershed and PWB applications due to its ability to (i) overcome limitations associated with interpolation-based approaches in across complex terrain, (ii) incorporate a variety of meteorological variables (temperature, precipitation, insolation, humidity, wind speed), and (iii) directly utilize daily GCM output in more faithfully capturing projected changes in extreme events (i.e., atmospheric rivers). This subtask will take advantage of available gridded downscaled datasets produced using the MACA methodology.

Deliverables

A. Downscaled data sets.

Historical data and downscaled climate scenarios from CMIP5 (1950-2100) in format compatible with selected hydrologic model selected in Task I for the following variables:

Daily maximum and minimum temperature
 Daily maximum and minimum humidity
 Daily mean dewpoint temperature
 Daily mean wind velocity
 Daily accumulated precipitation
 Daily mean solar radiation

B. Documentation - (\$2,000, Post Doc; \$2,000 Abatzoglou)

Documentation of process involved in selection of CMIP5 models, observation meteorological datasets and downscaling methodology, including limitations and appropriate uses of downscaled scenarios in planning activities. We will compare differences in climate projections between the four climate models used in the 2002 Climate Change Study for PWB and the group of selected CMIP5 models used in the proposed work and provide a brief overview of projected changes in primary climate variables listed in Section IV of the prospectus. Where possible, and where there is leverage with ongoing CIRC activities, we will also compare different downscaling methods within the study area (e.g., Abatzoglou and Brown, 2011). We will more formally compare meteorological outputs developed using the delta-approach of the 2002 Climate Change Study for PWB and MACA. A brief report will be provided at the completion of Phase II outlining the methodology and products in language accessible to the utility and other non-academic audiences.

C. Workshop- (\$2,000, Post Doc; \$2,000 Abatzoglou)

Workshop CIRC will conduct a 1-day workshop at PWB providing overview of project results and a few-hour training session on how to use the hydrologic model / view climate data. This workshop will include the results of both Phase I and II and may involve staff from both the University of Washington and Idaho, if resources under both IGA's are available or if from other sources can be identified. Other local WUCA members participating in the PUMA project will be invited, at their own expense.

References

Abatzoglou, J.T., and T.J. Brown. 2011, A Comparison of Statistical Downscaling Methods Suited for Wildfire Applications, International Journal of Climatology, doi: 10.1002/joc.2312