Assessing Pacific Northwest Water Resources Stakeholder Data Needs

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1. Introduction

Throughout the western U.S., the need to incorporate climate change information in water resource planning efforts and decisions has been widely acknowledged (Rayner *et al*. 2005; Callahan *et al*. 1999). However, appropriate tools, including hydrologic scenarios incorporating climate change, are often not available to water planners and policy makers to effectively guide decision making at the basin and sub-basin scale. Several studies have noted the challenge of developing climate change information that is appropriate for and integrated into decision making by water planners and policy makers (Callahan *et al.* 1999; Jacobs *et al*. 2005; McNie 2007). Existing barriers include difficulties recognizing the utility of the information generated and institutional management resistance.

Improved communication between researchers and data users is repeatedly cited as a key element to generating information relevant and useful to decision makers (Callahan *et al*. 1999; Jacobs *et al*. 2005; McNie 2007). Increasing communication with data users and stakeholders in research tool development, interpreting data resources, and demonstrating data utility can aid the development of appropriate and usable information for stakeholders (Callahan *et al*. 1999). More often, when research products have not been developed with stakeholder input, the specific needs of users go unmet (McNie 2007).

Recognizing this, the Climate Impacts Group (CIG) surveyed stakeholders in order to ensure that the research and web products developed as part of the Columbia Basin Climate Change Scenarios Project (CBCCSP) appropriately matched user data needs. This report summarizes the results of that survey.

2. Approach/Methods

The CBCCSP data needs survey took place between October and December 2007 using the SurveyMonkey.com online survey tool. Survey participants were solicited via the CIG's listserve and through regional contacts at various meetings, including the CIG's annual climate and water fall forecast meetings. A total of 178 respondents completed some portion of the online survey.

The survey consisted of 11 questions designed to assess the data users, their data needs, and data delivery preferences (Table 1). Four additional optional questions asked for perspectives on organizational capacity to adapt to climate change. Survey questions included a mix of multiple choice and open-ended response questions. Response rates for individual questions ranged from 21-99%.

Table 1. Survey questions and response rates

Question	Question type/Response options	Response Rate
1. What organization/agency do you work for?	Open response	144/178 (81%)
2. What specific geographic areas of the Pacific Northwest are important to your occupational activities?	Multiple choice with open response option: 63 geographic regions + Other	176/178 (99%)
3. What specific management areas are you involved with?	Multiple choice with open response options: Hydropower, instream flow management, water supply, navigation, irrigation supply, hatchery management, recreation, other.	176/178 (99%)
4. What specific occupational activities are you involved with?	Multiple choice with open response options: Resource management, watershed or ecosystem restoration, long-range planning, operations, policy making, other.	176/178 (99%)
5. From the following list of meteorological and hydrological variables, which would be useful to you in the context of planning for a changing climate?	Multiple choice • *1/16th degree gridded data* - Total precipitation, max. temperature, runoff, min. temperature, baseflow, snow water equivalent (SWE), fraction of precipitation as rain, date of peak SWE, date of 90% SWE melt, potential evapotranspiration (ET), total column soil moisture, natural ET, tall crop ET, short crop ET. • *Time-step choices:* hourly, daily, weekly, twice-monthly, monthly.	150/178 (84%)
6. (Same as #5 but for streamflow and water temperature data)	Multiple choice • *Streamflow data:* Streamflow, water temperature • *Time-step choices:* hourly, daily, weekly, twice-monthly, monthly	146/178 (82%)
7. Are there additional hydrological or meteorological variables that	Open response	38/178 (21%)

would be useful to you that are not included in the above list?		
8. What other kinds of information or products derived from the above data would be useful to you in planning for or adapting to climate change impacts? (e.g. spatial maps of changes in the mean?)	Open response	43/178 (24%)
9. How do you prefer to acquire electronic data?	Multiple choice with open response option: Conventional web services (e.g. html pages), FTP sites (download files via the web), CDs, electronic reports, paper reports, Other	133/178 (75%)
10. What file formats do you prefer for data?	Multiple choice with open response option: ASCII (text) files, conventional binary format, Excel spreadsheets, netCDF, Other)	135/178 (76%)
11. What documentation should be prepared to make available data resources most useful?	Open response	135/178 (76%)
Supplemental Adaptation Questions		
12. How has interest in including climate change information in your organizations planning changed in recent years? What (if any) specific events or types of information have led to this change?	Open response	49/178 (28%)
13. How do you expect climate change will affect your organization's interests and responsibilities?	Open response	83/178 (47%)
14. How would you rate your organization's capacity to integrate climate change data and information into planning and management activities? Why did you give it that ranking?	Multiple choice: Excellent, good, fair, or poor with open response option for second part of question	127/178 (71%)
15. What would increase your organization's ability to adapt to climate change?	Open response	84/178 (47%)

3. Key Findings: Survey Responses

3.1 Data Users *(Questions 1-4)*

Survey participants were involved in water resource management through a wide range of organizations and management activities across the Pacific Northwest (PNW) region (questions 1 and 3). State and federal agency staff made up 60% of survey participants, with the remainder represented by staff from private sector, local government, tribal, non-governmental (NGO), and academic organizations (Figure 1). Water supply, instream flow management, and hydropower production were the dominant management areas for survey participants, followed by irrigation supply and recreation (Figure 2).

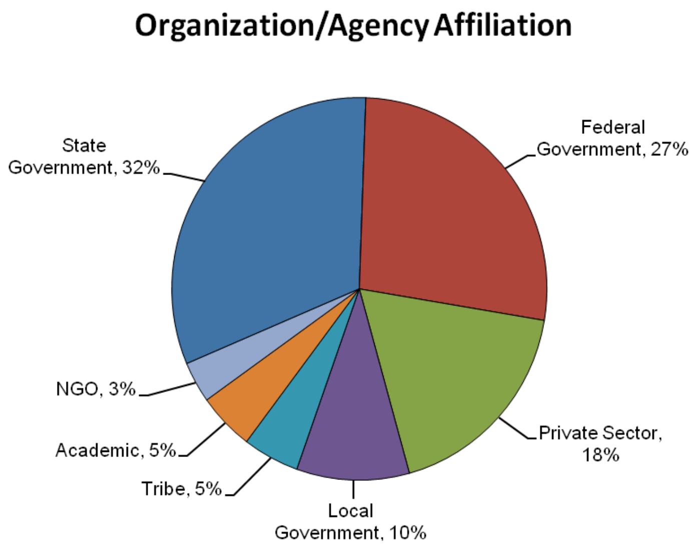

Figure 1. General organization/agency affiliation of survey participants

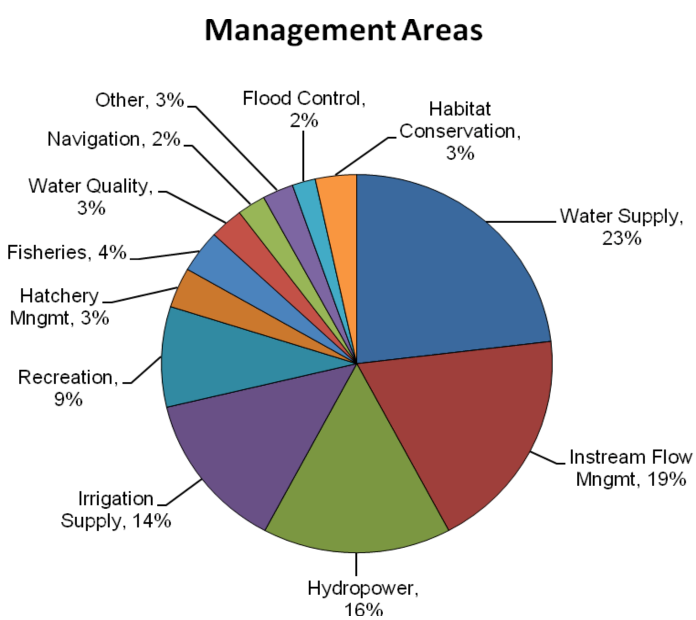

Figure 2. Management areas of survey participants

Respondents identified over 78 different geographic regions throughout the PNW as important to their occupational activities (question 2). Nearly half of the participants indicated the importance of the entire PNW region or Columbia River Basin in their management activities. Eastern Washington basins dominated the top 30 responses, although "Other" responses, which ranked third in total count, included numerous Idaho and Oregon basins. The Lower Snake, Lower Yakima, Upper Yakima, Middle Snake, and Okanogan regions - all arid regions with significant water management needs - were each identified as important to 15% or more of the 176 survey participants responding to this question. Other basins selected by 10% or more of respondents included but were not limited to: Grand Coulee (13%), Wenatchee (13%), Methow (12%), Naches (12%), Lower Crab (11%), Walla Walla (11%), Entiat (11%), Kettle (11%), Chelan (10%), and the Upper Skagit (10%). These geographic interest areas match well with the streamflow locations ultimately selected for the database (Figure 2, Chapter 8).

3.2 Data Needs *(Questions 5-8)*

The main product of the CBCCSP is a web-based data visualization and delivery system that provides stakeholders, researchers, and the general public with free access to the data products. Both the comprehensive hydrologic data base and downscaled climate scenario projections developed by the CIG provide increased spatial resolution relative to existing resources by using $1/16^{th}$ degree (approximately 12.5 sq. mi. or 36 sq. km) gridded data resolution. The data need priorities identified by the survey respondents provided direct feedback for the design and development of the database and web-based products.

Data need preferences for $1/16^{th}$ degree gridded data resolution (question 5) were remarkably uniform throughout different management areas. The most requested variable among survey participants was total precipitation (requested by 92% of question respondents) followed by maximum temperature (91%), runoff (87%), minimum temperature (86%), and baseflow (79%) (Figure 3). Survey participants overwhelmingly preferred data at a daily time step (42%); monthly was the next most requested time step (21%). This result confirmed the CIG's decision to provide analysis at a daily time step, which was based on previous observations that this planning element had received limited attention in past downscaling efforts (Hamlet and Snover, 2007).

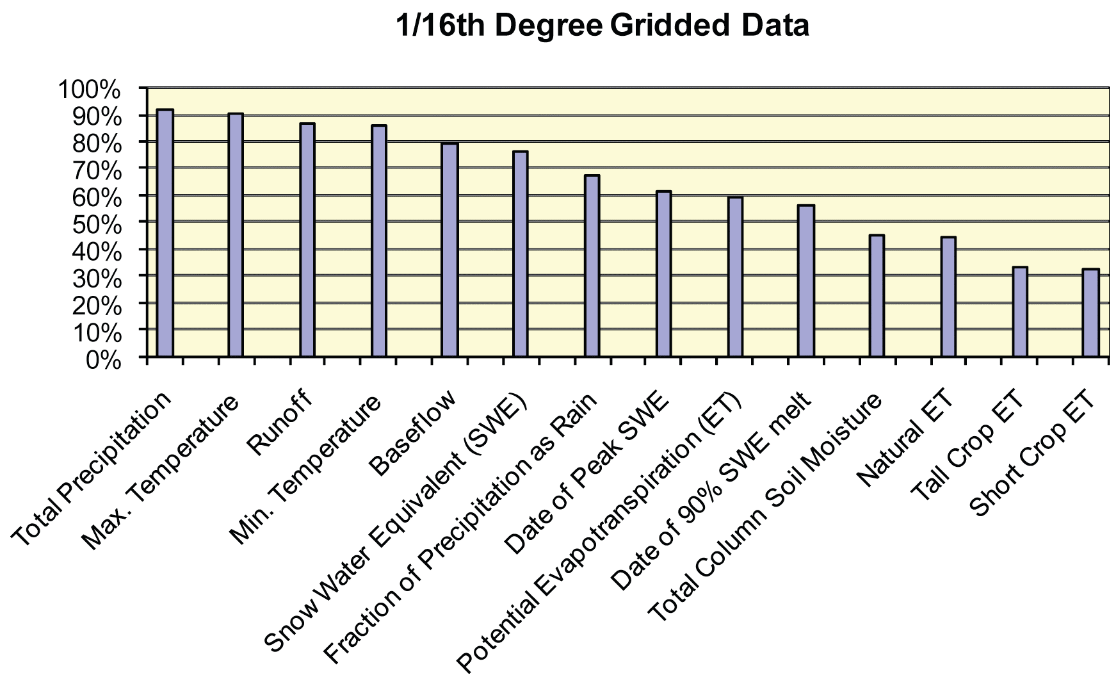

Figure 3. Overall ranking of 1/16th degree gridded variables by survey respondents.

The ranking of each variable's utility within leading management areas is shown in Table 2. For example, while total precipitation was the most requested gridded data variable among all survey participants (and daily the most requested time step for total precipitation), daily total precipitation ranked as the fifth most requested variable for water supply managers. With only a few exceptions, survey respondents from all management areas selected the same top ten data variables, differing only in their order of preference.

Table 2. Top 10 requested 1/16th degree gridded meteorological and hydrological variables sorted by leading management areas of survey participants. Although time step was not a factor in the ranking, the daily time step was the preferred time step choice for each of the top 10 requested data variables.

Data Variable, *ranked in order to total preference*	**Preferred Time Step**	**Water Supply**	**Instream flow mngmt**	**Hydro-power**	**Irrigation Supply**
1. Total Precipitation	Daily	5	5	4	6
2. Maximum Temperature	Daily	1	1	1	2
3. Runoff	Daily	2	2	3	1
4. Minimum Temperature	Daily	2	3	2	3
5. Baseflow	Daily	5	5	4	5
6. Snow Water Equivalent (SWE)	Daily	4	4	6	3
7. Fraction of Precipitation as Rain	Daily	8	7	7	7
8. Date of Peak SWE	Daily	7	8	8	9
9. Potential Evapotranspiration (ET)	Daily	10	10	10	8
10. Date of 90% SWE melt	Daily	8	9	9	10

Streamflow and water temperature data ranked high for respondents (question 6). Ninety-seven percent of respondents requested streamflow data and 76% requested water temperature data. As with other variables, respondents preferred the daily step over other time steps although hourly was a close second (36% versus 34%, respectively).

Questions 7 and 8 were open response questions asking for additional data variables and derived information products that would be useful. Although response rates were low for both questions (21% and 24% respectively), both questions provided valuable information. Additional suggested data variables included wind speed and direction, air temperature, relative humidity, turbidity, solar radiation, snow pack characteristics (e.g. snow depth, snowpack temperature) and additional streamflow characteristics (e.g. peak flow, canal flow). Many of these are included in the suite of variables offered to website users. Suggested derived products included spatial maps of data anomalies/patterns of mean changes such as changes in seasonal or inter-annual variability, peak flow timing, daily extremes (including extreme precipitation), and monthly runoff patterns compared to historic patterns. These products would serve as useful information products in planning for or adapting to climate change impacts. Several respondents indicated that spatial maps would be especially valuable for communicating information to the public.

3.3 Survey Responses: Data Delivery Preferences *(Questions 9-11)*

Survey respondents had clear preferences regarding data delivery formats (questions 9 and 10). Respondents overwhelmingly indicated a preference for receiving data via conventional web services (82%) or FTP sites (63%) over the use of CDs or paper reports. Additionally, respondents preferred Excel spreadsheets (83%) or ASCII (text) files (62%) over other file formats such as conventional binary format or net CDF.

Survey participants also provided a variety of suggestions regarding what types of documentation would make the available data resources most useful (question 11). Metadata - information that describes data, including information on data sources, definition of data variables, data collection methods, data manager contact information, data confidence and relevant assumptions - was requested. One respondent noted that the metadata that accompanies USGS stream gauge network is a useful model of appropriate data documentation. Data descriptions including short non-technical synopsis reports, summary tables, and data interpretation were also suggested.

3.4 Survey Responses: Perspectives on Integrating Climate Change Information *(Questions 12-15)*

Survey respondents, at a lower response rate, provided their perspectives on the integration of climate change information at their respective organizations through a series of mostly open-ended supplemental questions focused on adaptation. Responses indicate a growing interest in and recognition of climate change (question 12). Just over half (54%) of 49 respondents indicated increasing interest in climate change within their organizations, 31% cited that climate change information is being included in planning efforts, and 19% cited that management has made climate change a greater priority. Primary drivers of this increased interest included: a growing awareness of the problem sparked by specific climatic events such as regional drought and forest fires, or observed changes (e.g., earlier runoff event, rising surface water temperature); increased media coverage of climate change; increased knowledge of impacts by the general public; the availability of studies integrating climate change; presentations on climate change impacts; and attendance at climate change workshops. In one case, interest was driven by an organizational requirement to include climate change in planning.

Increased interest in climate change paralleled a strong recognition by 93% of respondents that climate change will affect the interests and responsibilities of organizations to varying degrees (question 13). About one-third (31%) of respondents expected reduced resource availability. Other expected changes - potentially driven by reduced resource availability - included changes in decision making and planning (21%), regulatory changes (21%), and the need to include climate change information in analysis (12%).

Despite the widespread recognition of potential impacts on their organizations activities, most respondents do not feel their organizations currently have the capacity necessary to integrate climate change information and data into planning and management activities (question 14). When asked to rank the capacity of their organization, 56% of 127 respondents gave a Fair or Poor ranking. Furthermore nearly three times as many negative justifications were provided for the selected rankings as compared to existing positive attributes. Responses highlighted several organizational barriers including any or all of the following: limited staff capacity, lack of clear guidance on how to integrate climate change into planning, lack of management support, institutional inertia, limited data availability, limited funding, lack of a mandate to plan for climate change, and complexity of the problem. For the 44% of respondents who rated their organization's capacity as Good or Excellent, reasons cited included existing use of climate information, good access to climate data, staff expertise, and a clearly demonstrated priority of dealing with climate change.

Current limitations clearly drove responses to question 15, which asked respondents to identify those things that would increase their organization's ability to adapt to climate change (Figure 4). Proposed strategies included both “top down” institutional needs as well as “bottom up” needs from staff and outside resources. Top down institutional needs included the need for a clear mandate (10%) and more funding (14%) or staff capacity (5%) dedicated to climate change. “Bottom up” needs included new data and/or more site specific data (21%), improved organizational understanding of climate change impacts (15%), improved communication/coordination on climate change issues within the organization (8%), and improved access to data (6%). While the “top down” institutional needs are beyond the scope of CIG’s current research efforts, the CBCCSP directly addresses several of the “bottom up” needs.

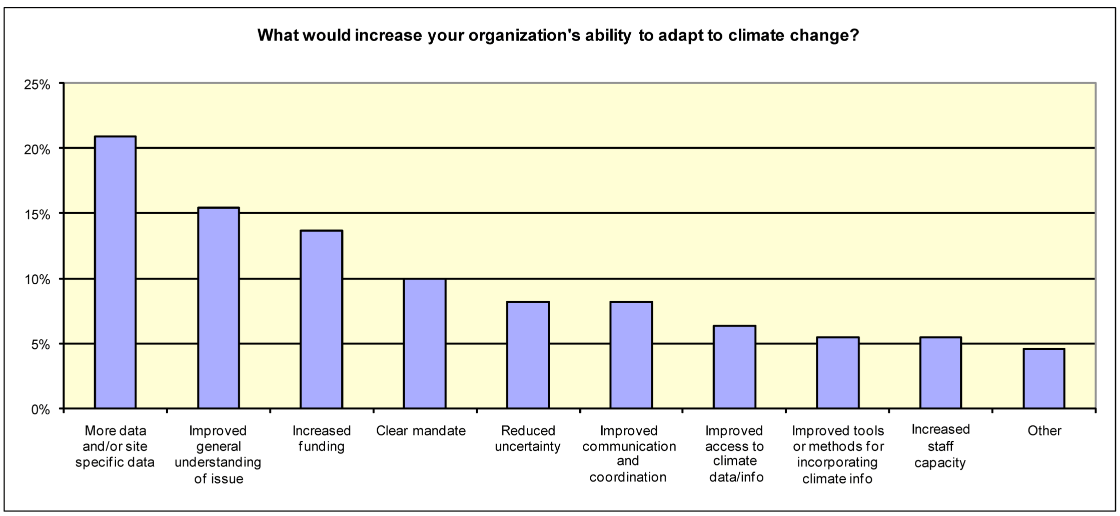

Figure 4. Increasing organizational capacity to adapt to climate change

4. Conclusions

Incorporating stakeholder input generated from the CBCCSP survey has enhanced the utility of research and web products developed from CIG’s research efforts for water planners and policy makers. Survey respondents represented a wide array of organizations, agencies, and management areas, providing a valuable range of stakeholder input. In several areas, survey responses provided clear recommendations for the design of CIG’s research products. Geographic areas of importance reflected the management priorities of survey respondents. Data provided at a daily time step and in accessible Excel or ASCII (text) file formats through conventional web services were strongly preferred by respondents across all management areas. Spatial maps and metadata accompanying data sets were recommended by respondents as useful tools for incorporating this information into planning for and adapting to climate change.

Incorporating these design elements into the CBCCSP research and web products efforts will address strategies proposed by stakeholders to enhance the capacity of their organizations to prepare for climate change by improving access to climate date and information, improving the ability to integrate data into analysis, and improve understanding of the issue. Beyond these efforts, stakeholders identified clear barriers that still remain to effectively plan for and adapt to climate change, including the need for greater funding and staff resources as well as a clearer organizational mandate to address climate change.

5. References

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