SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP) –
PROJECT ANNUAL REPORT

PROJECT TITLE: Collaborative Development of Public Water Supply Utility Relevant Climate Information for Improved Operations and Planning

INVESTIGATORS:

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I. PRELIMINARY MATERIALS

A. Research project objective.

To increase the regional relevance and usability of climate and sea level rise data and tools for the specific needs of water suppliers and resources managers in Florida. The project will (1) develop a collaborative "Working Group" comprised of public water suppliers, water resource managers, climate scientists, and hydrologic scientists focused on understanding how climate variability/change and sea level rise may impact planning and operations of Florida's public water supply utilities, (2) Identify the appropriate spatio-temporal scales, climatic indices, and events that drive utilities' decisions, and evaluate the practical applicability of current climate tools at these scales through synthesis nationally available General Circulation Model (GCM) simulations and statistically and dynamically downscaled data products for the region, and (3) Identify appropriate entry points for climate data and model predictions in Working Group members' models and decision making processes and, for at least two applications, evaluate the usefulness of these data for minimizing current and future risks associated with climate variability/climate change and sea level rise.

B. Stakeholders and decision makers

Florida Public Water Supply Utilities

- Alison Adams, Tampa Bay Water
- Nancy Gallinaro, Palm Beach County, Water Utilities Department

- Kevin Morris, Peace River Manasota Regional Water Supply Authority
- David Richardson, Gainesville Regional Utilities
- Robert Teegarden, Orlando Utilities Commission
- Douglas Yoder, Miami-Dade Water and Sewer Department

Florida Water Management Districts

- Jayantha Obeysekera, South Florida Water Management District
- Michael Cullum, St Johns River Water Management District
- David Zierden, Florida State Climatologist, SouthEast Climate Consortium

C. Approach

Our basic approach centers on building a Working Group that operates as a social learning and collaboration platform and promotes shared knowledge, data, models and decision-making tools relevant to climate impacts and water supply planning. The working group and key beneficiaries are public water suppliers, local governments, water resource managers, climate scientists and hydrologic scientists engaged with planning and operations of Florida's public water supply utilities. While the immediate focus of the Working Group is on Florida public water supply utilities, the Working Group process and the Working Group products will be transferable and useful nationwide. The project will provide feedback to the national climate science community on additional research needed to improve the utility of local- to regional-scale climate simulations/predictions for water resource based on applications.

The working group is collaboratively defining and exploring the most important issues faced by water utilities at a range of planning and management timescales, possible impacts of climate variability/change and sea level rise on these issues, and the relevant spatio-temporal scales at which climate-related information is needed to assess risks of potential impacts, and identifying sources of climate data that may provide the desired information, and process the data into a format consistent with Working Group needs.

We plan to evaluate the ability of nationally available reanalysis products and GCM retrospective simulations (CMIP3, CMIP5 and/or NAARCAP) to reproduce historic climatology in Florida at utility-relevant space-time scales using both dynamic and statistical downscaling techniques. We will also synthesize and evaluate alternative methods for generating future downscaled regional climate scenarios for use in water resource applications. We will evaluate the potential for incorporation this climate information into a few select cooperating utilities planning processes, models and decisions support systems to enable risk assessment and adaptation/mitigation planning. All Working Group members will participate in these assessments in order to gain experience and build capacity for their own future applications.

D. Matching funds/activities

All working group members from the Public Water Supply Utilities, Water Management Districts and local governments provide in-kind support through paying their own travel costs to quarterly project meetings and staff time to attend the meetings and conduct project specific activities between quarterly meetings.

E. Partners

- Southeast Climate Consortium (SECC)
- UF/IFAS Center for Public Issues Education
- Florida Climate Institute
- Florida State Climatologist
- Tampa Bay Water

- Palm Beach County Water Utilities
- Peace River Manasota Regional Water Supply Authority
- Gainesville Regional Utilities
- Orlando Utilities Commission
- Miami-Dade Water and Sewer Department
- SouthWest Florida Water Management District
- South Florida Water Management District
- St Johns River Water Management District
- USGS
- Martin County Board of County Commissioners
- Broward County Natural Resources Planning and Management Division
- Monroe County Sustainability Program

II. ACCOMPLISHMENTS

A. Project timeline and tasks accomplished

Project accomplishments are reported here by objectives and tasks in the work plan.

Objective 1: Develop a collaborative Working Group

- **Group Building and Workshops** - The NOAA project is building on a working group process (Public Water Supply Utilities Climate Impacts Working Group- PWSU-CIWG) initiated in June 2010. An active group of stakeholders is engaged and growing. The NOAA project planning and implementation has been integrated fully into the working group, and three workshops have been conducted since the project was funded (October 2011, February 2012 and May, 2012). Detailed reports of workshop are available on line. Activities have focused on understanding stakeholders' perspectives and understanding of needs relative to climate data, models and information. Needs vary in intensity and urgency by the utilities' location, water source, and contexts, however, all utilities are interested in addressing uncertainties and risks posed by climate variability, change and sea level rise/change. Workshop outcomes have informed the technical activities, and technical activities have been substantively incorporated into workshops. Average attendance at the workshops has been over 23 participants, and growing. Working Group contact list currently includes over 70 contacts. Recent additions have included folks working with local government planning units. Task groups have ensured relevant science presentations at workshops, compiled a growing Research Agenda reflecting research interests of Utilities, and explored communication and outreach efforts, and contributed to working documents to support shared learning. Six collaborative proposals have been submitted to different funding groups. One has been funded.

- **Knowledge Management System (KMS)** – A major interest expressed by participants is for a common base for communication and information to serve their needs. They anticipated a "clearinghouse" that would include vetted information, data, model assessments and scenarios, reports, quarterly newsletter, webinars, seminars, workshops and other information of relevance to climate and water. In December 2010, prior to NOAA project funding, a preliminary WEBSITE was established to support the working group. Activities include:
    - Conceptualization of an online content management system to aid the management of the knowledge acquired and/or used by the group
        - Completed a needs assessment to determine the basic structure and content to be presented by the CMS
            - Analyzed data from needs assessment

        - Created preliminary report in the form of a PowerPoint to relay findings to working group
    - Set-up a sub-committee to review CMS development process
    - Drafted a design document to help guide the format of the CMS
- Benchmarked similar CMS systems and explored platforms for website creation

Objective 2: Identify the appropriate spatio-temporal scales, climatic indices, and events that drive utilities' decisions, and evaluate the practical applicability of current climate tools at these scales

- **Industry Relevant Space/Time Event Scales** - Working Group discussions indicated predictions (rainfall, temperatures, extreme events and sea level rise/change) are needed at space, time and event scales relevant to operations (3-12 months), permitting (20 years) and capital planning (20-50 years). Three technical teams have been established, engaged the working group to develop "roadmaps," and initiated activities to address 1) **Seasonal Scale Forecasts** (to robustly diagnose seasonal climate predictability and skill for all 4 seasons), 2) **Long-term Climate Scenarios** (focused on the need to develop common climate scenarios for use in Florida that include precipitation, temperature and other climate variables (relative humidity, wind speed, solar radiation etc.), and 3) **Sea-level Rise/Change** (initially focused on improving access to information.

- **Evaluate output of existing Climate Change and Sea Level Rise/change data products** –

1. **Seasonal Scale Forecasts -** We have used the National Multi-Model Ensemble forecasted SST to develop high resolution (50km grid) seasonal forecasts for the summer, fall, winter and spring seasons. The summer and fall season forecasts have been completed and their skill verification indicate that they have considerably improved the precipitation skill over the NMME models for precipitation and surface temperature for the summer and fall seasonal hindcasts. The winter and spring seasonal hindcasts are still underway. These seasonal hindcasts are then being used to drive multiple hydrological models for seasonal forecasts of streamflow across 28 watersheds spread across the southeast US including 3 watersheds in Florida.

2. **Long term Climate Scenarios -**
   Dynamic Downscaling - We are examining the ENSO impact on streamflow in several watersheds in the southeastern US from multiple sources of centennial scale meteorological datasets of the 20th century including the dynamically downscaled 20th century reanalysis. We find that the ENSO impact on rainfall and streamflow are similar in small size watersheds but are significantly different when the size of the watersheds exceeds a critical threshold.

   Statistical Downscaling - To date the team has evaluated the ability of three statistical downscaling methods (BCSD (Wood et al 2002), SDBC (Abatzoglou and Brown, 2011), and BCSA, Hwang, 2011)) combined with 4 CMIP3 GCM retrospective predictions (BCCR-BCM 2.0, CCSM, CGCM 3.1, and GFDL-CM 2.0) to generate accurate precipitation and temperature fields over Florida at the time (daily) and space (12km) scales of interest to the working group. Results showed that the all the statistical downscaling approaches successfully reproduced the Results have been documented in one journal article that is currently under review (see SECTION E). Future work will investigate alternative methods for bias-correcting future climate projections and then use the BCSA method to downscale future CMIP3 projections over the state of Florida. Statistically downscaled results will be compared to dynamically downscaled results described above.

3. **Sea Level Rise/Change -** The group established four goals and a list of activities in order of priority. Through roundtable discussion during one of the PWSU-CIWG workshops, a group of eight members developed a strategic road map to address the needs for sea level change information. Although the group agreed that all four goals are important, they also agreed that it would be best to wait until the first two were well underway before addressing the third and fourth, so no progress has been made yet. Progress on each goal is as follows:

   Improved access to information already available
   - A list of sea level change tools available on the web was developed and made available to the working group. The offer to present a webinar on these tools was not deemed necessary by the group as they felt they could become familiar with the tools on their own.
   - All members of the PWSU-CIWG were invited to attend a drought briefing webinar that is conducted as part of a National Integrated Drought Information System pilot project in order to determine whether a similar briefing should be developed for the Florida peninsula. Those that attended the briefing agreed that a similar briefing for Florida would be useful and should be pursued when conditions indicate that drought is likely to develop.
   - Recent reports from the National Climate Assessment have been made available to the Knowledge Management System.

   Catalog current projects on sea level change – As efforts for the National Climate Assessment are already undertaking a similar task, we decided to build on that effort when it becomes available rather than to repeat work that other are doing.
   Develop and implement plan on how best to move from science to policy and action
   Investigate the role of governance structures related to responses to sea level change

Objective 3: Identify appropriate entry points for climate data and model predictions in Working Group members' models and decision making processes

- **Lumped Hydrologic Modeling for 5 watersheds in Florida** - The hydrological impact of climate change is assessed for 28 watersheds located within the Southeast United States using output from 17 global climate models (GCMs) from the Climate Model Intercomparision Project (CMIP) phase 3 run with three Special Report Emission Scenario (SRES) and from 31 GCMs from the CMIP phase 5 run with Representative Concentration Pathways (RCP) scenarios. Subsequently, the impact of projected change in seasonal streamflow is derived by propagating projected scenarios, generated using changes derived from GCMs and weather generators, through a suite of conceptual hydrological models. A generalized uncertainty estimation framework is used to combine predictions from different models. Analysis shows that the spread in the magnitude of change in temperature and rainfall for CMIP3 is wider than that for CMIP5. The spread in projected change in temperature (precipitation) increases (decreases) from Southernmost to Northern most latitude. Hydrological projection with CMIP3 output for the 2080s shows that streamflow decreases for most of the watersheds in MAM and JJA and increased in SON. In contrast, CMIP5 results show an increase in flow for all seasons except with the high-end scenarios in MAM. However, the uncertainty surrounding such projections is significantly high. The probability distribution function for projected seasonal flow for each scenario is markedly wide and therefore reflects that the uncertainty associated with using multiple GCMs is high. A typical example with three watersheds shows a marginal shift in the probability density function of seasonal average streamflow toward the right for high-end scenarios

- **Distributed Hydrologic Modeling for 1 watershed in Florida** - The working group is using the Tampa Bay Water Integrated Hydrologic Model (IHM) to demonstrate the hydrologic implications of

alternative dynamically and statistically downscaled reanalysis data, retrospective CMIP3 predictions and future CMIP3 projections for a representative Florida watershed. To date two dynamically downscaled reanalysis datasets (R2 and ERA40) and 4 statistically downscaled CMIP3 retrospective simulations have been used to predict streamflow and groundwater levels using IHM. The accuracy of streamflow and groundwater level predictions from each case was evaluated against observed data and model results that were calibrated using observed weather data. Results have been documented in two journal articles currently under review (see SECTION E). Future work will use dynamically downscaled GCM retrospective results as well as statistically and dynamically downscaled GCM future projections to drive the IHM model.

B. Application of your findings to inform decision making

Participants have reported sharing information in their own organizations, as well as making presentations to their contacts. Several new members of the group mention that they are joining the group based on presentations that they have heard in various venues.

C. Planned methods to transfer the information and lessons learned from this project

Website, newsletters, poster and oral presentations have provided opportunities to share project information to date. We will continue to develop these opportunities as well as broaden the outreach through our developing KMS. In addition, the participants are actively seeking collaborative project opportunities to build on lessons learned and have submitted over 6 proposals. One has been funded which will extend connections and contribute site specific experiences to the working group. As the group continues its work, more participants active in local government and planning are becoming interested and involved providing avenues for outreach.

D. Significant deviations from proposed workplan

None

E. Completed publications, white papers, or reports (with internet links if possible).

- Bastola, S., 2012: Assessment of the hydrologic impact of climate change on Southeast US watersheds using multimodel ensembles from CMIP3 and CMIP5 Models. Regional Environmental change. Submitted.
- Hwang, S; Graham, W., Adams, A., and Guerink, J., Assessment of the utility of dynamically-downscaled regional reanalysis data to predict streamflow in west central Florida using an integrated hydrologic model. Regional Environmental Change. Submitted.
- Hwang, S; Graham, W., Adams, A., and Guerink, J., Hydrologic importance of spatiotemporal variability in statistically downscaled daily precipitation data from general circulation models for west-central Florida. J. of Hydrology. Submitted.
- Hwang, S., Graham, W., Development of a stochastic downscaling method to reproduce observed spatiotemporal variability of daily precipitation. Under revision. Climate Science.
- A Review of Regional and Global Water Utilities Use of Climate Information
  Victoria Keener, PhD. University of Florida, Southeast Climate Consortium (Handout Workshop 1)
- Bibliography of resources related to Climate and Water Utilities
  Victoria Keener, PhD, University of Florida, Southeast Climate Consortium (Handout Workshop 1)

- Working Group Monitoring and Feedback – Research Summary of Report 1
  Wendylin Bartels, PhD, University of Florida, Florida Climate Institute (Handout Workshop 2)
- "What Can We Learn from other Groups"
  Includes participant summaries of groups focused on impacts of climate change, climate variability and sea level rise on public water utilities, compiled by Lisette Staal, UF Water Institute (Pre-workshop document Workshop 2)
- Participants' PROJECT Summaries
  Brief descriptions of participants' projects focused on Evaluation of potential climate impacts to Water Utilities — updated May 2011
- Posters
  - Development of Public Water Supply Utility Relevant Climate Information for Improved Operations and Planning: Implementing a collaborative working group process in Florida, Staal, L. et. al., November 2010 (Poster presented at Florida Climate Institute, Tallahassee Florida)
  - Development of Public Water Supply Utility Relevant Climate Information for Improved Operations and Planning, Staal, L. et. al., November 2011 (Poster presented at Southeast Climate Consortium, Tallahassee Florida)
  - Two Sides of the Same Coin: Communicating Climate Change Science to Stakeholders in Florida and Hawai'i. Keener, V. W., Staal, L., & Finucane, M. L. Poster presented at the Annual Meeting of the American Geophysical Union, "Scientist Participation in Science Communication" Session, San Francisco, CA, December 5-9, 2011.
- Pre-project Workshop Reports
  - Workshop 1, September 22, 2010 Workshop Report
  - Workshop 2, January 20, 2011 Workshop Report
  - Workshop 3, May 4, 2011 Workshop Report
- Project Workshop Reports
  - Workshop 4, October 7, 2011 Workshop Report
  - Workshop 5, February 28, 2012 Workshop Report
  - Workshop 6, May 10, 2012 Workshop Report

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS SEPARATE ATTACHMENTS TO YOUR REPORT

In order to better promote your work and the work of this program, please provide the following for use in communication materials for NOAA and external audiences.

☐ Slide 1: Public Water Supply Utilities Climate Impacts Working Group – Conceptual Framework

☐ Photo 1: Small Group Activity during PWSU_CIWG workshop, photograph by Lisette Staal, facilitator. Permission granted to use as appropriate.

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION

http://waterinstitute.ufl.edu/WorkingGroups/PWSU-CIWG.html

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES

NA

VI. REFERENCES

Abatzoglou, T. J., Brown, J. T., 2012. A comparison of statistical downscaling methods suited 565 for wildfire applications. International Journal of Climatology 32, 772-780.

Daniels, S., and G. Walker (2001), Working through environmental conflict: the collaborative learning approach, Praeger Publishers, Westport, CT.

Hwang S., 2011. Dynamical and statistical downscaling of climate information and its 627 hydrologic implications over west-central Florida. Ph.D. Thesis, University of Florida.

Kolb, D. A. (1984), *Experiential learning: Experience as the source of learning and development*, Prentice Hall, Englewood Cliffs, NJ.

Wilson, K. K., and G. E. Morren (1990), Systems approaches for improvement in agriculture and resource management, MacMillan, New York, NY.

Wood, A.W., Maurer, E.P., Kumar, A., Letternmaier, D.P., 2002. Long-range experimental 705 hydrologic forecasting for the eastern United States. Journal of Geophysical Research 107, 706 4429. doi:10.1029/2001JD000659.

Slide 1: Public Water Supply Utilities Climate Impacts Working Group – Conceptual Framework

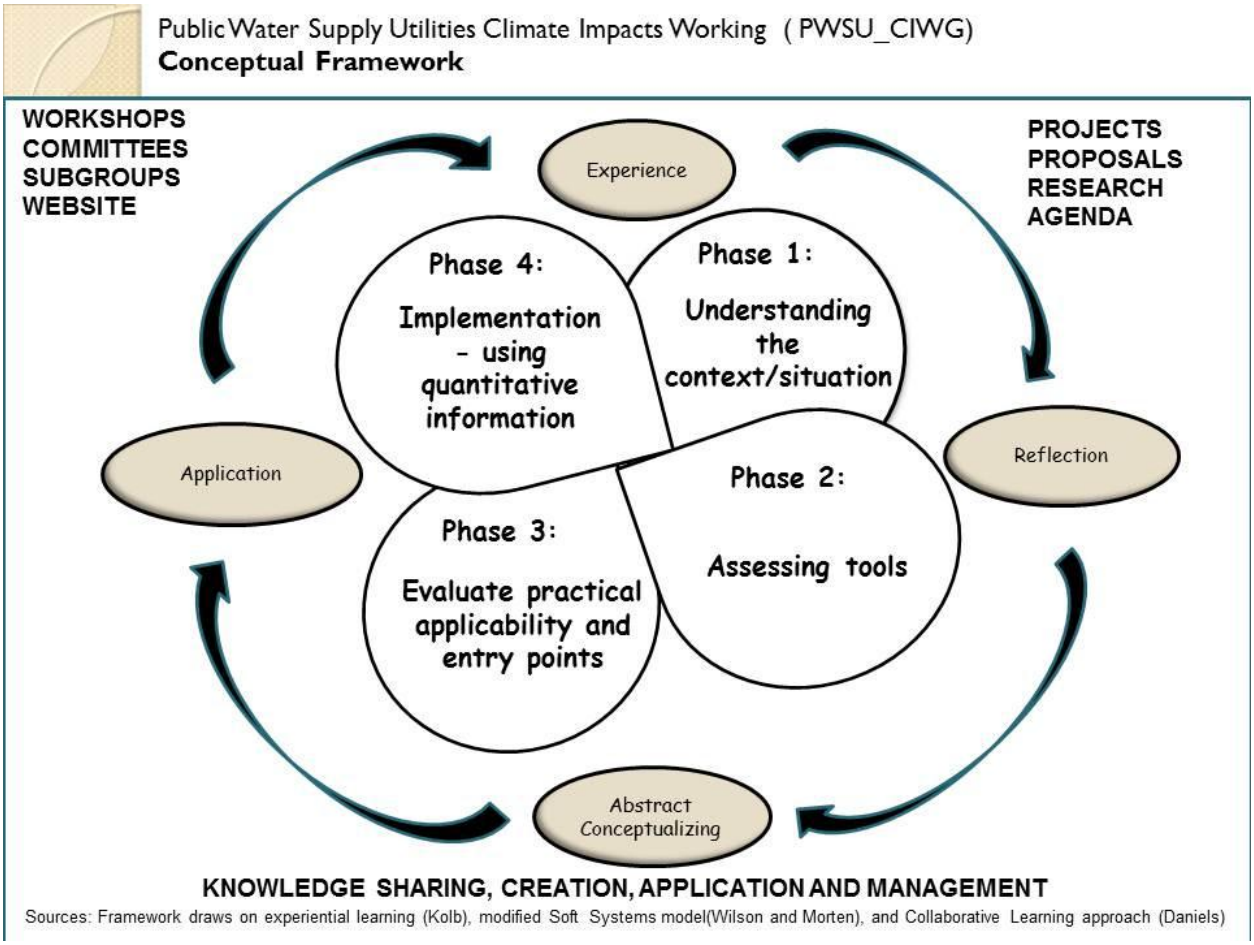

Photo 1: Small Group Activity during PWSU_CIWG workshop (February 25, 2012)
Photograph taken by Lisette Staal, facilitator. Permission granted to use as appropriate.