# Executive Summary

On December 13, 2012, the NOAA National Weather Service, in cooperation with the Delaware River Basin Commission, and in coordination with the IWRSS Federal partner agencies, convened a group of 43 representatives from national, regional, state and local organizations in West Trenton, New Jersey, for a one-day forum. IWRSS Federal partner agencies include the U.S. Geological Survey and the U.S. Army Corps of Engineers. Over the course of the day, participants engaged in discussions and brainstorming sessions focused on learning about hydrologic services IWRSS can provide, identifying key gaps that IWRSS might fill to inform water resources decision making, and discussing possible demonstration projects to build capacity for integrated water resources management in the Delaware River Basin.

In advance of the meeting, participants were polled to determine the highest priority resources issues for the basin. This poll indicated that the three issues of greatest interest were water supply, flooding, climate change impacts.

During the meeting, participants were divided into issue-based groups to identify key decisions, questions, and gaps IWRSS could address. The most commonly identified gaps involved (1) models, forecasts, and analysis followed by (2) data and data integration needs, and (3) communications, including expanded graphics and the conveyance of risk and uncertainty. The modeling needs covered a wide range of topics including weather and flood forecasting, upstream saltwater migration, demographics and land use, and economic impacts,. Modeling-related needs also included providing real-time and downscaled models for local impact assessment, integrating data from numerous sources into models, and integrating the models themselves. Data needs centered on accessibility and integration issues; and communication needs centered on visualization tools.

Each group proposed a pilot project that would demonstrate how some of these key information gaps could be filled to address priority issues. The three pilot projects are summarized below.

Project #1: Integrate data from federal, state, and local sources into existing models. Combine these data with climate change scenarios in order to better model the timing, volume, and location of water-related impacts in future scenarios. This project would help to assess environmental, social, and economic impacts; use graphic visualizations to communicate risk; and inform long-term facility management and planning decisions. Philadelphia was suggested for the pilot.

Project #2: Develop an integrated coastal estuarine and riverine flood model, including storm surge, that produces graphics using 3D visualization tools. The model would produce inundation graphics depicting the areal extent and depth of flood waters to better illustrate “on the ground” socioeconomic impacts to improve support for emergency action and scenario planning. This new model would also feature an integrated education and outreach component to better communicate local impacts of future storms, including social and environmental impacts.

Project #3: Create (1) a probabilistic drought and flood model based on future climate change scenarios and (2) an operational integrated coastal estuarine and riverine model, including storm surge, to inform “worst case” scenario planning. Combined, these efforts would improve basin coordination, reservoir management, salinity prediction, ecological sustainability, water availability, environmental protection, and water management, which would ultimately benefit economic growth and energy security.

# Delaware River Basin

On December 13, 2012, the NOAA National Weather Service, in cooperation with the Delaware River Basin Commission, convened a group of 43 representatives from national, regional, state and local organizations in West Trenton, New Jersey, for a one-day forum. Over the course of the day, participants engaged in full-group discussions and breakout group brainstorming sessions. Together they sought to achieve the following objectives:

* Learn about hydrologic services that can be provided by IWRSS for the IWRSS presentation)
* Identify key gaps that IWRSS might fill to inform water resources decision making for priority water resources issues in the Delaware River Basin
* Discuss possible demonstration projects to build capacity for integrated water resources management in the Delaware Basin and explore the benefits of such projects

Following is a summary of the discussion and recommendations from the forum.

## Priority Water Resources Issues in the Delaware River Basin

## Based on a review of DRBC’s Water Resources Program FY2010-2015 (dated July 14, 2010), and DRBC’s Strategy for Sustainable Water Resources – 2060 (dated February 29, 2012), suggested priority water resources issues were shared with participants prior to the forum. Participants were asked to indicate their top three highest priorities (with the option of writing in additional suggestions). Results of the participant poll were summarized and used to focus the discussion on the three issues of greatest interest (water supply, flooding, and climate change impacts). Each issue, along with the number of votes it received (indicated in parentheses) is presented below:

**Population change and distribution (6)**

* Population increase and/or re-distribution of population will likely increase the consumptive use of water, increase impervious surface cover, increase pollutant loadings, decrease forest cover and potentially change use of groundwater and surface water. These changes will have an even greater significance if the population density increases in the upper basin headwater areas.

**Energy generation and natural gas development (8)**

* The need to reduce once through cooling at thermal generation facilities will increase the consumptive use of water in the basin. Natural gas development, which consumptively uses water, creates potentially difficult to treat wastewater, and causes area-wide land cover issues, is proposed in the forested headwaters.

**Ecological flow protection (10)**

* Ecological flow analyses will likely affect pass-by-flows for water withdrawals and reservoir conservation releases. There may also need to be flow targets in some of the larger tributaries.

**Climate change (23)**

* Sea level rise will decrease protective wetlands and increase storm surge impact and will affect salinity levels in the tidal river, potentially affecting water purveyors and industries if saline water reaches their intakes.
* Changes in precipitation could results in more intense storms in winter/spring and drought conditions during summer months. Impacts include increasing intensity of floods, flashiness of streams, reduction in snowpack, extended summer drought, increased water temperature, decreased dissolved oxygen, and increased turbidity/sediment load. Reservoir capacity and necessary operational changes will have to be evaluated.

**Point and non-point pollution (11)**

* Major water quality issues include nutrient loading and associated decreases in dissolved oxygen. Greater attention will be needed on the influence of the non-tidal system on the water quality of the estuary.

**Flooding (22)**

* Reservoir management/storage, flood forecasting and flood warnings, flood mapping and flood management are key issues for which management schemes need to be in place. For purposes of ensuring a sustainable water supply in the basin, flood mitigation must be taken into account because of its effect on reservoir storage. Ensemble forecasting and nimble reservoir operations will be needed.

**Water supply (28)**

* Water supply concerns include: increased upper basin use, salt water intrusion, salt encroachment at the Philadelphia and NJ American intakes, water quality issues, increased drought, need to allocate water for in-stream needs. Integrated water resources management is needed to optimize reservoir operations and to ensure the long-term sustainability of water supplies from both water quantity and water quality perspectives especially in the face of climate change.

**Other (1)**

* Economic Value of Water

During the plenary session, Dr. Thomas Graziano (Chief, Hydrologic Services Division) and Carol Collier (Executive Director, DRBC) laid the groundwork for the day by providing an overview of IWRSS and Delaware River Basin priority issues, respectively. The following issues were raised during this session:

Importance of the IWRSS Federal partners coordinating with other federal agencies:

* Federal Emergency Management Agency (FEMA) - to address flood inundation issues and future Flood Insurance Rate Maps
* United States Department of Agriculture (USDA) - conservation evaluation and assessment program

In preparation for breakout groups, participants discussed each of the top three priority issues and expressed their views and questions about how IWRSS might possibly help address issues they are currently facing, or may need to address in the future. From this discussion the following issues emerged:

* Are there examples of how IWRSS can help solve problems in the Delaware? How exactly will IWRSS benefit the Delaware where three models are currently being used?
* Can a national integrated modeling system be “downscaled” at scales necessary to address issues in the Delaware, for example, optimizing water supply systems for water releases and water allocation to meet multiple objectives?
* How will next steps be determined to answer these questions about direct benefits to the Delaware?
* How certain are funding to provide services and what is the timing of service delivery?
* Is IWRSS tapping into academic consortia? A Memorandum of Understanding and/or coordination through the National Science Foundation are options that could be pursued.
* In the Delaware, there’s a need to integrate tidal and non-tidal flood forecasting to address convergence of storm surge and peak flooding from headwaters – is this the type of issue that IWRSS can address?
* Regarding salinity issues for water intakes on the river, it was noted that NOAA assigns freshwater a “zero” for level of salinity, while Philadelphia views the freshwater/saltwater interface along a salinity gradient. This disconnect represents a gap and could be problematic for consistent modeling of the salinity in the river.

Following is a summary of the first set of breakout group discussions. Each group was asked to take on the following task:

Identify up to three key decisions or outstanding questions (event-driven, high impact or important routine decision/question) that “keep you up at night.” For each question/decision, identify key information gaps that need to be filled to inform these decisions (keeping in mind capability of IWRSS).

# Water Supply

## Key Decisions/Questions and Gaps that IWSS Could Fill

**Question 1:** What will the regular water availability pattern be in the future [both temporal (long term and short term) and spatial distribution] and how will extreme climate events impact future water availability?

**Gaps:**

1. Accurate historical data and information to real-time data and information, to future predictability
2. Assistance with interactive basic modeling – too many models, need to know applicability of each
3. Need for readily available, integrated, and easily accessible data and information

**Question #2:** What are the larger regional implications of future water availability in the Delaware Basin? [i.e., what are the inter-relationships and inter-dependence between river basins (e.g., optimizing reservoir systems) as each faces future availability issues?]

**Gaps:**

1. Readily available, easily accessible and understandable information (intra basin and inter-basin)
2. Information is currently very fragmented among multiple agencies/entities – need to coordinate: need integrated clearinghouse for models, data and information, and guidance/interpretation on their use
3. Downscale modeling for local application
4. Stream gage information (stream gages being de-commissioned when historical data is desperately needed)

## Potential Pilot Project

**Philadelphia Water Supply Demonstration Project:**

* Integrate available data (federal-state-local) from all sources (e.g., daily precipitation and stream flow data for 100 years) into existing models
* Downscale climate outputs to useful scale with regard to different climate change design scenarios
* Model the timing, location, and volume of water for future climate scenarios. Climate model outputs should include daily forecasts of precipitation and streamflow which will serve as forcings for local model applications and decision support tools.
* Assess environmental, social, economic impacts relative to specific design scenarios
* Quantify and communicate risk (with graphic visualizations)
* Inform facility management/long-term planning

# Flooding

## Key Decisions/Questions and Gaps that IWSS Could Fill

**Question #1:** How can water resources be better managed with respect to both flooding and salinity gradient issues (currently and in future)?

**Gaps:**

1. Need to link coastal estuarine models with riverine models (flooding impact of converging peak flows and storm surge)
2. Need better mapping of land use and understanding implications of land use trends

**Question #2:** How can water supply reservoirs be better optimized for flood control?

**Gaps:**

1. Need to improve rainfall forecasts to inform decisions and communicate between reservoirs (i.e., improve accuracy, specificity, temporal resolution, and frequency of issuance to enable better timing for synchronizing basin-wide reservoir releases)
2. Improve interagency communication for reservoir management

**Question #3:** How can we effectively communicate risk?

**Gaps:**

1. Communication of impacts at the local level (local landmarks, infrastructure level)
2. Inundation maps linked to socioeconomic impacts - need visual graphics to communicate impacts effectively

**Question #4:** How do land use trends affect flooding?

**Gaps:**

1. USDA natural resources inventory in Delaware
2. Better projections of flood risk – incorporate USDA information into existing models

## Potential Pilot Projects and Benefits

**Pilot Project: Integrated Storm Surge and Riverine Flood Model with Visualization Tools**

* New model with education/outreach tool built in to communicate message that all storms are not equal in terms of impacts and areas impacted
* Develop coastal estuarine storm surge model coupled with riverine flood model including visualization graphic tool for inundation mapping.
* Link inundation maps to socioeconomic impacts
* Incorporate 3D visualization to show local impacts

**Benefits of Pilot Project:**

* Will fill gap that exists – we can’t currently show “on the ground” impacts
* Enhanced emergency action planning – communicate flood risk and avoid losses associated with nor’easters and tropical systems
* Enhanced ability to do scenario planning (land use changes, sea level rise, other climate change impacts)

**Partners:**

* NOAA, USGS, USACE, FEMA, DRBC, USDA and academic/private institutions, local media

# Climate Change

## Key Decisions/Questions and Gaps that IWRSS Could Fill

## Question #1: How will climate variability affect future temperature and other parameters in the main stem and tributaries?

## Gaps:

## Connecting models that currently exist and making them more utilitarian for stakeholders

## Determining the best climate change scenario to use for this region

## Risk assessment – gaps exist for socioeconomic impact analysis

## Risk communication – lack of tools to put science in terms that policy makers can translate into decisions and communicate to the public including integration of tools and processes to communicate impacts and risks associated with climate change

## Impact of demographic shifts

## Question #2: How do we value water as an economic resource? (flood and drought)

## What is the impact on the cost of water with climate change?

## Who pays?

## What is the optimal point for capital investment or mitigative action with respect to water resources decisions?

## Gaps:

## Economic analysis at multiple levels

## Range of possible impacts to specific structures

## Real-time flood inundation mapping

## Compounding of effects of various processes (flooding plus storm surge)

## Question #3: What change in climate is expected in the northeast region specifically and how can models be made more specific for this area?

## Gaps:

## Ability to get information out to people “on the ground” who need the information immediately

## Applying past storms to model various future scenarios with climate change

## Question #4: What is the “worst drought” or design drought that we should use in the future?

## Gaps:

## Information to develop metrics to define tipping point for drought

## Question #5: How are demographics going to change?

## Gaps:

## Data needed to answer this question – demographic change scenarios

## Question #6: How are wetland areas affected by climate change?

## Gaps:

## Better prediction of salinity and water level changes

## Question #6: When will there no longer be enough freshwater to keep the salt front from migrating up river?

## Gaps:

## Need to know how much freshwater will be required to keep the salt front from migrating and where the salt line is expected to go

## Costs associated with different climate as well as different management scenarios/actions that might be taken to increase resiliency

## Future conditions with respect to population, sea level rise, temperature

## Question #7: Are current standards adequate given climate predictions?

## Gaps:

## Need to define probable/different droughts to run through models to determine impacts

## Intensity, duration and frequency variables

## Streamflow, groundwater, precipitation, temperature variables

## Need estimates of future water availability for multiple uses and how to balance future demands given climate change impacts

## Potential Pilot Projects, Benefits and Partners

## Pilot Projects:

## Delaware River: Create a probabilistic drought/flood model based on future climate change scenarios to predict drought and flood intensity, duration, frequency in conjunction with salinity model (with sea level rise/storm surge inputs and other climate dependent variables such as temperature)

## Delaware Bay Estuary: Develop operational, coupled coastal estuarine and riverine model, including storm surge, for worst case scenario planning, in conjunction with a visualization tool (Phase 1 – coastal model and calibration)

**Benefits:**

* Basin coordination
* Reservoir management
* Salinity prediction
* Ecological sustainability
* Defining limits of water availability
* Protecting sensitive/vulnerable areas
* Energy security
* Better water management leads to economic investment – economic viability and future growth

**Partners:**

* DRBC, SRBC, DVRPC
* Municipalities including New York City, Philadelphia
* State agencies: PA DEP, other state regulatory and management agencies
* Federal agencies: USDA, EPA, NOAA, USGS, NPS, NFS , FWS
* Water providers, power companies, universities, agricultural community