# Executive Summary

On February 28, 2013, the NOAA National Weather Service, in cooperation with the Susquehanna River Basin Commission, convened a one-day stakeholders’ meeting in Harrisburg, Pennsylvania, involving 31 representatives from national, regional, state and local organizations. This meeting was part of a national initiative called the Integrated Water Resources Science and Services (IWRSS). The IWRSS Federal partner agencies are NOAA National Weather Service, the U.S. Geological Survey and the U.S. Army Corps of Engineers. At this stakeholders’ meeting, participants learned about hydrologic services IWRSS can provide, identified key gaps that IWRSS might fill to inform water resources decision making, and discussed possible demonstration projects to build capacity for enhanced integrated water resources management in the Susquehanna River Basin.

In advance of the meeting, participants were polled to determine the highest priority resources issues for the basin. Four issues of greatest interest rose to the top: water quality, sustainable water use, flooding, and the Chesapeake Bay.

During the meeting, participants were divided into issue-based groups reflecting the above priorities (water quality and Chesapeake Bay were combined) to identify key decisions, questions, and gaps that IWRSS could address. The most commonly identified gaps involved (1) models and analysis, followed by (2) data and monitoring, and (3) communications needs. The modeling and analysis needs covered a wide range of topics, including modeling scale, accuracy, scenarios, and indices as well as analysis of transport phenomena, permit effectiveness, ground/surface water interactions, and impacts of future climate change and land use scenarios on water resources. Monitoring and data needs included groundwater, temperature, precipitation, streamflow, water use, and data integration. Communications-related needs included effective and consistent public messaging, greater lead time to respond to events such as flooding, and addressing information dissemination gaps.

Each issue-based 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: Improved monitoring and measurement of basic water quality parameters to protect and manage critical fisheries habitat. This project would include expanded monitoring of water temperature (focus on critical habitats) and new predictive capabilities (impacts on fish, algae growth, biological indicators) influenced by air, water, and ground temperature.

Project #2: An easily accessible “warehouse” of water use data that can compile water-use information at user-specified levels. This project would be a building block for basin-wide water resources management models and tools and provide a wide range of historical information and forecasts to support water resources planning decisions.

Project #3: Risk-based action planning for flooding in urban and rural communities that quantifies certainty through the use of probabilistic forecasts, utilizes inundation maps to display the areal extent and depth of flood waters, and incorporates user-specified thresholds for taking mitigative action. The project would include improvements in inundation mapping (including real-time dynamic flood inundation mapping), better dissemination and communication of forecasts, and metrics to measure success.

# Susquehanna River Basin

On February 28, 2013, the NOAA National Weather Service, in cooperation with the Susquehanna River Basin Commission (SRBC), and in coordination with the IWRSS Federal partner agencies, convened a one-day stakeholders’ meeting in Harrisburg, Pennsylvania, involving 31 representatives from national, regional, state and local organizations. IWRSS Federal partner agencies include the U.S. Geological Survey (USGS) and the U.S. Army Corps of Engineers (USACE). During the stakeholders’ meeting, participants engaged in full-group discussions and breakout group brainstorming sessions to achieve the following objectives:

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

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

## 

Figure 1: Overview of the Susquehanna River, Basin, and Commission

## Priority Water Resources Issues in the Susquehanna River Basin

## The IWRSS team developed a list of priority water resource issues based on a review of SRBC’s “State of the Susquehanna Report – 2013” and other information from the SRBC web site, and in consultation with SRBC. The IWRSS team then shared the list of issues with participants prior to the stakeholders’ meeting. As part of the registration process, participants were asked to indicate their top three highest priorities (with the option of writing in additional suggestions). Each issue, along with the number of votes it received (indicated in parentheses), appears below.

## Water Quality (17)

## Sustainable Water Use (15)

## Flooding (13)

## Chesapeake Bay (13)

## Aquatic Ecosystem Management (8)

## Other (surface water data modernization) (1)

## Results of the participant poll were summarized and formed the basis for the top three issues of greatest interest to be discussed at the meeting.

### Top Three Water Resources Issues:

## Water Quality and Chesapeake Bay

## These priorities were combined because most people who voted for one also voted for the other, and because of the overlap between them. This priority was defined as follows:

## Support the designated uses of all water bodies by achieving water quality that meets or exceeds standards. Issues include: monitoring, mine drainage, stormwater management, point and non-point pollution, mine drainage, and emerging contaminants.

## Manage the water resources of the SRB to assist in restoring and maintaining the Chesapeake Bay so it meets or exceeds applicable water quality standards and supports healthy populations of living resources. Issues include: flow management, nutrients and sediments including legacy sediment behind the dams.

**Sustainable Water Use**

Sustainable water use was defined as follows:

Meet immediate and future water needs of the basin for domestic, municipal, commercial, agricultural, industrial water supply and recreational activities to maintain sustainable economic viability, protect in-stream uses, and ensure ecological diversity through regulation and planning. Highest priority sub-topics under this issue, along with the number of votes received (indicated in parentheses), were:

* Flow (8)
* Drought (7)
* Climate Change (7)
* Municipal and Industrial Water Supply (6)
* Regulation of withdrawals and consumptive use (5)

**Flooding**

Flooding was defined as follows:

Prevent loss of life and significantly reduce future damages from floods within the basin through an integrated system of structural and nonstructural flood damage reduction measures. Issues include: sustainable stream gage network, impacts due to climate change, emergency management/response, inundation mapping, and flood damage reduction alternatives for high-risk communities.

### Stakeholders’ Meeting – Opening Plenary Session

Dr. Thomas Graziano (Chief, NWS Hydrologic Services Division) and Andrew Gavin (SRBC Monitoring and Protection Manager) laid the groundwork for the day by providing an overview of IWRSS and Susquehanna River Basin priority issues, respectively.

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 the issues they are currently facing, or may need to address in the future. From this discussion the following topics emerged:

* What is the coordination mechanism between national level data and services and water resources activities on the regional and local levels? How is information shared and disseminated to ensure consistent messaging and to prevent duplication of efforts?
* Related to the above, participants emphasized the importance of communicating the most accurate technical information in a way that can be easily accessed and understood by local officials and emergency managers who are responsible for deploying equipment and staff in anticipation of flooding events. The group suggested that significant expenditures could be avoided if continually updated probabilities of flooding are provided in such a way that “on the ground” impacts are clearly and effectively communicated to the public. It would be particularly useful if lateral inundation zones were depicted (spatially and temporally within the watershed) to predict where and when flooding levels are likely to occur. Inundation maps depicting the areal extent and depth of flood waters would better inform critical life and property saving decisions and would replace the more generic “low lying areas” warning, which is not very useful in informing how local resources should be best spent to avoid and/or respond to extreme events.
* The group also noted that, although there are areas of duplication between federal, state, local and other initiatives, an important part of working in this industry involves knowing about what other agencies are doing, and communicating information effectively between agencies to minimize duplication and establish a common operating picture for water resources. The role of federal agencies is often to develop and provide the information that is used by a variety of state and local entities.

### Stakeholders’ Meeting – Morning and Afternoon Breakout Sessions

Following is a summary of the breakout group discussions. For the first breakout session, 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 the capabilities of IWRSS).

For the second breakout session, each group was asked to develop a general scope for a potential project for their priority area to be considered as a possible IWRSS pilot project. For each project, the groups were asked to provide a short narrative describing the project, identify key benefits of the project to help make the business case for implementing it, and determine what partner organizations and agencies would need to be involved to undertake the project.

Participants in each group are listed below.

* Water Quality and Chesapeake Bay: Andy Zemba, Karl Brown, Lee McDaniel, George McKillop, John Brosious, Paul Swartz, Andy Gavin, and Kate Abshire.
* Sustainable Water Use: Jim Richenderfer, Clark Howell, Matt Genchur, Josh Weiss, Ward Freeman, Hoss Liaghat, Mary Mullusky, and Sam Allin
* Flooding: Dan Bierly, Art Shapiro, James Wheeler, Kyle Shilling, Patti Wnek, Tom Graziano, Eric Jepersen, Jim Campbell, Susan Obleski, Ben Pratt, and Bob Hainly.

# Water Quality/Chesapeake Bay

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

## Question #1: What model scale and processes considered therein are adequate for making management decisions?

## Gaps:

* Need a model that addresses and is appropriate for local scales
* Need a more accurate model appropriate to needs (e.g., regulation)
* Need monitoring for real-world conditions

**Question #2:** Do we have adequate quality and quantity of monitoring data to make informed science-based management decisions needed to implement complex Chesapeake Bay TMDLs or complex smallmouth bass issues?

## Gaps:

* Need groundwater monitoring (groundwater quality information)
* Need to understand fate and transport (nutrient retention/release)
* Need standards for water well construction
* Need temperature data for smallmouth bass management

## Question #3: How does stormwater impact water quality?

## Gaps:

* Need to understand Municipal Separate Storm Sewer Systems (MS4) permitting requirements (e.g., numeric limits)
* Need enforcement and clear authority to ensure compliance
* Need monitoring to see if Best Management Practices are working

**Question #4:** What are the most viable solutions to preserve the sediment trapping capacity of the Lower Susquehanna dams? (Needs are being identified through Lower Susquehanna River Watershed Assessment.)

**Gaps:**

* Need modeled scenarios of sediment behavior for scenarios identified by the assessment

## Potential Pilot Project, Benefits, and Partners

## Pilot Project: Continuous monitoring data for the Susquehanna River.

## Continuous monitoring data in the Susquehanna is severely lacking. This project would focus on monitoring for basic water quality parameters on the Susquehanna River in critical habitats. It would provide much-needed information on ecological impacts of various water quality parameters on smallmouth bass and other fisheries or species of interest and concern, and overall water quality issues impacting the health of the Chesapeake Bay. This project would fill monitoring and management gaps and would include:

* Expanded monitoring of water temperature (focus on critical habitats), including real-time/in-stream monitoring and remote sensing.
* Predictive aspects of water quality (impacts on fish, algae growth, and biological indicators), including air temperature, water temperature, and ground temperature.

**Key Benefits of this Project:**

1. Understanding stressors on smallmouth bass, and other fisheries
2. Tracking the impacts of land use changes and new impervious surfaces on waterways
3. Restoring a fishery that would provide significant economic benefits (fishermen, guides, local tourism, fishing tournaments)
4. Improving regulatory decision-making through information for other Bay-related problems
5. Improving and expanding inputs to the Chesapeake Bay model
6. Adding an independent scientific perspective
7. Tracking climate change impacts on critical habitats
8. Adding information that would be useful for triennial review of water quality standards

**Key Partners:**

* Fisheries groups (source of reports on locations where smallmouth bass problems occur)
* PA Fish and Boat Commission, PA Department of Environmental Protection, EPA (impairment listing – Region III water quality)
* Vicky Blazer, USGS (currently doing work in this topic)
* SRBC (monitoring)
* US Fish and Wildlife Service
* NOAA (climate data)

# Sustainable Water Availability/ Water Use

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

**Question 1:** Will there be enough water? Concerns include: unknown water uses occurring below regulatory thresholds; new applications for water use, which should take into account changes in climate and changes in land use; and aging infrastructure.

**Gaps:**

* Need information for both short-term and long-term decisions
* Need to clarify perceived versus real data gaps in water use and availability (it is unclear what is really necessary)
* Need to understand how climate impacts will affect water availability
* Need vertical integration of data (how it is acquired and used from federal to local level)
* Need to consider groundwater/surface water interactions

**Question #2:** Will the water be of sufficient quality?

**Gaps:**

* Need to better understand the relationship between water quantity and water quality - for example:
  + Relationship between water quality and water usability
  + Effects of lower flows on water quality
* Need sufficient monitoring, modeling and forecasting of key parameters to better understand and respond to water temperature impacts and other seasonal impacts

**Question #3:** Do we have the tools necessary to manage basin wide water resources issues?

For example:

1. When can water from the Susquehanna be used for drought conditions, given river water availability and quality during these lower flow periods? Need early warning drought indices to switch to this source earlier and preserve local resources.
2. What is the risk and likelihood of forecasted drought?
3. What is the level of precision in models? (Need adequate spatial and temporal resolution for localized drought impacts.)

**Gaps:**

* Need earlier warning drought indices
* Need to be able to predict conditions under which the system reaches unsustainable/critical failure (given future climate and land use)
* Need to communicate public message to reduce water use with scientific integrity, political support and urgency
* Need a combined voice at a national level to communicate the economic and environmental value of water
* Need in-situ precipitation data
* Need to account for all the bullets under Question #1

## Potential Pilot Project, Benefits, and Partners

## Pilot Project: Data warehouse to support water resources management and planning decisions.

Easily accessible data warehouse that compiles state water use information and can be resolved at user-specified watershed levels. This project would be a building block for basin-wide water resources management models and tools. The warehouse could also include historical rainfall/runoff data, NWS forecasts, and climate forecasts to support water resources planning decisions. The data warehouse would include the following features:

* Connect state database to federal databases
* Provide better estimates of water uses not measured (e.g., thermal-electric power, evapotranspiration, irrigation, domestic self-supply)
* Provide basin stream statistics
* Continuously update data and provide data recovery features
* Provide for temporal resolution
* Provide sufficient data quality
* Include quantity and quality information

Potential funding could come from grants by the National Water Census to states for providing an interface between state and federal data.

**Key Benefits of this Project:**

1. Saving time and money typically invested by states and industry to collect data to support modeling and inform water resources management decisions.
2. Providing a tool to develop water budget on multiple scales and better understand water availability now and in the future.
3. Supporting sustainability decisions – e.g., water-intensive industries being located appropriately.
4. Providing public accessibility to water resources data, models, and other information.
5. Considering and measuring economic value, including:
   1. Government and industry receives economic benefits in terms of time and resources saved from data collection.
   2. Hydroelectric energy (or other industries) can better manage their “inventory”. Water in the river is “inventory” and better water resources models can improve the efficiency with which this inventory is used.
   3. Agriculture yield is associated with the cost of water. Measure yield performance under certain conditions (e.g., drought, flood).
   4. Money saved through management decisions (e.g., with accurate and timely forecasts of drought onset, Baltimore City saves money by preparing for drought earlier and not pumping in drought conditions when water quantity may be restricted and water quality is poorer).
   5. Industry would make informed decisions to meet water needs.

**Key Project Partners:**

* States
* USGS
* SRBC
* NOAA/NWS
* USACE
* Non-governmental organizations
* Academia
* Municipal/industrial dischargers
* Private industry (insurance)

# Flooding

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

**Question #1:** From an operational standpoint, on which NWS forecast should I base critical decisions?

* Need to balance operational decisions with forecast accuracy, certainty, and credibility (source of forecast)
* Need to be able to define short-term vs. long-term decisions and forecasts

**Gaps:**

* Need to communicate levels of confidence in the accuracy of forecasts
* Need to extend lead-time and associated uncertainty

**Question #2:** How do we provide sustainable funding for stream and rain gages in support of forecasts and warnings?

**Gaps:**

* Need sufficient data and information to determine if gage network is adequate (network analysis)
* Need to know if the network supports better spatial and temporal resolution of the forecast

**Question #3:** During flooding, when, where, and how much of an area is going to be affected?

**Gaps:**

* Need more hydraulic models
* Need user friendly delivery of static/dynamic inundation mapping
* Need to bridge dissemination gaps
* Need to base maps on best available data
* Need alternative mapping technology

## Potential Pilot Project, Benefits, and Partners

## Pilot Project: Risk-based action planning for flooding in urban and rural communities that quantifies certainty through the use of probabilistic forecasts, uses inundation maps to display the areal extent and depth of flood waters, and incorporates user-specified thresholds for taking mitigative action.

Test and evaluate effecting a transition from deterministic forecasting to probabilistic forecasting (or how each can be used) with streamlined risk-based action planning methodologies (spatial and temporal). Trigger planning would provide forecasting thresholds at which certain mitigative actions should be taken.

This project would involve a social science component and technical component, including better inundation mapping and better dissemination and communication of forecast information. The project would also include metrics to measure success and identify any difference the forecasts and communication methods made for users (emergency responders, media, communities, etc.). Also, on a spatial scale, the project would test and evaluate visuals so that decision makers can see/know the areal extent, depth, and local impacts of flooding expected from upper portions of the watershed.

The project would also consider the different needs of urban and rural/suburban areas.

* Urban Component – Dynamic inundation maps for larger river flooding with associated probabilities. Visualization tools and triggers for what actions locals should take at each level.
* Rural/Suburban Component – Same as above, but with more focus on improved communication and information dissemination given the lack of internet access in some places. Include better spatial data and possibly stormwater data. Unlike mainstem issues, focus on the “flashiness” of tributary flooding.

**Key Project Partners:**

* NOAA/NWS
* FEMA
* Local officials
* SRBC