Future Water Priorities for the Nation: Directions for the U.S. Geological Survey Water Mission Area

George Hornberger, Committee Chair
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The National Academies are not...

- Part of the federal government
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- Conductors of primary research (generally)
• Water is integral to the development, health, and growth of communities and ecosystems
• Too much or too little water can cause disasters and crises
• Hurricane Florence (2018) estimated to have caused:
  – At least 37 deaths
  – Widespread flooding
  – Untreated wastewater and agricultural releases
  – At least $17 billion in damages (likely to be much higher)

Source: USGS, NASA
Statement of Task

The committee will address the most compelling national water resource and science needs during the next several decades. In particular, the study will:

1. Identify the nation’s highest-priority water science and resources challenges over the next 25 years,

2. Summarize WMA’s current water science and research portfolio, and

3. Provide recommendations on the strategic water science and research opportunities for WMA that would address the highest-priority national water challenges.
Committee Membership

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Study Approach

• 4 in-person meetings (3 information-gathering)
• Presentations and webinars from and discussions with federal/state/local agencies, academia, NGOs
• Additional information gathered from questionnaires sent to Water Science Center directors and State Geologists
• Comprehensive literature review of relevant studies
• Identified important challenges, questions that could address those challenges, then a subset that benefits USGS strategic directions
Priority Water Science and Resource Challenges

- Understanding the role of water in the Earth system
- Quantifying the water cycle
- Developing integrated models
- Quantifying change in the socio-hydrological system
- Securing reliable and sustainable water supplies
- Understanding and predicting water-related hazards

Source: USGS, Wikipedia
Questions to Address High-Priority Challenges

• Committee defined 10 questions to address high-priority challenges
• Developed a rubric to score and rank these questions

Source: USGS
Prioritization Rubric

- Criteria:
  - Scientific importance
  - Societal need
  - Relevance to USGS mission
  - Relevance to USGS partners
- Committee narrowed questions down to USGS specific priorities

<table>
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<tr>
<th>Criteria</th>
<th>Scoring Value</th>
<th>Priority Questions Identified in Chapter 2 of Report</th>
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| Scientific Importance (global, national, regional, local) | • All four are high (4)  
• Three are high (3)  
• Two are high (2)  
• One is high (1) |                                                      |
| Societal Need (global, national, regional, local)          | • All four are high (4)  
• Three are high (3)  
• Two are high (2)  
• One is high (1) |                                                      |
| Relevance to USGS Mission  
Observes  
Understands  
Predicts  
Delivers | • All four elements (4)  
• Three elements (3)  
• Two elements (2)  
• One element (1) |                                                      |
| Relevance to Partners  
Other parts of USGS  
Other federal agencies  
State, tribal, and local agencies  
Stakeholders (nongovernmental organizations, general public, private sector) | • All four partners (4)  
• Three partners (3)  
• Two partners (2)  
• One partner (1) |                                                      |
| Total Score:                                            |                                                   |                                                      |
Questions Most Relevant to USGS

1. What is the quality and quantity of atmospheric, surface, and subsurface water, and how do these vary spatially and temporally?

2. How do human activities affect water quantity and quality?

3. How can water accounting be done more effectively and comprehensively to provide data for water availability and use?

4. How does changing climate affect water quality, quantity, and reliability, as well as water-related hazards and extreme events?

5. How can long-term water-related risk management be improved?
Additional Questions

6. How does the hydrologic cycle respond to changes in the atmosphere, the lithosphere, and the biosphere through Earth’s history and in the near future? And how do the hydrologic responses feed back to and hence accelerate or dampen the changes in the atmosphere, the lithosphere, and the biosphere?

7. How can short-term forecasting for climate, hydrology, water quality, and associated social systems be improved?

8. How do institutions and governance and institutional resilience impact the quantity and quality of water?

9. How can understanding of the connections between water-related hazards and human health be improved?

10. How can competing uses for water resources be managed and maintained to sustain healthy communities and ecosystems in a changing world?
Emerging Technologies

- Future observations will:
  - come from a wider array of sources
  - be more affordable
  - offer data from previously inaccessible locations
  - provide “fit-for-purpose” temporal and spatial resolution
  - deliver measurements of new parameters
  - require systems that can rapidly collect, assess, store, process, and share data in near real-time

- Technical challenges still exist for measuring and monitoring water quality, but approaches such as microsensors and eDNA are advancing rapidly

- Developments in “big data” and data integration support:
  - improved scientific understanding
  - improved models
  - interdisciplinary model integration
  - decision-making under uncertainty
Recommendations

1. What is the quality and quantity of atmospheric, surface, and subsurface water, and how do these vary spatially and temporally?
   - Recommendation 1.1: Enhance data collection, include citizen science, and develop Web-based analytical tools. WMA should... co-develop accessible, open, and codified data formats, protocols, interoperability, and software tools...
   - Recommendation 1.2: Coordinate with agencies and organizations on data delivery.

2. How do human activities affect water quantity and quality?
   - Recommendation 2.1: Increase focus on the relationships between human activities and water. WMA should prioritize... a careful synthesis of observations and coupled natural-human systems models.
Recommendations (cont’d)

3. How can water accounting be done more effectively and comprehensively to provide data for water availability and use?
   - Recommendation 3.1: Develop a robust water accounting system.
   - Recommendation 3.2: Collaborate with agencies and organizations on water-data standards and categories of use.

4. How does changing climate affect water quality, quantity, and reliability, as well as water-related hazards and extreme events?
   - Recommendation 4.1: Ensure that monitoring networks provide adequate information to assess changing conditions.
5. How can long-term water-related risk management be improved?

- Recommendation 5.1: Focus on long-term prediction and risk assessment of extreme water conditions.

Additional Recommendations

- Recommendation 6: Develop multiscale, integrated, dynamic models that encompass the full water cycle.

- Recommendation 7: Collaborate as appropriate both within and outside of USGS, including agencies and the private sector.

- Recommendation 8: Build a workforce who are ready to take on new water challenges.
Thank You!

Use the chat feature to send your questions to the participant labeled “Send Questions Here.”

The report can be found at: [https://www.nap.edu/catalog/25134](https://www.nap.edu/catalog/25134)

Please contact Deb Glickson ([dglickson@nas.edu](mailto:dglickson@nas.edu)) with any further questions.