

**Urban Flooding in the United States
Workshop
Towson Marriott Conference Center
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WORKING GROUP REPORTS

The key questions for each working group were identified by the committee. The answers from participants, which were not edited by the committee, are presented in priority order below.

Local Stakeholders

Local Stakeholders, Physical Group

What and where are the biggest urban flooding problems in the context of the built and natural environments in Baltimore?

- New and existing development (along areas at risk, allowing retrofit in floodplain)
- Lack of capability to retrofit aging infrastructure
- High frequency riverine flooding
- Lack of storm-water retention standards that drive new developments and upgrades
- Lack of space to install mitigation and retention structures
- Non-applicable D-soils (urban soil) classification; lack of performance information
- Maintenance of infrastructure and best management practices
- Lack of standards (lag-time between research and best practices)
- Vacant housing and poor construction
- Shallow and nuisance flooding: increased frequency, potential for compound storm effects (See Union of Concerned Scientists report *Encroaching Tides*)
- Unmapped buried streams and springs
- Low frequency coastal flooding

What are the causes of urban flooding in Baltimore?

- Political process and allowing high-risk development
- Construction of multiple physical causes
- Change in precipitation effects (cloud-bursts and short-duration and high intensity events)
- Reduction of wetlands and natural streams
- Gambling on liability (short-term and long-term)
- Regional land subsidence and sea-level rise
- Dam safety
- Sheet flow blocked (e.g., CSX tunnel)
- More impervious surfaces
- More development
- Location at base of four watersheds
- Reservoir management for flood risk as well as water supply

What can decision makers do to reduce the impacts of urban flooding?

- Proactive versus reactive development, operations and management
- Incentives preventing physical measures
- System upgrades (new design storms)
- Vegetation placement that does not interfere with infrastructure (e.g., port quarantine)
- Prioritize assessment of evacuation and logistics (hospitals, dialysis, critical facilities)
- Need seasonal preparation (thunderstorm and hurricane seasons)
- Address basement flooding (aggravated by infiltration and inflow consent decree)
- Assess and modify 311 flex questions to obtain better data
- Capacity analysis for public and private capacity (e.g., sump pumps and roto-rooter service companies, shop vacuums)
- Land acquisition and land surface tilling
- Private property doing their own mitigation
- Neighborhood organize for physical provisions (e.g., snowstorm and power outage)
- Weatherproofing for water
- Elevate generators
- Pests and vectors (e.g., asthma)
- Links to health (It's More Than the House – It's Your Health)
- Bureaucracy of claims

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Acknowledge current and optimal population (right size to infiltration)
- Model flood and sea level
- Focus on higher ground and retreat
- Elevate structure (private property issues; FEMA constraints)
- Storm-proofing
- Swap vacant and upland areas
- NSF design project Higher Ground (Katie O'Meara)
- Dedicated funding source (SRF, protection, urban flooding mitigation); University of Maryland EFC, Environmental Finance Center (Architecture School)
- Integrated planning framework
- Sanitary sewer upgrade (new infiltration and inflow program)

Local Stakeholders, Social Group

What are the impacts of urban flooding?

- Exposure to storm water contaminants in homes: continuous impact can result in loss of insurance
- Social equity: downstream affects, call responses in lower income areas
- Considerations of who are impacted: renters, low income, downstream impacts, capacity to make complaints, places of weakened infrastructure
- Threat of litigation creates "us vs them:" residual impacts of flood barrier projects
- Loss of use of public and private property
- Understanding complexity: temporal and geographic disconnect

- Unexpected surprises with the changing nature of flooding, social capital limited in dealing with it
- Poor water quality affects social fabric
- Mold and allergies exacerbated by flooding and standing water
- Persistent disinvestments
- More education and awareness around water quality than quantity
- Property values
- Losing and needing insurance due to floodplain changes

What are the causes of urban flooding in Baltimore?

- Equity in infrastructure investment
- Insufficient infrastructure capacity for urban drainage
- Infrastructure priorities based on complaints (inequality in reporting)
- Lack of proactive planning in the post-event response recovery phase
- Value and improvement focused on economic dimensions, rather than social
- Ordinance for floodplain development
- Lending equity

What can decision makers do to reduce the impacts of urban flooding?

- Utilize existing trusted community centers (e.g., faith, civic, resiliency hubs)
- Barrier: top-down approach can limit response
- CERT program not utilized as effectively as it could be
- Local foundations are another resources (e.g., Grantmakers)
- NGOs and organizations: Operation HOPE, Red Cross
- Community leaders to build and utilize trust
- Community hubs require time and energy

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Organizing neighborhoods through community hubs to promote prevention
- Incentive programs: home insurance and mitigation
- Synchronicity in government health and flooding issues
- Mass media contribution: protective actions, guidance
- Resident understanding of watersheds
- Scale issue in flooding: climate change down to neighborhood drainage; empowerment to make changes at the local level
- Perception issue: if flooding does not directly impact me, it is not important
- Need to include voice of businesses, churches, and universities and leverage them in community awareness

Local Stakeholders, Information Group

What are the biggest problems with data and information in relation to urban flooding in Baltimore?

- Poor retrofit development choices: building in places they should not
- Public trust in information collection

- Smaller events more chronic, but lack of understanding
- Flood maps inaccurate and incomprehensible
- Dynamic problem, static understanding
- Lack of financing information for mitigation
- Diffuse collection of events and impacts
- Lack of understanding of precipitation changes
- Accurate and quick post-event impacts

What is causing the information and data problem?

- Never get to the root of the problem
- Old data outdated methods
- Information not proactive, always reactionary
- Only address problems that they can control
- Uncertainty of the true responsibility
- Language and terminology
- Water value over-rated and discounts risk
- Do not know what information is available
- Distrust in information
- Inaccurate media reports
- Lack of public trust

What are the problems in accessing and using existing information to managing urban flooding?--Action

- Change cultural priorities
- More resources for inspection and enforcement
- Active and engaged data and information collection
- More political accountability
- Data case studies with community engagement
- Information and data clearinghouse
- Value and understanding of different economic paradigms
- Value of mitigation

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Real-time monitoring of the built environment
- Effective and integrated feedback loop
- Smart infrastructure
- Engaged communities
- Know limitations of dynamic issue
- Conveyance of true risk
- Hyper-local flood information
- Understand unintended consequences of action-systems view

Local Stakeholders, Action and Decision Making Group

What and where are the biggest urban flooding problems in Baltimore?

- How to make decision-makers to focus on these issues when there is not a crisis; proactive versus reactive; difficult to analyze
- Rain water and waterway problems in existing neighborhoods; can we stop developing in flood prone areas?
- Old infrastructure
- Need communications from communities; how we communicate is important

What are the causes of urban flooding in Baltimore?

- Pace of development in Baltimore (compared to Netherlands); accept urban; flooding as business as usual so they do not do anything
- Lack of knowledge of the causes of flooding (trash littering causes flooding on street and public awareness)
- Expenses (budgets blown by old infrastructure; e.g., sink hole); cannot get ahead of patching aging infrastructure
- Lack of space

What resources do decision makers have, and what action can they take to reduce impacts of urban flooding?

- No comprehensive plan or map of storm water infrastructure, so we do not know the best intervention
- Legal liability by development with higher standards
- Code: floodplain codes from the NFIP
- Funding focused on municipal separate storm sewer systems, but sink holes divert a lot of resources

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Political will and money
- Regional connectivity, systems approach
- Proactive actions
- Community empowerment to respond
- Data: precipitation rates and hyper local impacts (saturated ground)
- Incentives with a regulatory framework to encourage responsible development
- Communications to and from communities (best from nonprofits who know the communities)

Federal, State, and Regional Stakeholders

Federal, State, and Regional Stakeholders, Physical Group

What and where are the biggest urban flooding problems in the context of the built and natural environments in Baltimore?

- Lack of diverse spatial constraints and needs; efficacy of blue-green-infrastructure (often good for nuisance, but not overall)
- Floodplain encroachment and disappearance due to buildup
- Change in design parameters (from flood control to storm water to urban flooding)

- Irreversibility of urban hydrologic change (loss of access to diverse solutions in future)
- Unstable stream systems, sediment transport and geomorphic processes, increasing volume of discharge due to channelization
- Definition of urban flood (emphasis on large volumes and ability of stable stream system)
- Inability to estimate cost of recovery from urban flooding versus other flooding (partly due to lack of definition of problem)
- Do not know where water is coming from (multiple and often unknown sources). Arrival timing and underground paths are also unknown
- Trendy solutions (e.g., blue-green) are part of the problem
- Problem not defined as flood risk-reduction (e.g., projects driven for water quality and total maximum daily load; federal agencies cannot help with funds from other funding sources)
- Water goes where we do not want it
- Damage: lasting damage and ephemeral
- Urban is not used for physical hydrology (solutions are often jurisdictional)

What are the causes of urban flooding in Baltimore?

- Lack of green and natural space
- Lack of regional approach (federal role)
- Lack of maintenance of conveyance (e.g., cleaning culverts)
- Outdated design systems (pumps, pumping, backflow, tidal flow, raised infrastructure)
- Climate change impacts and changing storm characteristics
- Decreased infiltration. Development that had or has little storm water control
- No plan for gigantic storms (not applicable to smaller countries)
- Interaction between urban and coastal
- Lack of focus on hydrologic processes (interception, infiltration, and evapotranspiration)
- Urban soils (best management practice effectiveness)
- Link between flood plans and local planning and investment
- Floodplain and stream channel disturbance
- Buried streams and subsidence
- Green engineered approaches (permeable and porous surfaces)
- Emphasis on evaluating structures

What can decision makers do to reduce the impacts of urban flooding?

- Coordination of blue, green and grey infrastructure (watershed context and guidance for planning)
- Training of public representatives; political-professional link
- Maintenance is key (implementation, enforcement, compliance, and funding)
- Maryland “Silver Jackets” planning and operations
- Community-driven planning
- Coalition: Regional blue-green infrastructure and resilience (see Greater Baltimore Wilderness Coalition)
- Incentivize coordination of historic areas and flood mitigation
- Update design standards and parameters (life cycle assessment, risk analysis, outside-the-box and alternatives [e.g., flooding of indoor parking])
- Address flooding of commercial lands that affect the economy of cities, especially small businesses that lack expertise; Chamber of Commerce and peer networking

- Community resiliency problem
- Institutional collaboration strategy and institutional analysis and mapping

What do you need (but do not have) to reduce urban flooding impacts in the future?

- More money
- More adaptive approaches (adjust to changing conditions)
- Lessons from post-Sandy (e.g., Hoboken) for anticipatory design
- Built environment experiments
- Know all areas subject to flooding
- More investment in mitigation
- More planning and investment in aging infrastructure
- Disaster Preparedness and Planning Project (DP3): Hazard mitigation in storm water and watersheds
- Proactive and area-focused strategies (beyond individual properties)
- Link water quality and water supply problems
- Smart real estate development (repurposing of high-risk areas)
- More stringent zoning
- Investment incentives for permeable materials
- Develop long-term planning perspective, especially funding
- Steady funding sources
- Implementable imagination vis a vis highly speculative
- Multijurisdictional lessons and authorities (NY-NJ)
- Link academic resources and research with public and private work so that it is mutually beneficial
- Technical assistance for flood research programs

Federal, State, and Regional Stakeholders, Social Group

What are the impacts of urban flooding?

- Underemphasized feedbacks and connections with environment and economic implications
- Multiple source of flooding: sewer back-up, precipitation, insufficient capacity
- Differences in risk perception among the population
- Disproportionate burden and inequity due to poverty
- Older neighborhoods (e.g., higher impacts due to elderly, low income)
- High frequency, low impact events and threshold effects
- Lack of insurance coverage
- Lack of previous experience with larger events due to age
- Indirect effects (e.g., displacement, mortgage payments)
- Lifesaving vs. damage reduction
- Warning issuers understanding of needs of community

What are the causes of urban flooding in Baltimore?

- Not prioritizing infrastructure upgrades and willingness to pay by taxpayers
- Historical development patterns
- Low awareness (e.g., previous experience, varied flood sources)

- Disproportionate burden due to low socioeconomic status (elderly, low income)
- Jargon and terminology differences across fields and sectors: it is useful to build relationships
- Lack of connections with health and climate institutions
- Material resource access influences physical exposure
- Vulnerability of service and private sectors: reliance on a certain industry

What can decision makers do to reduce the impacts of urban flooding?

- Greater focus on prevention
- Neighborhood hubs for disseminating information and connecting resources
- Neighborhood characteristics of places with aging infrastructure
- State agencies assistance: technical advice, mapping, physical assistance
- Higher availability of maps of socially vulnerable populations
- Use of population projection information for long-term planning
- Consideration of pets in evacuation and sheltering
- Preparedness action plans for urban flooding
- Hazard mitigation plans that incorporate climate change
- 311 reporting

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Empowering and developing community champions
- Local level workforce development and awareness building
- Local sourcing provisions in service contracts (boosts supply and demand)
- Capacity (resources) and capability (knowledge base)
- Agency communication with communities (meet them where they live)
- Understanding behavior and perception
- Education about local infrastructure maintenance
- Awareness and information vis-a-vis high frequency events (nuisance flooding)
- Continuity of local and institutional knowledge with demographic changes

Federal, State, and Regional Stakeholders, Information Group

What are the biggest problems with data and information in relation to urban flooding in Baltimore?

- Understanding key drivers of risk
- Effective communication of risk
- Behavioral bias to low probability, high impacts events
- Same regulation for current versus future environment
- Lack of complex modeling: too many assumptions
- Disconnect between general public understanding and hydrologic reality
- Lack of information on how to embrace the flood
- FEMA map in right medium: more dynamic representation
- Lack of comprehensive information or clearinghouse
- Timely information about the event
- Old and outdated methods and data
- Mapping of underground stream data
- Lack of specificity of new (nontypical) events: only general trends

- Natural to current water conveyance gap

What is causing the information and data problem?

- Lack of accountability
- How to talk properly and effectively about uncertainty
- Not always incorporating individual decision-making bias in information: floodplain maps show in vs. out
- Accessibility and capacity issues
- Not effective enough in how use and coalesce existing information
- Unknown and unidentified trusted source: who is the right messenger?
- Lack of convergence on data integrity for identified events
- Understanding of different forms of resiliency
- Lack of learning from other cases (e.g., international)

What are the problems in accessing and using existing information to managing urban flooding?

- Actionable information
- Identify right messenger
- Take advantage of existing data and articulate better to stakeholders: make it more understandable
- Have geographic focus in discussions
- Get risk reduction information to proper audience, correct pathways and networks
- Expand Silver Jackets model, linking federal and state agencies
- Move away from status information communication: redefine risk zones

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Agreed upon plan that everyone looks to: the same common future state, not more information
- Focus value on benefits that are clearly articulated and quantified (e.g., economic effectiveness)
- Learn from existing effective public policy actions
- Long-term flood risk assessment tool; learn from financial industry
- Menu of mitigation choices with relevant information: portfolio of activities

Federal, State, and Regional Stakeholders, Action and Decision Making Group

What and where are the biggest urban flooding problems in Baltimore?

- Incentives to mitigate (e.g., permeable surfaces, green infrastructure); getting people to take action to mitigate with actionable information
- Coordination across sectors, leverage synergies, and find common ground to combine resources (e.g., Department of Natural Resources is focused on water quality for Chesapeake Bay; the City interested in retrofitting waste water systems that might help with the Bay)
- Communicating about risk and actions to take (e.g., when to evacuate an area when they are in harm's way)
- Understanding impacts of inaction (e.g., community, economic)

What are the causes of urban flooding in Baltimore?

- Opposition to relocation (rebuilding in the same spot)
- Barriers to even having the discussion
- Limited ability to predict the next big crisis allows decision makers to debate uncertainty and to invest or not invest
- Lack of information at the local level and list of project to access

What resources do decision makers have, and what action can they take to reduce impacts of urban flooding?

- Making risk-informed decision-making: need information on risk of urban flooding
- Getting individual and local communities to know their options: Flood proof, relocate, elevate, demolish (FRED)
- Technical expertise (e.g., Corps Technical Assistance Program to know where water is going and how much it would cost to address the problems) and operations and maintenance (e.g., map storm water program); Army Corps does not advertise this
- Coordinating bodies with specific actions (e.g., Maryland Commission on Climate Change has a Climate Action Plan and is advising on GHG reduction; the commission has not yet touched on urban flooding)

What do you need (but do not have) to reduce urban flooding impacts in the future?

- Mapping that is more dynamic to show inland flooding, and improved visualization of coastal impacts on cities
- Do not think about fighting flooding, but instead think about facilitating flooding (e.g., daylighting streams, reducing flows)
- Gap between aspiration and ability to fund mitigation and upgrades (e.g., Chicago has a storm water plan but no funding)
- Federal incentives