THE DEVELOPMENT OF AN URBAN RAIN RATE DASHBOARD (URRD) AT THE WEATHER PREDICTION CENTER

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URBAN FLOODING

Flooding is the most common, costly, and deadly weather-related disaster in the United States (Alliance 2020). Urban flooding is a specific subset of flooding, typically occurring in metropolitan areas when intense rainfall exceeds infiltration capacity and removal by natural and engineered drainage systems (Galloway et al. 2018).

Urban flooding is an expanding and increasing problem in the U.S. due to a combination of factors. These factors include: (a) urban population growth; (b) the expansion of impervious surfaces; (c) drainage into older or outgrown stormwater infrastructure; (d) local development policies and regulations that may not have kept pace with increased runoff; and (e) a warming climate that is increasing the frequency of intense rainfall events (National Academies 2019; Galloway et al. 2018).



A flooded intersection during a period of heavy rainfall.

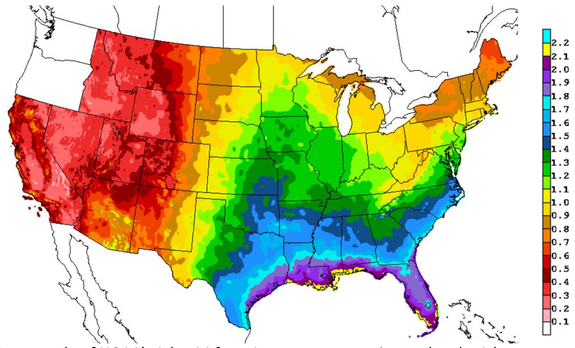
THE URRD DASHBOARD

The Urban Rain Rate Dashboard (URRD) is a website designed to provide high-level, automated guidance concerning the threat of urban flooding. The threat is determined by an ensemble of NOAA numerical weather prediction (NWP) models. Specifically, the threat is based on the forecasted likelihood of exceedance of NOAA's Atlas 14 Average Recurrence Intervals (ARIs) at major U.S. cities. Atlas 14 ARIs used in the URRD are: 1, 2, 5, 10, 25, 50, 100, 200, 500, and 1000 year return intervals, at durations of: 5, 10, 15, 30 minutes, 1, 2, 3, 6, 12, 24 hours. With the recent release of the Interior Northwest states, Atlas 14 is now available for the entire contiguous U.S. except for Oregon and Washington. Atlas 15 will cover the entire contiguous U.S. when released publically in 2026.

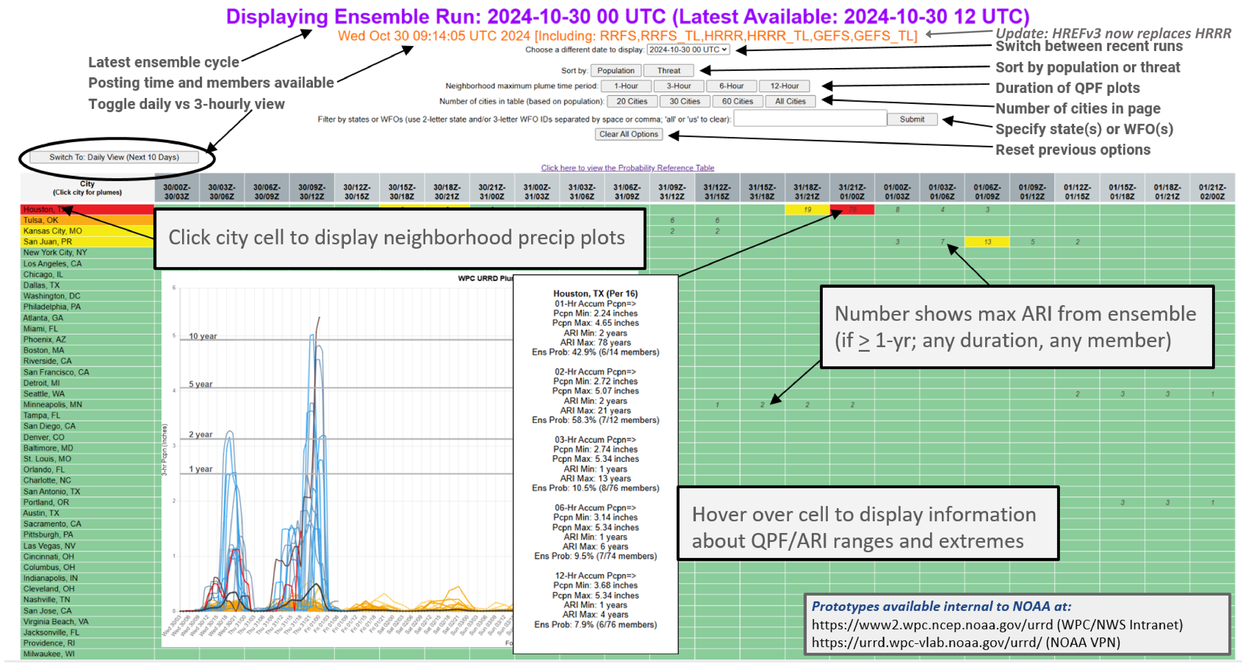
The URRD is an automated guidance tool that updates four times per day on the synoptic hours. The URRD does not replace official NWS watches, warnings, and decision support services provided by NWS field offices.

The NOAA NWP systems comprising the URRD ensemble include the most recent and one time-lagged cycle of each of the following:

- Rapid Refresh Forecast System (RRFS);
- High Resolution Ensemble Forecast version 3 (HREFv3);
- Global Ensemble Forecast System (GEFS).



An example of NOAA's Atlas 14 for a 1-year recurrence interval and a 1-hour duration period. Units are in inches of precipitation.



Development website internal to NOAA:
https://www2.wpc.ncep.noaa.gov/urrd (WPC/NWS Intranet)
https://urrd.wpc-vlab.noaa.gov/urrd/ (NOAA VPN)

Public website external to NOAA:
Real-time experimental website available on or before Oct. 1, 2025.

SOCIAL SCIENCE & COMMUNITY ENGAGEMENT

A unique aspect of the URRD project is its collaborative development with social scientists at the Nurture Nature Center (NNC). In the fall of 2024, the NNC conducted focus groups with stormwater, flooding, water resource, and emergency management professionals at six large U.S. cities. Those cities included: Atlanta, Denver, Houston, Los Angeles, New Orleans, and New York City. The focus groups were conducted virtually and each session lasted approximately two hours.

The NNC team used scenarios provided by the WPC, which were based on heavy precipitation events that had varying urban flood impacts and dashboard threat visualizations. The team presented various URRD mock-ups and supplemental graphics that could be incorporated into the dashboard. They discussed the value of ARIs vs actual precipitation amounts, and how to best visualize an automated dashboard for potential urban flooding. In addition to the discussion, data was also gathered from pre- and post-surveys on the topic.

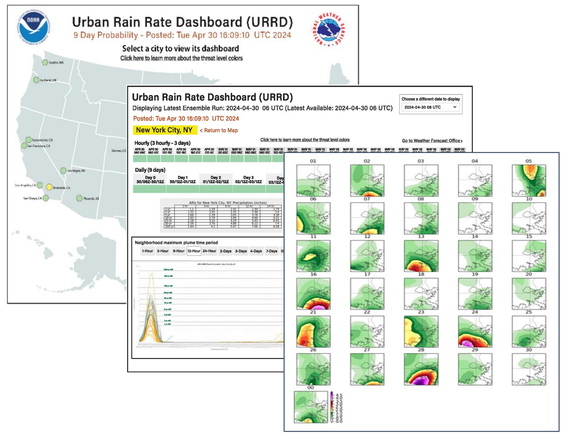
Refinement of the dashboard will be based on input received by these subject matter experts. Prior to the dashboard becoming publically available as a real-time experimental product, the NNC will revisit these community stakeholders for another follow-up session.



An illustration of the URRD physical and social science development cycle.

Nurture Nature Center Collaborators

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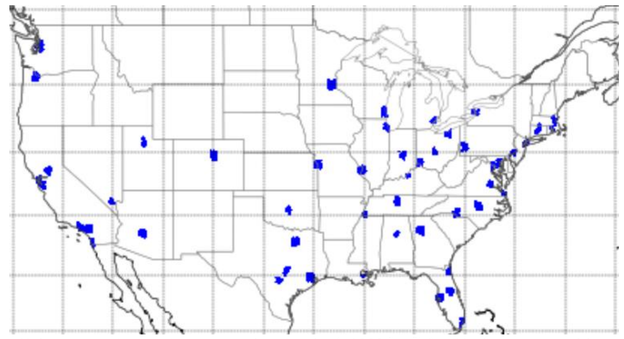


An example of NNC's pre-decisional material for focus group discussions. Various renderings of the URRD website and internal data were presented and discussed with stormwater and emergency managers from around the U.S.

URRD PROCESSING AND DISPLAY

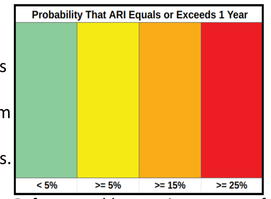
The URRD primarily focuses on short-term, intense precipitation through 72-hours. Most urban flood events arise from intense, often convective precipitation, with peak accumulation periods less than 12-hours, and frequently 6-hours or less. In order to best resolve these intense precipitation events, storm-scale ensembles such as the HREF and RRFS are utilized. The developmental version of the URRD also has an "outlook" perspective, which incorporates the GEFS, and can provide outlooks 7-10 days in advance. During the prototyping phase, the GEFS has proven to be a positive contributor for larger-scale rainfall events (e.g., atmospheric rivers, tropical systems), but lacks the storm-scale resolution for the more isolated, purely convective urban flood event.

The maximum precipitation from each ensemble member is found using a neighborhood approach. The neighborhood is determined by the population density (>= 1000/km^2) around the city center. The neighborhood maximum precipitation for durations of 1 to 12 hours (the other available ARI durations are not used) are found for each ensemble member, converted to an ARI, and then the percent that exceed a 1-year ARI are calculated.



Neighborhoods based on population density (≥1000/km^2) for 51 of the largest cities.

Using the neighborhood maximum precipitation, the percent of members exceeding the 1-year ARI for that duration is computed. The dashboard is highlighted (yellow, orange, red) based on the maximum exceedance percentage (ARI ≥ 1 year) from the 1-hour to 12-hour accumulation periods. The figure to the right shows the current reference table used by the dashboard.



Reference table mapping percent of members with an ARI ≥ 1 year to colors on the dashboard.

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