HYDROMETEOROLOGICAL DESIGN STUDIES CENTER
QUARTERLY PROGRESS REPORT

1 January to 31 March 2015

National Water Center

National Weather Service

National Oceanic and Atmospheric Administration

U.S, Department of Commerce

Silver Spring, Maryland

April 2015

DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various tasks associated with these projects. Values presented herein are NOT intended for any other use beyond the scope of this progress report. Anyone using any data or information presented in this report for any other purpose does so at their own risk.

TABLE OF CONTENTS

I. INTRODUCTION

The Hydrometeorological Design Studies Center (HDSC) within the National Water Center[1] of National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) has been updating precipitation frequency estimates for various parts of the United States and affiliated territories. Updated precipitation frequency estimates for durations from 5 minutes to 60 days and average recurrence intervals between 1- and 1,000-years, accompanied by additional relevant information (e.g., 95% confidence limits, temporal distributions, seasonality) are published in NOAA Atlas 14. All NOAA Atlas 14 products and documents are available for download from the Precipitation Frequency Data Server (PFDS). NOAA Atlas 14 is divided into volumes based on geographic sections of the country and affiliated territories. To date, precipitation frequency estimates have been updated for Arizona, Nevada, New Mexico and Utah (Volume 1, 2004), Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia (Volume 2, 2004), Puerto Rico and U.S. Virgin Islands (Volume 3, 2006), Hawaiian Islands (Volume 4, 2009), Selected Pacific Islands (Volume 5, 2009), California (Volume 6, 2011), Alaska (Volume 7, 2011), and Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Wisconsin (Volume 8, 2013), Alabama, Arkansas, Florida, Georgia, Louisiana and Mississippi (Volume 9, 2013). Currently we are updating estimates for seven northeastern states that will be published in September 2015 as Volume 10. Those states are Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. Work on updating precipitation frequency estimates for the state of Texas is expected to formally start in mid-2015 and due for completion in mid-2018. We have been working with the Federal Highway Administration (FHWA) using their "pooled funding" mechanism (Transportation Pooled Fund Program) to secure funding to extend NOAA Atlas 14 to the remaining five northwestern states (Idaho, Montana, Oregon, Washington, Wyoming). Figure 1 shows the states or territories associated with each of the Volumes of the Atlas. States that have already been updated in Volumes 1 to 9 are indicated by marking them with horizontal lines.

Over the last two years, in addition to precipitation frequency projects, HDSC has been working on two additional projects: analysis of potential impacts of climate change on precipitation frequency estimates and development of regional areal reduction factors to accompany NOAA Atlas 14 point precipitation frequency estimates. Due to lack of funding we had to suspend activities on both projects. No work has been done on either project during this reporting period and consequently we omit related sections in this progress report. For more details on the work accomplished so far, please see Oct - Dec 2014 progress report.

[1]As of April 1, 2015, the Office of Hydrologic Development reorganized into the National Water Center (NWC) with locations in Chanhassen, MN, Silver Spring MD, and Tuscaloosa, AL.

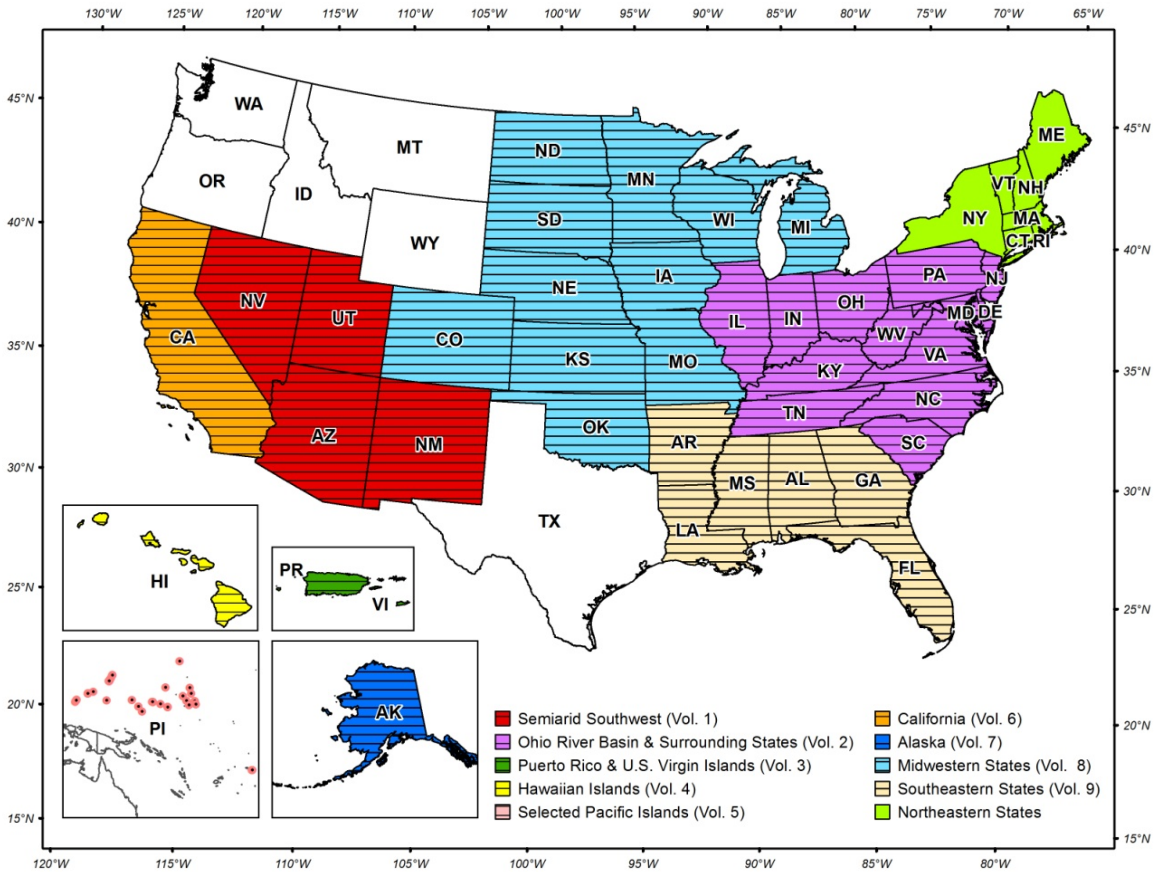

Figure 1. Current project area for Volume 10 (Northeastern states) and project areas included in published Volumes 1 to 9.

II. CURRENT PROJECTS

1. PRECIPITATION FREQUENCY PROJECT FOR THE NORTHEASTERN STATES

1.1 PROGRESS IN THIS REPORTING PERIOD (Jan - Mar 2015)

The project area for the Northeastern precipitation frequency project includes the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont, and approximately a 1-degree buffer around these states (Figure 2).

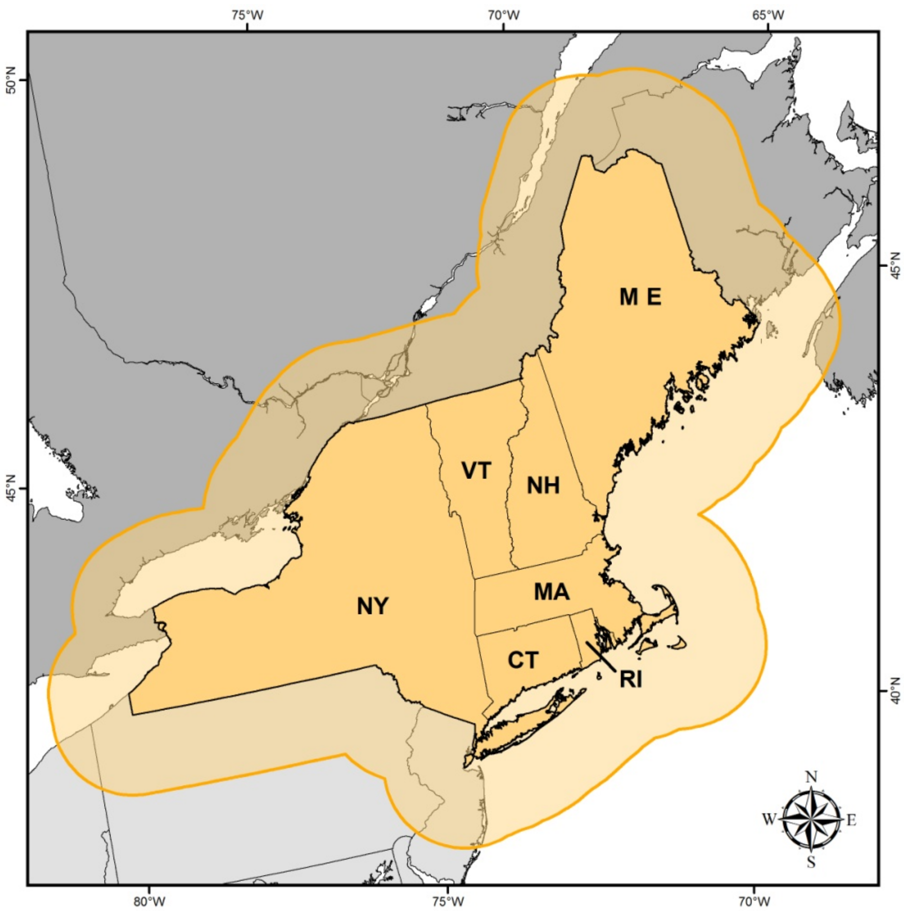

Figure 2. Northeastern precipitation frequency project area (shown in orange).

On September 30th, 2014 we sent an invitation to review our preliminary estimates to potential reviewers suggested by funding agencies as well as a list maintained by NWS which includes interested parties, recognized academics specializing in the field, and State Climatologists. More details on the review process and products are available from Jul - Sep 2014 progress report.

During the reporting period, we finished addressing all the comments received during the peer review process. The (anonymous) reviewers' comments with our responses and resulting actions will be published as an Appendix 4 of the NOAA Atlas 14 Volume 10 document. We revised the mean annual maxima maps for durations from 15 minutes to 60 days, completed non-stationarity analysis of AMS, and finished derivation of scaling factors that are used to calculate 5-min and 10-min estimates from corresponding 15-min estimates. We also digitized newly acquired data for selected observing locations, and updated records for the National Climatic Data Center's stations to include data from 2013 and 2014, where available. The individual sections below describe in more detail major tasks performed during this reporting period.

1.1.1 Data collection and data screening

In this reporting period, we digitized and formatted additional precipitation data for eight stations located in areas of high importance and scarce data from the Massachusetts Department of Conservation and Recreation dataset and from the NCDC's Climate Database Modernization Program (CDMP)***.*** The stations' names, recording intervals and periods of record digitized are shown below:

Station name	Recording interval	Period digitized
New Haven	1-day	1873-1899
New Haven	1-hr	1899-1943
New Haven AP	1-hr	1943-1948
Boston	1-hr	1892-1948
New York WB City	1-hr	1889-1948
Albany	1-hr	1897-1948
Phoenicia	1-hr	1997-2010
ATT801 (Attleboro)	1-day	1937-1965

Figure 3 shows, as an example, updated hourly annual maximum (AM) time series for the New York WB City station. For this station, hourly record was extended for additional 50 years (1889-1948 period). As can be seen from Figure 3, the largest four AM values in the series come from the newly digitized data.

In this reporting period, we also updated precipitation data for the National Climatic Data Center's n-min, hourly and daily stations, to include data from 2013 and 2014, where available.

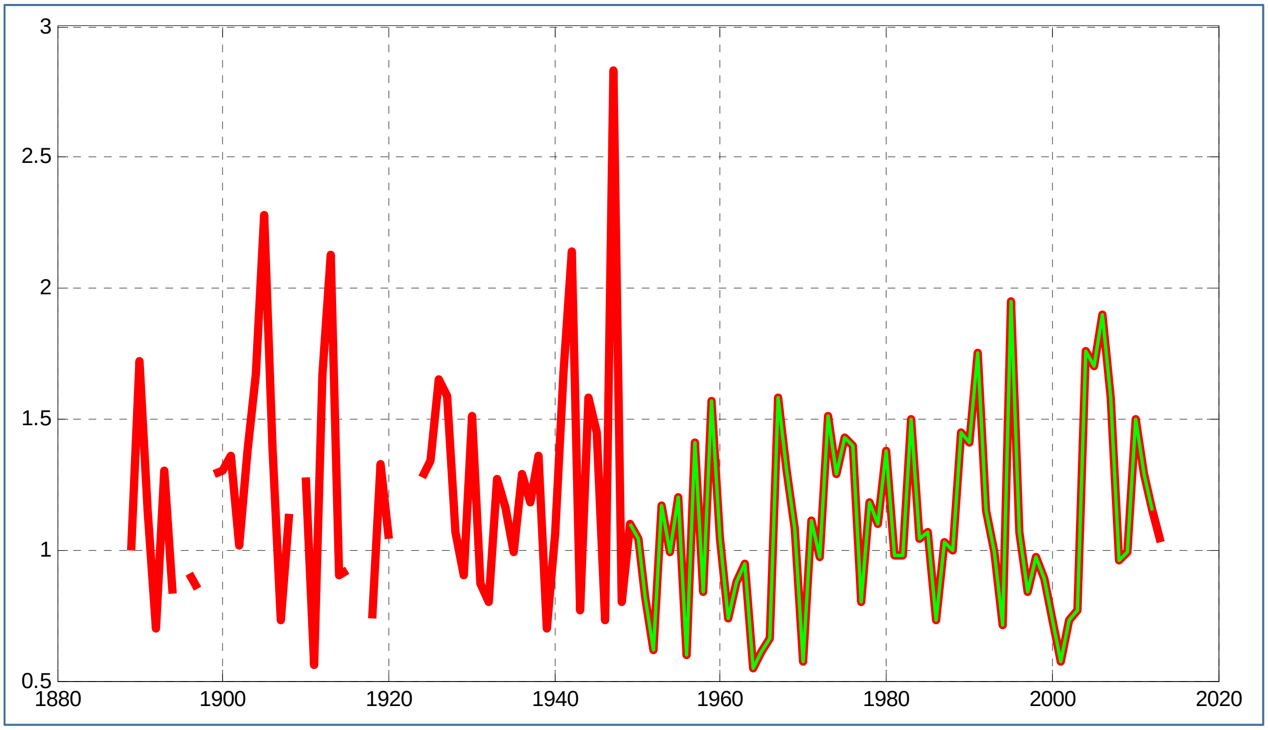

Figure 3. 1-hr AMS for the New York WB City station. The left part of the time series in red represents the AMS from newly digitized data while the time series is yellow is the original record.

1.1.2 Revision of MAM estimates in response to peer review

In NOAA Atlas 14, the grids of mean annual maxima (MAM) at 30 arc-sec resolution, together with at-station precipitation frequency estimates are basis for calculation of gridded precipitation frequency estimates and corresponding upper and lower bounds of the 90% confidence interval. MAM grids are developed from at-station MAM values by the Oregon State University's PRISM Climate Group using their hybrid statistical-geographic approach for mapping climate data named Parameter-elevation Regressions on Independent Slopes Model (PRISM). Since MAM grids are estimated for each duration independently, typically, several iterations are required to ensure consistency of interpolated MAMs across all durations.

Based on the comments received during the peer review, during this reporting period, we first re-examined at-station MAMs and then revised MAM spatial patterns at base durations (1-hr, 1-day and 10-day). Some at-station MAM estimates were adjusted or added back to the dataset to better anchor the spatial interpolation in areas of varied terrain and/or where the lack of stations or short records unduly influenced expected spatial patterns, particularly at sub-daily durations. We also examined and revised, as necessary, spatial patterns in MAM estimates interpolated to a 30 arc-sec grid for all remaining durations from 15 minutes to 60 days (15-min, 30-min, 2-hr, 3-hr, 6-hr, 12-hr, 2-day, 4-day, 7-day, 20-day, 30-day, 45-day and 60-day).

.

1.1.3 Scaling factors for 5-min and 10-min durations

The shortest duration at which AMS data are extracted is 15 minutes. MAM grids and grids of precipitation frequency estimates at 5-min and 10-min durations are derived by applying scaling factors on corresponding 15-min estimates. During this reporting period, we calculated scaling factors for n-min stations as average ratios of 5-min and 10-min annual maxima to corresponding 15-min annual maxima. We analyzed spatial patterns in scaling factors, but did not find any geographic clusters. Therefore, we'll assume they are uniform for the whole project area.

1.1.4 Trends in annual maximum series data

Precipitation frequency analysis methods used in NOAA Atlas 14 volumes are based on the assumption of stationary AMS over the period of observation. The stationarity assumption in at-station AMS is tested by applying a parametric t-test and nonparametric Mann-Kendal test for trends in the mean and the Levene's test for trends in variance. We expanded previously done analysis on 1-day AMS data to include sub-daily durations. Both parametric and non-parametric tests detected statistically significant trends in AMS means in fewer than 10-20% of stations (with 50 years of data or more) across all durations. We then plotted stations and trend analysis results on a map (see Figure 4 for tests results for 1-hr duration). Stations where tests detected positive trends (marked in red) or negative trends (marked in blue) are scattered across the project area with no geographic consistency. Similarly, Levene test indicated trends in variance for a very few stations for all durations.

The relative magnitude of any trend in the AMS means for durations between 1-hr and 1-day was also assessed for two delineated climate regions (see Figure 3 in Oct - Dec 2014 progress report). AMS were rescaled by corresponding mean values and then regressed against time. The regression results were tested as a set against a null hypothesis of zero serial correlation. The null hypothesis of no trends in AMS data could not be rejected at 5% significance level. Therefore, the assumption of stationary AMS was accepted for this project area.

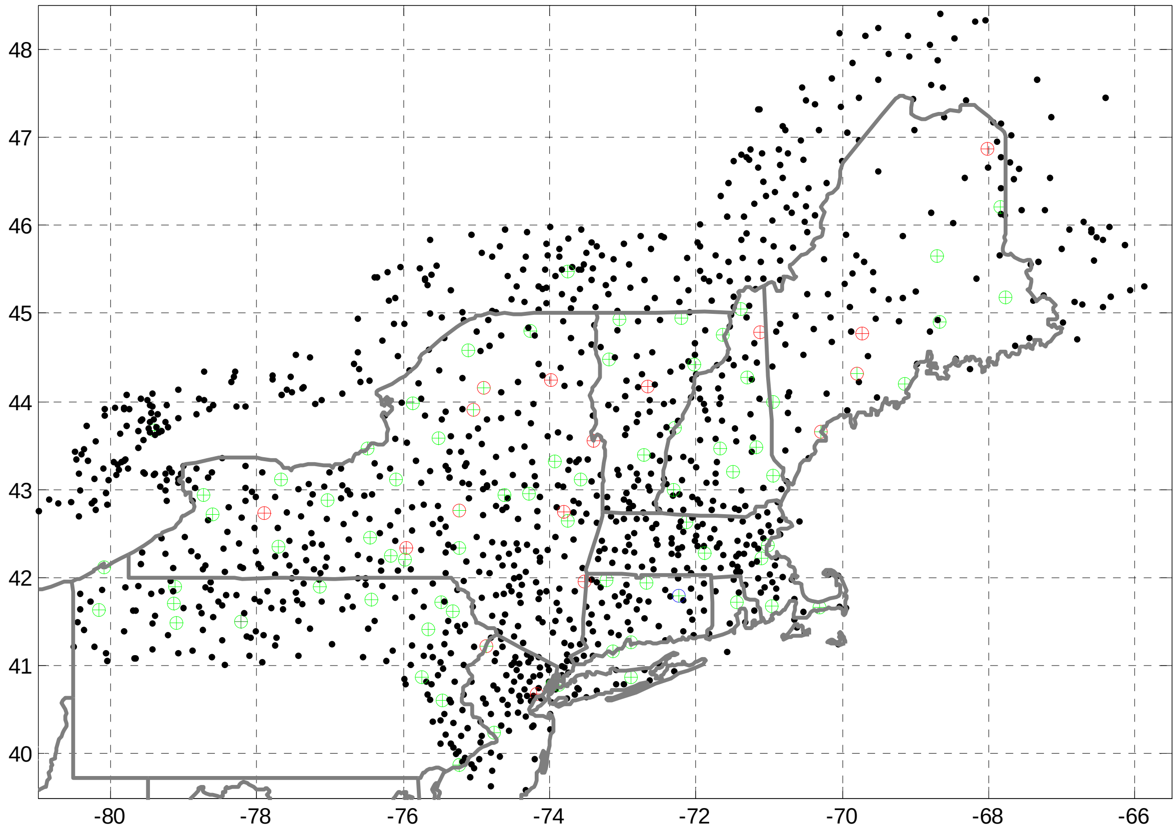

Figure 4. The trend analysis results for the 1-hour annual maximum series data from the parametric t-test (+ symbol) and non-parametric Man-Kendell test (o symbol) for trends in the mean. Stations where tests detected positive trend are marked in red, negative trend in blue and no trend in green. Black dots indicate stations with less than 50 years of data.

1.2 PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD (Apr - Jun 2015)

During the next reporting period, we'll develop grids of AMS-based precipitation frequency estimates and corresponding bounds of 90% confidence interval. We'll also work on the project documentation.

1.3 PROJECT SCHEDULE

Data collection, formatting, and initial quality control [Complete]

Extraction of annual maximum series (AMS); additional quality control and data reliability tests (e.g., outliers, independence, consistency across durations, duplicate stations, candidates for merging) [Complete]

Regionalization and frequency analysis [Complete]

Initial spatial interpolation of precipitation frequency (PF) estimates and consistency checks across durations [Complete]

Peer review [Complete]

Revision of PF estimates [June 2015]

Remaining tasks (e.g., development of precipitation frequency estimates for partial duration series, seasonality, temporal distributions, documentation) [July 2015]

Web publication [September 2015]

III. OTHER

1. STORM ANALYSIS

HDSC creates maps of annual exceedance probabilities (AEPs) for selected significant storm events that typically have observed amounts with AEPs of less than 0.2% over extended areas. AEP is probability of exceeding a given amount of rainfall at least once in any given year at a given location. It is an indicator of the rarity of rainfall amounts and is used as the basis of hydrologic design. For these storm events, we look at a range of durations and create a map for the one that shows the lowest AEPs for the largest area. Maps do not represent isohyets at any particular point in time but rather isolines of AEPs within the whole event. The maps are available for download from the following page: http://www.nws.noaa.gov/oh/hdsc/aep_storm_analysis/.

During this reporting period, HDSC analyzed annual exceedance probabilities for the Southeastern New England rainfall events that occurred during March 2010. Three rainfall events in the month of March delivered rainfall amounts that exceeded 20 inches in some locations. The runoff from the rainfall caused record river stages throughout Southeastern New England.

The map in Figure 5 shows the areas that experienced rainfall magnitudes with AEPs ranging from 1/10 (10%) to smaller than 1/1000 (0.1%) for the 20-day duration. Rainfall amounts were derived from rain gauge data from the Global Historical Climatology Network – Daily. Rainfall frequency estimates are preliminary estimates from the NOAA Atlas 14, Volume 10. The 20-day duration was selected because it showed the smallest AEPs for the largest area.

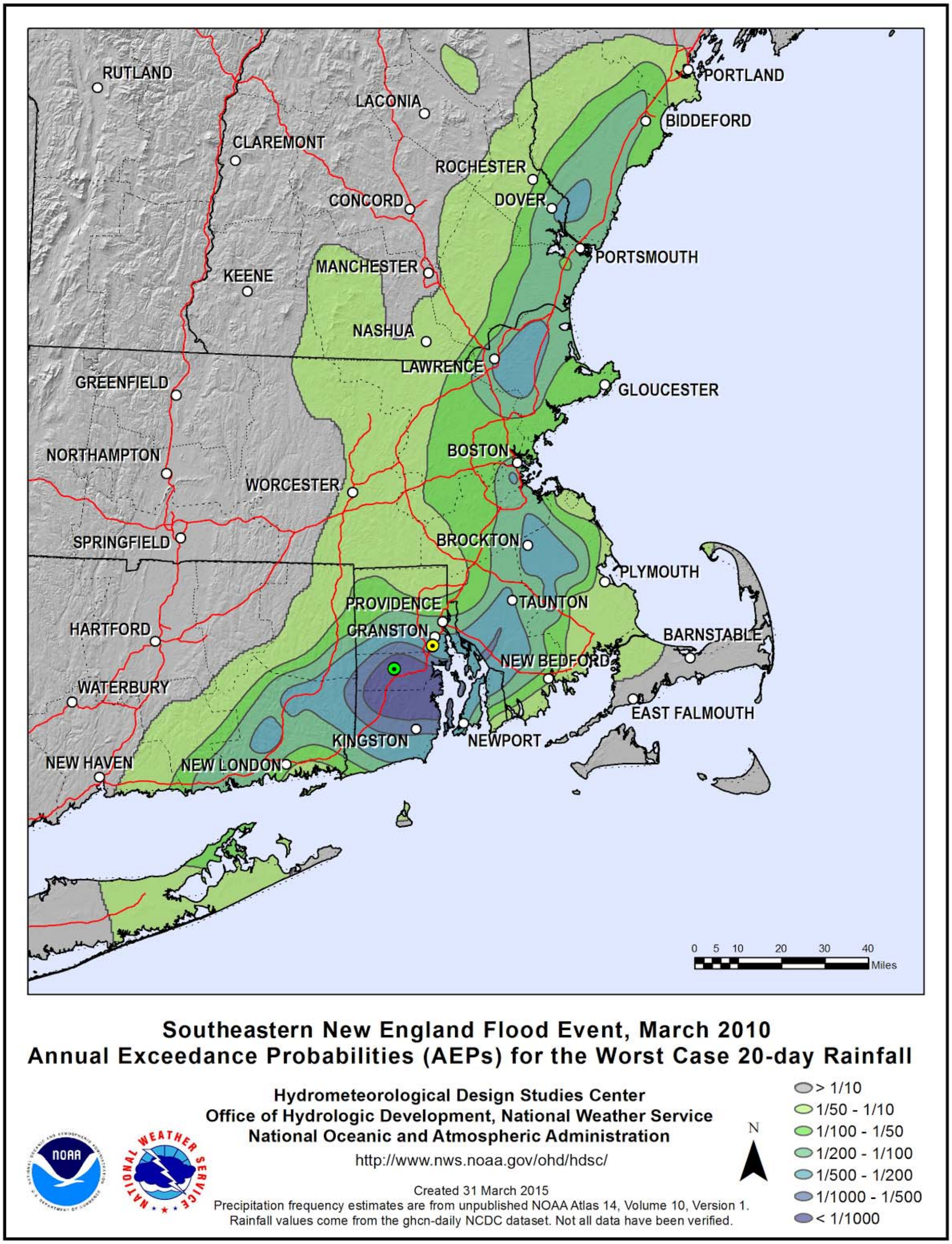

Figure 5. Annual exceedance probabilities for the worst case 20-day rainfall for the Southeastern New England rainfall events that occurred during March 2010.