HYDROMETEOROLOGICAL DESIGN STUDIES CENTER QUARTERLY PROGRESS REPORT

1 July 2007 to 30 September 2007

Office of Hydrologic Development

U.S. National Weather Service

National Oceanic and Atmospheric Administration

Silver Spring, Maryland

October 2007

DISCLAIMER

The data and information presented in this report are provided only to demonstrate current progress on the various technical 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 purpose other than for what it was intended does so at their own risk.

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I. INTRODUCTION

The Hydrometeorological Design Studies Center (HDSC) within the Office of Hydrologic Development of NOAA's National Weather Service is updating precipitation frequency estimates for various parts of the United States. Updated precipitation frequency estimates for durations from 5 minutes to 60 days and selected average recurrence intervals accompanied by additional information (e.g., 90% confidence intervals, temporal distributions, seasonality) are published in NOAA Atlas 14. The Atlas is divided into volumes based on geographic sections of the country. Each volume is published on the HDSC web site using the existing Precipitation Frequency Data Server (http://www.nws.noaa.gov/ohd/hdsc) with interactive web pages and with the ability to download digital files.

In addition, HDSC is developing Areal Reduction Factors (ARFs) for area sizes up to 400 square miles and durations of 30-minutes to 96-hours for the United States. The results of this supplementary study will be applicable to all volumes of NOAA Atlas 14.

II. CURRENT PROJECTS

1. PRECIPITATION FREQUENCY FOR HAWAII

1.1. PROGRESS IN THIS REPORTING PERIOD

1.1.1. Data

a. Quality control

At some daily stations from NCDC's TD3206 (pre-1949) daily dataset, days with zero precipitation were erroneously recorded as missing. After verifying the daily records against scanned observation forms on NOAA's Web Search Store Retrieve Display (WSSRD) website, software was written to automatically correct the error. Additional work is required to ensure that all cases are properly corrected.

b. Series extraction

During the past quarter, HDSC solicited opinions from key collaborators regarding the use of water year (October through September) versus calendar year (January through December) in extracting annual maximum series (AMS) data. The majority of those who responded to our survey were in favor of water year. Calendar year was used in all previous studies done by the NWS, including the first three volumes of NOAA Atlas 14 (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_docs.html). Although an in-house study showed no significant differences in precipitation frequency estimates, based on survey responses we decided to extract new AMS using the water year concept.

An evaluation of current annual maximum series suggested that the rules for extraction currently in place were not sufficient to accommodate the significant number of precipitation data recorded as accumulations for durations of 2 or more days. To ensure that only "true" maxima are extracted from the datasets, and that at the same time potentially valuable information is kept in records, HDSC is altering existing criteria for AMS extraction. Various data quality codes are assigned to accepted and rejected maxima to assist in assessing the resulting AMS. Software has been written and debugging is underway.

c. Miscellaneous corrections

HDSC is currently investigating inconsistencies in annual maxima between co-located and/or nearby stations. For example, daily annual maximum series extracted from State stations (which are hand-entered monthly maximums) and very nearby daily NCDC stations are very different for several locations. Similarly, a comparison of mean annual maxima from six co-located Hydronet and NCDC hourly stations indicated that annual maximum series data extracted from Hydronet stations are consistently lower than corresponding data extracted from longer NCDC records. Hydronet stations, which have less than 15 years of record, at those locations will not be used in the frequency analysis, however, they may be used to help derive the n-minute ratios.

1.1.2. Regionalization

The regionalization approach that made use of built-in GRASS GIS clustering functions to define preliminary homogeneous regions for the 24-hour and 1-hour AMS data is under review. In this approach, Ward cluster algorithm was used with interpolated grids of three attribute variables (mean annual maximum, mean annual precipitation and maximum observed) to produce initial regions. An approach based on at-site characteristics only will be compared. The following attribute variables will be investigated: latitude, longitude, elevation, aspect and mean annual precipitation (MAP). Although MAP is not exactly an at-site characteristic, it is generally accepted that it could be estimated with confidence at locations where no precipitation records are available. Also, for the Hawaiian Islands, it was found that MAP is highly correlated with the mean annual maximum data (correlation coefficient of 0.86), and therefore potentially very useful for this analysis. Regions will be finalized in the next quarter.

1.1.3. Determination and testing of trends

Preliminary annual maximum series and partial duration series were examined for trends. An at-site type of trend analysis was done on AMS, and regional detection of trends was performed on partial duration (peak-over-threshold) series.

Both non-parametric and parametric tests at the 5% significance level were used on AMS to test hypothesis that no trends exist. 274 daily sites and 53 hourly sites that had at least 30 years of AMS data were tested. Nonparametric statistical tests were used because they don't depend on distribution type and could be performed without specifying whether trend is linear or nonlinear. Two non-parametric tests were used in this study: Mann-Kendal test and Spearman-Conley test. Both tests indicated no trends in AMS in at least 70% of daily and hourly sites. On average, there were approximately twice as many sites where negative trends were detected than positive. No regional patterns were found. The parametric Student t-test detected statistically significant positive or negative linear trends in AMS in less than 5% of sites for both hourly and daily AMS. Analysis showed that there was almost no change in precipitation quantiles if trends were removed. Consequently, AMS time series will not be altered for this project.

We also looked at a number of 1-day events that exceeded selected threshold levels for each of the preliminary homogeneous regions used in the frequency analysis. The analysis did not indicate an increase or decrease in the frequency of very heavy precipitation in time.

1.2. PROBLEMS/CONCERNS

There will be a delay in reaching the peer review phase of the project for two reasons. 1) The extraction of annual maximum series data is being revised, particularly since HDSC decided to adopt a water year approach. Also, data quality control procedures indicated errors in NCDC datasets and numerous inconsistencies in co-located/nearby stations obtained from different sources. 2) Mean annual maxima for 24-hour and 60-minute will have to be submitted to Oregon State University's PRISM Group who will create corresponding gridded estimates at 800m resolution and the contract procurement for a spatial interpolation task has required more time than anticipated.

1.3. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD

1.3.1. AMS extraction

The newly developed criteria for extracting annual maximum series will be implemented for different durations and evaluated. Consistency in annual maxima from one duration to the next for a given year at a station will be also be checked.

1.3.2. Intersite independence in AMS data

Intersite dependence will be investigated for 1-day AMS data. Cases where annual maxima overlap (+/- 1 day) at nearby stations will be tested for independence using common statistical tests.

1.3.3. Regionalization and frequency analysis for 1-hr and 24-hr AMS

Existing GRASS GIS clustering functions and newly developed MATLAB codes will be used to investigate how sensitive the clustering approach is to number of clusters, different clustering algorithms, choice of attribute variables, and assignment of weights to each variable. The results will be compared and statistical tests will be applied to evaluate homogeneity of defined regions. The regions will be finalized during the next quarter and evaluated for longer duration data. In addition, frequency distribution for daily and longer duration data will be selected for each region.

1.3.4. Development of PRISM grids for 1-hr and 24-hr mean annual maxima

HDSC will submit point 24-hour and 60-minute mean annual maximum data to Oregon State University's PRISM Group to create corresponding gridded estimates at 800m resolution. Those grids will be used to develop preliminary maps for 100-year precipitation frequency estimates that will be then submitted for a Peer Review.

1.4. PROJECTED SCHEDULE

Data quality control [November 2007]

Regionalization and frequency analysis for 1-hr and 24-hr AMS [December 2007]

Development of precipitation frequency grids (1-hr & 24-hr) based on PRISM deliverables [January 2007]

Peer review of estimates [February 2008]

Regionalization and frequency analysis for other durations [February 2008]

Development of precip. frequency grids (all durations) based on PRISM deliverables [April 2008]

Remaining tasks and web publication [June 2008]

2. PRECIPITATION FREQUENCY FOR REMAINDER OF CALIFORNIA

2.1. PROGRESS IN THIS REPORTING PERIOD

HDSC has completed collecting all available daily, hourly, 15-minute, and 5-minute precipitation data for the project area. The project area encompasses the part of California that was not covered in NOAA Atlas 14 Volume 1. It also includes parts of southern California, south Oregon and west Nevada as a buffer zone to accommodate regionalization and smooth spatial transition.

Daily and hourly data from the National Climatic Data Center (NCDC), hourly data from the Remote Automated Weather Station (RAWS) Network and daily data from the SNOpack TELemetry (SNOTEL) network have been downloaded. In addition, we have collected various datasets from local contacts (Table 2.a).

Table 2.a. List of local data sources, data types (where type of data can be monthly (Mly), daily (Dly) , hourly (Hly), 15-minute, 5-minute, or ALERT) is given in the following table. ALERT data are Automated Local Evaluation in Real Time gauges that measure precipitation using tipping buckets in increments of 0.04mm.

Contact	Data Type	Quality Control	Format
U.S. Army Corps of Engineers, Sacramento District	Dly, Hly	Some	ASCII Text
Jim Goodridge, Retired State Climatologist	Dly, Hly	Some	ASCII Text
Ventura County Watershed Protection District	5-min	Good	ASCII Text
LA County Dept. of Public Works	Dly	Good	ASCII Text
California Nevada River Forecast Center	ALERT	Good	ASCII Text
County of San Diego Flood Control	ALERT	None	Micr. Access
County of San Diego Flood Control	Mly, Dly, Hly, 5-min	Good	Micr. Access
Riverside County Flood Control District	5-min	Good	ASCII Text
California Dept. of Parks and Recreation	ALERT	Some	ASCII Text
Metro Flood Control District, Fresno	Hly,15-min	Good	ASCII Text
Santa Barbara County Flood Control District	Dly, Hly, 5-min	Good	ASCII Text
CA Department of Water Resources, Division of Flood Management	Dly, Hly	Some	ASCII Text

HDSC has begun reviewing the datasets. Two datasets were converted into more accessible formats: daily and hourly data obtained from retired State Climatologist, Jim Goodridge and the County of San Diego Flood Control District’s ALERT data. Metadata and remarks have been extracted for data from five datasets: the U.S. Army Corps of Engineers, Metro Flood Control District in Fresno, Santa Barbara County Flood Control District, Los

Angeles Department of Public Works, and Ventura County Watershed Protection District. Possibly erroneous latitude and longitude information for several NCDC stations were reviewed.

2.2. PROBLEMS/CONCERNS

The formal agreement between HDSC and the California Department of Water Resources for this project is delayed. Once this is resolved, work can fully commence. Resolution is anticipated by November 2007.

2.3. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD

HDSC will compile metadata for each station and evaluate any data overlap, in which case we will use the dataset that has undergone the most quality control. We will format and prepare the data for quality control and begin a check of extreme values exceeding thresholds for the 1-day and 1-hour data.

2.4. PROJECTED SCHEDULE

Data quality control [March 2008]

Regionalization and frequency analysis for 1-hr and 24-hr AMS [April 2008]

Development of precip. frequency grids (1-hr & 24-hr) based on PRISM deliverables [June 2008]

Peer review of estimates [August 2008]

Regionalization and frequency analysis for other durations [September 2008]

Development of precip. frequency grids (all durations) based on PRISM deliverables [November 2008]

Remaining tasks and web publication [December 2008]

3. AREAL REDUCTION FACTORS

3.1. PROGRESS IN THIS REPORTING PERIOD

HDSC is developing geographically-fixed areal reduction factors that can be used to convert point precipitation frequency estimates into corresponding areal estimates in the United States. Suggested methodology utilizes recorded rainfall depths at dense area rain gauge networks to empirically derive ARFs. For a given ARI, rainfall duration and area size, the ARF is defined as a ratio of point depth and areal depth with same ARIs. Although straightforward, the method relies on accurate areal estimates (at various area sizes) which is challenging to establish without sufficiently dense and evenly distributed network of precipitation gauging stations. Although we have identified nearly 20 potentially adequate networks across the U.S., many of them still have some limitations in terms of either gauge density or gauge placement. That could potentially have a significant effect on accuracy of areal estimates. We are currently looking into different approaches to minimize the limitations of each potential ARF network.

3.2. PROJECTED ACTIVITIES FOR THE NEXT REPORTING PERIOD

To address the limitations of the gauge-based ARF analysis, the HDSC ARF team is looking into different approaches to minimize the limitations of each potential ARF network. We will also initiate a pilot study to evaluate the use of radar-estimated precipitation grids for computing ARFs. The pilot study will be for the Louisville, KY network, which has overlapping observed gauge data and radar data. Gauge-based and radar-based ARFs will be evaluated and compared, hence providing us grounds for making decisions on the final ARF computation approach.

In support of this study, the acquisition, decoding and reformatting of radar-estimated precipitation is taking place. Stage IV radar-estimated precipitation grids have been acquired and reformatted for the period 2002 through present. Since Stage IV data isn't available prior to 2002, the acquisition of Stage III radar-estimated precipitation data the period 1996-2001 is underway.

3.3. PROJECTED SCHEDULE

Data collection and quality control [December 2007]

Comparison of gauge-based and radar-based ARF approaches. Selection of the ARF computational approach [May2007]

Calculation of geographically-fixed ARFs [July 2008]

Peer review [August 2008]

Web publication [October 2008]

III. OTHER

HDSC participated in a teleconference with climate change scientists organized by Tom Karl, Director, National Climatic Data Center, to determine the potential impacts of observed and projected changes in extreme precipitation on our ongoing work to produce up-to-date estimates of precipitation frequency throughout the Nation. It was determined that HDSC should continue with our precipitation frequency studies under the assumption of a stationary climate. It appears that the potential impact of climate change on precipitation frequency may be small over the next 30-50 years in relation to the uncertainty of the climate change predictions. NCDC will sponsor additional research efforts to better refine our understanding.

HDSC also hosted a visit by Doerte Jakob from the Australian Bureau of Meteorology who is the technical lead on similar precipitation frequency analysis work. Our discussions identified new approaches that we will evaluate on U.S. data as well as our approaches that they will evaluate in Australia.