HAWAII PRECIPITATION FREQUENCY PROJECT

Update of *Technical Paper No. 43*

Eighth Progress Report
1 January through 31 March 2003

Hydrometeorological Design Studies Center
Hydrology Laboratory

Office of Hydrologic Development
U.S. National Weather Service
National Oceanic and Atmospheric Administration
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DISCLAIMER

The data and information presented in this report should be considered as preliminary and are provided only to demonstrate current progress on the various technical tasks associated with this project. 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.

TABLE OF CONTENTS

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1. Introduction

The Hydrometeorological Design Studies Center (HDSC), Hydrology Laboratory, Office of Hydrologic Development, U.S. National Weather Service is updating its precipitation frequency estimates for Hawaii. Current precipitation frequency estimates for Hawaii are contained in *Technical Paper No. 43,* "Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (U.S. Weather Bureau 1962). The update includes collecting data and performing quality control, compiling and formatting datasets for analyses, selecting applicable frequency distributions and fitting techniques, analyzing data, mapping and preparing reports and other documentation.

The Project will determine annual precipitation frequencies for durations from 5 minutes to 60 days, for return periods from 2 to 1000 years. The Project will review and process all available rainfall data for the Project area and use accepted statistical methods. The Project results will be published as a Volume of NOAA Atlas 14 on the internet using web pages with the ability to download digital files.

The Project area covers the Hawaiian islands including Hawaii, Maui, Lanai, Molokai, Oahu, and Kauai. The Project area including preliminary regions is shown in Figure 1.

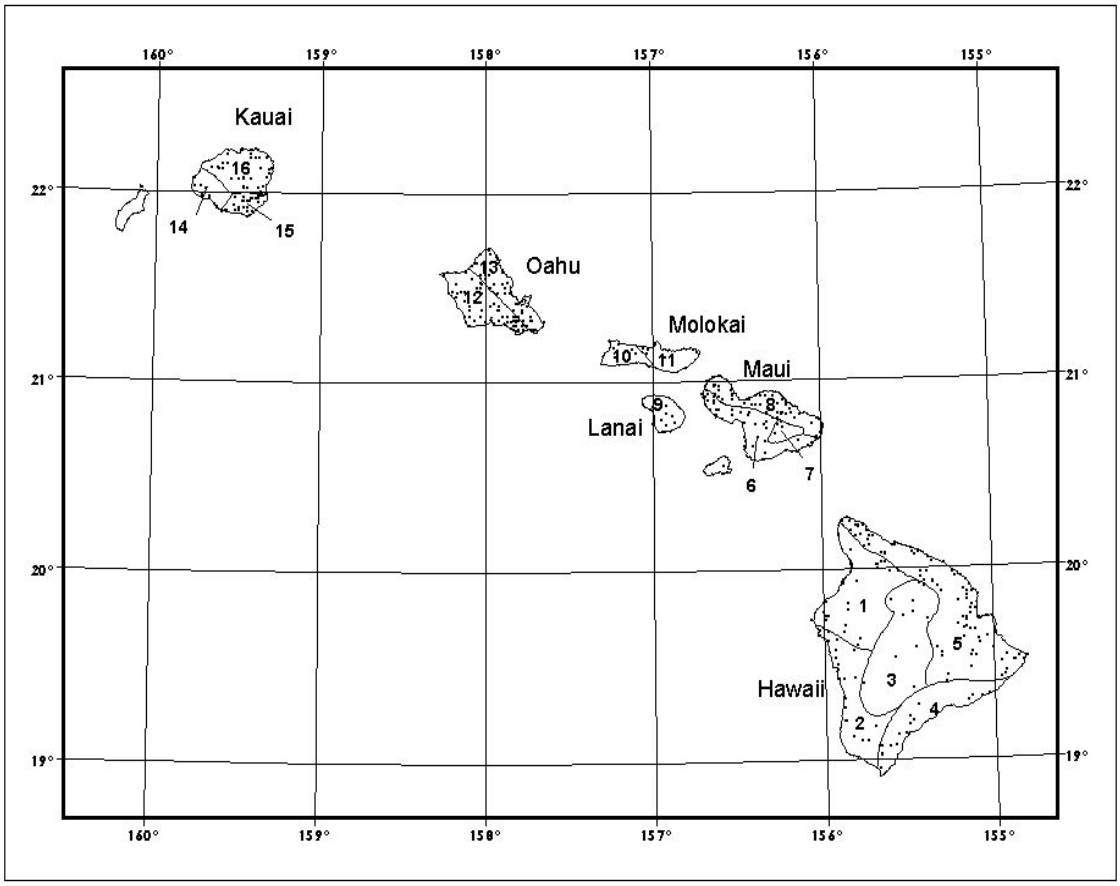

Figure 1. Hawaii Precipitation Frequency Project area, regional divisions and daily station locations.

2. Highlights

Data entry of monthly maximums from daily gages maintained by the State continues by the University of Hawaii. HDSC received data from the University for the City and County of Honolulu during the reporting period. Additional information on this subject is available in Section 4.1, Data Collection and Quality Control.

Software to compute multi-day duration return frequencies was refined to accommodate different numbers of stations and to insure internal consistency between 24-hour and 48-hour durations. Software to calculate confidence limits for all durations and frequencies was refined. Additional information is provided in Section 4.2, Software Updates.

The Cascade, Residual Add-back (CRAB) procedure has been fully tested and optimized. This will allow for quick production of final precipitation frequency maps from spatially interpolated mean annual maxima grids. Additional information is provided in Section 4.3, Spatial Interpolation.

The Precipitation Frequency Data Server is now operating at much faster speeds and is nearly ready for public release with the Semiarid Southwestern United States Precipitation Frequency Project. Additional information is provided in Section 4.4, Precipitation Frequency Data Server.

Progress toward the development of depth-area-duration (D-A-D) reduction relationships for areas from 10 to 400 square miles continues. An additional area in Hawaii has been added to the project. The possibility of including a dense area raingage network area in Puerto Rico is being considered. Additional information is provided in Section 4.5, Spatial Relations (Depth Area Duration Project).

3. Status

3.1 Project Task List.

The following checklist shows the components of each task and an estimate of the percentage completed per task. Past status reports should also be referenced for additional information.

Hawaii Project checklist [estimated percent complete]:

Data Collection, Formatting and Quality Control [30%]:

- Multi-Day
- Daily
- Hourly
- 15-minute
- N-minute

The University of Hawaii will continue digitizing daily data from a network of state operated gages. Once this data is added to our data set the number of daily stations will greatly increase. The University will enter monthly maximums of daily data.

L-Moment Analysis/Frequency Distribution for 5 minute to 60 days and 2 to 1000 years [0%]:

- Multi-Day
- Daily
- Hourly
- 15-minute
- N-minute

Software to produce the precipitation frequency estimates and associated confidence limits and adjust both for internal consistency has been refined.

Spatial Interpolation [0%]

- Create mean annual maximum (a.k.a. "index flood") grids with PRISM for all durations from 60-minute to 60-days.
- Apply a precipitation frequency map derivation procedure, known as the cascade residual add-back (CRAB) procedure to create a total of 162 grids. The same procedure will be used to create 162 upper and 162 lower bound precipitation frequency grids. (See 4.6, Spatial Interpolation for more details.)
- Apply Project-wide conversion factor to the 1-hour precipitation frequency grids to calculate the n-minute (5-, 10-, 15-, and 30-minute) grids.

The CRAB procedure has been fully tested and optimized.

Peer Reviews [0%]:
- External peer review of point precipitation frequency estimates
- External peer review of spatial interpolation grids

Data Trend Analysis [0%]
- Analyze linear trends in annual maxima and variance over time
- Analyze shift in means of annual maxima between two time periods (i.e., test the equality of 2 population distribution means)

Temporal Distributions of Extreme Rainfall [0%]
- Assemble hourly data by quartile of greatest precipitation amount and convert to cumulative rainfall amounts for each region
- Sort, average and plot time distributions of hourly maximum events by storm area, quartile and duration

Deliverables [20%]
- Prepare data for web delivery
- Prepare documentation for web delivery
- Write hard copy of Final Report
- Publish hard copy of Final Report

A detailed outline of the final documentation is complete for the Semiarid Project requiring only minor modification for the Hawaii Project. Minor modifications have been made to the Precipitation Data Frequency Server (PFDS) to accommodate the other projects.

Spatial Relations (Depth Area Duration Project) [67%]
- Obtain hourly data from dense-area reporting networks
- QC and format data from dense networks
- Compute maximum and average annual areal depth for each duration from stations for each network
- Compute maximum to average depth ratio for all durations and networks and plot
- Prepare curves of best fit (depth area curves) for each duration and network
- Combine all stations from all Project areas to compute the ratio of maximum to average depth for all durations and networks and plot
- Examine differences in individual D-A-D curve plots for durations and Project areas compared to those for combined Project area data plots

The D-A-D project is 2/3 completed. All areas to be used and tested in the D-A-D curve development have been selected and quality controlled. Software development to process the data and ultimately generate the D-A-D curves is 60% completed.

4. Progress in this Reporting Period

4.1 Data Collection and Quality Control.

HDSC received the hand entered digital rainfall data from the University of Hawaii for the City and County of Honolulu during the last quarter. The University began to hand enter State rainfall gage data for Kauai as well.

4.2 Software Updates

Minor inconsistencies were found in the Semiarid Project's daily and multi-day results that related to our automated processes. The inconsistencies typically occurred between 24-hour and 48-hour durations (i.e., the 24-hour estimate was greater than the 48-hour estimate). In all projects, 24-hour estimates are calculated from a combined dataset of hourly stations and daily stations. Multi-day durations are calculated from daily stations only. Therefore, it was necessary to modify the multi-day internal consistency software to accommodate the different number of stations between 24-hour and 48-hour. This modification eliminated all observed inconsistencies.

Other instances where there are a different number of stations at different durations may occur when the number of years of data at a station drops below the acceptable number of data years. Possible reasons for this drop may include:

1. The station has hand-entered monthly maximums resulting in 24-hour values only. Longer durations cannot be derived.
2. At a given station, a year does not have enough data to reliably extract an annual maximum for a given duration, but an observed value of that duration (usually 24-hour or 48-hour) exceeds a certain threshold and is therefore considered the maximum for that year.
3. There is not enough data to extract the longer durations such as 30-day and longer but there was enough data for shorter durations.

As mentioned, the existing internal consistency software is unable to accommodate different numbers of stations between durations. Therefore, to retain as much data as possible, the software will be modified to allow different numbers of stations at all durations. Each station where a discrepancy occurs will be flagged and checked for data quality.

Finally, software to calculate confidence limits for all durations and frequencies was refined. An internal consistency check was built in to the software.

4.3 Spatial Interpolation

HDSC received the final mean annual maxima (a.k.a. “index flood”) grids for the Semiarid Southwest for all durations (60-minute through 60-day) from the Spatial Climate Analysis Service (SCAS) at Oregon State University . This major milestone allowed HDSC to fully test and optimize the Cascade, Residual Add-back (CRAB) procedure. The CRAB procedure derives the precipitation frequency grids from the “index flood” grids and frequency distribution parameters. This will allow for quick production of final precipitation frequency maps for the Hawaii project.

4.4 Precipitation Frequency Data Server (PFDS)

Last quarter the available disk space for the PFDS computer server was increased to 30 gigabytes, but the access speed to the expanded disk was hindered by a slow network connection. This quarter the slow connection was resolved by moving the PFDS computer server to a faster internal network. The PFDS is now operating at much faster speeds. Minor modifications have been made to the PFDS to accommodate the Hawaii project.

4.5 Spatial Relations (Depth-Area-Duration Project)

Progress continues in the development of geographically-fixed depth-area-duration (D-A-D) reduction relationships for area sizes of 10 to 400 square miles. The second phase of the programming to relate spatial relationships in precipitation data used in the development of the D-A-D curves is nearly complete and will be tested in April 2003 on two areas.

The purpose of the programming is to generate statistics that measure the variability in the annual maximum for a given duration in a given area or basin. Means and standard deviations among groups of five stations, normalized to the distance between stations, are computed. Mean areal depths (using annual maximum precipitation) in a basin are generated, in order to ultimately compute the ratios of mean annual maximum amounts at stations to the mean areal annual maximum. To quality check the software, data from an earlier study (NOAA Technical Report NWS 24, using this D-A-D development approach) is being duplicated to verify that the same statistics are being generated using our software development. This is the last major software development for the project.

An additional area in Hawaii has been added to the project. The possibility of including a dense area raingage network in Puerto Rico is being considered. A total of 13 different geographic areas throughout the United States have been quality controlled and will be used in the project. The set of curves developed for each area will be tested

for differences to determine if a single set of D-A-D curves is applicable to the entire U.S. Otherwise, separate curves for different regions of the country will be developed.

5. Projected Schedule.

The following list provides a tentative schedule with completion dates. Brief descriptions of tasks being worked on next quarter are also included in this section. The University of Hawaii Digitizing completion date is indicated as Month Zero (M_0).

Data Collection and Quality Control [M_0 + 3 months]
Trend Analysis [M_0 + 4 months]
L-Moment Analysis/Frequency Distribution [M_0 + 5 months]
Peer Review of Point Estimates [M_0 + 7 months]
Temporal Distributions of Extreme Rainfall [M_0 + 8 months]
Spatial Interpolation [M_0 + 10 months]
Precipitation Frequency Maps [M_0 + 11 months]
Web Publication [M_0 + 11 months]
Spatial Relations (Depth Area Duration Studies) [May 2003]

We expect to be able to obtain NCDC data through 2002 and then start the quality control and testing of the regionalization on an island by island basis as complete data sets are assembled. The estimation of the appropriate probability distribution functions and the parameterization of these functions as well as the spatial interpolation steps will be done for all islands as a group to ensure consistency in this part of the process.

5.1 Data Collection and Quality Control.

During the next quarter the University of Hawaii will continue to hand enter monthly maximums from daily rain gages maintained by the State of Hawaii into a digital format for the island of Kauai. The University expects the data entry to be completed by June 2003.

5.2 Spatial Relations (Depth Area Duration Project)

Software for the D-A-D computations will be completed in the next quarter and the computations will be performed for at least 13 areas, and the resulting curves will be tested for differences to determine if a single set of D-A-D curves is applicable to the entire U.S. or whether curves vary by region.

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