

PRISM PRECIPITATION DATA

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DESIGN DOCUMENT OVERVIEW

Design documents are a series of technical papers addressing specific design topics on the Eastern Snake Plain Aquifer Model (ESPAM) Enhancement Project. Each design document will contain the following information: topic of the design document, how that topic fits into the whole project, which design alternatives were considered and which design alternative is proposed. In draft form, design documents are used to present proposed designs to reviewers. Reviewers are encouraged to submit suggested alternatives and comments to the design document. Reviewers include all members of the Eastern Snake Hydrologic Modeling (ESHM) Committee as well as selected experts outside of the committee. The design document author will consider all suggestions from reviewers, update the draft design document, and submit the design document to the ESPAM Enhancement Program Manager. The Program Manager will make a final decision regarding the technical design of the described component. The author will modify the design document and publish the document in its final form in .pdf format on the ESPAM Enhancement web site.

The goal of a draft design document is to allow all of the technical groups interested in the design of the ESPAM Enhancement Project to voice opinions on the upgrade design. The final design document serves the purpose of documenting the final design decision. Once the final design document has been published for a specific topic, that topic will no longer be open for reviewer comment. Many of the topics addressed in design documents are subjective in nature. It is acknowledged that some design decisions will be controversial. The goal of the Program Manager and the modeling team is to deliver a well-documented, defensible model, which is as technically representative of the physical system as possible, given the practical constraints of time, funding and manpower. Through the mechanism of design documents, complicated design decisions will be finalized and documented.

Final model documentation will include all of the design documents, edited to ensure that the “as-built” condition is appropriately represented.

INTRODUCTION

Precipitation is one component of recharge to the eastern Snake Plain Aquifer. While not the largest component of recharge to the system, it is a significant component that is associated with much uncertainty in the recharge calculation. Precipitation data are used in the ESPAM model in two ways: as the base data for calculating recharge to the aquifer on non-irrigated lands, and as one of several attributes used to calculate recharge to the aquifer on irrigated lands.

Precipitation data are needed for the study period years of 1980 to 2002. Three sources of data were considered for use in the model. One source is available for the entire study period, but limited in monitoring stations. Another source is available from

1980 to 1997, but data are not available in a timely manner for the years 1998 to 2002. The third source of data is available for limited years during the study period, and also has limited coverage of monitoring stations over the study area.

This paper summarizes the three available sources of precipitation data and describes the two precipitation datasets that were selected for calculating the recharge budget for the ESPAM Enhancement Project.

AVAILABLE DATA SOURCES

Three primary sources of precipitation data were considered for use in the recharge budget for the ESPAM Enhancement Project. The first of these three data sources is AgriMet data. AgriMet, a conjunction of the words “agricultural” and “meteorology”, is a satellite-based network of automated agricultural weather stations operated and maintained by the U.S. Bureau of Reclamation. There are fewer than ten AgriMet stations within the ESPAM study area, many of which have available data dating only as far back as the late 1980’s and 1990’s. Due to the sparse coverage of data stations within the model boundary and the unavailability of data for much of the study period, AgriMet precipitation data are not used for the ESPAM enhancement project.

NOAA, National Oceanic and Atmospheric Administration, data are another source for precipitation datasets. NOAA precipitation data are available for the entire ESPAM study period, however the spatial coverage of NOAA stations over the study area is limited.

The third considered source of data is PRISM precipitation data. PRISM (Parameter-elevation Regressions on Independent Slopes Model) uses point data, a digital elevation model, and other spatial data sets to generate gridded estimates of several spatial and temporal climatic parameters, including precipitation. These data are available for 1980 to 1997, but not available for 1998 to 2002.

PRISM data are the preferred precipitation data for use in model calibration due to the dense coverage of gridded data and the acceptance of the PRISM analytical tool in the meteorological community. However, because precipitation data are necessary for model calibration for the period 1980 to 2002 and PRISM data are available only from 1980 to 1997, another data source is necessary for the remaining years of the model calibration period, 1998 to 2002. To accommodate this necessity, PRISM data were obtained and processed for the years 1980 to 1997, and NOAA data were obtained and processed to a format consistent with the PRISM data format for the years 1998 to 2002.

PRISM DESCRIPTION

A collaborative effort between the Spatial Climate Analysis Service and the Oregon Climate Service has resulted in detailed, high-quality spatial climate datasets, referred to

as PRISM maps (Daly and Taylor, 1998). PRISM is an analytical model that distributes point measurements of monthly, seasonal, and annual precipitation to a geographic grid of four kilometers by four kilometers. By use of a resampling algorithm, two-kilometer by two-kilometer resolution grids can be estimated. These grids are produced in a GIS-compatible latitude-longitude grid or a gridded map projection.

Digital elevation models (DEMs) are used in conjunction with observed precipitation values in the PRISM model to determine variation in precipitation as a function of elevation. DEMs contain information that describes the earth's topography, including slope, aspect, and elevation. Because the PRISM precipitation dataset is a function of the observed data and topography, orographic precipitation and rain shadows are uniquely and accurately modeled in PRISM (Daly and Taylor, 1998).

Three existing climate datasets are used by PRISM to create maps: the National Climatic Data Center 1961-1990 normals dataset (CLIM-81) observed by the National Weather Service Cooperative Climate Network; the NRCS SNOTEL (SNOWpack TELEmetry) network dataset, and supplemental datasets submitted by the individual State Climatologists or regional climate centers (Daly and Taylor, 1998).

The PRISM Evaluation Group (PEG), composed of State and Regional Climatologists, representatives of national agencies, NRCS representatives and other state and local government users, evaluated and endorsed the PRISM model for Idaho, Nevada, Oregon, and Utah data (Daly and Taylor, 1998). An examination of average annual PRISM precipitation values in the Willamette River basin, northern Oregon, resulted in 0.1 cm (1.0 percent of observation) cross validation bias and 17 cm (10 percent of observation) mean absolute error (Daly et al., 1994).

PRISM is designed and updated to map climate parameters in varying terrains, including high mountains, rain shadows, coastal regions, and other complex climatic regimes. PRISM accounts for topographic facet (hill slope orientation) to handle rain shadows, and for elevation, a primary driver of climate patterns (Daly et al., 1998). Two main advantages of using PRISM data are that precipitation values are available on a regular grid size of four kilometers by four kilometers, and the data are available in digital form. These two factors allow PRISM data to be easily integrated with other water budget components and calculations within a Geographic Information System (GIS) environment.

DATA PROCESSING: PRISM

PRISM precipitation data were downloaded from an ftp site (<ftp://ftp1.ncdc.noaa.gov/pub/data/prism100/>) for the years 1980 to 1997, on a two-kilometer by two-kilometer grid scale covering the entire continental United States. A total of 247 ASCII files were downloaded and unzipped using a batch file. Because a very small window of the entire United States dataset was needed, clipping of the data to the

study area was completed as an initial step. These clipped data were then projected in a two-step projection process from their native projection of WGS72 to the transverse-mercator projection IDTM NAD 27. Once in IDTM NAD 27 projection, the data were converted to floating point grids in order to convert from the native units of millimetersx100 to decimal feet. The end product of data processing resulted in precipitation data in units of decimal feet, for an area that completely contains the ESPAM model boundary and its tributary basins. Final data are available in a GIS format for both monthly and annual totals for the years 1979 to 1997.

DATA PROCESSING: NOAA

Precipitation data for the years 1998 to 2002 were purchased from NOAA (<http://lwf.ncdc.noaa.gov/oa/ncdc.html>) for all NOAA stations on the eastern Snake River Plain. These data series include precipitation values, in inches, and the departure from normal values, in inches.

In order to maintain precipitation data consistency over the entire 22-year study period, 1998 to 2002 NOAA data were processed with 30-year average PRISM data to achieve consistent data formatting with the PRISM two-kilometer by two-kilometer grids for each monthly precipitation map. This 1998 to 2002 NOAA processed dataset was then used to supplement the 1980 to 1997 PRISM dataset. A detailed description of the NOAA data processing follows.

Using the NOAA departures from normal values and the NOAA monthly actual precipitation values, a normal for each NOAA station was calculated. Then, actual precipitation as a fraction of the normal was calculated for each NOAA station. This resulted in a multiplier which, when multiplied by the normal value, gave the actual NOAA precipitation value. A set of multipliers was calculated for each month for the timeframe of January 1998 to April 2002.

The NOAA multipliers were applied to the PRISM 30-year average monthly precipitation data using ArcView 3.2. The multiplier datasets were processed with the PRISM data to create a “multiplier raster” (raster data contain spatial information on a regular grid).

For each month of the 1998 to 2002 NOAA data, ArcView 3.2 was used to query for stations containing data for the month of interest. The software was then used to interpolate a raster grid, using the software options: interpolate to grid, inverse distance weighting, and nearest neighbor sampling. Specifically, twelve points and a weight of three were used. The resulting raster grid was named the “multiplier raster”. Kriging was one considered data processing method, but because kriging cannot be performed in ArcView 3.2, inverse distance weighting was used instead. Due to the relatively flat topography of the study area, the inverse distance weighting algorithm should be adequate (Allen, 2003). The multiplier rasters were multiplied by the 30-year average

PRISM raster for each month of interest, and converted to units of decimal feet. This resulted in “pseudo-PRISM” data for the period from January 1998 to April 2002.

DESIGN DECISION

Monthly and annual PRISM precipitation data for the study period 1980 to 1997 were obtained from the Spatial Climate Analysis Service and the Oregon Climate Service. Data for the period of January 1998 to April 2002 were obtained through processing of NOAA precipitation data in conjunction with 30-year average PRISM monthly precipitation data. NOAA departures of normal data and observed data were used to assimilate “multiplier rasters” that were then multiplied by PRISM 30-year average data for each month of this latter study period. This created “pseudo-PRISM” data for the remaining period during which actual PRISM precipitation data were not available.

REFERENCES

- Allen, R., 2003. Personal communication. Kimberly Research and Extension Center, University of Idaho.
- Daly, C., R.P. Neilson, and D.L. Phillips, 1994. A statistical-topographic model for mapping climatological precipitation over mountainous terrain. *J. Appl. Meteor.*, 33, 140-158.
- Daly, C. and G. Taylor, 1998. PRISM Briefing Book and Questionnaire, A Description of the PRISM Model for Spatially Distributing Observed Precipitation. Natural Resources Conservation Service Water and Climate Center and Oregon Climate Service, Oregon State University. (http://www.ocs.orst.edu/prism/nrcs_brief.html)
- Daly, C., G.H. Taylor, W.P. Gibson, T. Parzybok, G.L. Johnson, and P.A. Pasteris, 1998. Development of High-Quality Spatial Climate Datasets for the United States. Presented at First International Conference on Geospatial Information in Agriculture and Forestry, Lake Buena Vista, FL, June 1-3, 1998.

APPENDIX 1

PRISM Data Processing Description and File Naming Convention

PRISM FILE NAMING CONVENTION

PRISM file names, as downloaded:

The naming convention for the downloaded data files describes both the year and the month, or the year and the annual total:

Example:

| | |
|-------------------|--|
| us_ppt_1980.01.gz | January, 1980 PRISM ASCII file for continental United States |
| us_ppt_1980.02.gz | February, 1980 PRISM ASCII file for continental United States |
| us_ppt_1980.03.gz | March, 1980 PRISM ASCII file for continental United States |
| . | . |
| . | . |
| . | . |
| us_ppt_1980.12.gz | December, 1980 PRISM ASCII file for continental United States |
| us_ppt_1980.14.gz | 1980 annual total PRISM ASCII file for continental United States |

etc.

PRISM file names, after processing (these are ArcView coverages):

Example:

| | |
|---------|---|
| 1980_01 | January, 1980 PRISM precipitation grid for ESPAM study area |
| 1980_02 | February, 1980 PRISM precipitation grid for ESPAM study area |
| 1980_03 | March, 1980 PRISM precipitation grid for ESPAM study area |
| . | . |
| . | . |
| . | . |
| 1980_14 | 1980 annual total precipitation PRISM grid for ESPAM study area |

etc.

PRISM FILE PROCESSING DESCRIPTION

After ftp file acquisition:

1. Generate a list of the *.gz files
 - a. At DOS do "dir d:\prism*.gz > d:\prism\ziplist.txt" to generate a text file listing the zipped ASCII files.
2. Use a text editor program to generate an unzip batch file, unzip.bat, using the ziplist.txt file.
3. Install the command line extension for the compression software, Power Archiver software (available for download at <http://www.powerarchiver.com/>)

4. Run the batch unzip file.
5. Using a text editor program to generate a rename batch file, renlist.bat, using the renlist.txt file.
 - a. Sample "ren us_ppt_1979.01 1979_01.asc"
6. At the ARC command prompt run the Arc aml file to do the batch processing, using prism2.aml.

Processing file explanations:

| | |
|-----------------|--|
| pacl20.exe | command line extension for Power Archiver |
| prism2.aml | Arc aml file to do the batch processing - clipping, projecting, and renaming are some of the processes coded in this file (Appendix 2) |
| state.e00 | Interchange file, state of Idaho in IDTM NAD27 |
| state_wgs72 | Coverage of Idaho in WGS72 - must have info folder |
| state | Coverage of Idaho in IDTM NAD27 – must have info folder |
| renamebat.txt | rename batch file - must be renamed to *.bat before executing |
| unzipbat.txt | unzip batch file – must be renamed to *.bat before executing |
| wgs72_nar_c.prj | projection file WGS72 to NAR_C |
| nad83_nad27.prj | projection file IDTM NAD83 to IDTM NAD27 |

APPENDIX 2

ARC AML Batch Processing Code

```

/* Prism2.aml written by Jason M Carr, IWRRRI GIS Specialist, May 2002, revised March
/* 2003
/*
/* Creates a list of ASCII files with the extension .asc
/* Creates grids out of ASCII files, native projection WGS72
/* Clips the grid to the area of interest projected to WGS72
/* Projects the clipped Prism grid to IDTM NAD27 using a three step process
/* Converts the units mm*100 to decimal feet as a floating integer grid
/*
/* Dependent on the following, which must reside in the same workspace:
/* - wgs72_nar_c.prj projection file to project from wgs72 to IDTM nar_c
/* - nad83_nad27.prj projection file to project from IDTM NAD83 to IDTM NAD27
/* - clipwgs72 coverage of the area of interest projected to WGS72
/******
/* AML Startup
/* Aml trace...
/* &echo &on
/* &severity &error &routine bailout

/* Create a file of ascii files *.asc
&sv count = [filelist *.asc asc.list -file]
/* Open asc.list file
&sv file1 = [open asc.list openstat -read]
&if %openstat% NE 0 &then
&do
&type ERROR opening asc.list. Error number %openstat%
&call bailout
&end
/* begin main loop
&do i = 1 &to 1000 &by 1
/* Read filename
&call read
/* Set variables
&sv prismfile = [locase [before %.asc_file% .]]
/* Create grid
asciigrid %.asc_file% g%prismfile% int
&sys del %.asc_file%
/* Enter Grid module
grid
/* Generate Value Attribute Table
buildvat g%prismfile%
/* Set the Analysis Environment
setwindow clipwgs72
/* Clip using the bounding box of the state of Idaho projected to WGS72
c%prismfile% = g%prismfile%

```

```

    kill g%prismfile% all
/* Exit Grid module
quit
/* Project from WGS72 to NAR_C
project grid c%prismfile% p1%prismfile% wgs72_nar_c.prj bilinear
kill c%prismfile% all
/* Define projection as IDTM NAD83
projectdefine grid p1%prismfile%
datum nad83
parameters
1.0000000000
-114 0 0.00
42 0 0.000
500000.00000
100000.00000
/* Project from IDTM NAD83 to IDTM NAD27
project grid p1%prismfile% p_%prismfile% nad83_nad27.prj bilinear
kill p1%prismfile% all
/*Enter Grid Module
grid
%prismfile% = float(p_%prismfile% * 0.00003281)
/* Convert grid to shapefile
/* s_%prismfile% = gridshape(p_%prismfile%)
/* Exit Grid module
quit
/*kill p_%prismfile% all
/* exit main loop
&end

/*****
/* Subroutines

/* Routine Read -----
&routine read
&sv .asc_file = [read %file1% readstat]
&if %readstat% NE 0 and %readstat% NE 102 &then
&do
&type READ ERROR %readstat%
&call bailout
&end
&return

/* Routine Bailout -----
&routine bailout

```

```
&severity &error &ignore  
&call exit  
&return &error Bailing out of prism.aml...
```

```
/* Routine Exit -----  
&routine exit  
&sv cls = [close -all]  
&if [EXISTS asc.list -FILE] &then &sys del asc.list  
&type  
&type prism.aml completed.....  
/* &echo &off  
&return
```