WRA Bulletin 58

October 2020

OVERSEAS WORK

Use of CHIRPS satellite-based precipitation estimates in Azerbaijan

WRA have completed a study for managing flood defences, using perimeter channels and a recharge basin, at the new Dashgil-2 oil/gas terminal, which is located on the shores of the Caspian Sea near Alat in Azerbaijan (Figure 1). Partners Paul Holmes and Ron Manley undertook this work in conjunction with Mark Cramman and Rhys Coombs of CC Hydrodynamics Ltd. WRA Partner Frank Farquharson was also involved in undertaking the Quality Assurance review.

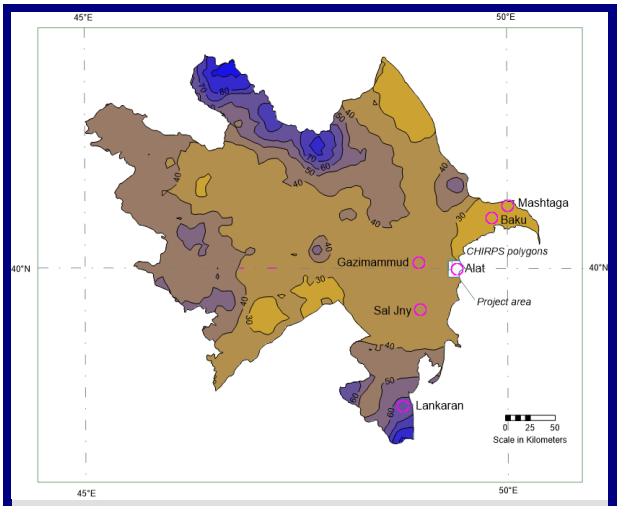

Figure 1 Showing location of project area near Alat. Station locations used for observing daily precipitation and temperature data shown by red circles. Isohyets of average annual maximum daily rainfall (mm) shown for the whole of Azerbaijan.

The study's Terms of Reference (ToR) included the requirement "Determine meteorological conditions including precipitation, temperature, humidity and wind speed." This part of the study was undertaken by Ron Manley, and is described below.

Precipitation

In previous WRA projects conducted in Azerbaijan, precipitation data were provided for three stations for the period 1992 to 2006: Alat, Mashtaga and Baku (Figure 1). The station at Alat is very close to the project area. For the first two stations the data are effectively complete but Baku is missing the whole of 1999 and parts of 1998 and 2001. This gives 15 years of daily data. This period is, however, too short to satisfy the ToR, as 15 years is not a long enough data record to assess floods of high return periods.

The data set of daily rainfall held by the National Climatic Data Center (NCDC) was also examined. This site holds daily rainfall for 55 stations in Azerbaijan. However, only 4 of those are close to the project area and have data after 1990. Even for these stations, data are very sparse after that date and not adequate for analysis. On the other hand there are four stations (Figure 1) which do have good data for most years from 1960 to 1990: Alat – 1960 to 1965 and 1977 to 1991, Baku – 1960 to 1987, Gazimammad – 1960 to 1987, and Sal Jny – 1966 to 1987.

What we proposed as a complement to the observed rainfall was to use CHIRPS data. The Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is a quasi-global rainfall data set. As its title suggests it combines data from real-time observing meteorological stations with satellite derived infra-red data to estimate precipitation. The data set runs from 1981 to the near present. CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create a gridded rainfall time series. Since 1999, U.S. Geological Survey (USGS) and the University of California Climate Hazards Group (CHG) scientists, supported by funding from the U.S. Agency for International Development (USAID), the National Aeronautics and Space Administration (NASA), and the National Oceanic and Atmospheric Administration (NOAA), have been developing techniques for producing rainfall maps, especially where surface data is sparse.

There are two main data sets. The first is quasi-global and covers the whole world from 50°N to 50°S. The second covers Africa and parts of the Middle-East. It covers the area from 40°N to 40°S and from 20°W to 55°E. The global data set has data on a 0.05° grid at monthly, pentad and daily time steps. The Africa and Middle-East data set also includes data on a 0.10° grid at a 6-hour time step. This means we can obtain 6-hour and daily rainfall for the project area from 1981 to 2018, a period of 38 years.

Water Resource Associates LLP has downloaded all the relevant data sets up to the end of 2018. The company has also developed a suite of programs to use these data. Each of the programs to process the data reads two files. The first is a file of the coordinates

bounding a geographical area (for example a river basin). The second is the appropriate CHIRPS data set. The program then downloads data extracted for the given geographical area. The program for daily data does some preliminary analysis and outputs the following files:

- the daily rainfall for each day averaged over the defined area.
- the average daily rainfall for each grid square. This can be used for plotting isohyets.
- the average annual maximum daily rainfall for each grid square. This can be used for plotting annual maxima.

The pentad (5-day) data are considered as definitive. It is therefore necessary to download both the daily and the pentad data sets. A separate program is then used to merge the daily and pentad data by adjusting the daily data to correspond to the pentad values. Where 6-hour data are available they are also adjusted to be consistent with the modified daily data series. The consistency of the selected rainfall records was checked by double-mass plots.

Figure 1 shows the locations used for observing daily precipitation and temperature data. The contours show the average annual maximum daily rainfall in millimetres derived from CHIRPS. This chart shows values for the whole country. However the data are at a fine grid, 0.05°, which is equivalent 5.6 km, so they are therefore suitable for the study area near Alat.

The next step was to produce Intensity/Duration/Frequency (IDF) curves for the project area. We examined two potential sources for developing such curves. The first is *Flood regimes in the Southern Caucasus: the influence of precipitation on mean annual floods and frequency curves,* published in Hydrology Research in 2008. Frank Farquharson, one of the joint authors, participated in the present study. The second source was a paper entitled *General Analysis and Description of Physical and Geographical Factors of Rainfall in Azerbaijan* by A.R. Maharramova of the Baku State University. This paper presents IDF curves specific to Azerbaijan.

In summary our approach was to:

- develop a daily rainfall record for Alat for the period 1960 to 2018.
- determine the relationship between daily and 6-hour extremes using CHIRPS.
- merge published IDF curves with the 6-hourly data.

Temperature

We have examined sources of temperature data for Azerbaijan. The main ones are:

- The Climate Research Unit (CRU) of the University of Norwich, United Kingdom
- Goddard Institute for Space Studies (GISS)
- National Climatic Data Center (NCDC)

The latter two are both part of the National Aeronautics and Space Administration (NASA), in the United States of America. The primary reason for the collection of these data is for analysis of the impact of climate change on temperatures. The data are freely available. The temperature data chosen for this project are shown in Table 1, and their site locations in Figure 1.

Table 1 Sources of temperature data used in this study

Site	Source	Years	Comments
Alat	NCDC	1960-65 1977-91	
Baku	NCDC	1960-87	
Gazimammud	NCDC	1960-87	
Sal Jny	NCDC	1966-87	
Lankaran	GISS	1893-2019	Some missing years for the early period
Mashtaga	CRU	1991-2019	
Lankaran	CRU	1882-1990	

The above list includes only those climate stations closest to the study area but most sources have more sites than those listed above. For example, GISS has four sites still operating at the present day. From the above we produced a daily temperature record at the project area for the period 1960 to 2018.

Humidity and Wind Speed

The TuTiempo website has climate data for Baku for the period 1974 to 2018. This is the only site with such data available in Azerbaijan. The parameters reported include temperature, humidity and wind speed. These data are at daily intervals, while monthly averages are also provided. The quality of these data is variable and, for some months, particularly for the earlier period, not all days have data. Where there are data gaps these were infilled by data from neighbouring countries with, of course, suitable adjustments.

Next WRA Board Meeting

Tuesday 19th January 2021, connecting by Zoom

The WRA Bulletin is a quarterly publication, and relies on contributions submitted by Partners, Associates and Consultants. The document is circulated by email, and published on the WRA web-site, aiming to keep the WRA network up-to-date with respect to current activities. Please email contributions for future issues to Nick Mandeville: nick@watres.com

Water Resource Associates LLP, PO Box 838, Wallingford, Oxon OX10 9XA. Tel: +44[0] 1491 838 190, www.watres.com