WRA Bulletin 53

July 2019

GLOBAL WORK

Satellite based precipitation estimates

One problem faced by hydrologists working internationally is obtaining rainfall data for hydrological modelling and for flood estimation. In some countries meteorological networks have not been maintained and the number of stations with data is fewer than in the past. In other countries adequate data are held by the country's meteorological service but access is not readily available to consultants working in the country. A solution to this is to use the data set produced by the procedure called CHIRPS (Climate Hazards Group InfraRed Precipitation with Station Data), as described by WRA Partner Ron Manley.

CHIRPS is a quasi-global rainfall data set. It was developed by the University of California at Santa Barbara and is supported by a number of US agencies. It combines data from real-time observing meteorological stations with 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 gridded rainfall time series.

Available data sets

There are two main data sets. The first 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. It has data on a 0.05° grid at monthly, pentad and daily time steps. An example of its use was described in the WRA bulletin No 50 of October 2018, for the River Kagera basin, which flows into Lake Victoria in East Africa. The 'Africa' data set also includes data at a 0.10° grid at a 6-hour time step.

The second data set is quasi-global and covers the whole world from 50°N to 50°S. This one has data on a 0.05° grid at monthly, pentad and daily time steps. This is the data set we examine here.

Other data sets are available. For example, annual data and sub-sets for different geographical regions including Indonesia and the Caribbean but these latter do not include daily or shorter time steps.

Using CHIRPS data sets

WRA has downloaded the CHIRPS data set and developed a suite of programs to extract data from it. The CHIRPS data set, up to the end of 2018, has 183,000 files and occupies 1.28 TB. The files are mainly in Tagged Image Format (TIF) files. The exception being the 6-hour data set which are in a Direct Access format. Each data time step uses 4 bytes. Programs are available for monthly, pentad and daily time steps, and, for Africa and parts of the Middle-East only, a 6-hours time step. The pentad time step is considered to be definitive and a further program is available to create separate files of daily data which adjusts the raw daily data to agree with the pentad data.

The input to each of the programs is a file defining the perimeter of a particular area (for example a river basin) and one of the CHIRPS data files. Two files are output. The first of these is a time series of data. The second is used for contour plotting and gives the coordinates of each CHIRPS cell and the average value for that cell.

Examples of CHIRPS applications

i) Slovakia

The first example is for rainfall for Slovakia (Figure 1). This country was chosen as it is at the northern limits of CHIRPS; Slovakia's northern limit is 49.5° and CHIRPS' limit is 50.0°.

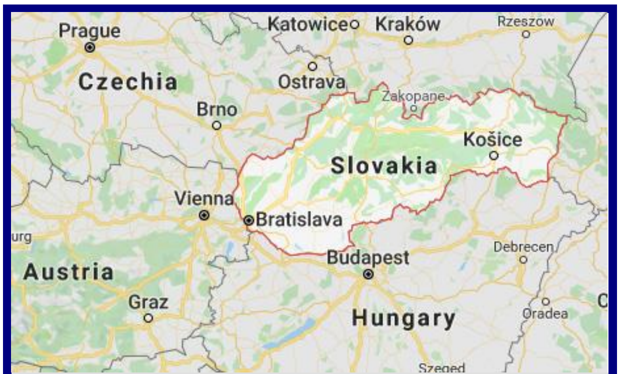

Figure 1 Map showing the borders of Slovakia

Figure 2 shows a plot of monthly rainfall, observed and CHIRPS, for Slovakia for the period 1981 to 2018. The observed values came for the Climatic Research Unit (CRU) of the University of East Anglia.

This particular chart shows the relationship if the line is forced to pass through the origin. In fact, the CHIRPS values were slightly biased and in the unrestricted case the relationship was:

CHIRPS rainfall = 0.79 * (Observed rainfall) + 6.5

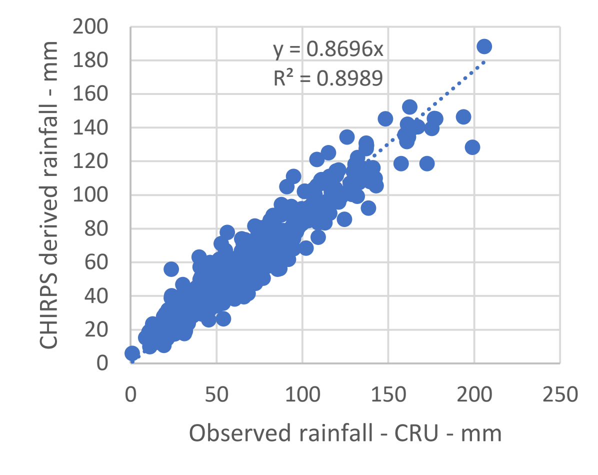

Figure 2 Monthly rainfall comparison for Slovakia for 1981 to 2018. Regression analysis between observed values provided by CRU and CHIRPS derived values

The observed average annual rainfall for Slovakia is 727 mm and the corresponding CHIRPS value is 816 mm, a difference of 12%.

Figure 3 compares the estimates of average monthly rainfall, from the two sources. Apart from the bias, noted above, the values are in good agreement.

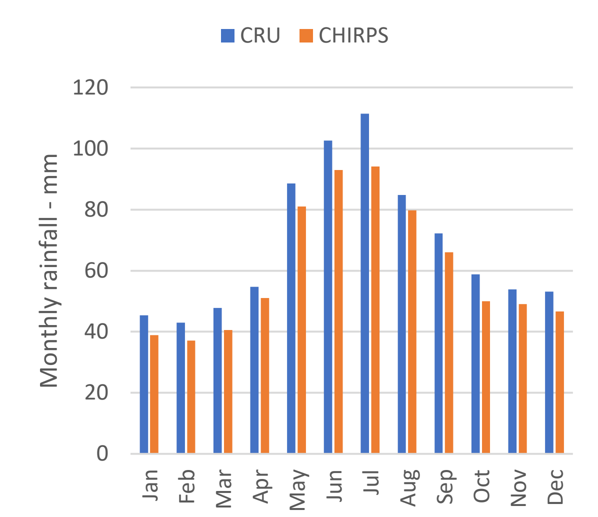

Figure 3 Average monthly rainfall in Slovakia for period 1981 to 2018. Comparing CHIRPS derived values with observed values provided by CRU

Average annual rainfall isohyets for the country from two sources were compared. The first was from CHIRPS for 1981 to 2018. The second was average data for the 1961 to 1990 period at a 10' minute grid produced by the CRU. The estimates were in good general agreement except for an area of high rainfall in the west of the country on the CHIRPS data.

ii) Tagus basin, Spain

The Tagus basin, known as the Tajo in Spain and the Tejo in Portugal, is illustrated in Figure 4.

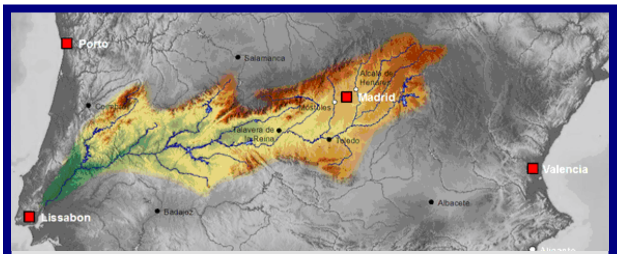

Figure 4 The Tagus basin, with its headwaters lying in central Spain, flows into the sea at Lisbon in Portugal

For hydrological modelling the basin was divided into four sub-basins in Spain and eleven in Portugal. Assessing the effectiveness of CHIRPS data in this basin demonstrates one of the problems of such an assessment. Here we examine daily rainfall data for two of the sub-basins in Spain upstream of Toledo: the Jarama river down to Aranjuez, and the Tajo river down to Embocador.

The CHIRPS rainfall values for the sub-basins were downloaded using the program mentioned above. The 'observed' values were based on data from individual raingauges. To evaluate the accuracy of CHIRPS in these sub-basins the metric chosen was the maximum annual daily rainfall for the period 1981 to 2018. For each sub-basin Table 1 shows the mean of these values, the standard deviation and estimated values for three different return periods. The values are in millimetres.

Table 1 Maximum annual daily rainfall for two sub-basins of Tajo river

	Jarama sub-basin down to Aranjuez		Tajo sub-basin down to Embocador	
	Observed - mm	CHIRPS - mm	Observed - mm	CHIRPS - mm
Mean	26.0	25.0	21.5	24.4
Standard deviation	7.4	6.7	4.6	6.6
1-in-10 years	35.7	33.7	27.5	33.0
1-in-25 years	41.2	38.6	31.0	37.8
1-in-100 years	49.3	45.9	36.1	45.0

At first sight it would appear that the accuracy of CHIRPS is superior in the Jarama sub-basin to that in the upper Tajo. However, there are 9 raingauges inside the former basin but in the upper Tajo only one. This means that the calculation of observed sub-basin rainfall by WRA was more accurate in the Jarama basin than in the upper Tajo. But it also makes it likely that the CHIRPS procedure used more raingauges to draw up its estimate in the Jarama basin. The conclusion is that the accuracy of CHIRPS in the Jarama basin is good. On the other hand, we can conclude relatively little about the accuracy of the CHIRPS procedure in the upper Tajo.

Conclusions

The two examples of comparisons between CHIRPS and observed data are also indicative of WRA's experience in other basins. CHIRPS appears to give a good representation of rainfall at time steps from daily to annual. If observed data from raingauges are available then these should be used. In the absence of such data then data from CHIRPS is an acceptable alternative.

UK WORK

Hydrological Investigation of Hendy Windfarm, Powys

Hendy windfarm is a proposed development located in the River Wye basin near Llandrindod Wells. WRA LLP were requested, by the Brecon and Radnor Branch of the Campaign for the Protection of Rural Wales (CPRW), to undertake a review of the surface water management plan which was submitted as part of the environmental statement for this development. The windfarm is located in the headwaters of the River Wye Special Area of Conservation (SAC), and CPRW had concerns that construction works had already started (Figure 5) without a detailed investigation of the potential impacts on the SAC and an adequate plan for mitigation measures.

Figure 5. Preliminary construction work for the windfarm development

The review by WRA Partner Harvey Rodda included a GIS analysis to identify a 50m buffer zone around all the relevant minor waterways, and an investigation to determine where this zone intersected with the construction works. The environmental statement had assured that no constructions works would be placed within 50m of receiving waters, but this was shown not to be the case by our study (Figure 6). The outcome was to alert the local planning authority to arrange a temporary cessation of construction until the appropriate mitigation measures were put in place.

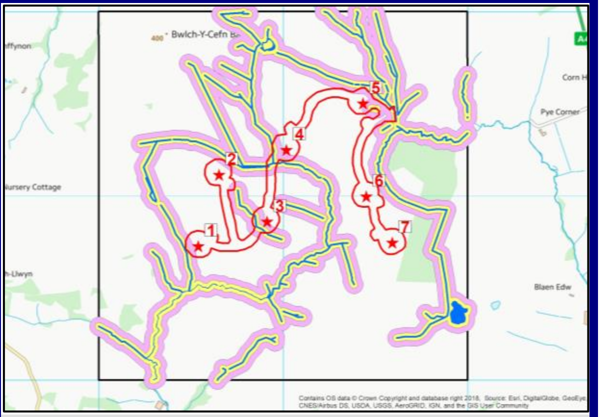

Figure 6. GIS analysis showing the windfarm development area (red outline) intersecting with the 50m buffer zone around the receiving waters (pink shading)

INTERNATIONAL CONFERENCE

Keynote presentation on Environmental Modelling, Nanjing, China

Partner Paul Whitehead gave a keynote presentation at the 1st Regional Conference on Environmental Modelling and Software (Asian Region), held on 18-20 May 2019 in Nanjing, Jiangsu, China. Two hundred people from China and across the world attended this meeting and Paul gave the third keynote presentation entitled *Multidisciplinary Modelling of Integrated Catchment Dynamics for Sustainable Management and Planning*.

The focus of the talk was how to link physically based models of hydrology and water quality with socio-economic factors such as population growth and changes in land use, agriculture and industry, all within the framework of future climate change. Email paul.whitehead@watres.com for a copy of the presentation, together with the paper on the Mekong river basin addressing the modelling approach.

OTHER NEWS

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Next WRA Board Meeting

Friday 11th October 2019, Chalgrove