

Rainwater monitoring crucial to catchment management – DWA



Courtesy of DWA

In response to the article, 'Taking on the Challenge of Water Resources Assessment' (the Water Wheel May/June 2012), N Vermaak, H de Haast, P Havenga and G Steyl offer insight into the importance of rainfall measurement in managing South Africa's catchments sustainably.

Rain, for some reason creates confusing reactions from people. When you talk to a farmer, for example, he will usually complain that the rain was too early, too late, not enough, too much, or not at all. Nevertheless, it is clear that the farmer needs the rain even though it might not fall at the time or in the volumes required. For the city dweller, rain is usually an inconvenience – it ruins his schedule, his clothes, and creates discomfort, causing him to get wet.

We are, however, not here to discuss people's perceptions of rain,

but the importance of rain in the hydrological cycle and the process of managing our water resources.

RAINFALL AND THE HYDROLOGICAL CYCLE

Every system has its inputs. Inputs are whatever enters the system, and this determines the outputs. The quality of inputs often determines the quality of the outputs. We humans have two kinds of inputs, the one being whatever enters the digestive system to provide us with energy to accomplish whatever we set out to do. The second input into the human system is, just like a computer, information. In our computer age, we should all be familiar with the saying: "Garbage in, garbage out".

Rainfall is the input into the hydrological 'system' and unlike the human body where we can control the inputs – whether it is what we eat and drink or the information we feed

our brain – we cannot control the input into the hydrological cycle. We have probably all heard about seeding the clouds, in an attempt to cause the clouds to bring rain, and this has apparently met with varying rates of success – but it can only be done if there are clouds in the sky. Humans cannot control wind direction or the formation of clouds; we cannot control the weather, we can only predict it. It is the same for rain – we cannot control it, we can only predict it – not always successfully, we can measure it and we can contain the run off caused by rainfall in dams and impoundments.

How important is rain to the hydrological cycle? In the 1970s and early 1980s, there was a drought of almost 11 years in the interior of the country, where children had never seen rain in their life. In England, two weeks without rain would be considered a drought, with withered grass and worried farmers. Rain and other forms of precipitation are

extremely important, for without rain the whole hydrological cycle will come to a stand still – eventually. The streams and rivers may continue running for some time (often underground in the dry areas of our country and in Namibia); groundwater – the tortoise of the hydrological cycle – may still provide water for a couple of years afterward as it did when the southern Cape was experiencing their recent drought; but when this is gone, what is left?

RAINFALL AND CATCHMENT MANAGEMENT

We are mandated by the National Water Act of 1998 (Act 36 of 1998) to use Integrated Water Resource Management to manage the water resources of the country, and it therefore becomes the main responsibility of the Department of Water Affairs (DWA) and the Minister of Water Affairs, as the custodians of the water resources.

We have seen above how important rain and other precipitation are in the hydrological cycle. It is, however, the one part of our water resources that we cannot manage in the real sense of the word. We can only measure it, which may create some problems in the management process. Management has to do with volumes, reducing risks – risks of floods, risks of droughts, etc. We cannot reduce the risk of no rain, with its ensuing droughts, or the risk of floods, without planning. We cannot plan for eventualities such as droughts and floods without data – which comes from measurements. The measurements of precipitation will not predict a flood or a drought, but there seems to be a cyclical pattern to rainfall, as with most other weather-related phenomena. When long-term records are available, it can be used to predict possible patterns, which can be used to plan for floods, droughts and anything in-between. It can also help to predict climate change and assist managers in planning for the associated effects

“Humans cannot control wind direction or the formation of clouds; we cannot control the weather, we can only predict it. It is the same for rain.”

it may have on the availabilities of water resources.

MEASUREMENT OF RAINFALL

Measurements of rainfall can be done with a simple funnel-shaped gauge that is fairly easy to find. The readings have to be taken daily at the same time to ensure a consistent pattern. More complex rain gauges with electronic devices that take the pain out of taking daily readings is also available, but not quite so easy to find. Rain gauges can also be set up with weather stations, where the rainfall is measured but not collected.

A cumulative rain gauge was developed by Dr Eddie van Wyk of DWA in Pretoria. This rain gauge also collects samples that can be analysed chemically, especially for chloride values and certain isotopes. This data can then be used to determine the recharge to groundwater when it is compared with the quantities of chloride and isotopes in the groundwater.

A number of these cumulative rain gauges have been installed in South Africa, and are maintained by DWA. In the Western Cape, for example, a series of such rain gauges are currently managed by the Geohydrology Section of the department. Some of these rain gauges were installed in the Western Cape in 2000, with the latest ones installed in February this year as part of Table Mountain Group (TMG) investigations.

WHAT CAN WE LEARN FROM RAINFALL DATA?

Climate change is something we hear about frequently. Rainfall records can help us to understand the patterns of change, and also help us predict how things can possibly change in future. It can give us an indication of how much water we will have available as surface water and groundwater – and this can help us to manage our water resources better.

Zachariashoek was one of the experimental sites for the Mountain Catchment Studies in the winter rainfall areas. Measurements of



Courtesy of DWA

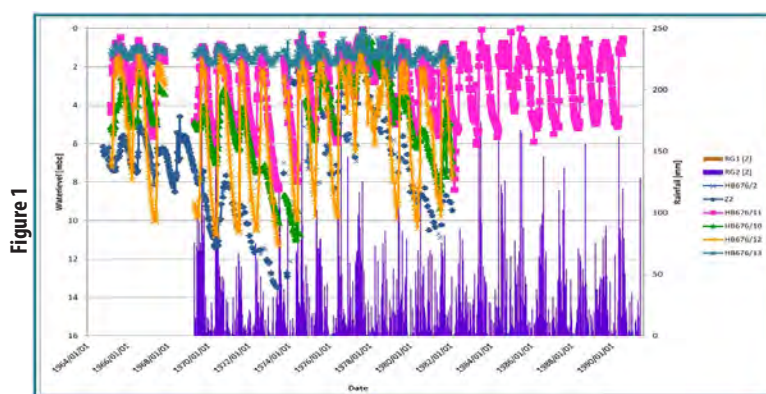
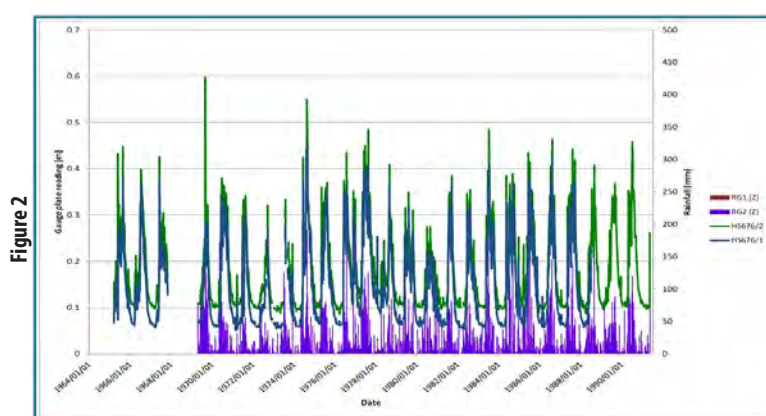
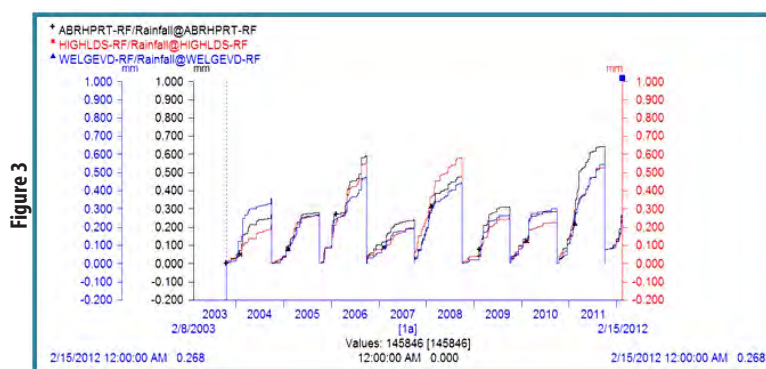
Top left: This rain gauge and weather station is situated at Rocherpan on the West Coast, near Dwarskersbos.

Bottom left: Cumulative rain gauge TMG488 forms part of the TMG monitoring programme.

Top right: Water levels of the boreholes in Zachariashoek compared to the rainfall measure in the same catchment.

Middle right: Gauge plate readings at the weirs in Zachariashoek compared with the rainfall measured in the same catchment.

Bottom right: Graph showing the rainfall data for three of the rain gauges in the Beaufort West area.



groundwater levels and surface water levels have been taken from around 1964. The record of rainfall measurements began in 1969. Figure 1 shows the groundwater levels in the Zachariashoek sub-catchment compared to rainfall, while Figure 2 shows the gauge plate readings taken at the two weirs in the Zachariashoek sub-catchments compared to rainfall.

It is very clear from this data that there is a definite correlation between rainfall and the groundwater levels and the surface flow. Figure 3 shows the rainfall record for three of the cumulative rain gauges in the Beaufort West area. It shows the

lower rainfall of 2009 and 2010 that caused the water problems in the area, with the higher rainfall of 2011 that brought the relief.

Figure 4 shows the rainfall of four rain gauges in the Breede River area, with those of the KOO valley being far inland, while Cape Infanta is next to the coast at the Breede River mouth. The graph shows the decline in rainfall as one move inland. Figure 5 shows the data record of four rain gauges near the Nuweberg Dam, which is also located in the Breede River area.

These rain gauges are at different altitudes, and give an indication

of the effect of altitude on rainfall. TMG489 is above 1000m above mean sea level, while TMG486 is right next to the Nuweberg Dam. TMG488 is somewhere in between. The record of TMG490 is too short yet to compare it with the rest, as it was only installed in February 2012.

Figure 6 shows the correlation of rainfall and groundwater levels for an unconfined porous aquifer in the Lower Berg River area. It can be seen how the rainfall events contributed to groundwater recharge.

The time lag between the rainfall event and the rise in groundwater levels can also give an indication of the transmissivity of the aquifer. Aquifers that respond quickly to rainfall events may have a higher transmissivity than aquifers that have a greater time gap. The response of an aquifer may also show whether the aquifer is unconfined or confined, as an unconfined aquifer will usually have a greater response to rainfall events than confined aquifers.

The unconfined aquifer will be recharged directly by the rainfall event, while the confined aquifer will mostly receive its recharge from a distance – giving it a greater time lag between the rainfall event and the response in waterlevels. Some confined aquifers may receive recharge slowly through a leaky aquitard, the layer that causes the confinement.

RAINFALL DATA PROCESSING

Raw rainfall data – the numbers on their own do not mean very much. It is pictures that usually tell the story better than a list of numbers. Rainfall is usually plotted as a bar chart, where different time periods are used, such as the rainfall per day or per month. In the Western Cape the highest rainfall occurs between April and October, while in the rest of the country the highest rainfall usually occurs from September to March.

The cumulative rain gauges

record the data automatically, taking readings at set time intervals. This data adds up cumulatively, but can be edited to give daily readings as with the other rain gauges. The data is downloaded from the Thalimedes during monitoring of the areas, and edited. One of the programmes used in editing the data is Hydras3. The editing of the data is done in such a way that it gives the cumulative rainfall for a hydrological year, which begins on the 1st of October – unlike the financial year that begins on the 1st of April.

COMMENDATIONS

The *Water Wheel* article mentions the decline in streamflow and rainfall data for South Africa at the beginning of the WRC project WR2012. It is also stated that the number of useful rainfall gauges is seriously low, with roughly the same number of stations as in 1920. With this in mind it would almost seem as if we need to commend the people that still take the time to measure rainfall. This would include:

- South African Weather Service and its volunteers, who keep records without incentives or payment and then make it available to the public.
- Farmers, who realise how important it is for their own farm management to record rainfall.
- DWA who sometimes keep rain gauges (and weirs) going despite budget and staff constraints.

CONCLUSIONS

The *Water Wheel* article quotes Dr Pitman, where he states the following: "Rainfall is the primary input to hydrological computer models, not only to determine streamflow, but also irrigation requirements and net evaporation from reservoirs (an important factor in the determination of yield). On the other hand, information on streamflow is necessary to calibrate the hydrological models to ensure

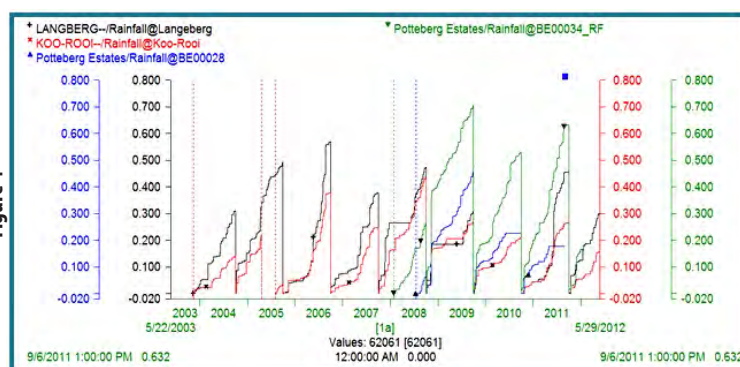


Figure 4

Top left: Graph showing the rainfall data for the Breede river area. Two of the rain gauges are in the KOO valley while the other two are near Cape Infanta.

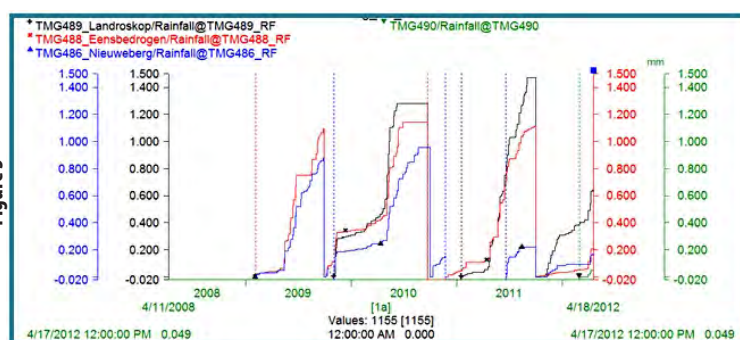


Figure 5

Middle left: Graph showing the rainfall data for the four rain gauges near Nuweberg dam.

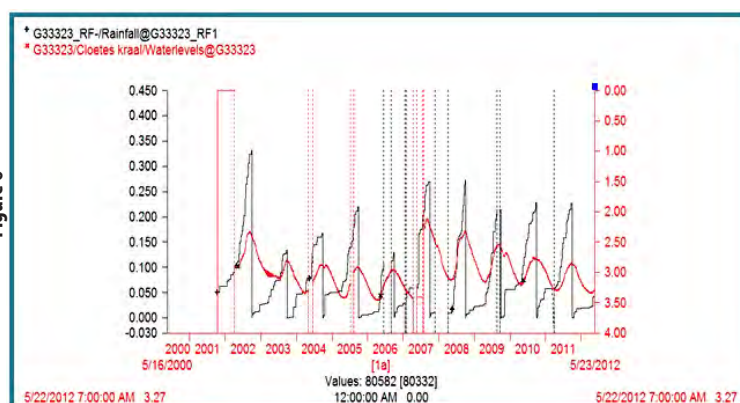


Figure 6

Bottom left: Graph showing the rainfall from cumulative rain gauge G33323-RF and the waterlevels in borehole G33323.

Below: Cumulative rain gauge G46105-RF, near Langebaan Road, showing the Thalimedes used to record rainfall.

we get the most accurate determination of our water resources. Thus to undertake water resource assessment without rainfall and streamflow data is a bit like trying to plan for population growth without a proper census."

If rainfall is the primary input into hydrological computer models, it is definitely the primary input into the hydrological cycle and this absolutely necessary when it comes to managing our water resources. To put it very bluntly: Without rain, you have no water in the hydrological cycle. Without rainfall measurements, you have no integrated water resource management as you cannot manage what you cannot measure.



Courtesy of DWA