Investigating the underestimation of rainfall measurement: impact of raingauge height and wind speed

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1. Introduction

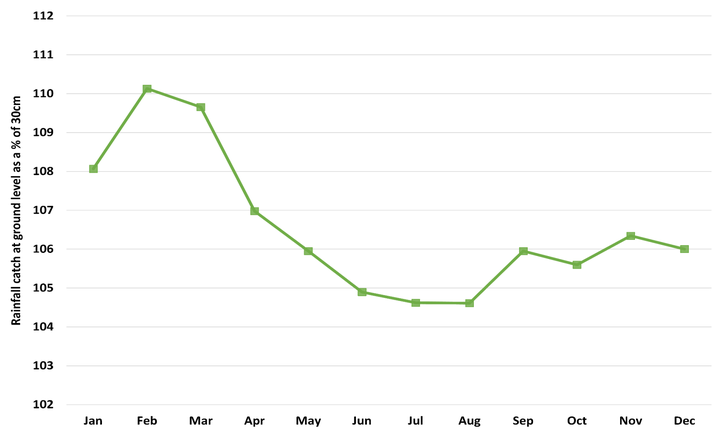
- Accurate measurement of rainfall data is vital for many aspects of hydrology, particularly the calculation of catchment water balance.
- Installation of raingauges above the surface underestimates the amount of rainfall reaching the ground[1,2].
- There is currently an increased use of weighing raingauges around the UK, replacing storage and TBR gauges.
- These gauges have the advantages of less maintenance and better recording at high intensities[3,4].
- But, the change in instrument type and raingauge height simultaneously raises questions about the homogeneity of rainfall series.
- **What effect does changing rain gauge type and installation height have on rainfall undercatch?**

2. Wallingford Meteorological Station (UK Climate Station 5558)

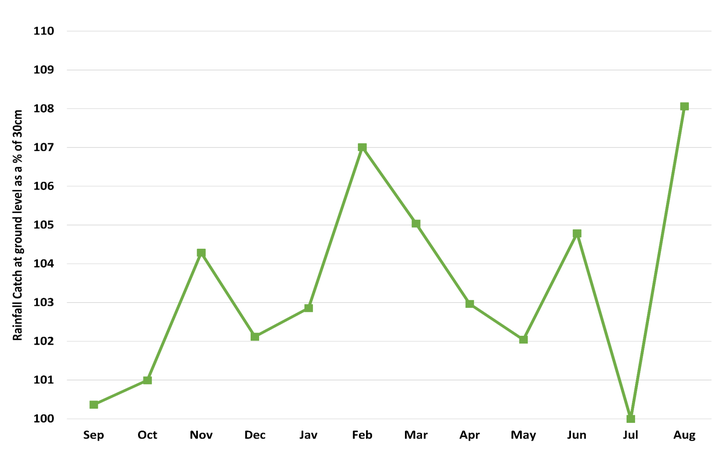
- Manual daily records since 1962, installation of Automatic Weather Station (AWS) (15-minute data) in early 2000s with the addition of Pluvio weighing raingauges in 2015.
- Research in the 1960s into size and shape of rain gauge pits and grids[5].
- Analysis of storage gauge data for 1969-2007 showed ~6% undercatch[1] between ground level and 30cm.
- Wind speed recorded at 2m height on AWS to use for comparison.

3. Gauge height

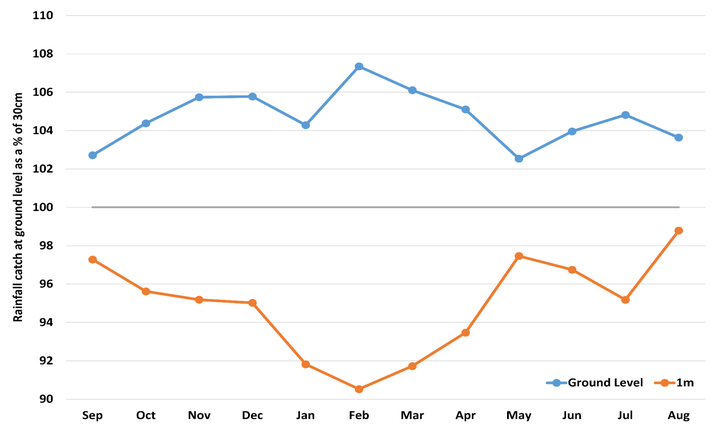
- 1969-2016 daily storage gauge data.
- Catch in ground level as a % of standard height (30cm).
- Average of 6.5% more at ground level with seasonal variation (4.6% - 10.1%).



- 2015-2016 tipping bucket gauge data (15 minute).
- Catch in ground level as a % of standard height (30cm).
- Average of 3.3% more at ground level with seasonal variation (0% - 7%).

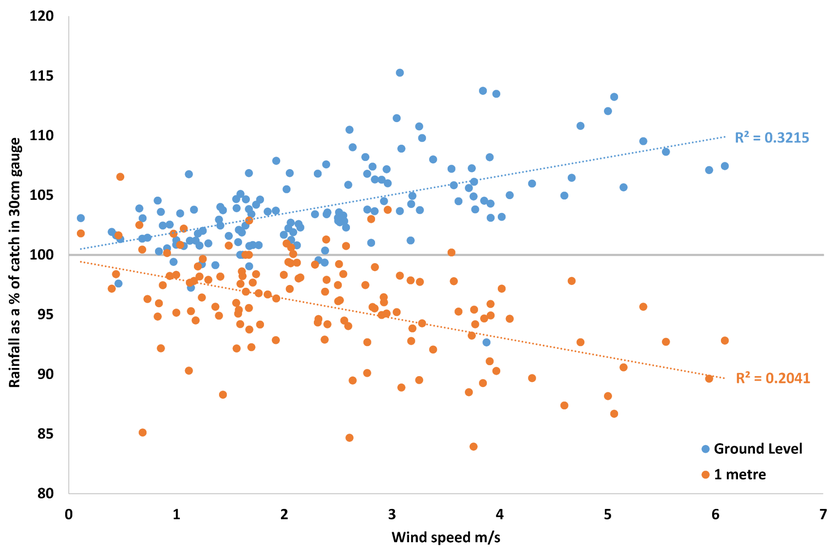


- 2015-2016 Pluvio data (15 minute).
- Catch in **1m** as a % of 30cm: average of 5.1% less rainfall (range: 1.3% - 9.5%).
- Catch in **ground level** as a % of 30cm: average of 4.7% more rainfall (range: 2.5% - 7.3%).
- Catch in **1m** as a % of **ground level**: average of 9.4% less rainfall (range: 4.7% - 15.7%).



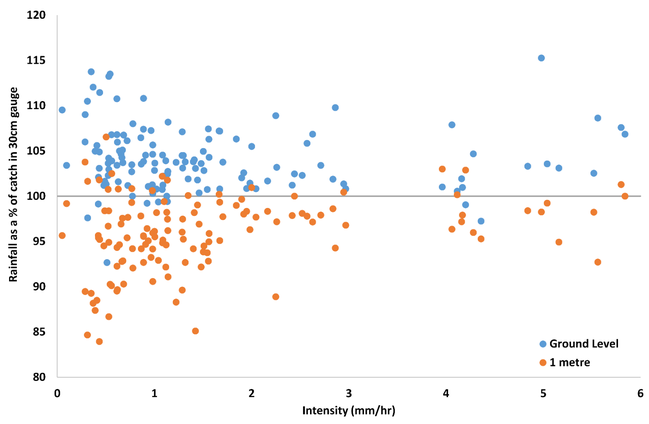
4. Wind speed

- Pluvio rainfall events above 1mm accumulation used in the period May 2015 to August 2016 (ground level, 30cm and 1m gauges).
- 136 events analysed against mean wind speed for the event (taken at 2m height).
- Some evidence of increasing undercatch with increasing wind speed (r^2 = 0.2041 / 0.3215).

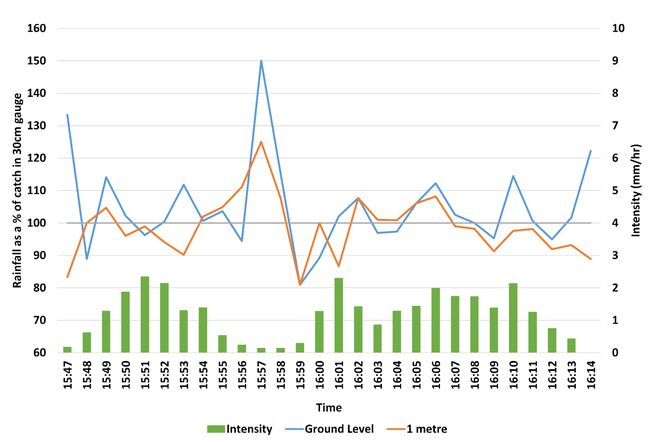


5. Rainfall intensity

- Event intensity calculated (rainfall total ÷ event duration) using standard height (30cm) Pluvio data.
- Little evidence of a relationship between undercatch and intensity using event totals.



- Therefore, we need to look at the available 1 minute data at the individual event scale for better understanding[3].
- Example event: 16th June 2016 (32.7mm in 30 minutes).
- Variation in intensity and undercatch through the event, addition of 1 minute wind speed would allow for full investigation



6. Summary

- Undercatch in 30cm Pluvio compared to ground level averages 4.7%, giving similar results to the tipping bucket and storage gauges.
- There is a potential for 9.4% undercatch (average) when recording at 1m, compared to rainfall recorded at ground level.
- Assessing undercatch with wind speed and intensity across events does not provide a strong indicator for the cause of the problem.
- More high resolution data (1 minute) are needed to look at intensity and wind speed within each event
- These data are available for intensity but not for wind speed, wind speed measurements are also needed at multiple heights.

References:
[1] Rodda, J. and Dixon, H. (2012) Rainfall measurement revisited. *Weather,* 67(5), 131-136
[2] Sevruk, B., Ondras, M., and Chilva, B. (2009) The WMO precipitation measurement intercomparisons, *Atmospheric Research,* 92, 376-380
[3] Vuerich, E., Monesi, C., Lanza, :.G., Stagi, L. and Lansinger E. (2009) WMO field intercomparison of rainfall intensity gauges, *WMO Instrument and Observing Methods Report No. 99*
[4] Grust, K. and Stewart D. (2012) UK trial of the OTT Pluvio, *BHS Eleventh National Symposium, Hydrology for a Changing World, Dundee*
[5] Rodda, J. (1968) The rainfall measurement problem, *Processings IASH General Assembly, Berne, Switzerland, 1967,* IAHS Publ. No 78, p21