



## **Errors in rainfall measurement using cellular communication networks**

Aart Overeem (1,2), Hidde Leijnse (2), and Remko Uijlenhoet (1)

(1) Wageningen University, Hydrology and Quantitative Water Management Group, Wageningen, Netherlands  
(aart.overeem@wur.nl), (2) Royal Netherlands Meteorological Institute, De Bilt, Netherlands

Various studies have shown that microwave links from operational cellular communication networks may be used for rainfall monitoring. Such networks cover 20% of the land surface of the earth and have a high density. This is particularly interesting for those countries where few surface rainfall observations are available. The basic principle of rainfall estimation using microwave links is as follows. Rainfall attenuates the electromagnetic signals transmitted from one telephone tower to another. By measuring the received power at one end of a microwave link as a function of time, the path-integrated attenuation due to rainfall can be calculated, which can be converted to average rainfall intensities over the length of a link.

A 2.5-year data set from a commercial microwave link network over the Netherlands is analyzed. The data set consists of roughly 2,000 links covering the land surface of the Netherlands (35,500 square kilometers). This study focuses on typical errors encountered in rainfall estimation employing microwave links. Country-wide rainfall maps are retrieved, which are compared to a gauge-adjusted radar data set and to data from automatic weather stations. This reveals under which circumstances link-based rainfall estimates are prone to errors, e.g., temperatures close to zero degrees Celsius. Results for higher temperatures are quite good, which holds a promise for regions with few surface rainfall observations, which are often developing countries in the tropics.

Case studies are presented to quantify errors due to melting snow at antennas and link paths, and due to wet antennas caused by dew formation or rain. A dew filter is presented to reduce or remove the wrongly estimated rainfall intensities caused by dew formation at link antennas. To summarize, limitations of rainfall estimation using microwave links from cellular communication networks are presented, as well as under which atmospheric circumstances these networks likely give good rainfall estimates.