RESEARCH HIGHLIGHT

RAINCELL

USE OF CELL PHONE NETWORKS FOR RAINFALL ESTIMATION IN THE CITY OF LUXEMBOURG

When an Israeli research team recently presented their pilot study on the use of cell phone networks for rainfall estimation at a Congress in Vienna, Dr Laurent Pfister and his colleagues, Dr Fabrizio Fenicia and Patrick Matgen, from the Centre de Recherche Public - Gabriel Lippmann (CRP-GL), recognized the novel technique's potential for their own research right away. His group, specialists in the fields of experimental hydrology and hydrologic modelling, had been battling a recurring problem for years: although the continuous increase in computational resources and human expertise makes the predictions of hydrologic models ever more accurate, the lack of precise spatial and quantitative measurements of rainfall remains one major factor of uncertainty. With the partnership of the Institut Royal Météorologique in Belgium and the P&T Luxembourg (TELECOM) and technical support from the city of Luxembourg, the team around Pfister proposed to investigate the use of cell phone networks for rainfall estimation in an urban agglomeration, namely the city of Luxembourg. Their project RAINCELL, funded by the FNR and coordinated by the CRP - Gabriel Lippmann, came to life in April 2009.

At present, rainfall is measured by a combination of two techniques, explains Pfister. Weather radars provide fairly accurate spatial distribution data, but are quite limited in determining the intensity and the amount of rainfall. One of their major shortcomings is the angle at which the measuring signal is sent out: with increasing distance to the radar, the signal points ever higher. For instance, Luxembourg's closest radar, based in the Belgian Ardennes, might not detect low-hanging winter clouds in some parts of the country. Rain gauges can complement the radar to a certain extent: they offer good quantitative precipitation measurements. However, they are spatially restricted to specific locations.
A rain gauge network that is spaced too widely can potentially give extremely misleading rainfall intensity values for a very localised thunderstorm. In an urban setting, where the high percentage of sealed surfaces prevents nearly all absorption and promotes free flow of the water masses, such false quantitative measurements can have a huge impact on the management of water run-off.

Pfister and his team are expecting more accurate rainfall measurements by adding the cell phone network into the equation: cell phone communication uses microwave signals, just like a weather radar does. Furthermore, the cell phone network offers two important advantages: firstly, the signals are emitted low enough off the ground not to miss any clouds, yet also high enough to avoid obstacles. Secondly, the cell phone network is very dense, at least in urban agglomerations. If the researchers can develop a fully mature technique, barely any further investments would be required: the infrastructure already stands, ready to use. Pfister's team is currently collecting and evaluating data from two directional radio links, running between four antennas within the city. Rainfall disrupts the microwave signal; the amplitude of the disruption should theoretically indicate the intensity of precipitation along the signal's line. In order to quantify the disruption and to evaluate the functionality of the cell phone network as a rainfall measurement device, the CRP-GL team have set up a

network of strategically placed rain gauges. According to Pfister, the first results are certainly promising. In a next step, the use of an entire network of crossing transmission lines should not only provide quantitative data, but also allow for a clear spatial delineation of the precipitation.

Besides from its fundamental research value (Pfister and his team are one of only a few groups world-wide to explore this technique), a successful RAINCELL project would lead to important practical applications as well. From a general point of view, the technique could find great use in any area that requires the management of an influx of large volumes of water within short periods of time. The team of the CRP-GL has a specific interest in the urban water cycle. One of their aims is to improve their current first-flush model for the city of Luxembourg.

The first fifteen minutes into an "urban downpour" are the most important for the so-called first-flush. Torrents of water flow down the streets, carrying with them not only dust and litter, but also heavy metals and oils that have accumulated on the tarmac. Theoretically, this first wave of surface run-off should be caught in the city's sewage plants. In practice, most of it flows straight into the city's rivers. The sewage plants can only hold a limited amount of water before overflow: a deviation of surface run-off into the plant thus needs to be tightly controlled, a process that relies heavily on accurate rainfall measurements and modelling performances.

"Our ultimate aim is to determine the extent to which a combination of weather radar, rain gauges and cell phone network measurements enable us to make more accurate short term predictions of the urban water flow. Optimised models should then enable us to achieve a controlled deviation of first-flush into the sewage system", explains Pfister. The previous models have already been adapted; once a sufficient data set is available, various combinations of input data will be tested. The next year will certainly still bring plenty of challenges to the team, but they are optimistic that their models will definitely see an improvement. "Once the technique has been proven valid, we can build up from there", says Pfister.