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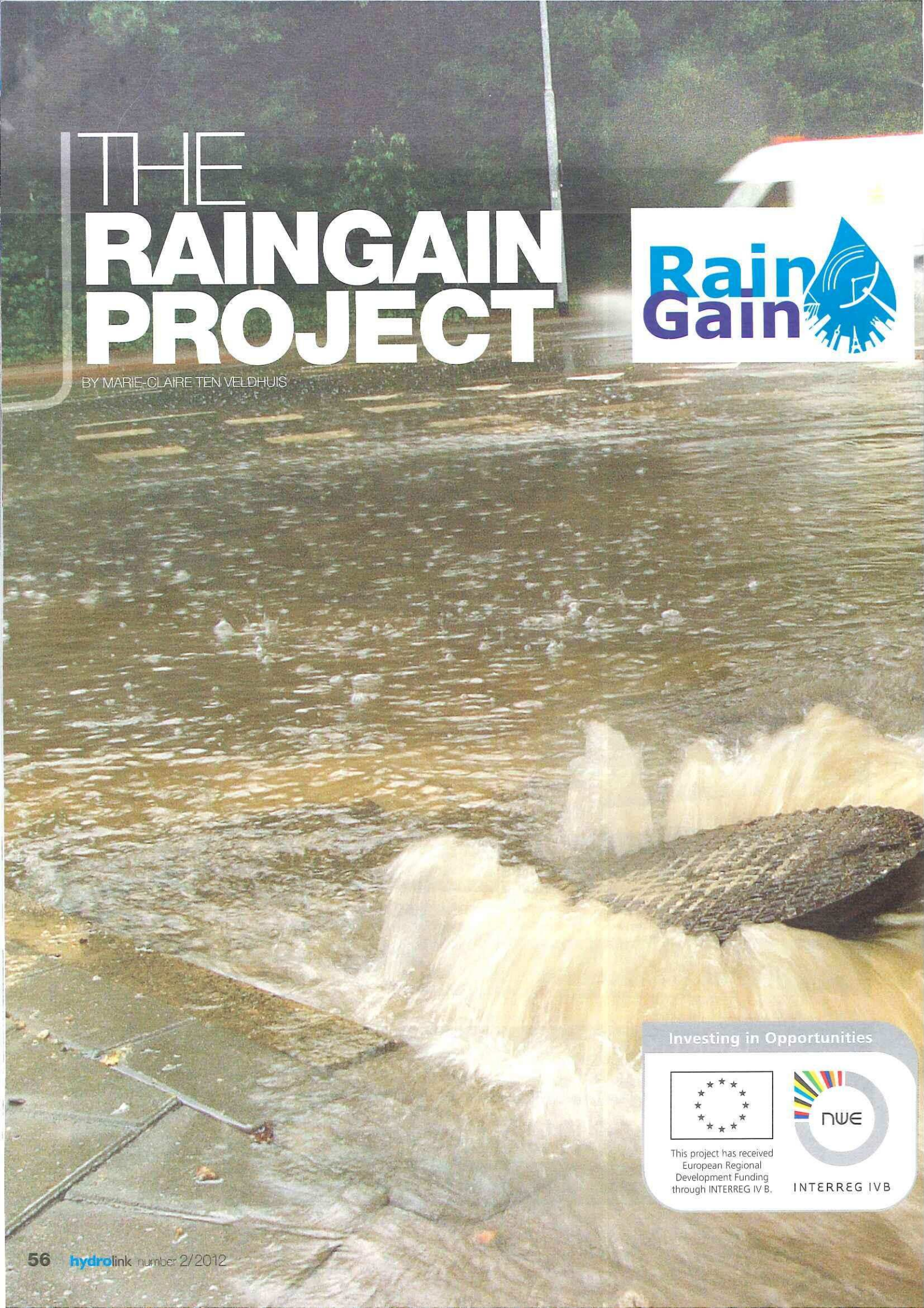
THE RAINGAIN PROJECT

BY MARIE-CLAIRE TEN VELDHUIS



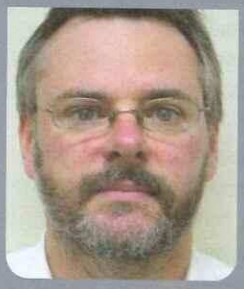
Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Marie-claire ten Veldhuis works at Delft University of Technology as assistant professor for urban drainage since 2006. She received her PhD degree in 2010 for her research on quantitative urban flood risk analysis based on data analysis of citizens' calls. She is coordinator of the RainGain project and supervises PhD research in the field of urban hydrology and flooding

Patrick Willems is RainGain WP2 leader. He is Associate Professor in water engineering at K.U Leuven and Chair of the International Working Group on Urban Rainfall of IWA and IAHR.



Johan van Assel is coordinating the model implementations for the RainGain case study of Leuven. He is senior research engineer at Aquafin.

RainGain project introduction

Localised storms with heavy rainfall can have disruptive consequences in cities for private lives and the urban economy. Accurate information about rainfall and flooding is needed to be able to prevent such damage. This information, however, is very difficult to acquire, especially for cities with their highly variable urban landscapes that cause storms and water flows to move in unpredictable ways. Whether we want to model flooding, explain occurred flood damage or flood complaints, accurate rainfall data are an absolute necessity and precisely this type of data is lacking for urban areas.

That is why the RainGain project was started: to obtain detailed data about peak precipitation and flooding at an urban scale. Rainfall radars will be implemented at four pilot locations: Leuven, London, Paris and Rotterdam, using the latest available technologies. The pilots serve as test sites to demonstrate the capabilities of radar technology for urban rainfall estimation and forecasting. The pilots represent a variety of urban characteristics, where different types of radar technologies will be tested; RainGain thus provides an outstanding platform to test the implementation of rainfall radars in urban areas.

Radar data will be used in detailed urban flood models to simulate and predict urban flooding down to the level of individual households. This information will help water managers in the cities to react adequately to heavy precipitation and to develop effective solutions for improved flood protection, such as warning systems and optimisation of storage capacity. Water managers from the four pilot cities are actively involved in the RainGain project to make sure the developed rainfall and flood data products are made fit for use in water management practice.

The project comprises 13 partners from four countries, Belgium, France, the Netherlands and the UK, including research institutions, meteorological agencies, cities and water management organisations. Their work is centered around the four pilots where innovative radar technologies will be installed for rainfall acquisition and forecasting. Installation of newly acquired state-of-the-art X-band dual polarisation radars is foreseen in the pilots Rotterdam and Paris in autumn 2012. In London and Leuven existing radars will improved to develop better protocols for fine-scale rainfall estimation in urban areas.

Introduction Leuven Case Study

Mid of 2007, the Flemish water company Aquafin in cooperation with the University of Leuven (KU Leuven) installed a short range high resolution X-band weather radar in the city centre of Leuven (Belgium) (Figs.1 & 2). The radar observations cover the entire area of the city of Leuven, which is the capital of the Province of Flemish Brabant in Belgium.

Water management aspects larger Leuven drainage area

The larger Leuven drainage area, as is the case for many cities in NW Europe, suffers from frequent sewer pressurizations and occasional

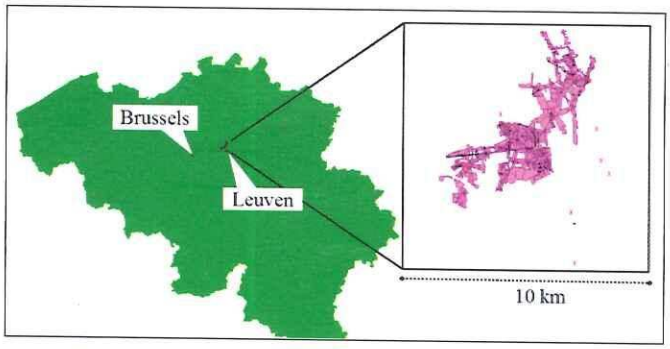


Fig. 1: Location of the city of Leuven, east of Brussels, in Belgium, and the sewer network and rain gauges installed in and around the communities of Winksele, Herent and Wijgmaal, north-western part of the larger Leuven drainage area.

Fig. 2: Location of the Leuven X-band radar of Aquafin, on the roof of the Provinciehuis building.

floods. Due to ongoing urbanization trends and climate change it is expected that the frequency of sewer floods will significantly increase in the future (www.iwawaterwiki.org/xwiki/bin/view/Articles/ICCREUDS). Aquafin is one of the water authorities/companies involved in the project. As a sole wastewater utility in Flanders (6,100,000 inhabitants), Aquafin operates about 230 wastewater treatment plants and almost 1,000 pumping stations. In search for an optimum flood management and control strategy, Aquafin prospects several modelling and monitoring possibilities. Tailored action plans are being drawn up, and a cost-benefit analysis of several static and dynamic adaptation and remediation measures is undertaken. This includes the use of Real Time Control (RTC) strategies and the set-up of a nowcasting system, which requires accurate fine-scale rainfall estimates and short-term forecasts using local radar technology. This RAINGAIN project will contribute to this need.

Experimental site

The experimental site that will be considered for the RAINGAIN project by Aquafin in cooperation with KU Leuven is the sewer network of the communities of Winksele, Herent and Wijgmaal, situated in the north-western part of the larger Leuven drainage area (Fig.1). The total catchment area of this network is about 9.13 km^2 and counts approximately 16,100 inhabitants. An existing sewer network model has been developed for that region by Aquafin. It contains several combined sewer overflow structures (CSOs) discharging on surface waters, of which four are permanently monitored since 2007. Along with this, flows and water depths are measured in a couple of other points in the sewer system, and rainfall is measured (at 2 mins interval) at four locations. Six more rain gauges (10 mins recording) from the Flemish Environment Agency (VMM) are available in this area, and four more rain gauges will be installed by Aquafin within the scope of the RAINGAIN project.

Leuven is approximately located at equal distance from the operational C-band radars at Wideumont (Royal Meteorological Institute of Belgium: RMI) and Avesnois (Météo-France). It is worth noting out that the Avesnois radar was installed under an Interreg project ("Radar du Nord") lead by Météo-France. Other partners were the Walloon region of Belgium, RMI, and different local authorities in the North of France. Moreover, it is very near to the operational C-band radar from Belgocontrol at Zaventem (Brussels Airport). An additional new Dual Polarization radar will be operational from spring 2012 near the Belgian coast at Jabbeke (Fig.3). In the RAINGAIN project, these different rainfall sources will be combined and integrated with Numerical Weather Prediction of RMI for the purpose of fine-scale rainfall nowcasting. The short-term rainfall forecasts can be used as input in the urban drainage system model of the study case to simulate 2D sewer inundations, in support of sewer flood forecasting, warning and RTC. Improved fine-scale rainfall estimates also will increase the accuracy of the urban drainage simulation models, hence increase the accuracy of these models as decision support tools.

National Observer Groups have been set up in each of the partner countries to disseminate project information and receive input from local organisations. More details of project activities can be found on the website www.raingain.eu. If the information in this article has triggered you to become more closely involved in RainGain, you are cordially invited attend one of the annual National Observer Group meetings in Belgium, France, the Netherlands or the UK or one of the international project events

Some technical specifications of the Leuven radar

The Leuven radar is a City Local Area Weather Radar (City-LAWR). It is a radar system based on naval navigation equipment, developed and distributed by DHI Water & Environment (Denmark). The antenna emits electromagnetic waves with a frequency of around 9410 MHz – this corresponds to a wavelength of approximately 3.2 cm – so the radar operates within the X-band. Its peak output power is 4 kW. Despite this low output power, no broadcasting licence would be delivered by the authorities without the guarantee that no waves would be emitted in the direction of Brussels Airport, out of precaution of interference with a ground communication system. After all, Brussels Airport is located only 15 km west of the catchment. The antenna has a width of only 55 cm, protected by a plastic cover (the radome with a diameter of 64 cm) and a weight of 8 kg. This limited size and weight make the system easy to install, and offers more flexibility in selecting a suitable installation site.

The Leuven City-LAWR is capable of delivering data with a spatial resolution of 125 m x 125 m. This high resolution implies less spatial averaging of the errors. On the other hand, the antenna rotates at 24 rounds per minute, taking a full 360-degree scan with each rotation. Each radar image, delivered every minute, is calculated as the average of those 24 scans. The vertical opening angle is 10 degrees up and down when pointing horizontally.

Finding the appropriate location was a critical step in the installation of the system, especially in the urban environment of the region. To find a suitable installation site for the City-LAWR, an empirical approach based on on-site clutter tests was used. In these tests a Micro radar (DHI) was used to carry out test experiments at each site of interest. This was done during dry weather conditions, since during such periods all received echoes can be assumed to originate from ground targets, such as buildings, roads and hill slopes. The resulting images are then used to assess the expected amount of clutter to be expected when the City-LAWR would be installed on the specific site. The procedure is described in detail by Goormans et al. (2008), as well as the results from the candidate sites. From those results, it was decided to install the radar on the rooftop of the "Provinciehuis"-building – the office building of the provincial government of Flemish Brabant –, 48 m above ground level (Fig.2). The system is provided with a broadband connection, which enables remote control and facilitates data retrieval. The system performs various pre-correction steps to the data before storing it locally, such as attenuation correction, volume correction and clutter subtraction.

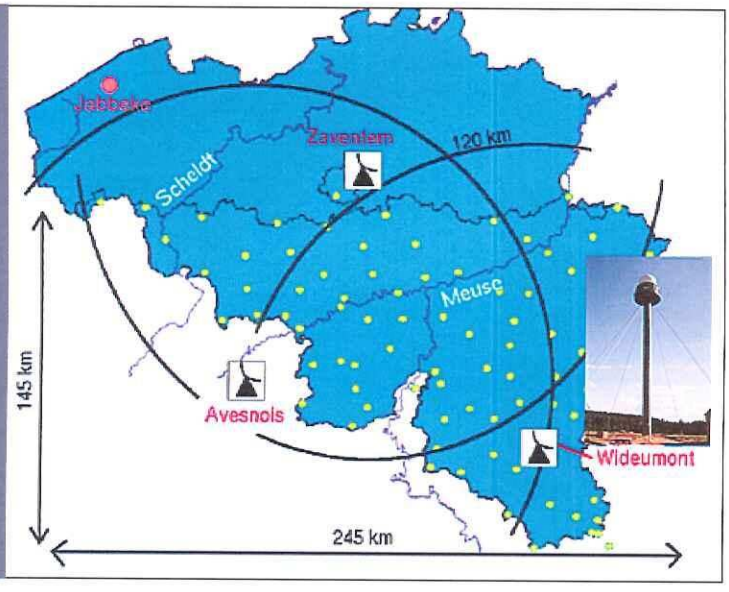


Fig. 3: Location of the SP C-band radars at Wideumont and Zaventem and the DP C-band radar at Jabbeke