# Monitoring of Stormwater Runoff with UV/Vis spectrometry

*Polluted stormwater runoff is a major problem in urbanised areas. Online monitoring of the pollution loads helps to devise effective management strategies.*

By Norlida Mohd Dom, Ismail Abustan, Robert Wurm and Joep van den Broeke

Stormwater runoff is a major cause of deterioration of surface water quality in urban areas. Runoff is the excess water which flows over land when the soil is infiltrated to full capacity during a storm event. It is mainly the result of rain falling on impervious or sealed surfaces such as pavements, roads and buildings. Even a light shower can produce runoff on these surfaces.

Thus, when rain falls on paved surfaces, large volumes of water are swiftly carried to (storm) drains and discharged into receiving surface waters. Along the way, the water picks up contaminants such as soil sediments, nitrogen, phosphorus and other chemicals, bacteria and metals, mainly arising from atmospheric dust and dirt from streets and vehicles, fertilisers and pesticides from agriculture and direct discharge of pollutants into storm sewers systems. It is known that surface water quality declines with the increase in sealed or paved surfaces in a watershed.

The majority of the pollutants originates from unidentifiable sources and are transported into receiving waters in a diffuse manner. Such non-point sources (NPS) are difficult to control. To formulate effective management strategies, estimation of the NPS loads directed to the receiving water courses is required. Storm event sampling and runoff quality analysis are fundamental to estimate pollutants loads and understand their characteristics. Due to the fast-changing nature of the runoff, effective sampling requires online monitoring equipment which operates at a high measurement frequency.

### Measuring and Monitoring

The s::can spectro::lyser™, a fully submersible, online spectrometer is ideally suited for this type of application (Figure 1). The spectrophotometric principles used in these probes allow for the determination of multiple parameters from a single source: the UV/Vis absorption spectrum. This makes it possible to use a single probe to measure e.g. COD, COD-filtered, BOD, TOC, DOC, $NO_3$-, $NO_2$-, TSS and turbidity. For long-term stability of the measurement signal, a dual light beam design is used: one beam passes through the sample while the other beam travels through an internal reference pathway and is used to compensate for any changes in the instrument (Figure 2).

Robustness is further enhanced by the absence of any moving parts in contact with the water and the use of compressed air for automated cleaning. Thus, it possible to operate the s::can spectro::lyser™ without ever taking it out of the water, resulting in almost zero operating costs. Besides the spectro::lyser™, s::can also supplies sensors to measure additional parameters for stormwater monitoring. These are the condu::lyser, oxi::lyser and ammo::lyser instruments which monitor TDS, DO and ammonium, respectively.

*Figure 1: River water monitoring using the s::can spectro::lyser™*

### Sungai Kerayong

For some time now, pollution loads during storm events have been investigatedin the Sungai Kerayong catchment, the majority of which is located in the city of Kuala Lumpur. This catchment is highly urbanised, with residential zones covering 50% of its surface area. During a 45-day monitoring campaign, the spectro::lyser™ was used to measure COD, BOD, TOC, DOC and NO3-N at 5 minute intervals. For this


Ultraflote CORPORATION
AN ISO-9001:2000 COMPANY
Qualify & Specify Before You Buy!
Advanced Aluminum Tank Dome & Basin Cover Technology
Best Prices – Best Delivery – Best For Your Project
Website – www.ultraflote.com
Email – covers@ultraflote.com

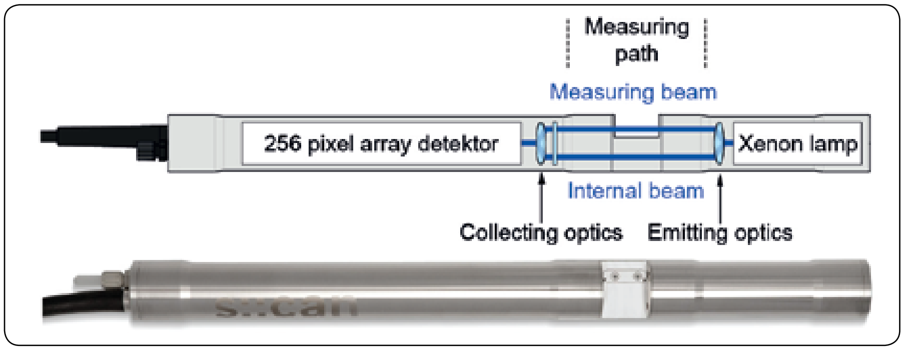


*Figure 2: The s::can spectro::lyser™.*

*Figure 3: Installation site of the spectro::lyser™*

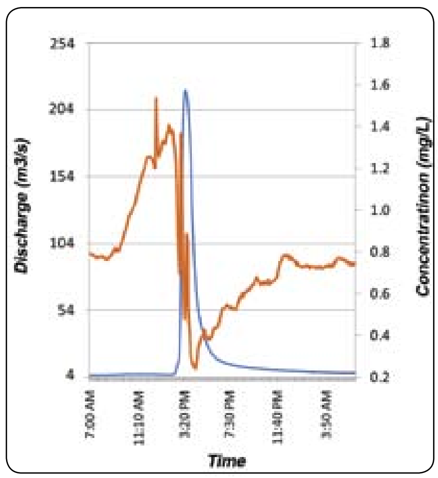


*Figure 4: Pollutograph, plotting discharge (blue) and pollutant concentration (orange) vs. time, clearly showing the first flush effect followed by a decrease in concentration below the dry period level due to dilution effects.*

temporary installation the instrument was powered by a dry cell battery. The compressed air, used to keep the instrument free from fouling and sediments, was supplied from a 5L air bottle. During this monitoring period, eight storm events were monitored. Concentration measurements were converted into pollution loads using a water-level-discharge rating curve developed for the river flow.

## Characteristics of Rainfall Events

The online measurements in the Sungai Kerayong River confirmed that the water quality changes dramatically and very rapidly during storm events due to runoff. Peak discharge depended strongly on peak rainfall intensity and its duration. The mean concentration of contaminants in the water was mainly dependent on the rainfall intensity, with high intensity leading to dilution of the pollutants. Furthermore, a first flush effect was observed especially for parameters affected by particulates collecting on surfaces during the dry periods preceding storm events. For example, up to 62% of the total TDS load was seen to be present in the first 30% of the cumulative discharge. Generally, pollutographs (Figure 4) showed a rapid increase in pollutant concentration before peak discharge, followed by gradual decrease.

Pollutant loads were calculated based on the online concentration measurements and the level-discharge rating curve. In all cases, the contaminant loading was high, indicating that the urban catchment is severely polluted, with pollutant loadings in the Sungai Kerayong catchment up to 9 kg/Ha for COD. Similar high COD loadings were also observed in studies in other urbanised areas in Malaysia.

An inventory of wastewater treatment plants in the catchment indicated that some plants were badly overloaded, handling as much as 32% more PEs than they were designed for. This contributes to the continued poor river quality, even though frequent intensive storm events 'flush' the catchment.

Despite a clear relationship between precipitation and water quality variation, accurate prediction of peak concentration and pollution loads proved impossible. To monitor the rapid variations in water quality and accurately measure the cumulative pollutant loadings, online monitoring is essential. The s::can spectro::lyser™ was found to be a tool ideally suited for this purpose.

## Summary and Outlook

Stormwater runoff is a major source of surface water contamination, especially in urbanised areas with large impervious surface areas. Management of this water of highly variable quality requires insight into its dynamics. Due to the rapidly changing quality, online monitoring is necessary. The s::can spectro::lyser™ has proven to be an ideally suited instrument for the monitoring of river water quality. At Sungai Kerayong it has been used for the online measurement of suspended solids, organic parameters as well as nitrate. This has allowed the documentation of water quality variations during various storm events as well as characterisation of first flush phenomena and pollutant loadings. This information is indispensable for the development of best management practices and efficient treatment strategies. Furthermore, online water quality information allows proactive management of treatment plants to handle variable treatment requirements.

Norlida Mohd Dom is hydrologist at the Department of Irrigation and Drainage Malaysia. Ismail Abustan is Professor at the School of Civil Engineering, Universiti Sains, Malaysia. Joep van den Broeke is water quality and sensoring consultant at Benten Water Solutions. For more information, please contact Robert Wurm (at sales@s-can.at or visit www.s-can.at)