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ASSESSMENT OF OIL-INTERCEPTOR PERFORMANCE FOR SOLID REMOVAL IN HIGHWAY RUNOFF

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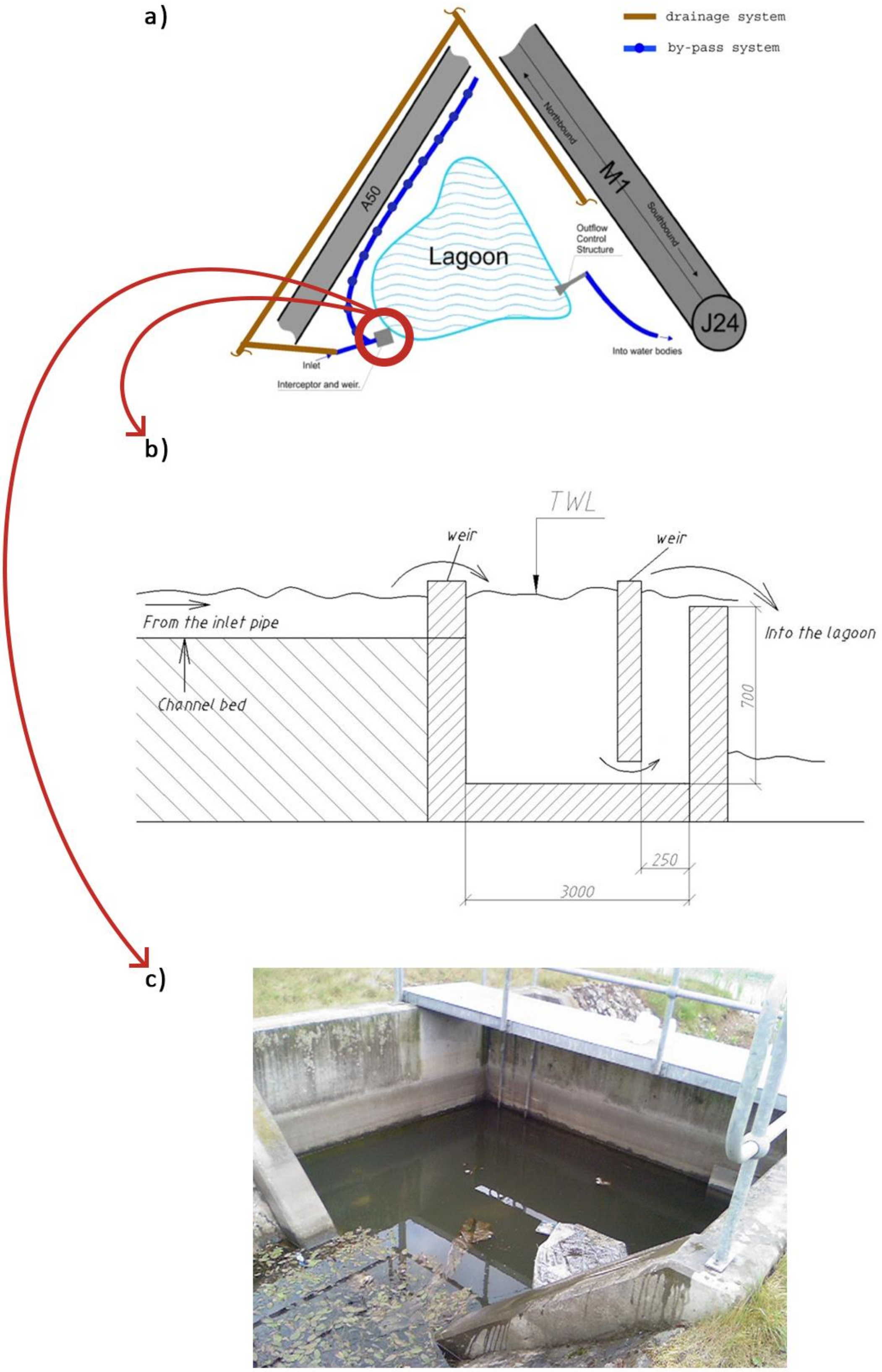
Abstract

Oil interceptors are traditional SuDS devices used in highway runoff treatment to remove both floatable impurities (leaves, oil) and total suspended solids (TSS). This paper presents the results of an examination of the performance of an oil interceptor based on particle size distribution (PSD) and TSS during three rainfall events. The interceptor is situated on one of the busiest motorways in the UK (where peak traffic flow is 30, 000 vehicles per hour). Although the overall data collected for this study provided evidence that the interceptor removed, in most cases, 70 % of TSS, the data for particle size distribution (PSD) showed that the interceptor did not always cope with particle separation for particles of less than 25 μm diameter.



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Key words: ADWP; highway runoff; oil interceptor; Particle size distribution; SuDS; Total suspended solids.

Introduction

Excessive amounts of suspended solids adversely impact receiving water courses and a criterion for assessing the performance of any water treatment system will be its success in removing solid wastes (Pfeiffer et al., 2008).Thus, for highway runoff, for example, such a system is provided by a unit called an interceptor, i.e. a trap that is used to prevent hydrocarbons from flowing into the water environment in the event of a road traffic accident with oil spillages. These devices, which are based on gravity separation, will also be effective in the removal of total suspended solids (TSS). Oil interceptors capture coarse particles on the surfaces of which, according to the fundamental theory, ions of metals, inorganic salts and aromatic hydrocarbons would occur. These contaminants might subsequently be released into the water column, which could have an adverse effect on the aquatic environment (Pouran, 2008 & 2018[a]) Most highway runoff treatment systems include an interceptor, if only to catch accidental spills (Crabtree et al., 2006; DMRB, 2017).

The transport of particles would be a function of their velocity, density and the particle size. Particle size will influence the particle settling velocity and, as a consequence, the efficiency of the interceptor during the treatment process (Drapper, 2008; Li et al., 2005; Pouran, 2018[b,c], Sansalone et al., 1998).

How can solids be characterised in stormwater runoff?

Solids in stormwater runoff are classified using various methods, most of which are dependent on particle size. Total solids (TS) encompass all solids found in runoff, both suspended and dissolved. TSS refers to particles that exceed 1.2 µm in size. Any particle that is smaller than 1.2 µm is classified with total dissolved solids (TDS) (APHA, 2005). A PSD analysis further categorises solids with regard to their size ranges. Solids larger than 2,000 µm are referred to as 'gravel' and those between 75 and 2000 µm as 'sand'. For size ranges from 2 to 75 µm they are termed as 'silt', while 'clay' is used for particles of less than 2 µm. All particles that are less than 75 µm in size are commonly referred to as 'fines' (Smith, 2014). Characklis and Wiesner (1997), cited in Engstrom, 2004 state that particles in stormwater runoff are designated as 'colloidal' if they are less than 1.0 µm in diameter. Particle size in stormwater runoff can significantly affect various physical and chemical processes. For example, fine particles may agglomerate, causing PSD to vary along the longitudinal path of stormwater runoff (Minton, 2002). Larger particles settle faster than smaller particles. This settling mechanism affects the relative concentrations of different sizes of particles, depending on the runoff velocity and depth of flow. Surface area, being a function of particle volume, increases significantly with decreasing particle size, i.e. smaller particles have a larger surface area to volume ratio in comparison to larger particles. This physical characteristic is enhanced by the fact that the actual particles are pitted and porous, which raises their surface area above the estimate for surface area that is based on a completely spherical particle (Sansalone et al., 1998).

Solids may enter stormwater runoff through different routes and one of them is the erosion of natural soils. As to the highway runoff in particular, then solids will enter the runoff stream from vehicle emissions, vehicle tyre, engine and brake wear, as well as through pavement wear and atmospheric deposition (Sansalone et al., 1998; Crabtree et al., 2006). The concentration and size distribution of solids depend on the runoff rate, runoff duration, traffic intensity and the location of sampling within the watershed (Sansalone et al., 1998, cited in Engstrom, 2004). TSS may demonstrate a 'first flush' phenomenon through a system, where the highest concentrations of solids are transported during the initial stages of the storm hydrograph - a graph showing the rate of flow versus time. This trend may not hold for concentrations of finer particles, which often stay consistent throughout the hydrograph. This happens due to differing settling velocities for different sizes of particles. Solids in stormwater runoff are mainly less than 250 µm (Furami and Boller, 2002), especially if best management practices (BMPs) such as street sweeping are in effect. PSD analyses indicate that most stormwater particles are quite small, especially those under low-flow conditions where larger particles are not in suspension. Memon and Butler (2005) monitored rainfall conditions at residential areas in East London and found that the predominant size fraction (65% of the total number of particles) was less than 50 µm. It was found, however, that the average particle size increased with the runoff rate. In a similar study of rainfall events in Los Angeles at highway sites with heavy traffic loads (greater than 260,000 vehicles per day), Li et al. (2006) found that more than 90% of the total number of particles had diameters of less than 10 µm. Herngren et al. (2005), on the other hand, took samples from low-traffic residential, commercial and industrial areas and found that the major fraction of particulates in the runoff samples ranged in diameter from 0.45 to 75 µm. These findings are important for the design of treatment facilities, since it is likely that most of the pollutants are attached to the finer particles (Davis and McCuen, 2005), i.e. <10 µm fraction.

Coagulation of smaller particles also occurs, thereby altering the PSD of stormwater runoff over the runoff path. For example, on analysing different storage times and temperatures of the rainwater samples, Li et al. (2005) found that the PSD could change with storage time because of particle aggregation. They believe that rapid growth in particle size is indicative of such a phenomenon as a coagulation/flocculation mechanism. According to Atteia et al. (2001), a significant fraction of all particles greater than 10 µm lump together to form larger conglomerate particles. Li et al. (2005) believe that an increase in particle size could have a profound impact on sample storage and, as a result, on the design of stormwater treatment systems because of its effect on settling capabilities, as noted in Atteia (2001).

While studying the central parts of Luleå in norther Sweden (with a traffic intensity of about 7400 vehicles per day) Westerlund and Viklander, 2006 concluded that there was a significant difference in PSD between melting and raining periods. Another useful conclusion made as a result of their study was that cold climates require special considerations, so that different treatment solutions should be considered during different seasons or in different climatic regions.

The aforementioned studies show that solid characterisation is a broad subject and their concentration and size distribution in highway runoff will depend not only upon stormwater characteristics and traffic intensity but also the relevant seasons and climate zones. We can also see that the majority of studies have been devoted to the particle size characterisation of runoff, and their results and findings are amenable to systematisation and fairly close comparison. A more complicated picture, however, is evident in cases where it is necessary to summarise and compare stormwater systems based on particle size characterisation. According to USGS (2011), a great number of BMPs provide some level of sediment control. However, their effectiveness will depend on the range of particle sizes in stormwater runoff, as the devices rely on the settling of solids. Another challenge is that there are a large number of different types and constructions of separators and interceptors and their location within the stormwater system may also differ. Moreover, different methods of analysis might be used to assess the performance of this or that device. Thus, Wilson et al. 2009, for example, evaluated the performance of a hydrodynamic separator in respect of its suspended solid removal efficiency using a Pèclet number to account for two major processes: (1) settling of particles and (2) turbulent diffusion or mixing of particles. Another study (Alam et al., 2018) analysed catch basin inserts (CBIs) – another device used in BMPs for the reduction of stormwater pollution in urban runoff. On top of that, the test results will be overcomplicated by the fact that different monitoring programs have been used, e.g. real rainfall events or simulated rains, and different parameters have been measured, e.g. flow rate or rainfall intensity. Hence, the factors referred to above make the comparison of presented data and findings about stormwater systems questionable. Some studies focussing on particle size distribution are available but the devices in question are related to different areas, such as recirculating aquaculture systems, for example (Pfeiffer et al., 2008).

This paper provides test data and details of the performance of an oil interceptor which functions as part of the treatment systems SuDS lagoon based on PSD at the busy junction 24 of the M1 motorway in the UK.

Runoff samples were collected on three rainfall occasions and PSD and TSS before and after passing through the interceptor were analysed to assess its performance.

Methods

The following section describes the sampling site, which was an M1 motorway lagoon, as well as sample collection and preparation.

Sampling site

The location selected on the M1 was on the northbound carriageway (labelled junction 24A). This location is at Kegworth, approximately 7 miles north of Loughborough. A general view of that area is shown in Figure 1, as well as the location of the lagoon, which is circled in red.

This stretch of the M1 motorway is one of its busiest sections, linking as it does the major East Midland cities, and it has one of the highest levels of traffic in the UK (peak traffic flows are 30,000 vehicles an hour). The test site is located at the junction of the M1 with the M42 and A50 link roads. During rainfall events the runoff flows along a ditch adjacent to the motorway which links up with the drainage from the A50 slipway, by means of which runoff is channelled into an oil interceptor before entering a SuDS lagoon (Fig. 2a). An impermeable area of around 3,000 m^2 is drained by this means. The volume of the lagoon is 2000 m^3 and the average depth is 0.9 m. More detailed information on the history of the sampling site as well as conditions of the runoff formation for the studied area have been thoroughly described and presented in Zakharova et al. (2020).

Table 1 shows the dimensions of the oil interceptor and Fig. 2 (b, c) represents the oil interceptor diagrammatically as well as by photo.

Table 1 Dimensions of the oil-interceptor

Length, m	Width, m	Operating depth, m
3.0	3.5	0.7

Sample collection and preparation

Samples were collected during three random rainfall events which covered conditions ranging from those of a long period of ADWP to those of an extended wet-weather period. This was done in order to present an overall picture of the interceptor's ability to cope with different conditions during rainfall events. In total, nine samples were taken during the rainfall events. **Triplicate** grab samples for PSD were taken before the passage of runoff through the oil interceptor and after it. The technique of sample collection was different before and after the interceptor and it was as follows. Before its passage through the oil interceptor, the water was collected by a sampler from the medium layers of the water depth with minimal water disturbance. After the interceptor, the actual discharge formed a so-called 'waterfall with pressed stream', so a 1L bottle was held next to the wall facing the lagoon until the bottle was filled with the required sample. This technique allowed us to gather only the water flowing over the chamber before it touched the surface of the lagoon. Consequently, this method enabled us to collect a water quality sample which was more representative, demonstrating the 'pure' work of the interceptor during a monitored rainfall event, rather than having the sample biased by the presence of sediment from previous rainfall events. A similar technique, after the interceptor, was used by Li et al (2005), whose aim was to characterise PSD of highway runoff in order to develop a protocol for reproducible results. The samples were collected from a free waterfall as runoff exited the drainage pipe.

Upon collection, samples for PSD were analysed within 6 hours to prevent their natural aggregation (Li et al., 2005).

Analysis was carried out by means of a "Mastersizer" 2000 analyser (Malvern Instruments) which allows particles to be measured in a range from 0.02 µm to 2000 µm with a degree of reproducibility that depends on the obscuration factor, i.e. the particle concentration from 10 to 20%. The gently inverted sample (Li et al. 2005) was put into a 850 ml glass beaker. Analysis of the sample could only proceed when the correct obscuration values, ideally 15%, were maintained for 6 seconds. The analysis of each sample was repeated 5 times and the three best results (±5%) were chosen to create an average result. During the sample analysis the sample was stirred with the magnetic stirrer. In their study, Li et al. (2005) found that gentle inversion and stirring produced similar PSD results. When the analysis was finished and the graph had been plotted, the sample was drained into the sink and the system was cleaned three times with deionised water, making sure that the system reached a background reading that showed an obscuration value of below 1 %.

Samples were also collected for the study of the TSS content. They were stored at 4°C until analysis had been performed within 24 h. The analysis was carried out in accordance with APHA, 2005.

Upon arrival at the test site, a rain gauge was installed and the amount of precipitation was also recorded.

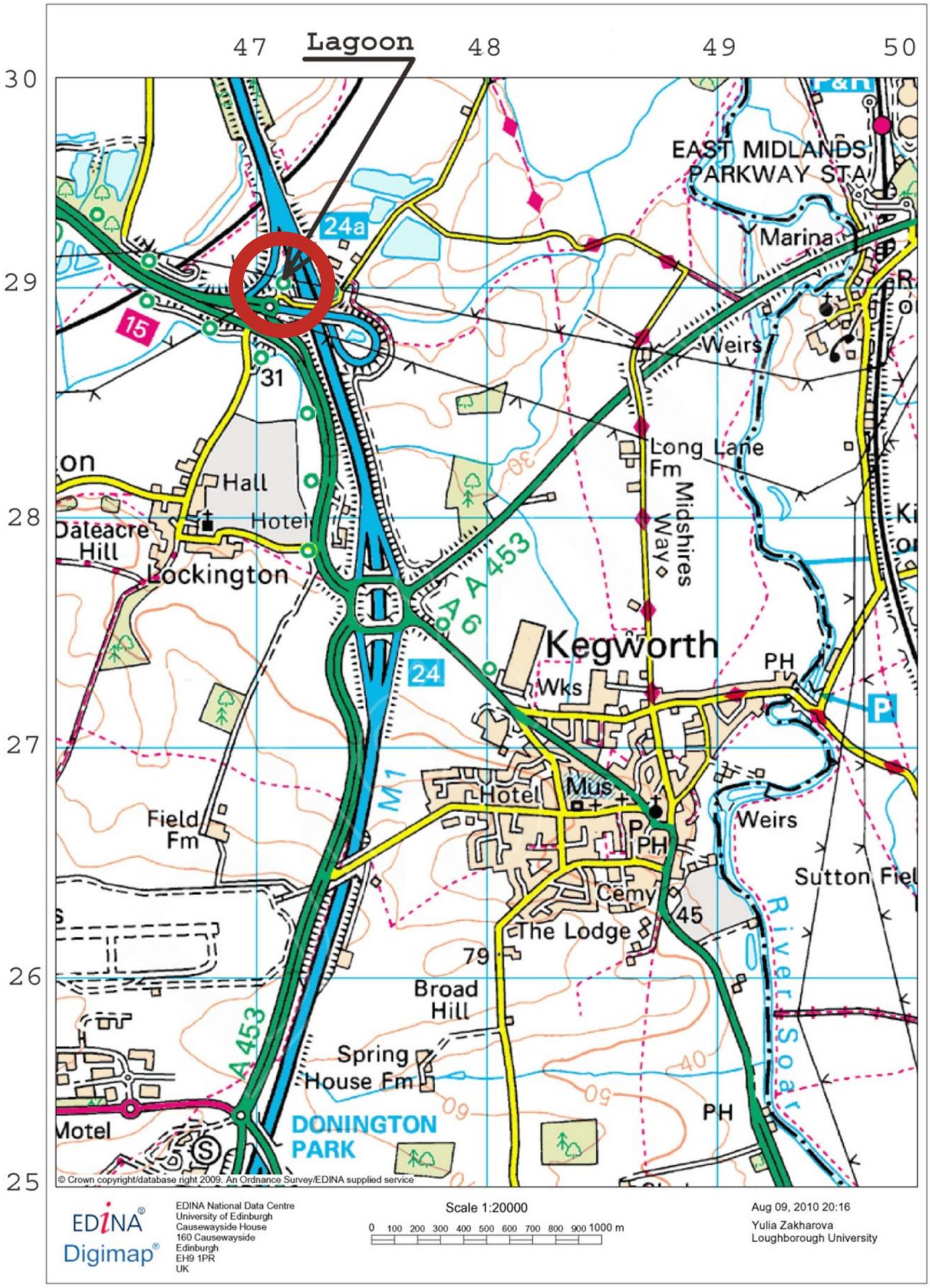


Fig. 1 General view of the M1 (Junction 24)

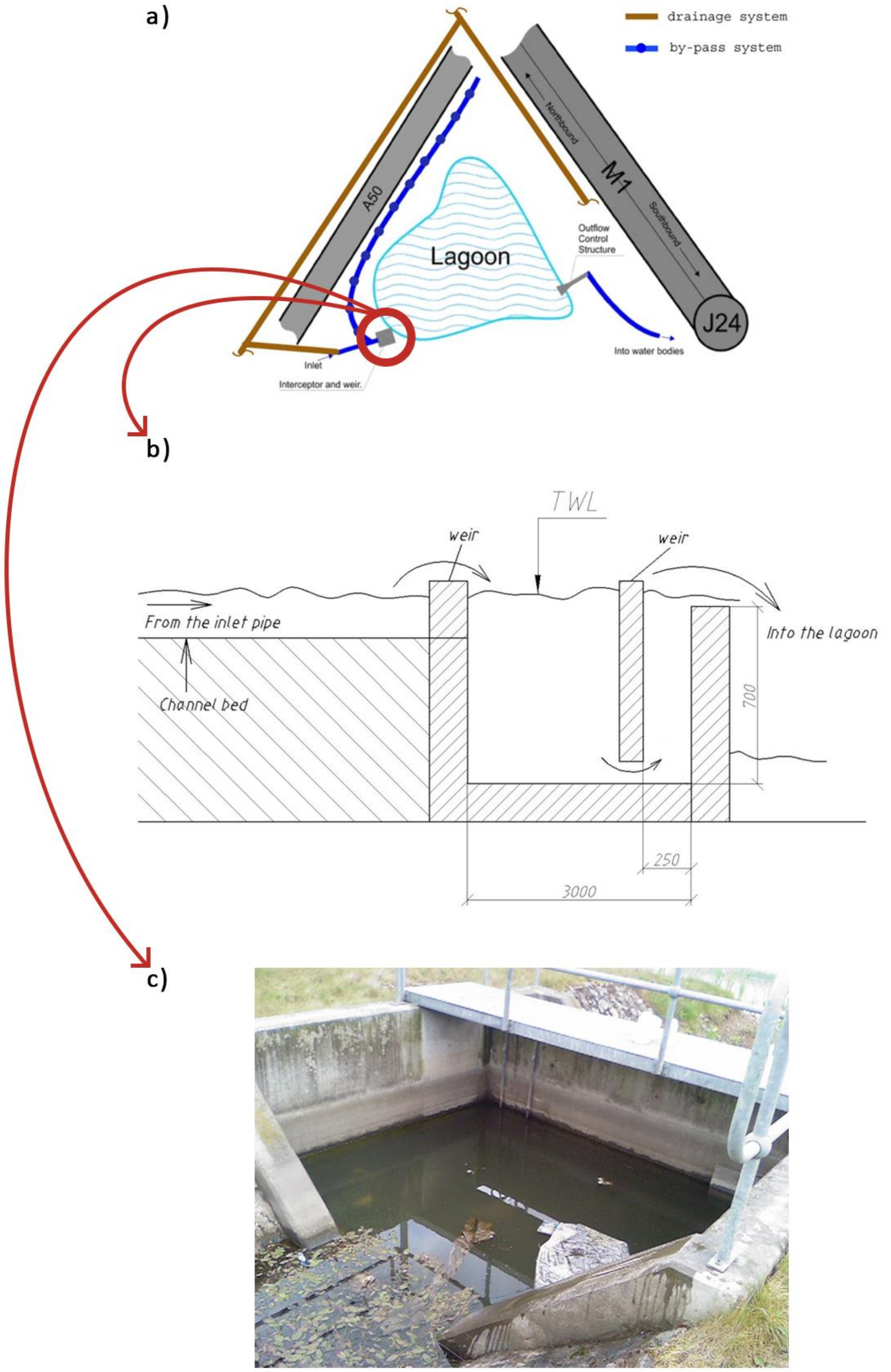


Fig. 2 Oil-separator: (a) schematic view of the SUDS lagoon with the oil separator (circled); (b) the diagram of oil separator; (c) receiving chamber of oil interceptor

Results and Discussion

Observed rainfall events and sample size

Despite the fact that over the monitoring campaign a good number of rainfall events were observed, only certain rains were considered to be suitable for the interceptor performance analysis. These rains are summarised in Table 2. Two main conditions, while choosing the rains for this analysis, should have been fulfilled: 1) The event should have been observed from the very beginning, i.e. from when it started; 2) there should have been a sufficient amount of rain water to cause actual discharge from the interceptor into the lagoon itself. Although the sizes of the particles and their concentrations (TSS) may vary widely according to the weather conditions, the chosen events represented two common, frequently occurring weather conditions in England: 1) prolonged wet weather and 2) prolonged dry weather. It is worth noting that, according to Zakharova et al. 2020, the variables in weather conditions and long-term trends will affect the statistical reliability of the results and, ideally, continuing work will always be needed to adjust the range of values determined in any further study.

Table 2 Observed rainfall events

Number of event	Weather conditions before the event
I, 11/07/2008	Prolonged and extended wet-weather period, (Fig. 3a).
II, 09/09/2008	Prolonged and extended wet-weather period (Fig. 3b).
III, 03/07/2009	Prolonged dry-weather period with a high ambient temperature of around 30°C (Fig. 3c).

Some characteristics of the observed rainfall events linked to overall performance in terms of TSS removal are summarised in Table 3.

Table 3 Overall interceptor performance linked to some characteristics of the observed rainfall events

Rainfall event	Observed amount of precipitation, mm	Time of taking samples for PSD and TSS concentration	TSS, mg/l	
			Before interceptor	After interceptor
I	6	2.45 pm	42	7
		3.00 pm	45	12
II	1.7	9.30 am	13.75	4.75
		9.45 am	45	10.25
		10.00 am	76.43	22.5
		10.15 am	105.95	41
III	14.1	2.00 pm	86	10.5
		2.15 pm	118	49
		2.30 pm	121	41

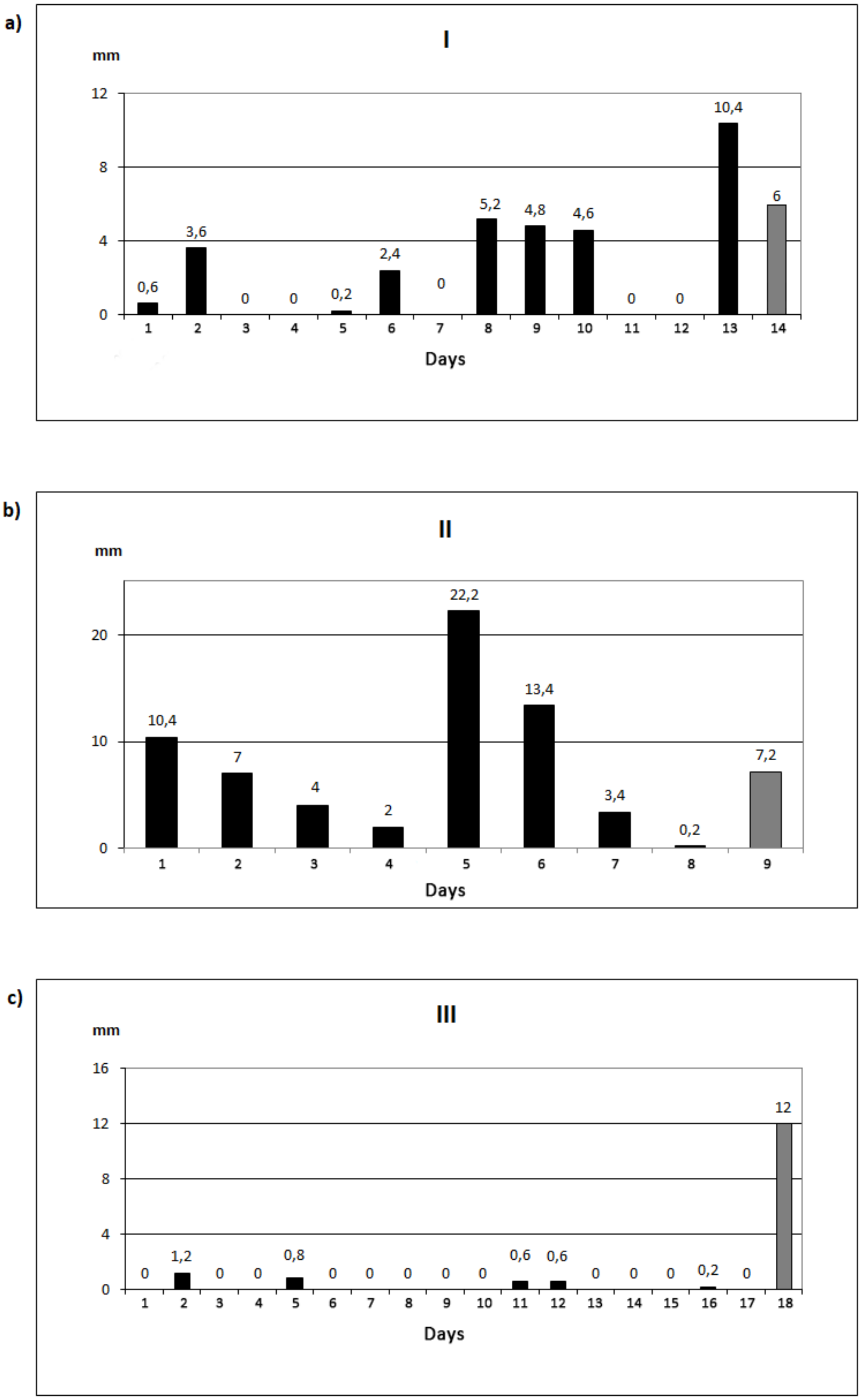
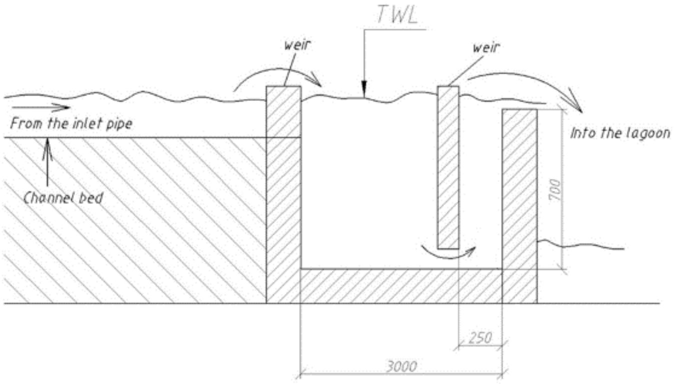


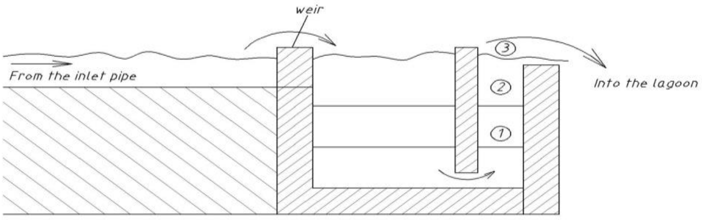
Fig. 3 Daily precipitation: a) from 28th June to 11th July 2008; b) from 1st to 9th September 2008; c) from 16th June to 3rd July 2009

Water accumulation within the chamber of the interceptor for the three events (**I**, **II** and **III**) is shown in Fig. 4.

a) I, II



b) III



1 - prior to storm (48 cm); **2** - 4 hours after the storm started (57 cm); **3** - overflowing point (70 cm)

Fig. 4 Water accumulation within the interceptor for three rainfall events: a) rains **I** and **II**; b) rain **III**

From Fig. 4 and with the support of Fig. 3 (a – c) showing the precipitation, one can see that for rains **I** and **II**, at the beginning of the rainfall events the oil interceptor was already full and the discharge into the lagoon began after the rains had started.

Analysing Table 3 further, one can see that for all rains, in terms of their periods of sampling and types, the oil interceptor removed TSS to some extent (from 58 to 85%). More polluted water (TSS from 41 to 49) was flowing into the lagoon towards the end of the actual discharge, assuming that the water will undergo the sedimentation process in the lagoon itself.

Alam et al. (2018), on analysing different types of interceptors – catch basin inserts – also reported high removal efficiency of the TSS (70 – 80%), although the initial mean concentration of TSS was around 165 mg/l.

Rainfall event **I** happened during a period of prolonged wet weather. Fig. 3a shows the rainfall pattern from the beginning of July till the observed rain event. The samples for PSD were taken after the rain had stopped, although the discharge from the interceptor would have started before the sample was taken, bearing in mind the wet conditions that prevailed during that period.

Rainfall event **II** also happened during an extended wet-weather period and the rainfall pattern is shown in Fig. 3b. The interceptor was therefore already full (because of these overall weather conditions, the rain had already begun by the time sampling started). The total amount of precipitation before the observed event was 69.8 mm.

The storm conditions of rainfall event **III,** by contrast with **I** and **II,** followed a prolonged dry-weather period. The actual discharge into the lagoon took place only after the interceptor had been refilled, which was after the rain had stopped. Water accumulation within the chambers of the interceptor from the beginning of the rainfall event till the beginning of the discharge (when the chamber was full) is shown in Fig. 4b. Precipitations occurring before rainfall event **III** (17 days) are shown in Fig. 3c

PSD analysis

The particle size distribution in and out of the separator is shown in Figures 5 – 8 for the three detailed events. A shift to the left suggests a reduction in particle size, as might be expected if the interceptor selectively removes the larger particles.

Thus, for example, looking at rainfall event II first (following an extended period of wet weather, see Fig. 5) the PSD noted at 9.30 am (Fig. 3b) is as would be expected.

At 9.30 am the median particle size of the effluent (d_{50}) (after the interceptor) is 11.5 µm compared to that of 17 µm found at the inlet (d_{50}) (before the interceptor). 15 minutes later, however, the pattern has changed (Fig. 5 b): the median particle size in the outlet is ~ 11 µm, as before, but the inlet median particle size has fallen to 9.5 µm, presumably due to dilution. The TSS in the feed and outlet from the interceptor increase during the storm (Table 3) and, similarly, the solid removal efficiency decreases, as might be expected when the PSD in the feed gets smaller.

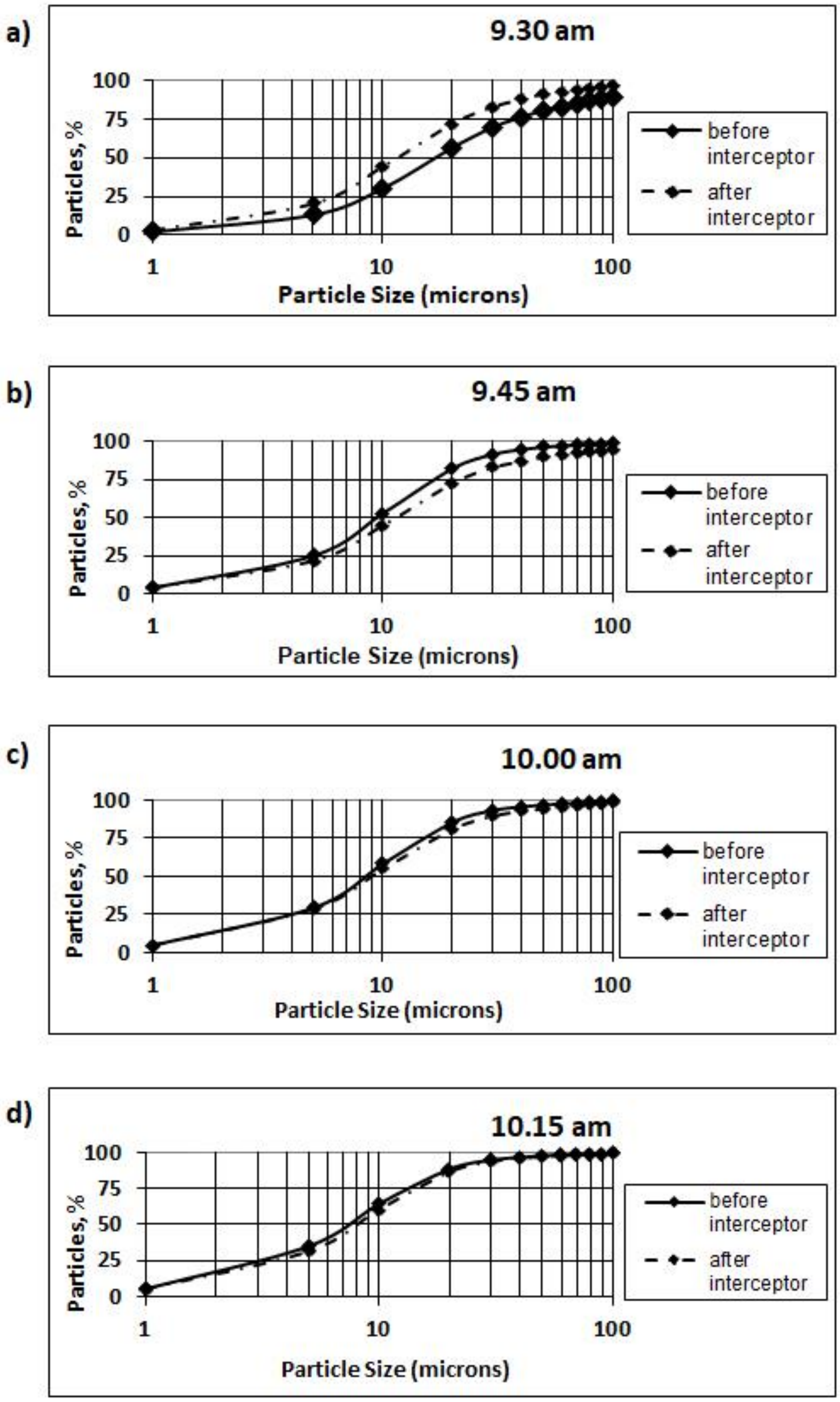


Fig. 5 PSD of the rainfall event on 09th of September 2008

There is a shift in particle size to the smaller sizes from the inlet to the outlet and this is because the larger particles are retained by the separator (TSS removal is 66%, Table 3).

The Mastersizer adjusts the PSD to the total volume of particles that it analyses, so the reduction in particle size in the feed (Fig. 5) must therefore be combined with the increase in the number of particles to give a greater mass of TSS (Table 3).

Larger particles of sediment are present in the initial stages of the rainfall event but these are captured by the separator down to a critical particle size (~10 µm). Thus the data is evidence of first flush effects. This is summarised in Fig. 6 (a – b) which shows after the first sample 9.30 am at the start of the storm that the PSDs are all very similar.

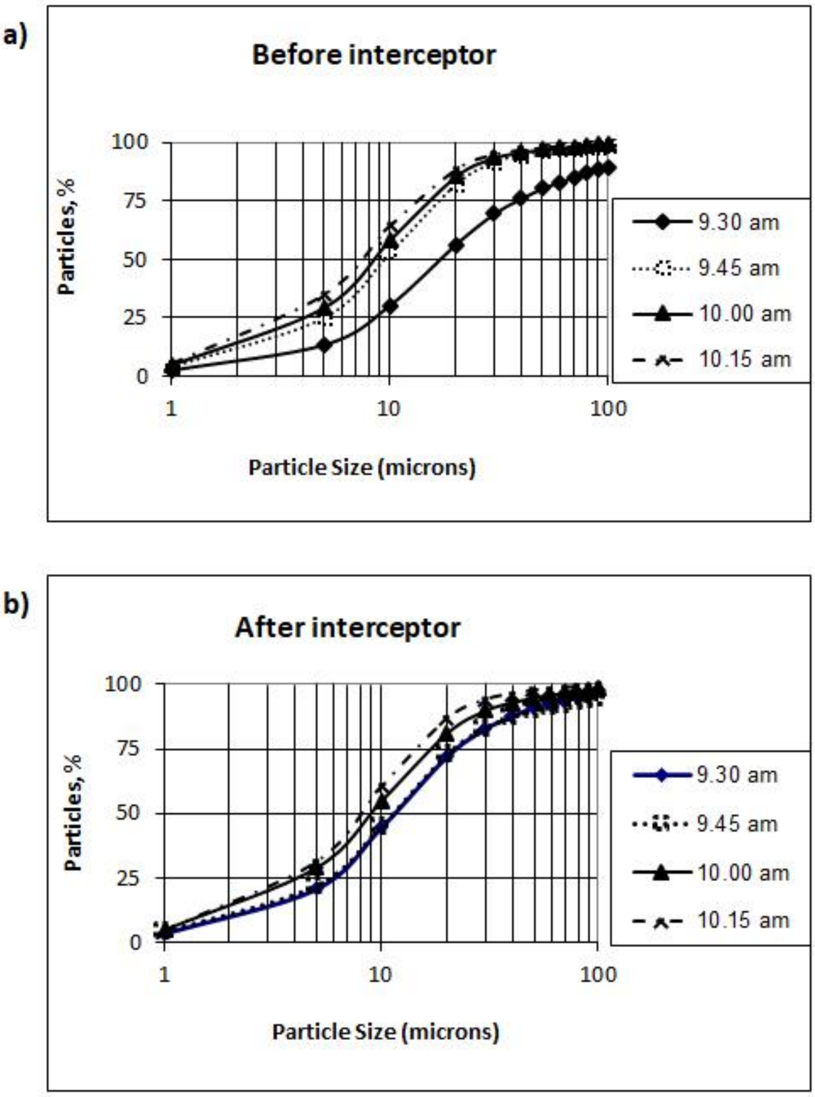


Fig. 6 Comparison of PSD before and after interceptor on 09th of September 2008

The TSS increased in both the inlet and outlet of the separator during the storm (Table 3), while the removal efficiency (range 60 – 70%) also decreased, as would be expected. As the flow rate increases the PSD reduces and this is the same in the inlet and outlet.

It could be predicted that the ADWP effect on PSD would be magnified in the storm event investigated on the 3rd July (storm III), since this occurred after a 17-day dry period.

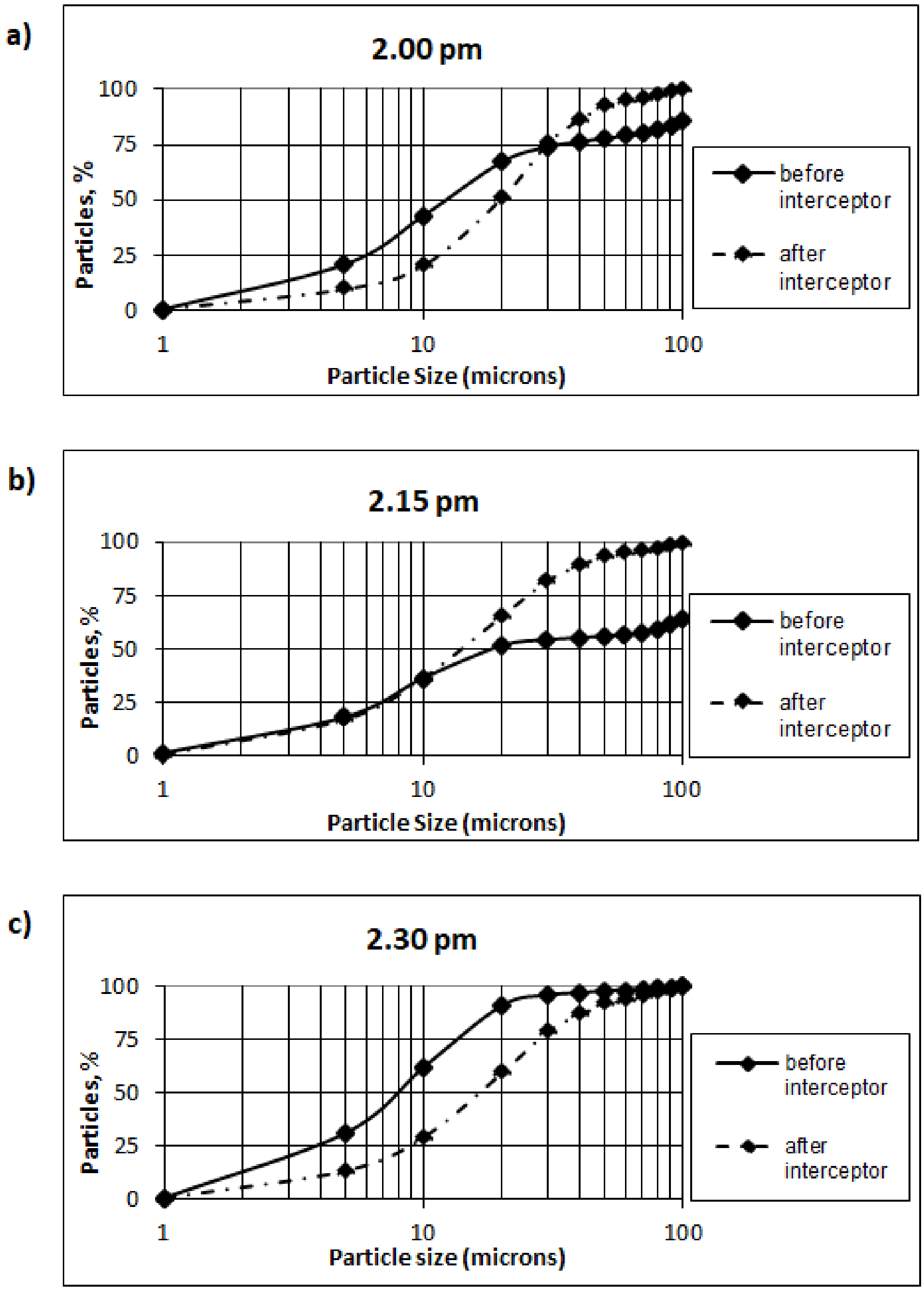


Fig. 7 PSD of the rainfall event on 03rd of July 2009

In this case the average particle size (d_{50}) in the feed (Fig. 7a) is smaller than that of particles in the outlet, which must reflect the extended holdup time in the interceptor between inlet and outlet. The inlet flow during this storm does include some larger particles (> 100 um) of d_{90}, as was to be foreseen from the storm in the first example because of the longer preceding ADWP.

The TSS concentration in the inlet (at 2.15 pm [Table 3]) is greater than in the first sample, as would be predicted on the basis of the previous literature and results relating to the effects of an ADWP. The TSS concentrations increased in both the inlet and outlet, as in previous storms, suggesting an increase in both particle numbers and flow rate. By the end of the storm (Fig. 7c), then, most of the larger particles had been flushed through and captured by the interceptor. Although the particle size profile in the effluent is larger than in the inlet, this can again be attributed to the hold-up time in the interceptor. The PSD in the effluent is constant throughout the storm as is also the case in the storm rainfall event of the first example, which shows that the interceptor is successful in removing all the particles over the critical size (10 – 30 µm). The increases in the number of particles at or below this size are, however, indicative of an increase in TSS in the treated flow (Table 3).

The third example (storm **I**) was selected as a typical or average rainfall event (20 mm for the month) and the rainfall on the previous day gave a comparison between above-average and typical ADWP. The particle size profile in both the separated effluent samples was larger than that in the influent (Fig. 8). The PSD in both the treated samples were therefore also larger than in the previous storms. The rainfall was low but it followed a preceding wet day which, as suggested previously, had led to dilution and flush through of the larger particles.

The amounts of TSS removed during this case-study storm were similar to those predicted (Table 3) by previous measurements, i.e. between 70 – 80% which were typical of TSS removal rates for the relevant particle settlement velocity and retention time in the separator.

Table 4, which summarises PSD for the three rainfall events, gives figures of 10, 50 and 90 µm respectively. Each cell represents the value of the PSD and its standard deviation (SD), varying from 5 to 19%, i.e. PSD±SD. The cells indicated in **orange** show that the interceptor did not cope with the removal of particles of certain sizes. The cells indicated in **green** show that the interceptor removed the particles and those in **grey** indicate a borderline, suggesting that the situation could change over time in either direction – 'coping or not coping'. From the summary table one can see that the worst event was storm **I** as it shows that the interceptor did not cope with the particle removal. The rain occurred during a prolonged spell of wet weather, which suggests that the particles of all sizes were

probably well disturbed within the water column, floating around. By contrast, rainfall event **III** happened after a prolonged ADWP, and the data shows that although the interceptor coped well with large particles >50 µm most of the time, it had no success in removing small particles.
These data also suggest that most of the particles had sizes of less than100 µm.

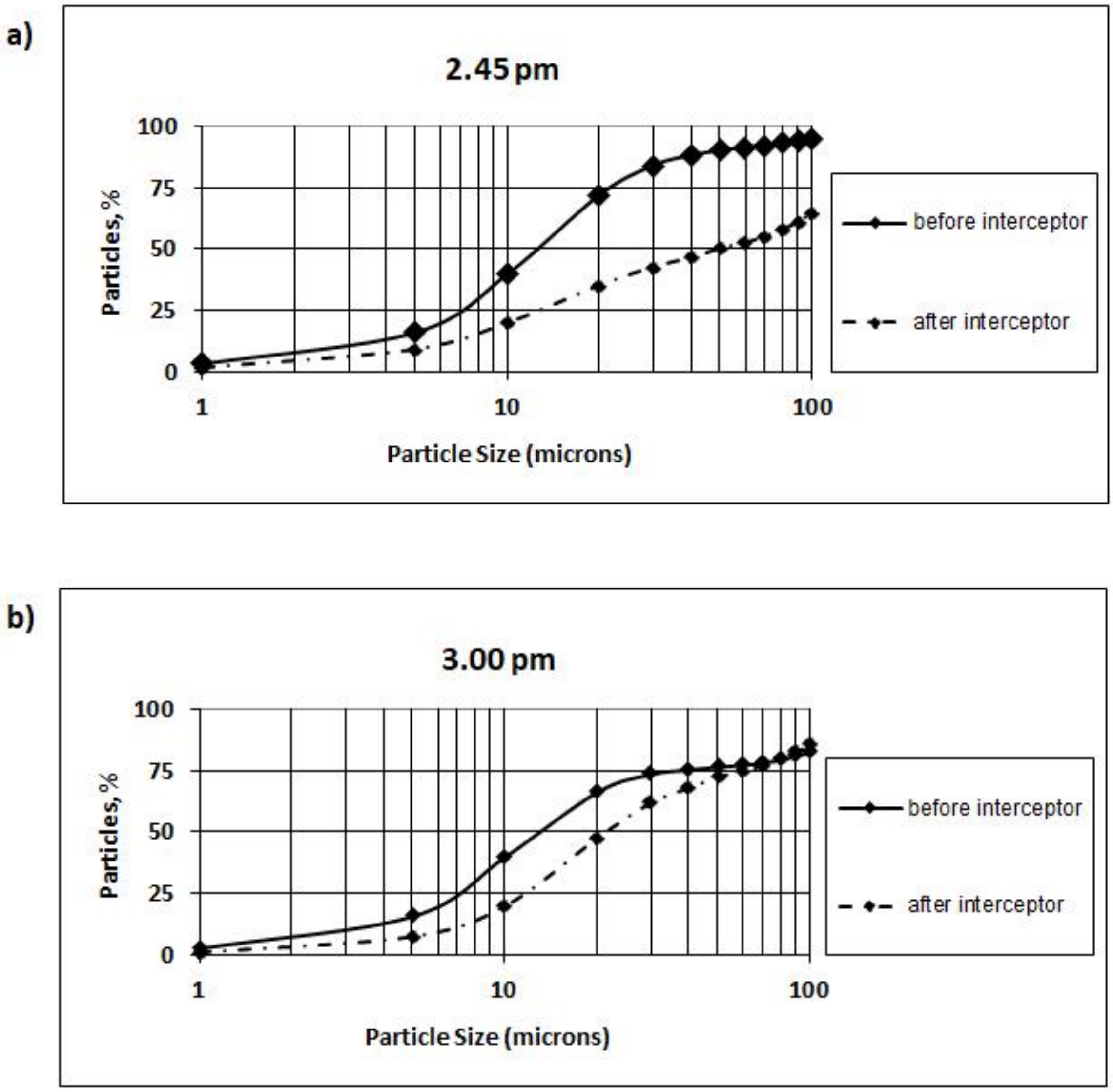


Fig. 8 PSD of the rainfall event on 11th of July 2008

Table 4 Percentile of particles smaller than 10; 50 and 90 µm for three rainfall events

Time of sampling	Before interceptor			After interceptor		
	10	50	90	10	50	90
	I					

2.45 pm	39.90±1.99*	90.13±5.41	94.13±7.53	19.74±2.96	49.51±8.91	55.82±7.82
3.00 pm	40.06±2.61	76.86±5.38	81.25±9.75	19.82±1.58	71.85±5.68	82.5±6.61
II						
9.30 am	30.31±2.12	80.27±9.63	88.51±4.43	44.45±2.24	90.59±5.43	96.1±15.38
9.45 am	52.84±2.64	96.25±6.26	98.15±6.87	44.89±3.59	89.36±4.53	93.68±6.28
10.00 am	58.28±4.95	96.97±9.61	99.92±8.99	54.95±4.95	94.84±8.38	98.09±8.14
10.15 am	64.6±3.23	97.93±4.89	99.46±5.97	60.49±8.35	97.52±5.85	99.48±4.98
III						
2.00 pm	42.66±4.69	78.23±6.25	83.52±6.68	19.64±1.57	92.13±7.92	98.82±12.25
2.15 pm	36.04±3.24	55.89±8.38	61.48±9.22	35.95±1.80	92.94±7.43	97.89±13.22
2.30 pm	61.45±3.69	97.47±9.75	98.10±7.85	28.71±5.46	91.16±7.29	98.3±9.63

*PSD±SD.

This result is consistent with the work of Memon and Butler, 2005, who monitored the washoff of different pollutants from impermeable road surfaces, as produced under both artificial and rainfall conditions. They found that the predominant fraction of the solids in stormwater entering drainage networks is less than 100 µm. A more detailed comparison would be extremely questionable and difficult, as the PSD will change in relation to the land use, rainfall intensity and flow rate. Given the size of the interceptor (10.5 m^3), it was to be expected that most of the particles (< 50µm) would be removed and this was the case except under the conditions of storm **I**. That event produced a typical 6 mm of rain and, therefore, a possible explanation is that at this point in the storm particles were being re-suspended or were floating within the separator.

Another important point which needs to be made is the need for these units to be serviced regularly. The interceptor featured in this study was monitored on a regular basis from 1996 – the year when it was built - until 2015, when access to the lagoon became hardly possible due to its coverage by deep vegetation, as a result of which the monitoring programme was terminated. As far as is known, the interceptor had never been discharged and at the time of this sampling campaign the sludge depth in the interceptor was 8 cm, i.e. 20% of its available depth. In the foreseeable future it may become necessary in order to meet future water quality requirements for improvements to be made to interceptors and for there to be a widespread understanding of the need for them to be continually maintained Maintenance possibilities, including their regular de-sludging or inspection, should be included in the design guide.

Alam et al. (2018) noted, likewise, that the devices for capturing suspended solids could improve stormwater quality only if they were serviced on a regular basis. Otherwise, the release of nutrients during biodegradation of the organic compounds may cause problems further down the stormwater route – along the drainage system or in a water course.

Compatibility of the data with some other studies

As has already been mentioned, rain is an event based on probability and every single event will depend on its duration and intensity. With this in mind, a monitoring work programme will always be desirable in order to adjust conclusions in terms of statistics from previously collected data. Nevertheless, our data do coincide very well with the study, conducted by Andral et al. (1999), dedicated to studying a section of the A9 motorway, Kérault in France, on solid matter. They found that solid particles smaller than 100 µm will remain in suspension compared to larger particles which will be separated by settling.

A one-month runoff monitoring study conducted by Furami et al. 2002 at an inlet of the retention pond in Switzerland showed that particles smaller than 45 µm will occupy 93% of the sample, with TSS from 67 to 89 mg/l (based on 4 samples). This is comparable to our values for the TSS (see Table 3 [before the interceptor values]) and Furami's findings tally not only with those fromwour study but also with others' Both Memon and Butler, 2005 and Andral et al. (1999) stated with regard to the particles of less than 106 µm that the predominant fraction of the solids in runoff would be smaller than 100 µm.

Conclusions

This study is limited to weather-dependent samples that were obtained when there was a sufficient discharge into the lagoon in order for the oil-interceptor's performance to be observed.

Analyses conducted for the size characterisation of particles collected before and after an oil interceptor showed in overall terms that oil- interceptor installation could lead to improvements in stormwater management.

The combination of what has been adopted as the standard treatment for sensitive areas and highly trafficked roads, that is the interceptor and SuDS (lagoon in this case), removes, in most cases, TSS and consequently other pollutants attached to the particles. However, the data for PSD shows that the interceptor does not always cope with smaller particle separation (< 25 µm).

The separator successfully removes on average 70 % of the TSS and almost all particles above 50 µm in size and it therefore provides protection against or, at least, a reduction in the likelihood of solid load entering the lagoon, which is more difficult to maintain.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Data Availability Statement

Data available on request from the authors

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