In search of effective bioassessment of urban stormwater pond sediments: enhancing the "sediment quality triad" approach with oligochaete metrics

Vers le perfectionnement de la bio-évaluation des sédiments de bassins d'orage urbains par l'intégration de métriques oligochètes à la « sediment quality triad »

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RÉSUMÉ

Les bassins d'orage sont largement utilisés pour contrôler les volumes et les flux de ruissellements sur les surfaces urbaines. En tant que milieux récepteurs, ils sont influencés par les rejets polluants urbains de temps de pluie. Cependant, ils constituent de nouveaux habitats aquatiques, ce qui compense en partie la modification de la biodiversité des écosystèmes initiaux. La bioévaluation de ces bassins d'orage s'avère en conséquence primordiale pour assurer la conservation et la réhabilitation de la biodiversité dans les zones urbaines.

Cependant, les méthodologies classiques de bioindication, comme par exemple la Sediment Quality Triad (SQT), basées sur des comparaisons avec des sites de référence, sont handicapées par le caractère artificiel et atypique des bassins d'orage. Le souci de trouver des méthodologies plus performantes et plus adaptées à ces milieux particuliers nous a conduits à associer les méthodologies oligochètes (indices oligochètes et métriques associées) à la SQT. Dans un système de deux plans d'eau urbains tests, cette étude montre que, moyennant quelques ajustements, la méthodologie oligochètes a pu apporter à la SQT des informations nouvelles et complémentaires, en particulier sur la qualité biologique des sédiments fins et sur l'effet spécifique des contaminants.

ABSTRACT

Stormwater ponds have been widely used to control increased volumes and rates of surface runoff resulting from urbanization. As receiving waters, they are under the influence of intermittent pollution from urban wet-weather discharges. Meanwhile they offer new aquatic habitats balancing the transformation of initial ecosystems and their associated biodiversity. Bioassessment of stormwater facilities is therefore crucial to insure the preservation and rehabilitation of biodiversity in urban areas.

Nonetheless, the application of traditional bioassessment methodologies such as the Sediment Quality Triad (SQT), based on the comparisons with reference sites, is challenged by the artificial and atypical features of urban stormwater ponds. Our concern in finding a more specific and effective bioassessment methodology led us to consider associating the Oligochaete Index Methodology (OIM) with the SQT. This study shows that although some adjustments were needed, the OIM brought new and complementary information to the SQT assessment on the effects of contaminants and on the biological quality status of the sediment in a test urban stormwater pond.

KEYWORDS

Benthic invertebrates, oligochaete assemblages, sediment quality bioassessment, sediment quality triad, urban stormwater ponds

1 INTRODUCTION

Urban stormwater ponds have become a common feature of the urban landscape during the past 30 years (Marsalek et al., 2005a). Indeed, their numbers in large metropolitan areas of Canada and USA are counted in high hundreds. Typically, these facilities were built to control flows and quality of stormwater, but they also fulfil many other functions, including those of new aquatic habitats (Marsalek et al., 2005b). Considering that the pond environment is generally disturbed and potentially impaired by high fluxes of runoff, sediments, chemicals, microorganisms, and waste heat (Crawford et al., 2009), the quality of pond aquatic habitats, and wildlife habitats on their terrestrial fringe, has been questioned (Bishop et al., 2000). Conflicting demands on stormwater pond performance, i.e., serving as stormwater treatment facilities as well as aquatic habitats, and suggestions that stormwater ponds have the potential to act as ecological traps (Robertson and Hutto, 2006), create an urgent need to assess the quality of pond habitats, and in particular, the quality of fine sediments accumulating in stormwater ponds in significant quantities.

The assessment of sediment quality is a common task in environmental studies (Chapman, 1990), which is however more complicated in stormwater ponds, because of the dynamic nature of pond benthic sediments and the transitory nature of the contributing catchment in various phases of development. Among the more common methods used in Canada for fine sediment quality assessment, two methods clearly dominate: (a) the Sediment Quality Triad (SQT), which is based on laboratory analysis of the sediment chemistry and toxicity, and the field assessment of the benthic community structure (Chapman, 1990), and (b) the CABIN (the Canadian Aquatic Biomonitoring Network) program used operationally in biological assessment of environmental conditions (Reynoldson et al., undated). Both methods use benthic invertebrates as the end points, and while the SQT greatly benefits from the availability of reference sites, the CABIN program is fully based on the reference sites, which are selected as the sites with minimal anthropogenic impacts. Recognizing the lack, respectively the absence, of such sites in urban areas, it is necessary to search for other methods which would either remove or lessen the methodological dependence on reference sites. In this search, a method potentially meeting such criteria was identified in the Oligochaete Index Methodology (OIM) developed by Cemagref (Lafont, 1989), further standardized in France and currently appraised in the context of the European Water framework Directive as one of the components for addressing the ecological quality of lakes. Adaptations of OIM to urban waters are currently being investigated (Lafont et al., 2007).

While the initial research question for our study was formulated as assessing and choosing between SQT and OIM, it was very quickly modified after recognizing that each of these methods provides some complementary information, and the research issue was redefined as enhancing sediment bioassessment studies by coupling SQT and OIM methods, and obtaining additional information in this process. In the initial study phase reported here, the coupling of both methods was addressed for a specific stormwater facility, but eventually the research will be expanded to include different types of stormwater ponds with respect to their aquatic environment, age, maintenance, and operation. Thus, the main objectives of the study presented herein are: (a) examine applications of SQT and OIM methods to two stormwater management ponds (connected in a series) in Toronto, Canada, and (b) identify the potential benefits of such conjunctive applications.

2 STUDY AREA AND METHODS

2.1 Study area

The Terraview-Willowfield stormwater management facility was built in the mid-1990s and receives runoff from 9 ha of a 16 lane freeway and 30 ha of residential lands. The facility was designed with a surface flow treatment train comprising a pre-treatment sediment forebay, two ponds in series and connecting channels. The treatment train and the main study sites are shown in Fig. 1.

2.2 Experimental methods

A total of 8 sites (TP23, TP18, TP15 and TP1 in Terraview pond; WP15, WP10, WP1 and WP4 in Willowfield pond) along a longitudinal gradient were sampled once in August 2008. Water samples were taken at 10 cm above the sediment surface using a peristaltic pump and sediment samples were taken using a corer (8 cm diameter) for benthos and Petite Ponar grab (15 cm x 15 cm) for sediment chemistry and toxicity analysis. The cores were instantly preserved in 100 ml of formalin at 10%.

Water and sediment samples were screened for the determination of the 16 USEPA Priority Polycyclic

Aromatic Hydrocarbons (PAHs) concentrations by extraction with dichloromethane and gas chromatography / mass spectrometry analysis. Trace metals Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn were analyzed by inductively-coupled plasma spectroscopy. Sediment samples were analyzed for Total Organic Carbon (TOC) by combustion using a Leco TOC Analyzer, and organic content, measured as the Ash Free Dry Mass (AFDM), was calculated as the mass loss on ignition from dry sediment samples burnt at 550°C for 1 hour in a muffle furnace. Water samples were analyzed for the determination of chloride concentrations by ion chromatography using a Dionex ICS2000 system equipped with an IonPac AS15 Column.

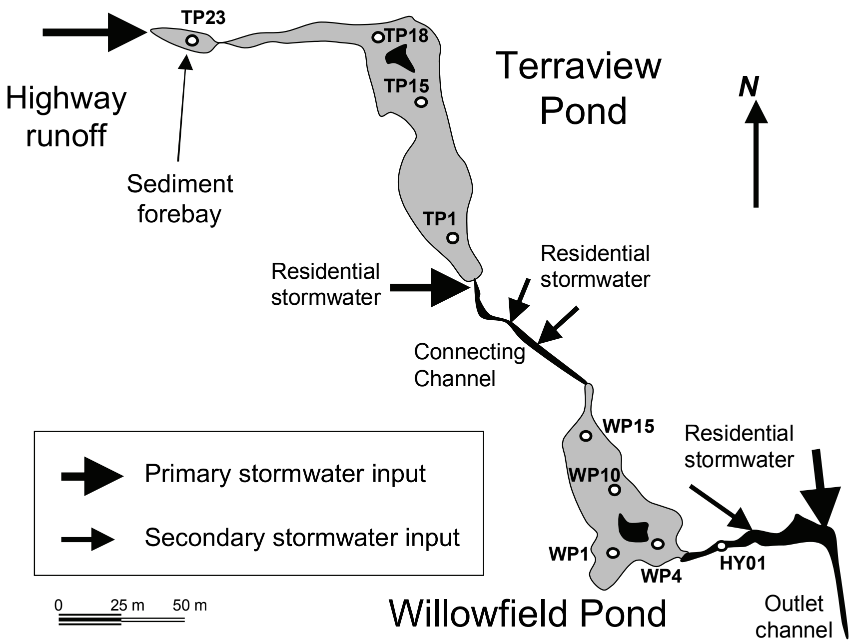

Fig.1: Terraview-Willowfield stormwater management ponds and connecting channels

Sediment toxicity was measured in the laboratory using survival and growth bioassays with the amphipod *Hyalella azteca* (28 d) and the mayfly *Hexagenia spp.* (21 d). Tests were conducted in replicates of 3 for pond samples and 5 for laboratory control sediment from Long Point, Lake Erie. Detailed descriptions of the test methods are given in Grapentine et al. (2004).

Three replicate cores per site were sieved at 250 µm separately. All invertebrates were sorted under a binocular microscope. Invertebrates were preserved in 70% ethanol and identified to the family level (Merritt et al., 2008) except for Turbellaria, Nematoda, Ostracoda, Cyclopoida and Hydrachnida. For each sample, a minimum of 100 oligochaete specimens (when possible) were randomly chosen and identified to the lowest taxonomic level under a compound microscope according to Kathman and Brinkhurst (1998). Setting the taxonomic resolution for the benthos analysis at the family level followed from considerations of a cost/efficiency ratio, which is always critical in ecological risk assessment surveys. Therefore, we seek to compare the information given by the oligochaetes and the whole benthos at a realistic and equivalent cost in terms of the time spent for their respective analyses.

2.3 Metrics and statistics

Univariate metrics used to characterize the benthic community structure were total and average taxonomic richness, total invertebrate density (number per 0.1 m²) and evenness. The metrics used to characterize the oligochaete community structure were the indices IOBS (Oligochaete Index of Sediment Bioindication), IOBL (Oligochaete Index of Lake Bioindication), IOBL* (Oligochaete Index of Lake Bioindication slightly modified from the original formula where the logarithm of the density is magnified by 3 to increase the importance of densities in constrained environments such as the bottoms of deep natural lakes) and IOPP (Oligochaete Index of shallow lake bioindication) presented in Lafont et al. (2007) and calculated as follows:

$$IOBS = 10 \times S \times (\max [\%TUSS, \%TUBC])^{-1}$$

$$IOBL\ (*) = S + (3\ x)\ \log_{10} (D + 1)$$

$$IOPP = 1 + (100 - \%\ DEDI + \%TUB)$$

Where *S* is the oligochaete taxonomic richness, *D* is the oligochaete density (per 0.1 m²), *TUSS*: Tubificinae without hair chaetae; *TUBC* Tubificinae with hair chaetae, *DEDI Dero digitata* and *TUB* Tubificinae. As the calculations of IOBS and IOPP involve the percentages of abundance of certain taxa, they must be based on the identification of a minimum number of individuals to be sufficiently accurate. Therefore, whenever the oligochaete abundance in the replicates fell below 100 individuals, IOBS and IOPP were calculated on the total abundance of the 3 replicates (when possible). On the other hand, IOBL*, based on richness and density variables, was applicable to all sites.

All chemical data were $\log_{10}$-transformed prior to analysis. Separate principal component analyses (PCA) were used to identify the major axes of variation in sediment and water chemical data. Oligochaete abundance were $\log_{10}$ (n+1)-transformed prior to analysis. Detrended correspondence analysis (DCA) (Legendre P. and Legendre L., 1998) was preferred over regular correspondence analysis to detect the different axes of variation in the oligochaete community. Spearman rank correlation analyses were used to examine relationships between biological and environmental variables including surrogate variables from data reduced by multivariate analysis (PCA scores). Correlation coefficients (Rs) were considered significant at the probability $p<0.017$ according to a Bonferroni adjustment for multiple comparisons (Chapman, 1996). Statistical analyses were carried out using Statsoft Statistica 6.0 and ordinations were made with PC-ORD 5.0.

2.4 Integration into the weight of evidence (WOE) assessment

In order to compare the lines of evidence of the triad and the oligochaete indices within a coherent WOE decisional framework, integration of the results was made according to a five–class criteria model ranging from Bad to Very Good quality following the biological quality classification of the IOBL (Lafont et al., 2007). The integration of the oligochaete analysis was made accordingly to the calculation of the IOBL.

The integration of the data for water and sediment contamination by trace metals and PAHs was made by comparisons with the Canadian Sediment Quality Guidelines (CCME, 2002) in the form of a sediment quality index (Grapentine et al., 2002) and with the Provincial Water Quality Objective (PWQO) values for protection of aquatic life (MOEE, 1999). The integration of the results from the sediment toxicity tests was based on the 20% and 50% endpoint reduction benchmarks. More weight was given to the survival tests as acute endpoints. The integration of the benthos analysis required a comparison with an appropriate reference site (Grapentine et al., 2002). Initially, a potential reference site (HY01, Fig.1) was chosen at the outlet channel of the system. However, the habitat effect unacceptably impaired comparisons with test sites. As an alternative, a PCA including only the test sites was performed on the $\log_{10}$-transformed benthic community metrics. The integration of the site metrics was made according to their position along a gradient of diversity on first principal component (91.4% explained variance) and TP18 appeared to be the minimally impacted site.

3 RESULTS AND DISCUSSION

3.1 Water and sediment contamination

Water and sediment chemical data are summarized in Table 1. In the water, the concentrations of several trace metals were generally higher at the Willowfield pond and exceeded the limits of the PWQO guidelines (MOEE, 1999). PAHs were undetectable in water. In the sediment, trace metals showed concentrations above the Interim Freshwater Sediment Quality Guidelines (CCME, 2002) at all sites especially in the Terraview pond. The general trend was a decrease in contamination along the hydrological gradient. PAHs showed the highest concentrations at the inlet of each pond (especially WP15), decreasing below the Probable Effect Limit (PEL) (CCME, 2002) towards the outlet in both ponds.

3.2 The oligochaete analysis

A total of 1466 organisms from 19 taxa were counted in the 24 samples analyzed. Oligochaetes were the most abundant taxon as they accounted for 59% of the total invertebrate abundance. Even though IOBS and IOPP gave relatively consistent results with IOBL* for the Terraview sites (Table 2), neither IOBS nor IOPP could be calculated at any of the Willowfield sites since abundance of oligochaetes was very low (total individuals < 100). Consequently, the biological quality assessment by the use of IOBS and IOPP was limited in this study.

Centred in the DCA biplot (Fig. 2), Tubificinae with hair setae (TUBC), Tubificinae without hair setae (TUSS), *Limnodrilus hoffmeisteri* (LIHO) as well as the Naidinae *Dero digitata* (DEDI), were the main representatives of the oligochaete community. As they largely dominate in the Terraview-Willowfield system, they indicate a highly polluted environment (Rosso et al., 1994). In general, the Willowfield sites had lower IOBL* than the Terraview sites. Oligochaete community was almost decimated at WP1 (1 specimen, not included in the DCA) where IOBL* was the lowest.

Parameters	Units	TP23	TP18	TP15	TP1	WP15	WP10	WP1	WP4
				WATER					
Chloride	mg/L	1053	357	173	140	137	121	126	188
Cr	µg/L	9.15	5.35	4.46	4.62	9.72	9.19	6.82	2.51
Cu	µg/L	13.6	6.07	6.81	5.74	18.1	15.9	10.2	2.8
Fe	µg/L	267	672	692	610	2090	2200	1050	680
Pb	µg/L	2.05	3.22	4.67	3.2	9.41	8.59	5.11	1.96
Zn	µg/L	18.9	21.2	19.2	16.5	60.8	55.3	32.3	9.87
				SEDIMENT					
TOC	%	4.5	2.4	2.1	3.4	4.7	3.0	8.6	1.9
AFDM	g	5.3	1.3	0.8	2.7	1.4	0.4	0.1	0.3
Cd	µg/g	1.27	0.79	0.83	0.95	1.07	0.52	1.08	0.43
Cr	µg/g	166.0	88.9	81.3	76.5	75.4	46.2	75.8	41.4
Cu	µg/g	207.0	185.0	169.0	165.0	133.0	72.6	137.0	62.3
Fe	m/g	27.9	19.9	22.0	29.4	25.3	21.3	31.9	20.0
Ni	µg/g	23.6	26.6	23.6	27.9	24.5	19.0	30.9	20.3
Pb	µg/g	116.0	79.9	80.3	80.1	75.1	43.3	78.3	37.5
Zn	µg/g	522	488	462	476	405	232	425	202
B.(a)anthracene	µg/g	0.57	0.27	0.29	<0.084	1.26	0.35	0.40	0.17
B.(a)pyrene	µg/g	0.76	0.51	0.53	0.08	2.01	0.74	0.84	0.37
B.(ghi)perylene	µg/g	0.37	0.31	0.29	<0.084	0.88	0.31	0.45	0.23
Chrysene	µg/g	0.90	0.55	0.62	0.09	2.10	0.78	0.94	0.43
Fluoranthene	µg/g	2.45	1.21	1.35	0.15	4.92	1.31	1.70	0.89
Phenanthrene	µg/g	0.95	0.45	0.36	<0.084	1.23	0.28	0.44	0.20
Pyrene	µg/g	1.81	1.14	1.26	0.15	4.36	0.58	1.47	0.66

Table 1: Chemical data at the Terraview-Willowfield sampling sites. Only trace metal and PAH concentrations exceeding the PWQO (MOEE, 1999) and PEL (CCME, 2002) are displayed.

Conversely, TP1 showed the highest IOBL* and was separated along the axis 1 of the DCA according to the presence of *Nais* species, indicative of a significant ecological recovery (Brinkhurst, 1965) and of *Pristina* species, indicative of active water exchanges between surface water and groundwater (Lafont and Vivier, 2006). TP23 had the lowest IOBL* of the Terraview sites and was mainly characterized by the pollution-tolerant taxa, including *Nais elinguis*, especially tolerant to high chloride concentrations (Lafont, 1989), as confirmed by chemical analyses (Table 1). Separated from the rest of the sites along axis 2, TP18 and TP15 were characterized by a specific fauna revealing a transitory quality status. This is confirmed by the presence of taxa intolerant to excessive pollution like *Aulodrilus pigueti* and *Chaetogaster diastrophus* (Lafont, 1989).

	Terraview pond				*Willowfield pond*			
	TP23	TP18	TP15	TP1	WP15	WP10	WP1	WP4
IOBS	1.0	0.68 ± 0.06	1.2	3.1	n.a	n.a	n.a	n.a
IOBL*	6.6 ± 2.71	8.3 ± 0.15	7.9 ± 1.02	13.1 ± 2.88	5.5 ± 1.63	6.3 ± 1.17	0.8 ± 1.34	6.8 ± 1.71
IOPP	4.7	10.5 ± 13.4	4.4	47.7	n.a	n.a	n.a	n.a

Table 2: Numerical values of the oligochaete indices IOBS, IOBL*and IOPP at the Terraview-Willowfield sampling sites. (±SD, n.a: not applicable)

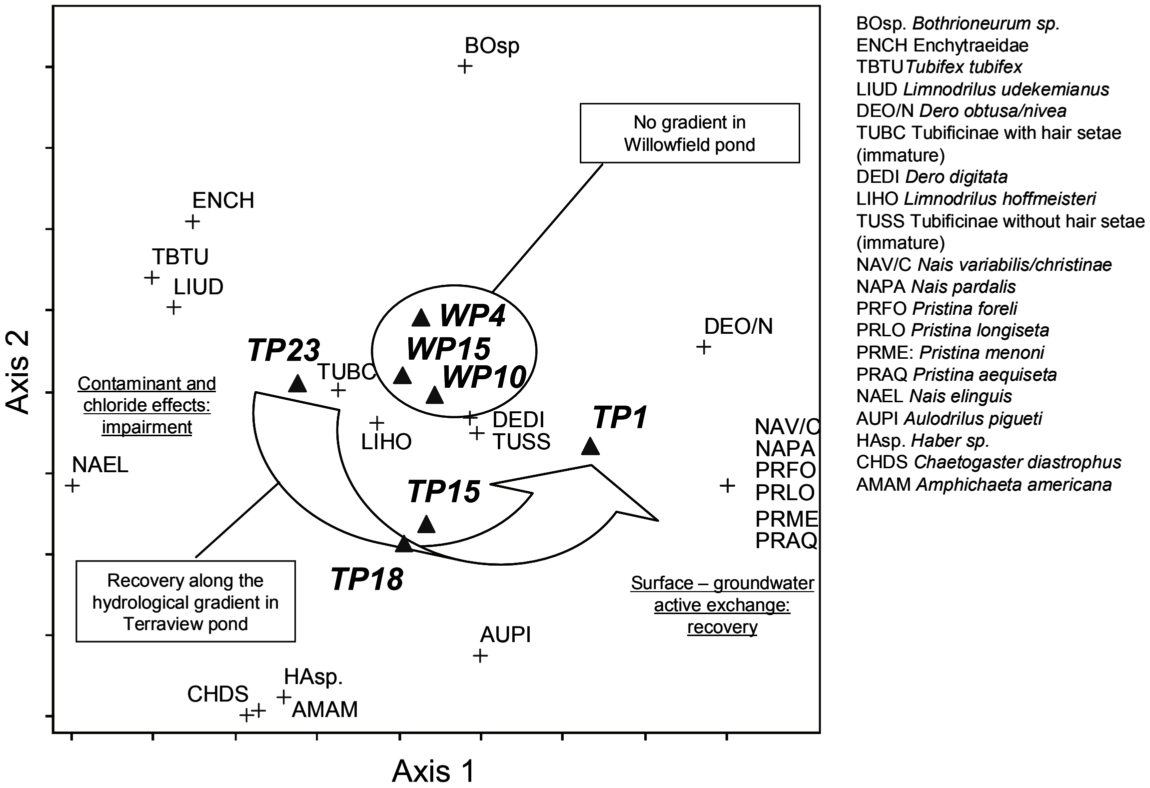

Fig. 2: Ordination biplot from Detrended Correspondence Analysis (DCA) of the oligochaete community data in the Terraview Willowfield sampling sites. Explained variance Axis 1 = 18.3%; Axis2 = 34.6%. ▲and + respectively indicate the position of sites and the position of species according to their scores in the two dimensional DCA representation. Based on ecological traits of the oligochaete species and environmental conditions, a hypothesized impairment-recovery gradient is shown for the Terraview pond sites.

3.3 Weight of evidence assessment

Conclusions of the WOE assessment are given on a station by station basis in Table 3. The impacts of the contamination indicated by the sediment toxicity tests, the benthos, and oligochaete analyses differed between the Terraview and the Willowfield ponds. In the Terraview pond, if contamination involved toxicity, perturbation was observed at the oligochaete level but not at the benthos level. In the Willowfield pond, contamination was not always accompanied by toxicity (e.g., WP1) and *in situ* perturbations did not necessarily result from contamination (e.g., WP4). Adaptation or resistance of the benthos *in situ* could partly explain the lack of sensitivity to contaminants relative to test organisms (Chapman et al., 1991). However, without a valid reference site to prove it, the results also suggest that the benthic community could be already reduced to pollution-tolerant species.

Potential bioavailability of contaminants, indicated by their affinity with organic matter and TOC was tested. Organic matter (AFDM) content in sediment was found to play an important protective role for the benthos and oligochaetes against the contamination by PAHs. Indeed, significant relationships were found between the concentrations of PAHs normalized by AFDM (PCA scores) and benthos richness, abundance, evenness and IOBL* (Rs = -0.880; -0.929; 0.833; -0.833 respectively; $p<0.017$). Organic matter provides shelter and food for the benthic communities but also substantially sequesters hydrophobic contaminants affecting their bioavailability for biota (Rockne et al., 2002). However, benthos and oligochaete responses differed in the Terraview pond. Oligochaete response showed improvement towards the outlet TP1, concomitant with a decrease in PAHs contamination. Indeed, unlike with the benthos, significant negative correlations were found between the concentrations of PAHs alone (PCA scores) and both IOBL* and the survival of *Hexagenia spp.* (Rs = -0.810; -0.856 respectively; $p<0.017$).

	Water	Sediment Metals	Sediment PAHs	Sediment Toxicity	Benthos	IOBL	Conclusion
TP23	Bad	Bad	Bad	Bad	Very good	Poor	Sediment impaired/ sensitivity of oligochaetes to contaminants, not harmful for the rest of the benthos
TP18	Bad	Bad	Bad	Bad	Very good	Poor	Sediment impaired/sensitivity of oligochaetes to contaminants, not harmful for the rest of the benthos
TP15	Bad	Bad	Poor	Poor	Good	Poor	Sediment impaired/sensitivity of oligochaetes to contaminants, less harmful for the rest of the benthos
TP1	Poor	Bad	Moderate	Moderate	Very good	Moderate	Sediment may be impaired/low level of contaminants (ex: PAHs) and/or low bioavailability (ex: metals) for the benthos and oligochaetes
WP15	Bad	Bad	Bad	Moderate	Moderate	Bad	Sediment strongly impaired/strong sensitivity of oligochaetes and alteration of the benthos / toxicity in sediment and water
WP10	Bad	Moderate	Poor	Very good	Moderate	Poor	Sediment impaired/sensitivity of oligochaetes, alteration of the benthos/perturbation not due to sediment contamination/ toxicity in water
WP1	Bad	Bad	Bad	Good	Bad	Bad	Sediment strongly impaired/strong sensitivity of oligochaetes and benthos/perturbation unlikely due to sediment contamination/toxicity in water
WP4	Poor	Moderate	Moderate	Very good	Moderate	Poor	Sediment impaired/strong sensitivity of oligochaetes, alteration of the benthos/perturbation not due to sediment contamination/toxicity in water

Legend: Very good, Good, Moderate, Poor, Bad

Table 3: Weight of evidence (WOE) assessment of the ecological quality of the Terraview-Willowfield system on a station by station basis integrating the results of the SQT and the IOBL

Heavy metals occurring at high concentrations in TP1 did not impact strongly the improvement in ecological conditions and were likely unavailable or not harmful to the biota. According to the significant correlations between the concentrations of heavy metals normalized by the TOC (PCA scores) and IOBL* ($R_s = 0.833$; $p < 0.017$), heavy metals would be more problematic when associated with high TOC content, as is the case at TP23, WP15 and WP1. Corroborating this hypothesis, organic carbon can influence the bioavailability of heavy metals in various ways and has also been considered as a detrimental factor contributing to the toxicity to the benthos (Thompson and Lowe, 2004). Nevertheless, we acknowledge that the multivariate analysis and integration of the results in the WOE approach contribute to reducing the information into a single conclusion (Grapentine et al., 2004). In this way, although TP1 showed the same overall level of contamination by heavy metals in sediment as in TP23, concentrations of cadmium, chromium and copper were much higher in TP23 whereas concentrations of iron and nickel were much higher in TP1. The higher IOBL* at TP1 tends to demonstrate a significantly lower toxicity of iron and nickel than cadmium, chromium and copper.

The oligochaete and benthos analyses gave consistent responses throughout the Willowfield pond showing stronger signs of *in situ* community perturbations. While such perturbations agreed with the chemical conditions at WP15 and WP1, the toxicity levels were much lower compared to similar levels of contamination in the Terraview pond (e.g., TP23, TP18). Although a different cocktail of contaminants could be responsible for a lower toxicity at WP15 and WP1, stronger alterations of *in situ* communities suggest that the impairment was more likely the result of water toxicity, not tested by the bioassays. At WP10 and WP4, a lower sediment contamination than in the rest of the pond agreed with the absence of sediment toxicity but the benthos and oligochaetes were still significantly impaired. Perturbations of the benthos at WP10 and WP4 may have also resulted of water toxicity and/or of some acute toxic events during storms. Remobilization and flushing of contaminants during storm events could significantly increase acute toxicity in water and at the outlet of the system (Hatch and Burton, 1999).

Recognizing that the presence of chemical contaminants does not necessarily cause adverse effects, ecotoxicological and biological approaches are complementary to the sediment chemistry approach in determining the quality status of the sediment (Chapman et al., 1991). Unlike many other benthic taxa, oligochaetes live permanently in the bioturbation layer of the sediment and show little spatial and temporal variability (Verdonschot, 2006). By integrating all exposure pathways over time, they represent a cumulative biological response to the environmental conditions including bioavailability and potential ecotoxicological effects of contaminants. However, the IOBL classification so far has been designed for applications in larger water bodies (i.e., lakes) and further research is needed prior to generalizing the findings. The methodology would also require adjustments of the classification and/or of the index (cf. IOBL*) for application to stormwater ponds because the resistance and resilience potentials in smaller waterbodies are likely to be different. Like any other ecosystem, stormwater ponds are multidimensional dynamic systems, whose ecological risk assessment must be considered in a time dimension (Landis and McLaughlin, 2000). Therefore, particular attention should be given to seasonal influences, as well as to the impact of particular storm events on the benthos. Finally, more research is needed towards an ecotoxicological approach based on the oligochaete species sensitivity to specific pollutants and mixtures of pollutants in water and sediment, including their interaction with complexants (organic matter, TOC).

4 CONCLUSIONS

Among the three oligochaete indices employed, IOBS and IOPP suffered from an uncertain applicability due to low abundance occurring in the system studied, but IOBL* appeared complementary to the benthos in the WOE assessment analyses. The OIM reinforced and confirmed some effects detected by the sediment toxicity tests and/or by the benthos analysis. But it also brought new evidence of pollutant effects and on the biological quality status of the system. In the absence of a valid *in situ* reference site, which could be inherent to the system studied (and many other urban sites), the information given by the benthos analysis could lack some sensitivity to changing environmental conditions such as occurring in the Terraview pond. The OIM on the other hand benefits from integration at a greater scale, within a classification system established over a wide range of ecological gradients in lakes and could offer promising information for the assessment and management of stormwater ponds.

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