Brief report

The dynamic structure of a stream water quality

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The dynamic structure of river flow (base, inter and storm dynamic components) is the intrinsic part of the entire hydrosphere structure within any examined spacetime, and its assessment is the intrinsic part of the water resources sustainability assessment such as the Harmonized Frequencies Analysis (Vedom, 2011). How do the quantity and quality structures changes near the source of contamination?

Three neighboring watersheds of different size and proximity to Toronto were selected in order to estimate their water quality conditions in short-term period of 2004-2005. Both remote watersheds, the examined part of the Credit River and the upper part of Etobicoke Creek, can be identified as the mostly rural; the lower part of Etobicoke Creek locates in the Greater Toronto as well as the entire watershed of Mimico Creek. Daily concentrations of chlorides, copper, total dissolved solids (TDS) and turbidity were obtained from the relation of their sampled concentrations with the corresponding dynamic components of flow: base, inter and storm ones (Vedom, 2002). Obtained this way daily concentrations were then processed like all other hydro-meteorological variables of this spacetime revealing their individual dynamic structures.

Results of the dynamic structures assessment are presented in the table below.

Watershed	**Area, km^2**	**Dynamic structure**										
		Dyna-mic compo-nent	**Flow, m3/s**		**Chlorides, mg/L**		**Copper, mkg/L**		**TDS, Mg/L**		**Turbidity, mg/L**	
			Ampl.	**Avrg.**	**Ampl.**	**Avrg.**	**Ampl.**	**Avrg.**	**Ampl.**	**Avrg.**	**Ampl.**	**Avrg.**
Credit R.	402				**R = 0.91**		**R = 0.91**		**R = 0.81**		**R = 0.96**	
		Total	**8.7**	**4.72**	**37.2**	**85.5**	**2.9**	**1.45**	**281**	**463**	**59.8**	**13.8**
		Base	0.15	0.77	0.76	0.91	0.08	0.68	0.61	0.85	0.09	0.39
		Inter	0.17	0.10	0.05	0.03	0.13	0.09	0.08	0.07	0.16	0.20
		Storm	0.67	0.14	0.19	0.06	0.79	0.23	0.30	0.08	0.75	0.41
Etobicoke Cr. (head-water)	62.3				**R = 0.78**		**R = 0.66**		**R = 0.76**		**R = 0.99**	
		Total	**4.31**	**0.65**	**572**	**269**	**3.14**	**2.78**	**1597**	**862**	**123**	**19.8**
		Base	0.06	0.34	0.27	0.62	0.26	0.81	0.39	0.81	0.02	0.17
		Inter	0.10	0.18	0.20	0.17	0.30	0.08	0.07	0.09	0.05	0.06
		Storm	0.84	0.48	0.53	0.21	0.45	0.11	0.53	0.09	0.94	0.77
Etobicoke Cr. (mouth)	204				**R = 0.97**		**R = 0.91**		**R = 0.94**		**R = 0.92**	
		Total	**18.3**	**2.72**	**1054**	**664**	**22.1**	**6.18**	**2146**	**1269**	**60.5**	**10.3**
		Base	0.05	0.31	0.49	0.69	0.08	0.57	0.58	0.70	0.03	0.26
		Inter	0.10	0.17	0.14	0.15	0.13	0.11	0.21	0.15	0.06	0.11
		Storm	0.85	0.53	0.38	0.15	0.80	0.32	0.21	0.15	0.91	0.74
Mimico Cr.	70.6				**R = 0.89**		**R = 0.90**		**R = 0.85**		**R = 0.93**	
		Total	**6.79**	**0.89**	**1014**	**712**	**14.8**	**4.75**	**1450**	**1239**	**121**	**18.2**
		Base	0.04	0.24	0.56	0.75	0.22	0.68	0.73	0.77	0.05	0.23
		Inter	0.06	0.13	0.11	0.11	0.23	0.14	0.10	0.08	0.11	0.17
		Storm	0.90	0.63	0.32	0.14	0.55	0.18	0.17	0.15	0.84	0.60

There are dynamic structures expressed as the parts of the monthly amplitudes in the column “Ampl.” and the corresponding structures of the traditional daily averages in the column “Avrg.”. It is easy to see that they are totally different for the same variables indicating the numerical difference between the volumetric (Avrg.) and one-dimensional considerations of water dynamic. The one-dimensional measure of a variable used in HFA is the energy scale for this variable in the particular time period; the volumetric measure characterises the time period duration rather than the power of the variable.

The quantitative structures have noticeable decrease of their base and inter dynamic components and increase of the storm ones and, therefore, erosion with approaching to the city. The one-dimensional structure of turbidity, which is one of the erosion measures, shows that control of it is increasing as well (increase of the base and inter components) not reaching, however, the situation at Credit River with natural vegetation.

Generally, in pristine watersheds the one-dimensional dynamic structures of dissolved solids have to show higher weight of baseflow concentrations than the total ones (Ladouche et al., 2001; Salmon and Walter, 2001), which at first glance is seen in all examined watersheds. However, the level of chlorides, the Maximal Allowable Concentration for which is 250 mg/L, and TDS shows the accumulation of contamination in baseflow and interflow (permanent and temporary groundwater discharges), especially chlorides used every winter in this area for de-icing the roads of all types, which obviously elevates TDS as well. This strong impact can be seen in both dimensions: singular and volumetric.

The dynamic structures of copper with the highest storm components indicate the surface source of this substance in rural area and dual process in the urban one: the source is still the surface flow, but accumulation in groundwater is high as well.

The correlations between the sampled and calculated concentrations (R) confirm the reliability of the separated flow transport capacity assessment for both dissolved and suspended matters in the urbanised area, which is goes along with Nagano, T. (Nagano et al, 2003). For the upper part of Etobicoke Creek the noticeably lower coefficients indicate the transformational situation from the natural drainage system to the man-made one. However, the relation between discharge and suspends is still closer than between discharge and dissolved matter.

References:

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