Daily Chloride and Mercury contamination of Lake Ontario by Etobicoke Cr.

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Challenges: How much salt (chloride) goes into the Etobicoke creek via surface (storm network) or ground water? Can surface water monitoring results be interpreted this way? Is it possible to assess daily dynamics of surface and groundwater chlorides based on the available monitoring database? These, and other, questions were raised within the framework of the Wet Weather Flow, Snow Disposal and Salt Management plans (City of Toronto). An attempt to quantitatively estimate daily dynamics of surface and groundwater contamination in a highly urbanized watershed (209 km2) was done using the only source of quality data – the monitoring database of Environment Canada (~ 1 sample/month). In winter, salt crystals and other chlorides are used for deicing, in summer for suppressing dust. How are the chlorides from these two sources distributed between surface and ground waters; how subsequently ends up in Lake Ontario?

Description: Separation of daily total flow into base-, inter- and surface components using SimpleBase © model was done to estimate the daily proportion of each in the total flow. Available Etobicoke Cr. Monitoring data for 1990-97 periods were sorted by representing of the flow category in different seasons. For each category the concentration-discharge ratio's parameters were established by correlating daily total concentration with the available monitoring data. Groundwater and interwater alone contribute ~30% and ~ 45%, respectively, of the estimated 26,330 tons of total chlorides brought annually by Etobicoke Cr. into the Lake Ontario. Average daily concentration of chlorides in the total flow for examined period was 326 mg/L, baseflow – 263 mg/L. Mercury loads were estimated the same way and the biggest source of it is the storm water sewage (~ 68% and 2.0 kg/year).

Application: The method and modeling employed here is an excellent planning and optimization tool to be used in connection with the Lake Ontario water quality improvement framework (i.e. surface/groundwater monitoring network and sampling optimization).

Strengths: Quantitatively accurate flow separation is a crucial parameter and a requirement if we are to be successful in linking climate change research with groundwater research. The combination of water quality and quantity components with climate features provides unique opportunities to assess past and present relationships. The great strength of this approach is that it allow us to predict changes to water quality in the context of climate change.

Capacity Needs: Monitoring data should be revised in order to estimate exact values of corresponding discharge at the moment of sampling. Discrepancies in the measurement of daily average discharge can be a huge source of error in the concentration-discharge relations. This is a key issue for this method. To ensure high reliability it is necessary to do several more runs of the model for other watersheds after revision of the monitoring data.

Keywords: Salt management, flow separation, groundwater, surface water, daily loads of chlorides, daily loads of mercury, water quality monitoring optimization, Lake Ontario.

5. Results

Chlorides (R = 0.825)

Yearly

Tons	1990	1991	1992	1993	1994	1995	1996	1997	Average
Total	29040	21375	28754	20712	19540	20042	43239	27967	26334
Baseflow	7164	6808	8756	7225	7326	6684	10520	7849	7792
Interflow	13797	8272	11659	9264	7107	9005	17859	13050	11252
Peaks	8079	6292	8335	4223	5108	4352	14860	7071	7290

Monthly

	Loads, tons				Percentage, %			
	Total	**Baseflow**	**Interflow**	**Peaks**	**Total**	**Baseflow**	**Interflow**	**Peaks**
Jan	4134	794	1840	1501	15.7	19.2	44.5	36.3
Feb	3569	737	1801	1030	13.6	20.7	50.5	28.9
Mar	4946	1038	2682	1226	18.8	21.0	54.2	24.8
Apr	1997	1029	671	297	7.6	51.5	33.6	14.9
May	1680	616	496	569	6.4	36.7	29.5	33.8
Jun	705	430	219	56	2.7	60.9	31.1	8.0
Jul	651	389	145	117	2.5	59.7	22.3	18.0
Aug	777	402	222	153	2.9	51.7	28.6	19.7
Sep	694	393	179	122	2.6	56.5	25.8	17.6
Oct	848	452	258	138	3.2	53.3	30.4	16.3
Nov	2321	670	968	683	8.8	28.9	41.7	29.4
Dec	4013	844	1771	1398	15.2	21.0	44.1	34.8
Year	26334	7792	11252	7290	100	29.6	42.7	27.7

Daily

Concentrations, g/m3						Loads, tons					
Minimal		**Maximal**				**Minimal**		**Maximal**			
base	**Total**	**base**	**Inter**	**Peaks**	**Total**	**base**	**Total**	**base**	**Inter**	**Peaks**	**Total**
190 Apr-96	23 Apr-92	582 Dec-97	2527 Nov-92	3520 Mar-93	2348 Dec-91	4.6 Oct-95	4.6 Oct-95	1236 Jan-95	649 Nov-95	1221 Nov-95	1504 Nov-95

Total year amount of chlorides amounts to **20 000- 45 000 tons**: highest amount in 1996;
~ 43% brought by interflow, 30% - by base- and 27% by storm flow;
Minimal daily load varies from 4.6 to 1504 tons per day.

Mercury (R = 0.551)

Yearly

Kilograms	1990	1991	1992	1993	1994	1995	1996	1997	Average
Total	2.25	2.27	3.83	2.29	1.51	2.88	4.27	2.21	2.69
Baseflow	0.71	0.69	0.96	0.75	0.76	0.66	1.22	0.83	0.82
Interflow	0.23	0.17	0.26	0.25	0.13	0.21	0.29	0.20	0.22
Peaks	1.31	1.41	2.61	1.29	0.61	2.01	2.75	1.18	1.65

Monthly

	Loads, kg				Percentage, %			
	Total	**Baseflow**	**Interflow**	**Peaks**	**Total**	**Baseflow**	**Interflow**	**Peaks**
Jan	0.330	0.067	0.023	0.241	12.3	20.2	7.0	72.8
Feb	0.221	0.061	0.020	0.141	8.2	27.6	8.9	63.6
Mar	0.321	0.115	0.044	0.162	11.9	35.8	13.6	50.5
Apr	0.366	0.144	0.023	0.199	13.6	39.3	6.2	54.5
May	0.240	0.068	0.013	0.160	8.9	28.3	5.2	66.5
Jun	0.105	0.046	0.014	0.045	3.9	44.0	13.0	43.1
Jul	0.173	0.040	0.011	0.122	6.4	23.0	6.4	70.6
Aug	0.182	0.042	0.015	0.126	6.8	22.9	8.1	69.0
Sep	0.165	0.042	0.011	0.113	6.1	25.2	6.6	68.2
Oct	0.140	0.050	0.015	0.076	5.2	35.3	10.4	54.2
Nov	0.226	0.068	0.017	0.142	8.4	29.8	7.6	62.6
Dec	0.218	0.081	0.015	0.122	8.1	37.3	6.8	55.9
Year	2.688	0.822	0.219	1.648	100	30.6	8.1	61.3

Daily

Concentrations, mg/m3						Loads, g					
Minimal		**Maximal**				**Minimal**		**Maximal**			
base	**Total**	**base**	**Inter**	**Peaks**	**Total**	**base**	**Total**	**base**	**Inter**	**Peaks**	**Total**
0.020 Dec-97	0.014 Jul-90	0.041 Apr-96	0.038 Mar-93	0.136 Jan-95	0.125 Jan-95	0.395 Dec-97	0.395 Dec-97	15.3 Apr-96	27.3 Mar-93	495 Jan-95	502 Jan-95

Total year amount of mercury amounts to **1.5 – 4.3 kg**: highest amount in 1996;
~ 8% brought by interflow, 31% - by base- and 61% by storm flow;
Minimal daily load is 0.4 g, maximal – 502 g.

