

McGill University
Department of Geography

GEOG203 – Environmental Systems

Assignment #2 – Hydro-Biogeochemistry and Anthropogenic Disturbance

Due: Start of class November 1st 2006

HAND IN TYPED WITH COMPUTER GENERATED TABLES & GRAPHS

The objective of this assignment is to combine information on seasonal patterns of runoff and stream concentrations of nutrients to estimate nutrient export and to evaluate the effect of forestry practices and anthropogenic changes.

This exercise uses data from the Hubbard Brook Experimental Forest (HBEF, <http://hubbardbrook.org>). In this assignment, we are looking at the seasonal patterns of precipitations and runoff at the monthly scale, and the effect of forestry and time of year on these patterns. In addition, the researchers measured concentrations of chemical elements and nutrients in the streams draining the two basins, allowing a calculation of their export, by month and over the whole year.

In this exercise, we shall deal with the monthly runoff (in mm) and concentrations of calcium (Ca^{2+}), nitrate (NO_3^-) and chloride (Cl^-). Calcium and nitrate are two important plant nutrients, whereas chloride is not required in large amounts by plants, is relatively unaffected by the ecosystem and can be used as a hydrologic “tracer” (also biogeochemical tracer). Table 1, which is available on the website (excell format): <http://www.geog.mcgill.ca/grad/turgeon/203.htm>, gives the monthly precipitation and runoff (in mm) and concentrations of Ca^{2+} , NO_3^- and Cl^- in milligrams per litre, or (mg L^{-1}) in the W2 and W3 basins for 1967 (two years after the trees were cut, left in place and a herbicide applied), 1977 and 1987. Note : W3 is the control basin.

Format of Assignment :

Times New Roman, 12 point font, 1.5 spacing, double-sided (if possible), page number and name on header or footer of each page)

TA Hours : Burnside Hall 5th Floor Library
October 25th, 26th and 27th : from 4 to 5 pm
October 30th and 31st : from 3 to 5 pm

Answer the following questions :

1. Calculate the export (in kg/ha) of Ca^{2+} , NO_3^- and Cl^- for each watershed (Table 1). Present the results in a table and graphs. Each graph should present the export of one element (Ca^{2+} , NO_3^- and Cl^-) for the 3 years (Total is 6 graphs : 3 for W2 and 3 for W3. All plots should be arranged in 2 pages).

Calculation of export in kg/ha

The export (kg/ha) is the combination of the monthly runoff (mm) and the concentration (mg/L). In order to calculate the export of one element, you need to multiply the runoff by the concentration. To do so, you have to make sure that the units of both members are the same.

- to convert runoff in mm to litres per hectare, multiply by 10000 (10^4)
there are 10000 m² in 1 ha and 1 mm water depth over 1 m² equals 1 litre
- to convert the concentration from mg/L to kg/L, divide by 1 000 000 (10^6)
there are 1000000 mg in 1 kg
- to calculate the export of Ca, per example, for january 1967, multiply the Runoff (in L/ha) by the concentration (in kg/L) which gives you the export (or flux) of the element. Example : $31 \text{ mm} * 10\,000 * 8,1 \text{ mg/L} \div 1\,000\,000 = 2.511 \text{ kg/ha}$

2. For each graph produced in Q1, at what time of the year is most of the Ca^{2+} , NO_3^- and Cl^- is exported from the cut-over basin (W2) and from the undisturbed basin (W3)? What common factor(s) can explain the similarities, if any ? **(4 typed lines)**

3. How and why is the pattern of NO_3^- export are different from that of Cl^- ? (hint : Values in Table 1 (concentrations and runoff) can help you answer this question) **(8 types lines)**

4. Describe and explain the differences of export of Ca^{2+} , NO_3^- and Cl^- in 1967 between the 2 basins. **(12 typed lines)**

5a. What changes in export of Ca^{2+} , NO_3^- and Cl^- have occurred in the W2 basin during the 20 years period (from 1967 to 1977 to 1987) and explain why ? (Hint : there are two major periods : i) the period of cut-over (1967) to the regrowth of vegetation (1977) and ii) the regrowth of vegetation (1977) to the establishment of a young forest (1987))

5b. How does W2 compare to W3 in 1987, why ? **(15 types lines for part a, 5 types lines for part b)**

6. Over the 20 years period of data presented here, Hubbard Brook has been exposed to acid precipitation. What impact do you think this atmospheric deposition of acids has had on the biogeochemistry of the forest and streams that might affect these data ?

(Readings in the coursepack)

(Answer should be no longer than 1 page)

Table 1. Monthly W2 and W3 precipitation (same for both watershed), runoff and stream concentrations of Ca^{2+} , NO_3^- and Cl^- for 1967, 1977 and 1987.

Year	Month	P (mm)	W2				W3			
			Runoff (mm)	Ca^{2+} (mg L^{-1})	NO_3^- (mg L^{-1})	Cl^- (mg L^{-1})	Runoff (mm)	Ca^{2+} (mg L^{-1})	NO_3^- (mg L^{-1})	Cl^- (mg L^{-1})
1967	1	58	31	8.1	48.3	0.9	23	1.7	2.24	0.7
	2	109	18	7.6	44.2	0.9	15	1.6	2.37	0.8
	3	55	91	6.8	41.6	0.8	45	1.6	2.42	0.5
	4	137	279	6.2	38.9	0.8	272	1.6	1.82	0.6
	5	111	111	6.0	36.1	0.8	119	1.5	0.92	0.6
	6	81	52	6.5	38.3	0.7	19	1.6	0.54	0.4
	7	113	69	7.6	47.6	0.8	8	1.6	0.41	0.4
	8	137	92	10.1	66.1	0.8	11	1.8	0.99	0.5
	9	135	99	10.8	73.4	0.9	27	1.7	0.84	0.4
	10	120	130	11.2	78.4	0.8	96	1.8	0.54	0.4
	11	112	76	10.1	70.7	0.9	71	1.8	1.9	0.5
	12	149	86	8.0	61.4	0.8	75	1.7	3.14	0.5
1977	1	76	13	1.6	0.22	0.4	12	1.5	1.7	0.5
	2	75	12	1.7	0.2	0.3	9	1.6	1.89	0.5
	3	161	325	1.4	0.23	0.4	258	1.5	3.93	0.3
	4	110	140	1.4	0.06	0.3	149	1.3	2.14	0.3
	5	40	21	1.5	0.04	0.2	25	1.3	0.81	0.4
	6	123	23	1.6	0.01	0.2	20	1.4	0.24	0.5
	7	69	4	1.7	0.03	0.2	3	1.5	0.77	0.4
	8	99	5	1.8	0.01	0.1	3	1.6	1.3	0.4
	9	199	74	1.8	0.02	0.2	42	1.5	0.44	0.4
	10	194	198	1.8	0.01	0.3	187	1.4	0.06	0.4
	11	100	68	1.7	0.01	0.3	63	1.4	0.27	0.4
	12	137	83	1.7	0.02	0.3	73	1.4	0.53	0.4
1987	1	89	20	1.4	0.06	0.4	20	1.1	0.29	0.4
	2	11	10	1.4	0.09	0.4	11	1.1	0.31	0.4
	3	162	263	1.4	1.04	0.4	247	1.2	1.2	0.4
	4	70	98	1.4	0.69	0.4	102	1.2	0.92	0.4
	5	84	46	1.4	0.13	0.3	49	1.1	0.1	0.4
	6	193	96	1.4	0.01	0.3	95	1.1	0.05	0.4
	7	73	16	1.4	0.01	0.2	21	1.1	0.07	0.4
	8	110	4	1.8	0.01	0.3	7	1.1	0.17	0.4
	9	155	40	1.4	0.01	0.4	46	1.2	0.06	0.4
	10	105	62	1.4	0.02	0.5	64	1.1	0.02	0.4
	11	113	84	1.5	0.3	0.6	79	1.1	0.48	0.5
	12	57	52	1.5	0.16	0.6	54	1.1	0.41	0.5