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Contribution of pollution load of storm water runoff in Shillong city

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ABSTRACT

The focus of the present research was based upon contamination of urban storm water run off . As urban storm water is harmful to the environment and imparts harmful effects on the water quality as well as water quantity of receiving waters. A variety of water quality parameters were monitored at high traffic areas for the consecutive two years in Shillong city. Aqueous loading of chloride, sulphate, nitrate, Pb, Cd, Al, Zn, Fe increased during the two monitored storm events. The highest increases in pollutant loadings were associated with chloride, sulphate, Pb, Cd and Fe.

Keywords: storm water; runoff; shillong; anions; trace metals; control sample.

INTRODUCTION

Urban storm water once was recognized as a major source of pollutants, is now considered as a valuable resource for non-drinking purposes in cities.Urban storm water non-pollutant source pollutants are recognized as a major cause of receiving waters quality deterioration.Urbanization, development & populating of an area create different pollutants.

Storm water runoff from urban areas is a significant source of pollution to inland water bodies such as streams, rivers & lakes[1] .The level of contaminates in rain water runoffs has become an increasing concern in rain water utilization.And one of the best countermeasures against a water shortage in urban areas, rain water utilization plays a very important in urban areas, rain water utilization plays a very important role.It can overcome a shortage of water supply and in the mean while is very effective for runoff control [2],[3],[4].

Non potent pollution resulting from urban surface runoff was recognized as one of the major cause of quality deterioration in receiving water bodies [5], [6],[7]. Storm water runoff not only flows into the river but also rubbish, animal droppings, chemicals, fertilizers, oils soil & anything that is placed in or washes into street gutters can end up in the river and polluting the environment [8].

Rain water washes dusts away from the atmosphere & the impervious urban surfaces and in the form of storm runoff, carries of dissolved colloidal. Solids constituents in a heterogeneous mixture which includes organic & inorganic compounds, nutrients, oil, greases & heavy metals.

The associated pollutant load is mainly produced by vehicular traffic & other human activities.The wash off process from roof surfaces has been pointed out as an important source of pollutants.High concerns of heavy metals in dissolved from such as Cu &Pb are easily removed in the form of soluble corrossion products of metal surfaces that are commonly used as roofing or gutter materials[9], [10], [11], [12].

Heavy metals, e.g. Pb& Cu are readily soluble salts in runoff, are regarded as hazardous to water[13].Urban surface storm water runoff can be divided into the main types.

a) Permanently sealed surfaces (such as overgrown soil in backyards, urban green spaces &porces parting)
b) Impermeable roof surfaces
c) Impermeable road surfaces

The present study is aimed to check the contamination status of city roads with high traffic intensity and commercial activities by selected organic and inorganic compounds with special emphasis on potentially toxic trace elements those which are recognized as carcenogenic.

MATERIALS AND METHODS

Description of The Study Area
Shillong, India (Khasi: Shillong) is the capital of Meghalaya, one of the smallest states in India and home to the Khasis. It is also the headquarters of the East Khasi Hills district and is situated at an average altitude of 4,908 feet (1,496 m) above sea level, with the highest point being *Shillong Peak* at 6,449 feet (1,966 m). The city had a population of 314,610 according to the 2011 census. Shillong is located at 25°34′N 91°53′E / 25.57°N 91.88°E/ 25.57; 91.88. It is on the Shillong Plateau, the only major pop-up structure in the northern Indian shield.

The city lies in the centre of the plateau and is surrounded by hills, three of which are revered in Khasi tradition: LumSohpetbneng, LumDiengiei and LumShillong. Shillong is said to be the second largest hill station in the world after Brasillia.

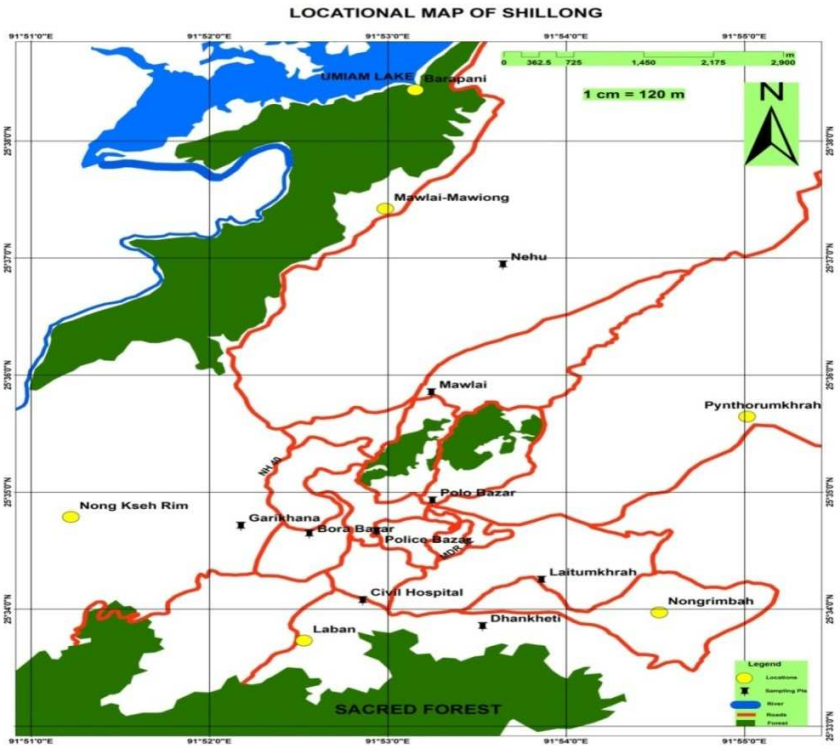


Fig1 : Sampling Location map of Shillong

Table 1: Sample locations with GPS values

Sample Location	GPS Value
Nongpoh	N 25-54-04 and E 091-52-38.2
Police Bazar	N 25-34-33.4 and E 091-52-58.0
Mawlai	N 25-35-33.4 and E 091-52-20.5
Dhankheti	N 25-34-01.3 and E 091-53-25.8
Garikhana	N 25-34-43.7 and E 091-52.2-23.0
Polo Ground	N 25-34-53.0 and E 091-53-15.8
Boro Bazar	N 25-34-41.2 and E 091-52-35.4
NEHU	N 25-36-29.9 and E 091-53-56.2
Laimukhrah	N 25-34-17.4 and E 091-53-49.1
Civil Hospital	N 25-34-05.0 and E 091-52-54.1

Street runoff water: The water samples have been collected in pre-cleaned 2 L polyvinyl containers from different locations of shillong on the basis of high traffic density areas. One rain water sample will be collected directly about 5 meters above the ground level at residential area after the initial events of rain and it is treated as control sample. Necessary care has been taken to prevent contamination of the samples during transportation to the laboratory, storage and analysis [14],[15].

All pH measurements were done using a digital pH meter (Model LT-120, ELICO, India). The instrument was calibrated for each set of measurements with standard buffer solutions. Conductance was measured using a digital conductivity meter (Model: ACM-340913-R,India), calibrated with 0.01 M KCl solution (of conductivity 1287 μS/cm at 298 K).Chloride (Cl-) in drinking water was estimated by the silver nitrate method. Nitrate-nitrogen (NO^{3-} - N) in water sample was determined using UV spectrophotometrictechnique (Shimadzu-UV-Mini-1240) by measuring the absorbance of the phenol-disulphonicacid nitrate complex at 410 nm [15].

Sulphate (SO_4^{2-}) ion is precipitated in an acetic acid medium with barium chloride (BaCl2)so as to form barium sulphate (BaSO4) crystals of uniform size. Light absorbance of theBaSO4 suspension was measured by UV-Visible spectrophotometry (Shimadzu-UV-Mini-1240) and the concentration of the SO_4^{2-} ions were determined by comparison of thereading with a standard curve.

The concentrations of Pb, Cu, Fe Ni, Cd, Mn, Zn, Cr and Al were analysed by using Atomic Absorption Spectrometer (Perkin Elmer A- Analyst 200) with Flow Injection Analyze Mercury Hydride Generation System as per the standard procedures [14].

RESULTS AND DISCUSSION

The present investigation has allowed us to gather a large amount of data regarding the content of selected analysis from the inorganic compound groups in storm runoff samples from roads with high traffic intensity in Shillong Table2 and table 3lists the ranges of concentration determined and mean concentrations of P^H, EC, Cl^-, NO^{3-}, Pb, Cd, Zn, Fe, SO_4^{2-} for the sampling period between 2010-11 and 2011-12.

Road runoff is found to follow an acidic trend with average P^H values ranging from 6.38 to 6.76 in 2010-11 and 6.28 to 6.64 in 2011-12. The Control samples also showed an acidic trend with the P^H value of 6.76 and 6.29 in the respective years.

The concentrations of anions in runoff waters was higher than the control sample and increased with increasing traffic intensity.The mean chloride ionic concentration has been determined to be 67.88 and 69.256 mg/l in 2010-2011 and 2011-2012 respectively. Higher chloride concentration may be due to roadside dumping of solid wastes.Higher concentrations of NO^{3-},and SO_4^{2-} in road runoff samples may be due to industrial activity in the region/sampling area. Mawlai being a commercial area with higher traffic intensity showed higher concentration of chlorine while NEHU Road being a non commercial area showed lesser chlorine concentration in runoff samples.Nongpoh and Laimukhra being high traffic zones showed higher concentration of NO^{3-} and SO_4^{2-}.

Heavy metals in the runoff samples were significantly higher(Table 2 and 3)Higher concentration of Pb, Cd, Zn and Fe could be attributed to the automobile exhausts,corrosion products of metal surfaces that are commonly used as

roofing materials in the study area.Moreover abrasion of Cd bearing alloys and tyre rubbers could also be considered as sources of Cd in runoff samples.Higher Zn concentration is assumed to be due to the use of lubricating oils in vehicles which contain Zn for the quality improvement.

Table 2: Statistical results of storm water analysed in 2010-2011

Storm water of Shillong 2010-11									
	PH	Cond.(mS/cm)	Cl-(mg/l)	SO42-(mg/l)	NO3-(mg/l)	Pb(mg/l)	Cd(mg/l)	Zn(mg/l)	Fe(mg/l)
MIN	6.38	0.03	57.91	33.19	1.04	0.00	0.00	0.38	1.74
MAX	6.76	0.11	86.08	63.38	6.27	0.41	0.02	2.42	4.22
MEAN	6.51	0.06	67.88	45.40	2.28	0.14	0.01	1.08	2.61
Std. dev.	0.12	0.02	8.31	9.14	1.48	0.16	0.00	0.59	0.80
KURT	0.80	3.60	1.64	0.06	7.30	-0.59	-0.42	2.37	0.06
SKEW	0.93	1.02	1.30	0.69	2.58	0.91	-0.17	1.30	0.82
Control Sample	6.76	0.04	16.74	29.86	0.68	BDL	BDL	0.01	0.18

Table 3.Statistical results of storm water analysed in 2010-2011

Storm water of Shillong 2011-12									
Sample No.	PH	Cond.(mS/cm)	Cl-(mg/l)	SO42-(mg/l)	NO3-(mg/l)	Pb(mg/l)	Cd(mg/l)	Zn(mg/l)	Fe(mg/l)
MIN	6.28	0.0383	58.61	35.23	1.21	0.003	0.008	0.397	1.921
MAX	6.64	0.1227	87.31	64.67	6.351	0.43	0.018	2.431	4.453
MEAN	6.439	0.074164	69.256	47.261	2.4122	0.15155	0.01262	1.1127	2.7892
Std. dev.	0.11	0.02	8.45	8.76	1.47	0.17	0.00	0.59	0.82
KURT	0.11	1.49	1.28	0.17	6.91	-0.61	0.30	2.06	0.10
SKEW	0.42	0.93	1.19	0.73	2.52	0.89	0.18	1.21	0.85
Control Sample	6.29	0.06	21.63	31.63	0.68	BDL	BDL	0.01	0.24

Fig.2.Varition of storm runoff water and control sample values (2010-11) for PH,cond.,SO42-,NO3-,Pb,Cd,Zn,Fe

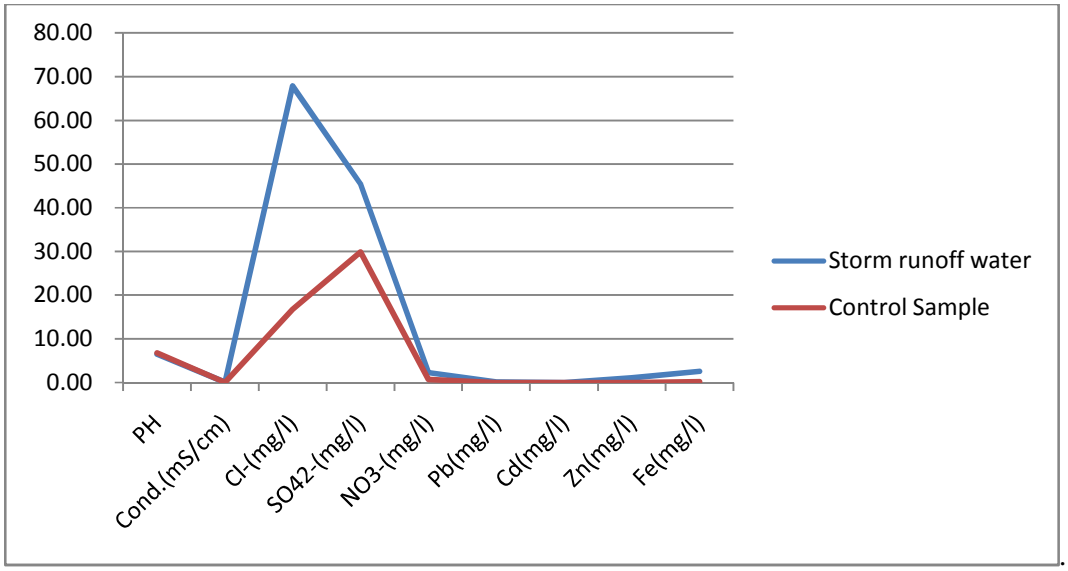


Fig.3.Variation of storm runoff water and control sample values (2011-12) for PH,cond.,SO42-,NO3-,Pb,Cd,Zn,Fe

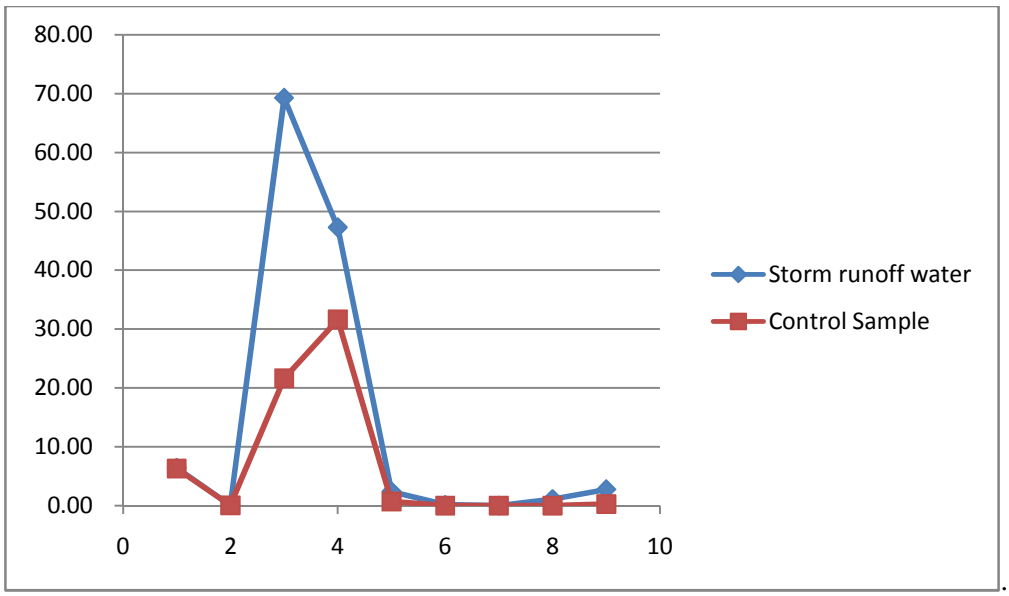
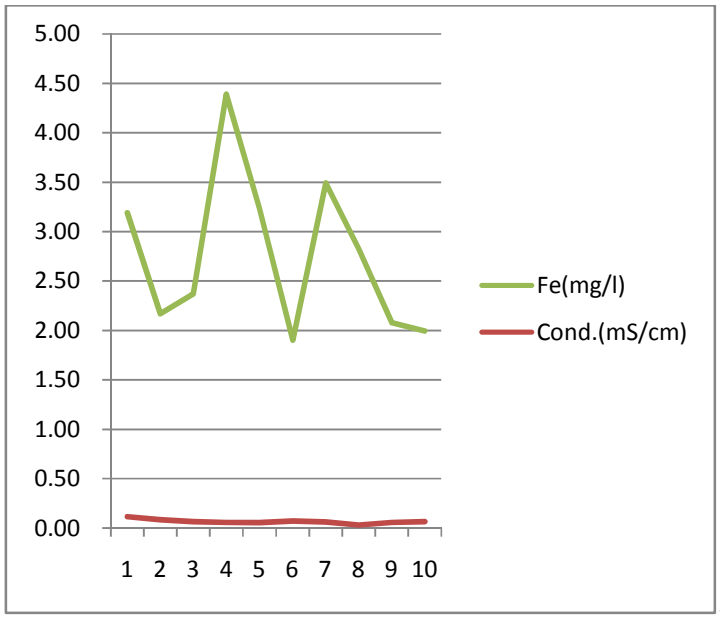


Fig.4. Variation of mean conductance values with mean concentration of Fe metal



CONCLUSION

The results of this study indicate the extent to which discharges from houses, Municipality and vehicles alter the chemical quality of the normal storm water. High traffic densities have enormous effects on pollutant distribution and concentration. Heavy metals show significant differences that depend on the materials' impact on the pH value. Concerning different traffic density on road surfaces, the motorways show the highest concentration of pollutants for all the parameters. Storm water runoff in urban areas can influence the quality of surface water, and canpotentially carry pollutants into seepage water and ground water. The surface water bodies receive the storm water runoff directly through the local urban drainage system. The seepage water is influenced by the centralised and de-centralised infiltration of storm water in the subsurface. The ground water is influenced by the seepage water, which is affected by the pollution retention capacity of the subsurface soil. Furthermore, the quality of ground and surface water is related to their interaction processes. [16]. Comparative investigation and estimation of the degree of environmental hazards on surface water, seepage water and ground water may be considered in order to check the pollution. The qualitative effects of storm water infiltration (infiltration via swales, trenches or wetlands) on soil, seepage water and ground water can be investigated with long-term numerical modeling [17].

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