Research Article

A COMPARATIVE STUDY OF THE WATER QUALITY BETWEEN UMKALIAR AND LWAI STREAM, EAST KHASI HILLS DISTRICT, MEGHALAYA

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ABSTRACT

Study of the physico-chemical parameters such as colour, turbidity, dissolved oxygen, nitrate content, fluoride content, etc shows a marked difference between the two streams. Further when biomonitoring was done, it was observed that the macroinvertebrates inhabiting Umkaliar stream were pollution tolerant such as aquatic worms (Tubificidae), midge larvae (Chirominidae) and fish fly larvae (Nigronia) etc. During this study a dead fishes were also found from this stream. In Lwai stream, macroinvertebrates which are pollution sensitive (i.e. residing in clean water) such as variety of species from taxonomic orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) were found to be more dominant. Umkaliar stream have high anthropogenic activities along its bank and during field work for one year it was observed that there was a permanent anthropogenic activity. Sewage was observed to be directly release in to the stream from the houses. Washing of clothes and vehicles were seen to take place almost every day. Unlike Umkaliar stream, Lwai stream is far from human impact making it still pollution free. Thus, it can be concluded that due to anthropogenic activity there is a change in composition in both physico-chemical and biological properties in Umkaliar stream which indicates water pollution as compared to Lwai stream.

INTRODUCTION

The presence or absence of the indicator or of an indicator species or indicator community reflects environmental conditions. Unanticipated changes in freshwater ecosystems are often due to alterations in the complex connections among sediment-dwelling species and associated food webs (Goedkoop and Johnson 1996, Lodge *et al.*, 1998b, Stockley *et al.*, 1998) or to disturbances, such as floods or drought (Covich 1993, Power 1995, Johnson *et al.*, 1998), that alter the species composition of the benthos. Absence of a species is not a meaningful as it might seem as there may be reasons other than pollution that result in its absence (e.g., predation, competition or geographic barriers which prevented it from ever being at the site) (Johnson *et al.*, 1993). Certain aquatic plants have also been used as indicator species for pollutants including nutrient enrichment (Batiuk *et al.*, 1992; Phillips and Rainbow, 1993). There are advantages and disadvantages to each. Macro invertebrates are most frequently used (Rosenberg and Resh, 1993). Absence of multiple species of different orders with similar tolerance levels that were present previously at the same site is more indicative of pollution than absence of a single species.

Macro invertebrate community responses to environmental changes are used in assessing the impact of municipal, industrial, oil, and agricultural wastes and impacts from the other hand uses on surface waters. Four types of environmental changes for which patterns of macro invertebrate community structure change have been documented are increased inorganic micronutrients, increased organic loading, substrate alteration, and toxic chemical pollution. Inorganic micronutrients and

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sewer organic pollution usually result in restriction in the variety macro invertebrates to only the most tolerant ones and corresponding increase in density of those tolerating the polluted conditions, usually associated with low dissolved oxygen concentration. In some cases severe organic pollution, siltation, or toxic chemical pollution may reduce or even eliminate the entire macro invertebrate community from an affected area. Not all cases conform to those described because conditions may be mediated by other environmental (biological, chemical, and physical) conditions. Macro invertebrate have been extensively monitored in water bodies to evaluate water quality and to complement physico-chemical surveys. Macro invertebrates community can indicate the effect of pollutant sources, which may not have been detected by either intermittent physico-chemical sampling or continuous monitoring of a restricted range of parameters. Benthic macro invertebrates are animals inhabiting the sediment, or living on or in other available bottom substrates of freshwater, estuarine, and marine ecosystems. During all or part of their life cycles, these organisms may construct attached cases, tubes, or nets that they live on or in; roam freely over the rocks, organic debris, and other substrates; or burrow freely in substrates.

occur along Umkhrah Stream system causing stress to the biota of stream, it thus becomes important to identify and study whether the upper zone of the stream system is also affected by the human activities or is the water quality of Wah Umkaliar still fit to be called clean. For control, another stream called the Lwai stream was taken in order to compare the parameters as well as macro-invertebrates. This stream is situated at Thangsning Village, 22 kms away from Shillong. This stream is use for drinking purpose as huge iron pipelines are seen. Other than that the stream seems to be free from anthropogenic activities.

METHODS

Various physical and chemical parameters like turbidity, dissolved oxygen, pH, alkalinity, total hardness, colour, odour, nitrate content, chloride content, fluoride content, iron content were done using standard methods of APHA (2012). The physical parameters were analysed using Deluxe Water and Soil Analysis multi-parameter instrument, Model 172 (Epson Pvt. Ltd, India) and the chemical parameters were analysed using Aqua Check Multi-parameter Water Testing Kit, WT 015 (HiMedia Laboratories, India).

Table showing Biological Water Quality Criteria (CPCB, 2005)

Sl. No	Taxonomic Group	Range of Saprobic Score	Range of Diversity Score	Water Quality Characteristic	Water Quality Class	Indicator Colour
1	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Diptera	7 & more	0.2-1	Clean	A	Blue
2	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Planaria, Odonata Diptera	6-7	0.6-1	Slight Pollution	B	Light Blue
3	Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Odonata, Crustacea, Mollusca, Polychaeta, Coleoptera Diptera, Hirudinea, Oligochaeta	3-6	0.3-0.9	Moderate Pollution	C	Green
4	Mollusca, Hemiptera Coleoptera Diptera, Oligochaeta	2-5	0.4 & less	Heavy Pollution	D	Orange
5	Mollusca, Coleoptera Diptera, Oligochaeta	0 – 2	0-0.2	Severe Pollution	E	Red

Benthic macro invertebrates are useful indicators of water quality because they can be found in all but most severely polluted to disturbed habitats and because they have a wide range of pollution tolerances amongst various species. This means that a benthic macro invertebrate community will be composed of different species depending on the amount of exposure to pollution it receives. By identifying the relative abundances of species that are tolerant of pollution versus species that are intolerant of pollution, the bio monitoring program gains valuable information about the impact of pollution and habitat disturbance on rivers, streams and wetlands of Meghalaya.

Study Sites

Shillong lies on the deeply dissected Meghalaya Plateau which runs in an East West direction. The greater Shillong area is bound by the coordinates of 25º32´10´´ N to 25º36´20´´ N latitude and 91º51´30´´ to 91º51´30´´ E longitude. The uppermost part of this area is a mildly undulating plateau top with an altitude of 1900 m as the highest points being the Shillong peak (1964m) and the Laitkor peak (1960m). The field study that is being taken up for this study is the Wah Umkaliar which belongs to the upper zone of the Umkhrah Stream System and originates from Spread Eagle Waterfalls, located 3 kms from Umkhrah Stream. Various anthropogenic activities like encroachment, sand mining, direct sewage dumping has

Bio monitoring was done by using Biological Water Quality Criteria (BWQC) developed by Central Pollution Control Board (CPCB, 2005).This criteria is based on the range of Saprobic Values and Diversity Score of benthic macro-invertebrate families with respect to water quality. To indicate changes in water quality according to pollution levels, the taxonomic groups of benthic macro-invertebrate families with their saprobic score range from 0 to 10, in combination with the range of diversity score 0 to 1 have been classified into five different classes. The abnormal combination of saprobic score and diversity score indicates sudden change in environmental conditions and poor substratum of water body.

RESULTS

From fig 1, the results indicate that there were differences in the amount of physical parameters in Umkaliar stream as compare to that of Lwai stream which 22 km from Shillong. Turbidity measurements in NTU also show to be more in Umkaliar than Lwai stream. However in both the streams, temperature and pH shows almost the same range. Table 3 shows the chemical parameters of both the streams. Except nitrate, chemical parameters like chloride, iron, are low. However the amount of free chlorine and fluoride are slightly high in Umkaliar as compare to Lwai stream which is very negligible.
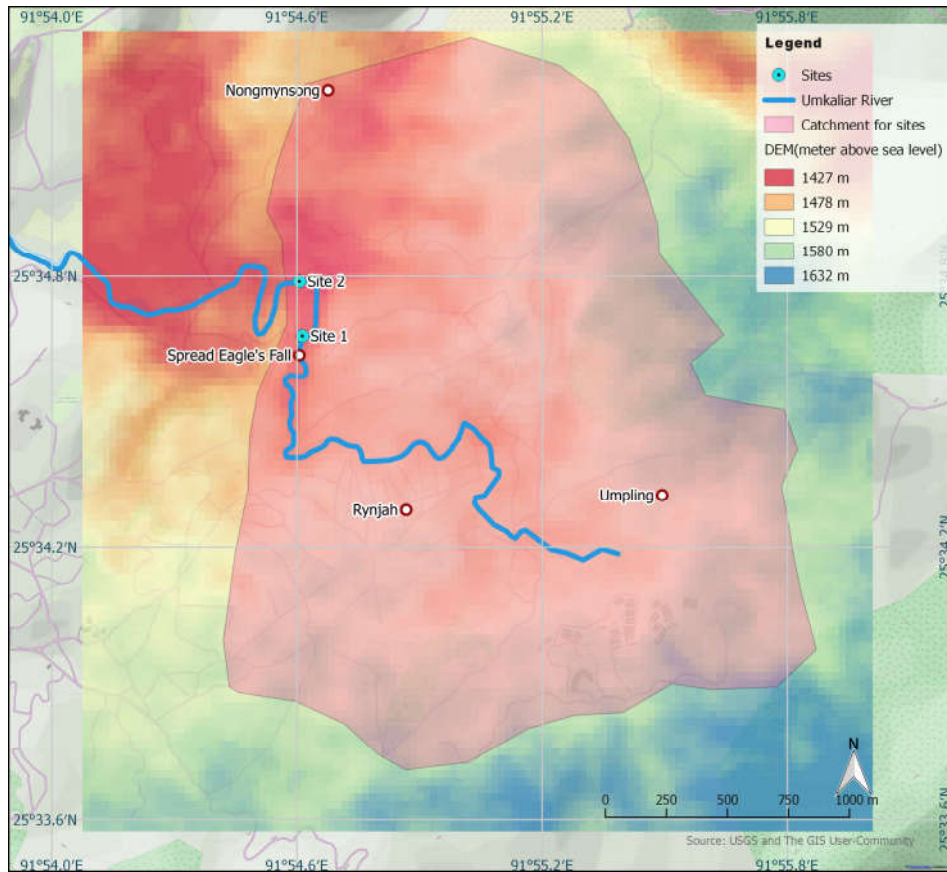
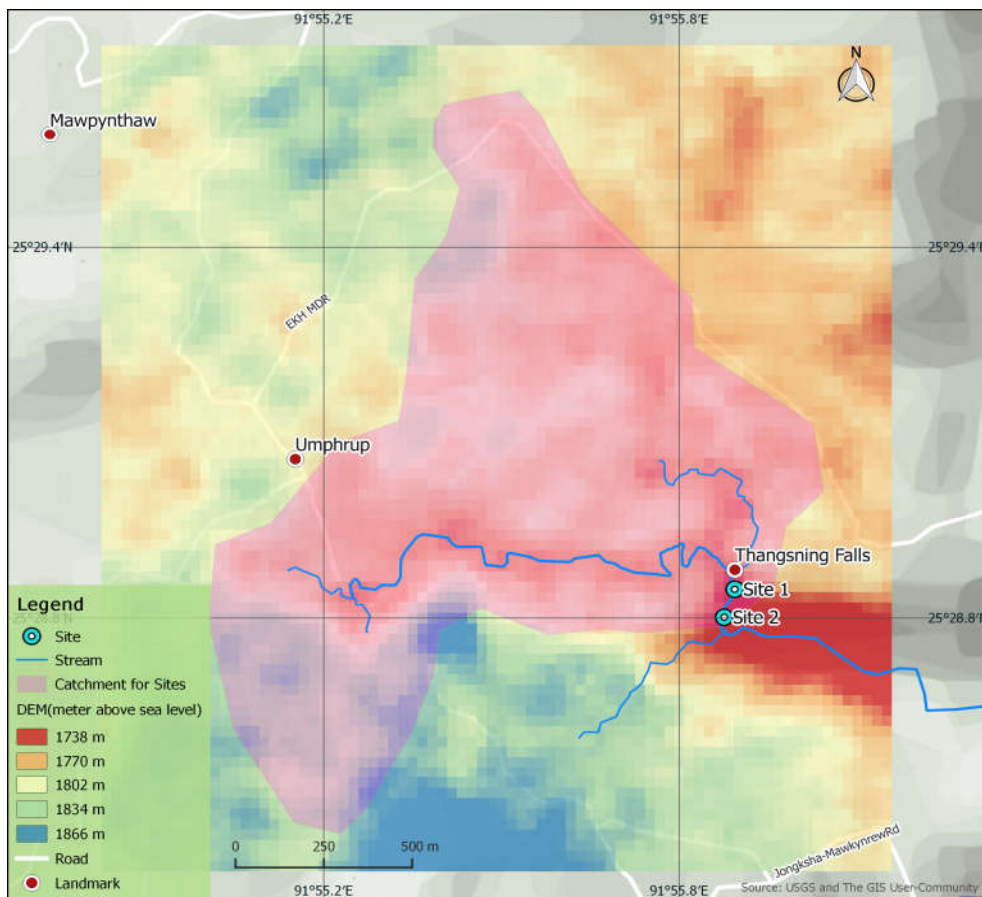**Fig1** A map showing the sites studied of the Umkaliar stream

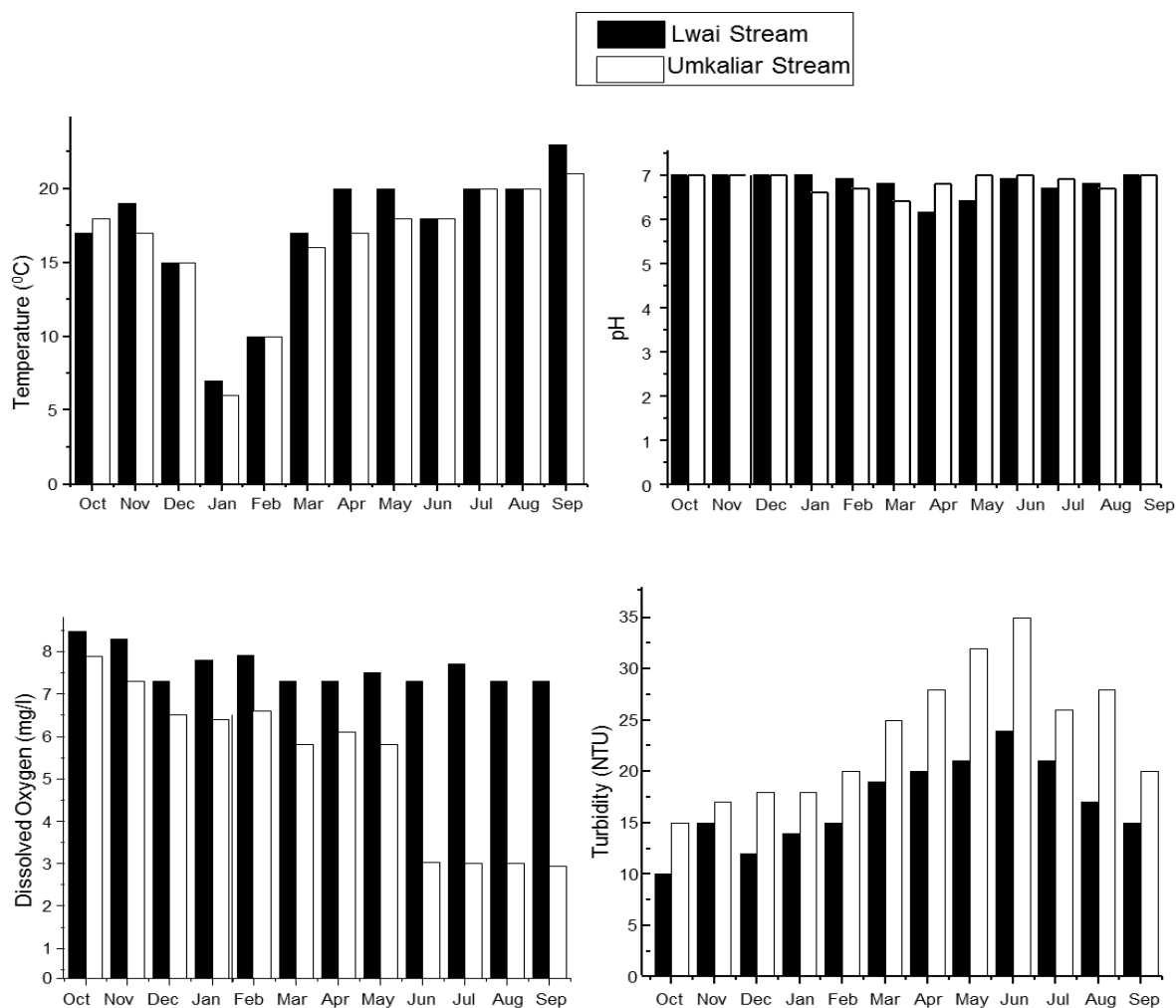**Fig 2** A map showing the sites studied of the Lwai stream

Fig 3: Showing graphical representations of the physical parameters recorded for a period of one year of two streams namely Lwai and Umkaliar of Meghalaya

Table 1 Shows the biological water quality evaluation for Lwai Stream using benthic fauna, which can easily be done by combining the observed saprobic score and diversity score and the biological water quality class can be determined through comparing the results with the ranges of Saprobic and Diversity score prescribed in Biological Water Quality Criteria (BWQC) of Central Pollution Control Board, 2005.

Months	Saprobic Score	Diversity Score	BWQC	Biological water quality	Indicator colour
October	7	0.007	Clean	A	Blue
November	8.2	0.008	Clean	A	Blue
December	8	0.010	Clean	A	Blue
January	6.9	0.009	Clean	A	Blue
February	8	0.010	Clean	A	Blue
March	7	0. 011	Clean	A	Blue
April	8	0.034	Clean	A	Blue
May	10	0.058	Clean	A	Blue
June	8	0.05	Clean	A	Blue
July	9	0.03	Clean	A	Blue
August	8	0.08	Clean	A	Blue
September	7	0.133	Clean	A	Blue

The most striking difference between the two streams is the amount of dissolved oxygen that is presence in their water. In Umkaliar stream the annual average amount of dissolved oxygen was about 4.75 ± 0.09 mg/litre whereas in Lwai stream the annual average amount of oxygen was about 7.36 ± 0.07 mg/litre. The presence of aquatic macro invertebrates can be clearly correlated with the amount of dissolved oxygen. In Umkaliar stream, the macro invertebrates that were found were snails, midge larvae, leeches, mosquito larvae. Their saprobic score and diversity score are presented in Table 2.

In biomonitoring, all these are under pollutant resistant family. In Lwai stream however the type of macro invertebrates that were found belongs to pollutant sensitive category. These include stoneflies, caddish flies, Hellgrammites etc. Their saprobic score and diversity score are given in Table 1.

DISCUSSION

The results clearly indicates the physico-chemical parameters such as colour, turbidity, dissolved oxygen, nitrate content, fluoride content, etc between the two streams.

Table 2 Shows the biological water quality evaluation for Umkaliar Stream using benthic fauna, which can easily be done by combining the observed saprobic score and diversity score and the biological water quality class can be determined through comparing the results with the ranges of Saprobic and Diversity score prescribed in Biological Water Quality Criteria (BWQC) of Central Pollution Control Board, 2005.

Months	Saprobic Score	Diversity Score	BWQC	Biological water quality	Indicator colour
October	3.5	0.010	Moderate Pollution	C	Green
November	3.3	0.018	Moderate Pollution	C	Green
December	3.4	0.008	Moderate Pollution	C	Green
January	3.1	0.009	Moderate Pollution	C	Green
February	3.4	0.009	Moderate Pollution	C	Green
March	3.6	0.012	Moderate Pollution	C	Green
April	3	0.016	Heavy Pollution	D	Orange
May	6.5	0.009	Slight Pollution	B	Light Blue
June	5.5	0.105	Moderate pollution	C	Green
July	5.4	0.115	Moderate pollution	C	Green
August	5.3	0.02	Moderate Pollution	C	Green
September	6.5	0.035	Slight Pollution	B	Light Blue

Table 3 The table shows the chemical parameters of Umkaliar and Lwai Streams. Values are represented as Mean ± SEM.

CHEMICAL PARAMETERS	LWAI STREAM	UMKALIAR STREAM
Nitrate (ppm)	11± 0.2	100±11
Fluoride (ppm)	Nil	0.2 ±0.01
Chloride (ppm)	34±5.3	60 ±16.83
Iron (ppm)	0.42±0.001	0.74±0.04
Free chlorine (ppm)	0.04±0.001	0.32±0.02

It was further observed that the macroinvertebrates inhabiting Umkaliar stream were pollution tolerant. However, dead fish was found in this stream. In Lwai stream, macroinvertebrates which are pollution sensitive (i.e. residing in clean water) were found to be more dominant.

Any physical, chemical or biological change in water bodies affects one or all species and disturbs the normal function of the aquatic ecosystem. Physico-chemical parameter greatly affects the survival of aquatic organisms. Low DO greatly impacts the survival rate of oxygen sensitive organisms like fish. High fluoride content can lead to fluorosis or softening of the bones. High ion contents like chloride, nitrogen can cause hyper-osmotic stress and hyper-ammonia stress on the aquatic organisms.

Benthic macroinvertebrates are often used as indicators of water quality because of the limited mobility relatively residence times and varying degrees of sensitivity to pollutants. Unaffected streams like Lwai have a variety of species including high diversity of insects class in the taxonomic orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies)(Weed and Rutschky, 1971), whereas severely contaminated conditions are characterised by dominance of a certain taxonomic representation of pollution tolerant organisms such as aquatic worms (Tubificidae), midge larvae (Chirominidae) and fish fly larvae (Nigronia) etc. (Rosemund *et. al.*, 1992).

Umkaliar stream have high anthropogenic activities along its bank. During the field for one year it was observed that there was a permanent anthropogenic activity. Sewage was observed to be directly release in to the stream from the houses. Washing of clothes and vehicles were seen to take place almost every day. Unlike Umkaliar stream, Lwai stream is far from human impact making it still pollution free. Thus, it can be concluded that due to anthropogenic activities there is a change in composition in both physico-chemical and biological properties at Umkaliar stream which indicates water pollution as compared to Lwai stream.

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