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Study of amount of Oxygen (BOD, OD, COD) in water and their effect on fishes (Devprayag to Haridwar)

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Abstract

Present investigation is carried out during December 2014 to April 2015, for which three rivers were chosen i.e. Alaknanda, Bhagirathi, and Ganga to assess the effect of pollution on water and fish diversity of river Ganga-Uttrakhand (DevPrayag to Haridwar). Water and fish samples were collected from all 4 sites .The samples of water were analyzed for amount of Oxygen(BOD,OD,COD) and fish samples were analyzed. Reduction in dissolved oxygen concentration is one of the most important factor and direct effect of fish life cycle because less DO in water can cause mortality, reduced growth rates, and altered distributions and behaviors of fishes as well as less DO can also lead to large reductions in the abundance, diversity, and harvest of fishes within affected waters . During the course of study a total of 35 samples of mainly 5 species Catla catla, Labeo rohita, Cirhinus mrigala, Hypphthal michthys molitrix, , Cyprinus carpio were collected from all 4 sites and all these specimen were caught with the help of cast net.

Keywords: *Water samples, COD, mortality, distribution, behaviors.*

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Introduction

Uttrakhand is surrounded by great Himalayas in the North, Shivalik hills in the South, Ganga in the East and Yamuna in the West. Region of Uttrakhand enjoy moderate climate with maximum temperature of summers (April to July) is around 36 Degree Celsius while the minimum temperature of winters (November- February) is around 5 Degree Celsius. But due to rapid increase in pollution, rising standard of living and exponential growth of industrialization and urbanization have polluted the water resources of Uttrakhand. In addition to that, dumping of city garbage, human and animal excreta, agricultural wastes, pesticides, burning of human bodies, community bathing and faulty social and religious practices. According to an estimate about 1965 9 tons of polluted matter enter the river every year of which 55.4% is contributed by Uttrakhand and Uttar Pradesh while 18.8% by West Bengal.

At Haridwar (Uttrakhand), Ganga water is not free from pollution, which starts from Rishikesh itself where industrial wastes from Bharat Heavy Electrical s Limited (BHEL) have polluted the water. The waste from Indian Drug Production Limited (IDPL) adds to the problem. About 15 large and small sewage drain discharge and about 42 mid municipal sewage into river, community bathing, discharge milk pots, and bunches of flowers and leaves etc. into the river. Pollution get accentuated sharply during Kumbh (every 12 years) then up to 5 million devotes descend in small town to bathe in the holy river. Most of the river water is drained out of irrigation canal at Haridwar which also decrease the pollution absorbing capacity of the river.

Consequently, the problem was taken up when effluents of these industries go into the water system and change the physiochemical quality of the water and make it unfit for drinking and creates difficulty for survival or aquatic life. Since all natural water waste contain bacteria and nutrients, almost any waste compound introduced into such water waste contain bacteria and nutrients will initiate biochemical reactions. These biochemical reactions are measured as BOD and COD in laboratory (Tehovanoglous *et. al* 2003). Both the BOD and COD tests are measure of relative oxygen-depletion effect of waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD tests measure the oxygen demand of oxidizable pollutants. Chemically, waste water is composed of organic and inorganic components as well as various gases. Organic components may consist of carbohydrates, proteins, fats and greases, surfactants, oils, pesticides, phenols etc (Tehovanoglous *et. al* 2003, Maiti 2004).Further in this paper we explained how variation in oxygen quantity (BOD, COD, DO) affect the life of fishes of Uttarakhand (Ganga).

Study Area

Devprayag is located in 30.146315 N 78.598251 E, in Tehri Gharwal District in the state of Uttrakhand, India and is one of the Panch Prayag of Alakhnanda river where Alakhnanda and Bhagirithi rivers meet and take the name Ganga. The original path of Ganga River is on South west direction, then it moves through Easterly direction and final in last lap, it flows again southwards and merges into the sea. During its middle course on easterly direction, a number of big and small tributaries have joined on the northern side from the Himalayan sub-basin, namely, Ramaganga, Gomati, Ghagra, Gandhak and Kosi, all of which have their origins within the mountain range of the Himalayas in Nepal. Therefore, the contribution of flow of these tributaries is from Nepal within the Himalayan range and also from the Indian soil on the Southern side of the Himalayan foothills. There is another tributary, Mahayana which joins the river in Bangladesh.

Materials And Methods

Fish and water samples were collected from 3 rivers of Uttrakhand. The areas from which samples were collected include Devprayag and Haridwar. The river for this study was Alakhnanda, Bhagirathi and Ganga. Water samples were collected once every month during February to April 2014. Site of collection are :

1. Haridwar : Har ki Paudi and Brahmakunda
2. Devprayag: Alakhnanda and Bhagirathi

For water, samples were collected in clean 15polythene bottle from all 4 river sites. Their samples were used in titration method to measure their BOD, DO and COD.

For fish, total 30 samples of mainly 5 species *Catla catla, Labeo rohita, Cirhinus mrigala, Hypphthal michthys molitrix, Cyprinus, carpio* were collected from all 4 sites and all these specimen were caught with the help of cast net. These fishes were transported to plastic container to lab. Then these fishes were analyzed to check the effect of BOD, COD, OD made in their structure in addition to this some observation were made on the research sites.

Table1-Oxygen analysis of river water of Uttarakhand (mg/l)

Samples	I-H-H	II-H-B	III-D-A	IV-D-B
Name of water body	Ganga	Ganga	Alakhnanda	Bhagirathi
Location	Har ki Paudi	Brahmakund	Daveprayag	Daveprayag
City	Haridwar	Haridwar	Devprayag	Devprayag
Colour	Clear	Clear	Clear	Clear
Odour	Odourless	Odourless	Odourless	Odourless
DO (mg\l)	9.5	8.1	10.9	10.0
BOD (mg\l)	3.1	4.9	2.1	3.2
COD (mg\l)	12.2	34.2	6.1	12.9

I-H-H (Haridwar-Har ki pauri), II-H-B(Haridwar-Brahmakund), III-D-A(Daveprayag-Alakananda), IV-D-B(Devprayag-Bagirathi)

Results

A. Effect on water

COD (Chemical Oxygen Demand) range from 6.1 to 34.2 mg per liter. The highest value 34.2 mg per liter is observed at Haridwar (Brahmakund). While the lowest value of 6.1 mg /l is observed at Devprayag (Alakhnanda). DO varies from 8.1 to10.9 mg/l. The average value of DO is meeting the criteria at all monitoring locations. Except some period of year, the DO is not meeting the criteria in river Ganga at 2 sites i.e. Har ki paudi and Brahmakund in Haridwar. BOD ranged from 4.9to 2.1 mg/l .The highest value 4.9per liter is observed at Haridwar (Brahmakund). While the lowest value of 2.1mg /l is observed at Devprayag (Alakhnanda). DO varies from 8.1 to10.9 mg/l.

B. Effect of Oxygen depletion on Fishes

With the help of Table 1, it is clear that effect of pollution is more on site 1 and 2 as compared to 3 and 4. First observation made was that fishes from site of low DO lacked swim bladder which led to increase in mortality on these sites. Mortality of adults was high as compared to young fishes within a water body.

Second observation made during this study was that fishes in area where DO was less become lethargic and stop feeding which explained that dissolved oxygen is not only related with breathing but also with feeding of fishes. As oxygen level decreased, the fishes do not have enough energy to swim, feeding and utilizing yet more oxygen. Often it was recognized that due to less DO in water, some of the fishes get prone to some deadly diseases.

Thirdly, it was observed that the ventilation rate was increased to bring more water in contact with the gill within a unit of time. There are, however, limits to increase flow attainable, the space between secondary lamellae is narrow and water will tend to be forced fast the tip of primary lamella when the respiratory water flow was high, thus by passing the respiratory surface.

Fourth observation was that most of the fishes of sites 1 and 2 were suffering from oxygen deficiency disease called Asphyxiation (disease more common in cyprinids). Symptom of these diseases are fish do not take food, skin became pale in color, congestion of cyanotic blood in the gill, adherence of gill lamellae, small hemorrhages in the front of the ocular cavity and in the skin of gill covers. In the majority of predatory fishes the mouth gaps spasmodically and the operculum over the gills remains loosely open. Not only this, fish reduced food intake, lead to reduction in growth.

Fifth observation was that Low DO concentrations contributed to poor spawning success by troublemaking spawning activities and limiting the amount of energy available for the production of viable eggs and larvae. The physiological pressure and energy demands resulting from exposure of adults to high water temperatures and low DO concentrations can reach levels that affect the amount of energy obtainable for the production of viable eggs and larvae.

Sixth change obsserved was that all fishes had an initial limiting threshold for DO below which they experience a turn down in the ability to perform certain activities and functions. Exposure to low DO concentrations can affect the behavior of fish, resulting in changes in distribution, habitat use, activity, and respiration mode. Fish can stay away from mortality and other adverse effects of low DO concentrations through a number of behavioural responses that reduce either their exposure to low DO concentrations or their need for oxygen. Potential behavioural responses to low DO concentrations include avoidance, changes in activity, increased use of air breathing, increased use of aquatic surface respiration, and habitat shifts.

The concentration of DO that will activate avoidance behaviors varies among species and life stages, depending on their tolerances of low DO concentrations. Field and laboratory studies indicate that fish tend to avoid oxygen concentrations that are two to three times higher than those that cause 50% mortality in 24-hour and 96-hour exposures, roughly equal to the concentrations associated with reduced growth in laboratory experiments (Breitburg 2000). Such behavior indicates that fish can avoid hypoxic waters and select more highly oxygenated waters if available .Some species may also use air breathing or aquatic surface respiration to increase oxygen uptake under such conditions (Weber and Kramer 1983). Where alternative habitats are limited or not accessible, low DO concentrations coupled with high water temperatures can block or delay migration or restrict fish to small refuges where they may experience increased susceptibility to predators, disease, and food limitation .Changes in action in response to low DO concentrations include increased gill ventilation and swimming activity (associated with avoidance behavior) followed by decreases in activity, depending on the period of exposure. Reduced motion levels can help reduce oxygen requirements and allow fish to stay alive exposure to low DO concentrations when escaping is ineffective. However, such a response can reduce feeding and spawning opportunities, potentially foremost to reduced growth or reduced reproductive success, depending on the duration of exposure.

These responses can be important strategies for reducing or avoiding unfavourable effects caused by straight exposure to low DO concentrations but also can increase the possible for adverse effects from other factors (e.g., increased predation risk).Therefore, the degree to which fish exhibit these responses in nature likely will be influenced by the differences in energy costs and mortality risks associated with alternative responses.

In seventh observation, some general effects like (a) Susceptibility to predation, all fishes have an incipient limiting threshold for DO below which they experience a turn down in the ability to perform certain activities and functions. Experience to low DO concentrations can raise the susceptibility of fish to predation by altering normal behavior, reducing activity levels, and reducing swimming performance. Prolonged or frequent exposure to hypoxia may reduce growth rates enough to reduce the size of fish and thereby increase the period of time that fish are weak to predators. (b) Susceptibility to Parasites/Pathogens Environmental conditions, including natural and anthropogenic stressors, can heavily influence the parasite-host interaction because they regulate the physiological condition of both the host and the parasite. Traumatic environmental conditions, such as low DO concentrations, can increase the vulnerability of fish to infectious diseases and parasites. The compounding effects of numerous stressors elicit significant physiological and behavioural responses that may result in increased rates of mortality. Parasites and pathogens alone are known to cause significant changes in reproduction, endurance, and growth of individual fish. Affected fish often become incapacitated, reproduce less, and become more susceptible to predation and less able to tolerate environmental extremes. Though it may be difficult to divide the combined effects of numerous stressors acting at the same time, combining low DO concentrations with parasites and pathogens likely amplifies negative effects.(c) Suscep tibility to Contaminants Fish species may be negatively affected by chemical pollution in urban or agricultural runoff. The toxicity of particular chemicals to fish often changes depending on water quality parameters, including DO concentrations, pH, salinity, and hardness. Poisonous substances and low DO concentration changes the physiology of fish and can affect the function and behavior of fish in the field. In broad-spectrum, organisms living near their environmental tolerance limits (such as low DO concentrations) are more vulnerable to additional chemical stress, especially when exacerbated by enlarged temperatures or low food supplies. An boost in susceptibility to toxic substances may be caused by an increase in respiration attributable to low DO concentrations. Fish respiring more bring more water, and therefore more toxic substances, across the gills and into their systems.

Discussion

Decreased DO concentration causes harmful effects on fishes can be explained by the bio energetic principle proposed by Fry (1971), according to that, the DO concentration that can be explained as upper threshold below which oxygen causes direct mortality as shown in graph within the range, the potential magnitude of adverse effects increases with decreasing oxygen concentration and increasing duration and frequency of exposure. The initial limiting level is important threshold below which the lack of available oxygen resists the ability of fish to perform at maximum levels and increases physiological stress and expenditure of energy to meet oxygen demand.

Rombough 1988 and Cech *et al* 1990 explained different species of fishes have different ability to tolerate low oxygen concentrations, depending on the natural and range of DO concentration that fishes encounter in their preferred habitat. In fish metabolic rate, respiration and feeding activity, growth is highly affected by the concentration decrease, as a results of all this disease attack fishes which lead to mortality of fishes (Tom 1998).Wederm eye 1996 studied that not only physiological or metabolic activities but production of fishes also get affected by decrease oxygen concentration .He also added that, DO requirement varies with species, body size and activities of fishes. Tom (1998) said that oxygen requirements per unit weight of fish significantly decline with increasing individual weight. Randolph and Clemenens (1976) found that feeding patterns of catfish varied with temperature and oxygen availability. When the oxygen content drops below 59% fish starts to lose its appetite.

India is gifted with rich water resources nearly 45000 km long riverine system crisscrosses the length and breadth of the country. Out of this Ganga basin is extraordinarily varied in altitude, climate, land use and cropping patterns. Ganga has been a cradle of human civilization since time immemorial. It is one of the most sacred rivers in the world and is deeply regarded by the people of the country. India has 12 basins, 14 minor and dessert river basin. Out of this Ganga is the largest river basin which flows through the state of Uttrakhand, Uttar Pradesh, Haryana, Himachal Pradesh, Bihar, Jharkhand and West Bengal. But these water resources are losing their beauty and life every day. The reason behind these losses are swiftly increasing pollution, growing standards of living and exponential growth of industrialization and urbanization have exposed the water resources, in general and reverse in particular to various forms of degeneration. Several Indian rivers, including the Ganga in several stretches particularly during lean flows, have become unfit even for bathing.

The Ganga revered for its purity subsistence every day. The river in which millions wash off their sins is now left with 15% of its original water, while the remaining 85% comprises sewage, slu dge, several conservation efforts backed by crores of rupees have failed to restore the sensitivity of the national river. The river Ganga water quality evaluate on the basis of pollution indicate us (DO, BOD & COD) indicate the dissolved oxygen level of river Ganga increasing very rapidly so the need is, in fact, made all the more urgent by the recent spurt of human activities in this region in exploiting its water resources for hydroelectric purposes. Not only are the rivers directly affected by the developmental activities, but they are also affected by other threats like introduction of exotic species, over fishing and the disposal of industrial and domestic wastes from new industries and settlements. Before the rich species diversity of this region of the subcontinent is lost forever, some immediate action and some more research work will be done to save Ganga.

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