



Research Article

A study on the effect of plywood factory effluents on the water quality of receiving streams and nearby wells in Perumbavoor, Kerala, India

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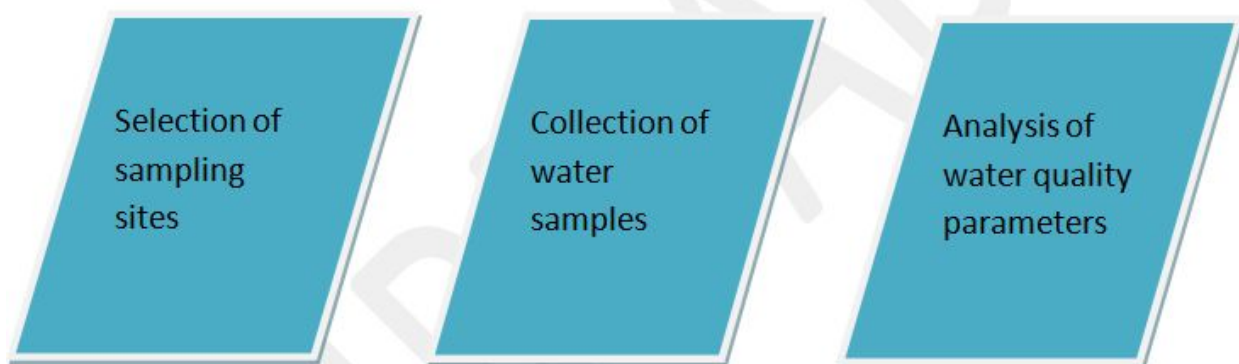
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Objective: To determine the physico-chemical characteristics of water different points of streams that receiving effluents from plywood factories and wells near the plywood factories in Perumbavoor and thereby assess the impact of plywood factory effluents on water quality of receiving streams and wells near the plywood factories.

Methodology:



Duration taken for the research: 5 months

Conclusion: The study has shown that the effluents from plywood industries have a big impact on the water quality of the receiving streams and nearby wells. This is depicted by the fact that there is a general increase in the concentration of the parameters analyzed at downstream from effluent discharging point as opposed to up stream. The wells near the plywood factories also have high levels of analyzed parameters, which show that the effluents have a negative impact on groundwater also.

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Abstract

Perumbavoor, in Eranakulam district is a region well known all over Kerala for its plywood industries. Pollution due to these industries is a sensational issue in this region. The effect of plywood factory effluents on the water quality of receiving streams and nearby wells in Perumbavoor was assessed for a period of five months from December 2016 to April 2017. Samples were collected from streams and wells near randomly selected five different plywood factories in Perumbavoor. In streams, samples were taken from the point of effluent discharge, 100 m upstream from and 100m downstream from the point of effluent discharge. While analyzing the parameters like pH, nitrate, phosphate, Total Dissolved Solids, Biological Oxygen Demand, Chemical Oxygen Demand, copper, chromium and formaldehyde it was found that there is a general increase of the concentration of these parameters in downstream as opposed to upstream. Comparison of these values with BIS guidelines showed that the concentration of these parameters in downstream were higher than the permissible levels except in the cases of copper and chromium. The present study showed that the effluents from the plywood industries have a big impact on the water quality of receiving streams and nearby wells.

Key words: Plywood factory effluents, effluent discharge, water quality in wells, water quality in streams, physico-chemical parameters

Introduction

Water is essential for the existence of all life forms. In addition to household uses it is vital for agriculture, industry, fisheries, tourism etc. In spite of a good number of water resources, we have shortage of usable water. This is due to increasing population, urbanization and industrialization. The net result of these activities is water pollution. Water pollution can be defined as the contamination of streams, lakes, seas, underground water or oceans by substances which are harmful for living beings. If the concentration of naturally present substances in water increases, then also water is said to be polluted. Among the various sources of water pollution, industrial pollutants are of great importance. Many industries are located near rivers and fresh water streams. These are responsible for discharging their untreated effluents in to the water bodies (Sharma *et al.*, 1990). Plywood industry is one among the polluting industries, but often remains un-noticed. Plywood is a building material consisting of veneers (thin wood layers or plies) bonded with an adhesive. Common ingredients for adhesive preparation include phenol, formaldehyde, urea sodium hydroxide, acetic or formic acid. Very often, washings from resin kettle, glue mixer and glue spreader which contain these harmful chemicals are thrown out of the

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factory that can contaminate the soil and water bodies around them. Most plywood mills use preservative chemicals for treatment of wood, veneer and plywood. The widely used chemicals are salts of copper, chromium, arsenic and boron. The usual practice is to dip the wood and wood products in to solutions of these chemicals contained in tanks. With repeated treatment these chemicals settle at the bottom of the tank along with wood dust and the entire solution become unsuitable for use. At this stage the bottom crust of chemicals and that in solution are thrown out of the factory or dumped in to a pit. Thus these poisonous chemicals contaminate the soil and water bodies surrounding the factory, when tolerance limit is exceeded. The characteristics of plywood effluents are generally dominated by the value of Biological Oxygen Demand, Chemical Oxygen Demand, phenol, ammonia and total suspended solids (Nath and Sujatha, 2012).

While the plywood industry has more than a century of existence around the world, large scale proliferation of plywood in Kerala is a relatively new phenomenon. In a small city, called Perumbavoor, in Ernakulum District, there are over 1000 plywood industries, 90% of them established in the last 10 years. Since there is no strict legal regulation for the treatment of effluents from plywood industries, the untreated effluents are continuously discharged in to the nearby streams in this region. Pollution due to these industries is now a sensational issue in this region. This study is aimed to assess the impact of plywood factory effluents on the water quality of receiving streams and nearby wells in Perumbavoor by determining the physico-chemical characters.

Very little work has been done in the past on the effect of plywood factory effluents on the water quality of receiving water bodies. Methods for removing hexavalent chromium on plywood factory effluents using activated carbon were specified by Huang and Wu (1975). Gupta and Tiwari (1985) used aluminium oxide as an adsorbent to remove hexavalent chromium from the plywood factory effluents. Identification of waste from plywood processing industry and its utilization capabilities at PT Kayu Lapis, Indonesia was carried out by Sibari (1991). Practical guidelines for environment management of plywood industry were given by Minarish in 2006. Nath and Sujatha (2012) carried out a study on the treatment of effluents discharged from plywood factories. The effectiveness of liquid waste management in plywood industry in South Kalimantan was studied by Subari (2014). Different methods for the treatment of effluents from plywood industries in Kerala were reported by Neena *et al.* (2016). A study was conducted on the impact of plywood effluents on the haematological parameters of fresh water fish, *Labeo rohita* by Juginu *et al.* (2017) which shows that how the contamination of receiving water bodies by these effluents

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affect the health of aquatic organisms and thereby indicate the effect of these effluents on the water quality.

Methodology

Five different plywood industries (located in Panickarambalam, Rayamangalam, Vaikkara, Pulluvazhy and Malamuri) within the area limit were randomly selected for the study. Then water samples were collected from nearby wells and streams into which the effluents from these industries were dumped. In streams, samples were collected from three different locations; from the point of discharge of effluents, 100m upstream from the point of discharge and 100m downstream from the point of discharge. Physico-chemical parameters of the collected samples were analyzed by using standard procedures. pH of the samples were determined by using pH meter. Nitrate content was determined colorimetrically by the nitration of salicylic acid. Phosphate, Total Dissolved Solids and copper content were determined by using methods prescribed by Dickman and Bray, Howard and Noll and Betz respectively. Biological Oxygen Demand was determined by estimating dissolved oxygen using Winkler's method. Chemical Oxygen Demand estimation was done by titration with sodium thiosulphate and formaldehyde estimation was used for the estimation of formaldehyde. US EPA 7196A method was used for the estimation of hexavalent chromium.

Table 1: Water quality parameters at different points of streams and in wells

Parameters analyzed	Average amount at 100m upstream (mg/L)	Average amount at the point of effluent discharge (mg/L)	Average amount at 100 m downstream (mg/L)	Average amount at wells (mg/L)
pH	6.82	5.9	6.16	6.09
Nitrate	21.6	84.16	40.13	8.16
Phosphate	4.3	12.34	8.36	4.1
TDS	1980	33920	22344	6760
BOD	4.14	12.90	9.59	5.23
COD	450.8	7941.6	4382.4	1028.8
Copper	0.00	0.0038	0.0020	0.00
Chromium	0.00	0.0016	0.0010	0.00
Formaldehyde	0.00	0.099	0.039	0.00

Results and Discussion

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The study shows that there is a general increase in the level of parameters in downstream when compared to the upstream. While comparing the obtained levels with Drinking Water Standards of BIS (IS: 10500: 1991), it was found that the levels of parameters in 100m upstream are within the permissible limits while they are beyond the limits at the point of discharge and 100m downstream, except in the case of copper and chromium (Table 1). The levels of copper and chromium are very much lower than the permissible limits. Normal pH range of potable water is between 6.5 – 8.5. The pH of water upstream to the point of effluent discharge is in the normal range. From the point of discharge, the pH began to decrease and the water become acidic. Water in the wells near the plywood factories also has acidic water. As pH levels move away from normal range (up or down) it can stress animal systems and reduce hatching and survival rates. pH levels outside of 6.5-9.5 can damage and corrode pipes and other systems, further increasing heavy metal toxicity.

The nitrate content of streams upstream from the point of discharge is within the normal range. Nitrate content of the streams downstream from the point of effluent discharge was higher than that in the upstream (Figure 1). The levels of phosphate, Total Dissolved Solids, Biological Oxygen Demand and Chemical Oxygen Demand also follow this increasing pattern (Figure 2). Higher levels of nitrate and phosphate content in streams will lead to nutrient enrichment and eutrophication that eventually result in increased Biological Oxygen Demand and decreased dissolved oxygen content. As per BIS the permissible level of Total Dissolved Solids in potable water is 2000 mg/L. Higher levels of Total Dissolved Salts can cause undesirable taste; gastro intestinal irritations; corrosion or incrustation. . TDS levels of wells are also higher than the normal levels. An elevated total dissolved solids concentration is more of an aesthetic rather than a health hazard. High biological oxygen demand means that a lot of oxygen is being used up, typically by bacteria breaking down organic material. Generally water bodies with Biological Oxygen Demand levels higher than 5mg/L are considered as heavily polluted (www.mrgscience.com). In the present study, the Biological Oxygen Demand levels are higher in all points except at 100m upstream. Higher Biological Oxygen Demand and Chemical Oxygen Demand levels will result in decreased dissolved oxygen levels (hypoxia). Hypoxic conditions can leads to suffocation of fish and other animals that play important ecological roles, Release of other pollutants (including nutrients and toxicants) that may be stored in the sediments, due to changing chemical conditions associated with anoxia, loss of biodiversity, increasing dominance of nuisance species such as carp that can cope with lower oxygen concentrations.

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Copper, chromium and formaldehyde are not found in 100m upstream and in wells. The level of these parameters follows a decreasing pattern from the point of discharge to 100m downstream from the discharge point (Figure 3). But the determined levels are much lower than the permissible levels. Copper and chromium salts are the commonly used preservatives in plywood industries. Even though they are essential trace elements, their higher levels can cause health problems. Formaldehyde is not a common compound found in water and it is not considered as a primary water pollutant. But its presence can lead to serious health problems. Formaldehyde is an important ingredient of the resin used to make the plywood. It is toxic, allergic and carcinogenic.

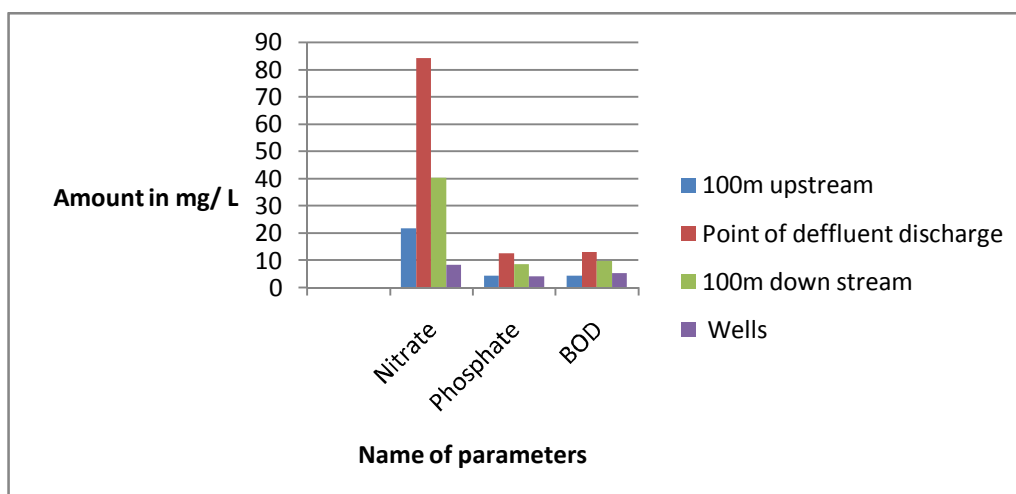


Figure 1: Effect of plywood factory effluents on nitrate, phosphate and BOD content

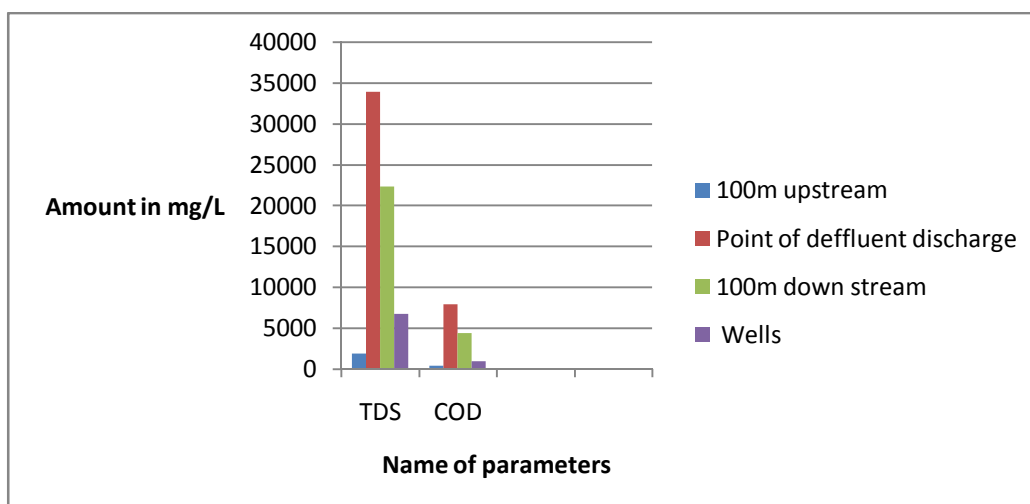


Figure 2: Effect of plywood factory effluents on TDS and COD content.

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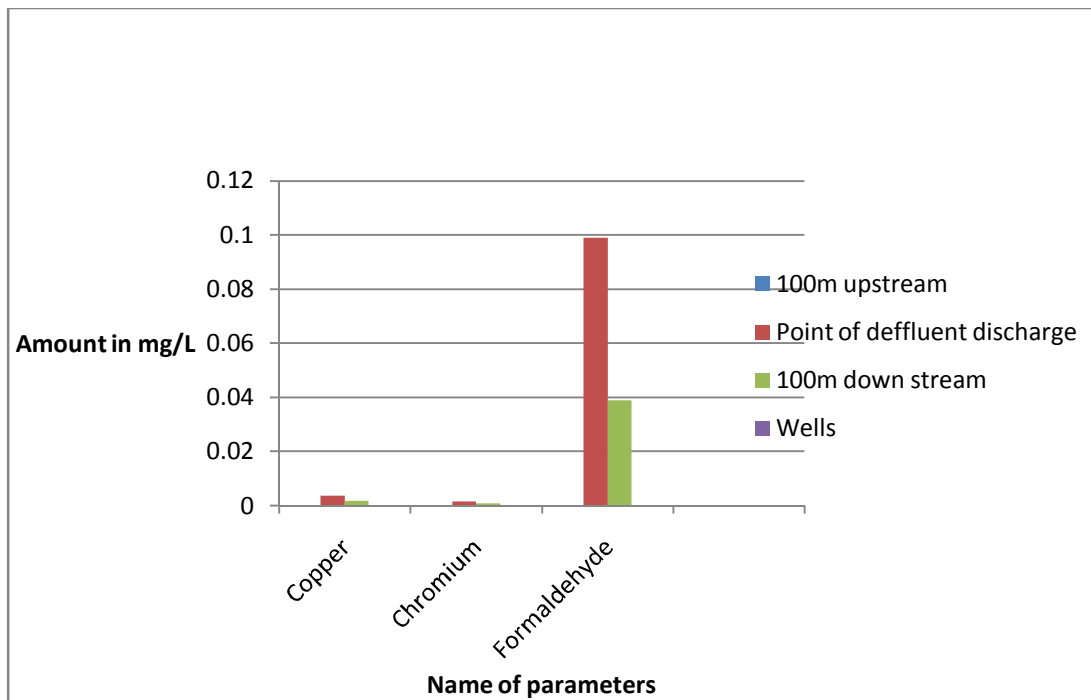


Figure 3: Effect of plywood factory effluents on copper, chromium and formaldehyde content.

Conclusion

The study has shown that the effluents from plywood industries have a big impact on the water quality of the receiving streams and nearby wells. This is depicted by the fact that there is a general increase in concentration of the parameters analyzed downstream as opposed to up stream. The levels of copper and chromium are lower than the permissible level of BIS, but the continued discharge of un-treated effluents in the stream may result in severe accumulation of the contaminants. The wells near the plywood factories also have high levels of nitrate, Total Dissolved Solids, Chemical Oxygen Demand and low pH which shows that the effluents has a negative impact on groundwater also.

Recommendations

Introduction of cost-effective cleaner production technologies must be enforced, such as on-site waste separation and reduction, and effluent recycling. Careless disposal of the effluents should be discouraged and there is need for each industry to install an effluent treatment plant with a view to treat wastes before being discharged into the streams. Government should take appropriate measures to monitor the levels of contaminants in industrial effluents and also should ensure its proper implementation.

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