Ecological damage in the vicinity of two industrial areas of Uttarakhand

Shweta Ranghar and Mamta Baunthiyal

Received 21.03.2016 Accepted: 29.04.2016

Abstract
Pollutants from industries can directly affect plants via leaves or indirectly via soil and water. A study was carried near industrial areas of Dehradun and Kotdwara cities of Uttarakhand to evaluate the risk of pollution on water, soil and natural vegetation near industrial area. Water samples were checked for Total dissolved solids (TDS), Turbidity, pH, Alkalinity, Fluoride, Chloride and Total hardness. The soil sample was checked for pH and number of microorganism. The natural vegetation was checked for various biochemical parameters. The estimation of chlorophyll (a and b), Carotenoid, pheophytin (a and b), protein, peroxidase activity were studied in the species such as Tagetes, Brassica, Rosa, Morinda and Murraya. Result were obtained and compared with the control (2kms apart from sampling area). The study concluded that industrial area may be polluted with organic pollutants which resulted in change in some chemical parameters of water mainly total hardness and change in soil pH. Plant pigment and protein level was reduced in sample collected from polluted areas. The pheophytin a and b and peroxidase activity was enhanced in leaves of polluted area due to increased stress level and microbial diversity was reduced near industrial areas.

Key words: Pollution, Biochemical parameters, water quality, soil quality, microbial diversity

Introduction
Water, soil and vegetation are the valuable resources of nature on which humans, animals and other life form directly or indirectly depend for their living. The purity of these natural resources is essence for the healthy living. For the socioeconomic development of nation industrialization plays a vital role, but the increased pace of industrialization has put these natural resources to serious threat and ultimately poses threat to living being (Tiwari et al., 2008). The waste and pollutants from industries affect soil, water and vegetation equally. The release of pollutants and waste differs from industry to industry. For e.g. Leather industry waste is mainly composed of chromium, zinc, copper, sulphones, carbonates, sodium and many other toxic organic compounds and inorganic compounds. Pulp industry mainly contain carbohydrates, textile industry contain dyes, plating industry contain nickel (Nouri et al., 2009). These pollutants not only alter the quality of soil and ground water but also pose serious problems (Karthikeyan et al., 2010). The altered ambient environment due to the intrusion of air pollutants in urban area is exerting a profound influence on the morphological, biochemical and physiological status of plants. Oxides of Nitrogen, Sulphur are released in all types of combustion as they are formed by the oxidation of atmospheric nitrogen and sulphur at high temperature (Shyam et al., 2008). Air pollutants either alone or in combination with other pollutants influences plant physiology. The effect of these pollutants can be directly visualized by anatomical damages to leaflets such as darkening at the adaxial face and a wide brownish necrosis. Biochemical changes due to exposure of plants to various pollutants can be used as suitable bio monitoring tool to evaluate the impact of pollution in a particular area. For example peroxidase enzyme is used as an air pollution marker enzyme as its activity varies with the species of trees, season and concentration of pollutant (Yadav et al., 2013, Shyam et al., 2008). Water used in industries creates a waste that has potential hazard for our environment because of the introduction of various contaminants such as heavy metals into soil and water resources (Bichi and Bello, 2013). Metal pollutants can easily enter the food chain if heavy metals contaminated soils are used for the production of crops (Verma and Dwivedi, 2013). The accumulation of metals in an aquatic environment have direct consequences to

Author’s Address
Department of Biotechnology, G. B. Pant Engineering College
Pauri-Garhwal Uttarakhand
E-mail: mamtabaunthiyal@yahoo.co.in
man and ecosystem. The present study was conducted to determine the impact of industrial pollution on water, soil and vegetation.

**Material and Methods**

**Study area and sample collection:**
The study areas were two cities of Uttarakhand, India. First was Dehradun situated between latitudes 29°58' N and 31°2'N and longitudes 77° 34' E and 78° 18'E and second Kotdwara situated between latitudes 29°45'0 N and 31°2'N and longitudes 78° 31' 48E. The main industrial area of Dehradun was Selaqui, which is also known as pharmacity as it contains most of the pharmaceutical industries. In Kotdwara the main industrial area is Balbhadrapur the place is popularly known as Sigaddi growth centre.

**Botanical Sampling:**
Leave of *Rosa amblyotis*, *Murraya koenigii*, *Morinda citrifolia* Linn. from Kotdwara region and *Tagetes minuta*, *Rosa amblyotis*, *Brassica nigra* from Dehradun region were randomly collected for estimating the vegetation damage due to pollutants. Two sampling sites were chosen as polluted site 1 and polluted site 2, the details of which are presented in Table 1 and Table 2. For control, leaves of these plants were collected 2 Km away from the polluted site.

**Water Sampling:**
For water analysis, two sampling sites were chosen one for control and other as polluted site from both the cities. Water Samples from different sites were collected in the plastic cane of 2.5 litre, about ½ litre water samples was collected from one hand pump from one site and these were mixed to get one sample from one site. In this way sample collected were analyzed in 2-3 days so no special preservation required.

**Soil Sampling:**
For soil sampling composite sampling was done, where sub-samples were collected from randomly selected locations in a field, and the subsamples are composited for analysis. The soil samples were then air dried and tested in laboratory.

**Methodology:**
For studying the impact of industrialization on vegetation, the commonly found plant species near the industrial site was chosen and following parameters were compared between control site and industrial site: Chlorophyll a and b, pheophytin and carotenoid was estimated using Arnon method (Arnon 1949). Protein content using Lowry method (Lowry et al., 1951) and Peroxidase activity using methodology of Puccinelli and Bragloni (Puccinelli and Bragloni, 1998). For water quality analysis around control and industrial site various water parameters like Total dissolved solids (TDS), Turbidity, pH, Alkalinity, Fluoride, Chloride and Total hardness were analyzed using water testing kit. For assessing the impact of industrialization on soil, soil pH was measured and number of microbial activity determined by plate count method, around control and industrial site.

**Results and Discussion**

**Effect of industrialization on water Quality**
Ground water is the prime source of drinking water in India. The quality of drinking water in Indian cities has been deteriorated in the recent years mainly due to growth of population and increased level of pollution in cities (Venkatasubramani, 2007). For assessing the quality of water for drinking purpose in these two cities various water parameters were tested and compared with values of ISI. The value of pH in control and industrial site of Kotdwara was same but in case of Dehradun pH varied from control to industrial from 7.5 to 6. pH value in both the cities was within desirable limit of 6.5-8.5. The value of pH was in accordance with the alkalinity value, which decreased from control site to industrial site of Dehradun i.e from 200mg/l to 100mg/l and in case of Kotdwara it was 200mg/l in control site and 150 mg/l in industrial site. The desirable limit of TDS is 300mg/l but in both the cities the TDS value was greater than desirable in both control and industrial site. But from control to industrial there was increase of TDS value from 692mg/L to 750 mg/l in Kotdwara and 698mg/l to 780 mg/l in Dehradun which indicates that increased pollution by extraneous sources can adversely affects the quality of water. The value of Turbidity was 0 NTU in both control and industrial which is desirable. The total hardness which is mainly caused due to calcium and magnesium salts were within the desirable limit of less than 300 ppm. The desirable limit of chloride according to ISI is 250 ppm and in both cities the value of chloride decreased from control to industrial site.
but was within the desirable limit. But fluoride content in both the cities were below the desirable limit which make it unfit for drinking purpose. The value of fluoride was 0 ppm in both the control and sampling site of both the cities.

**Effect of industrialization on soil Quality**

For assessing the impact of industrial pollution on soil, the soil pH and microbial growth from the soil sample was analyzed. Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. As shown in table 4 the soil pH was found to be lower in industrial area of both the cities as compared to control site. The soil with pH greater than 8.5 is generally called as sodic soil. But pH of all soils samples are less than 8.5 indicating that soil samples are free from sodicity hazards. The decrease in pH could be due to the decreased amount of carbonate and bicarbonate (Sonawane, 2010).
Table 3: Effect of industrialization on water quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Kotdwara KWC</th>
<th>Kotdwara KWS</th>
<th>Dehradun DWC</th>
<th>Dehradun DWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS (gm)</td>
<td>0.6924</td>
<td>0.7502</td>
<td>0.6986</td>
<td>0.7894</td>
</tr>
<tr>
<td>Turbidity</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>pH</td>
<td>7.0</td>
<td>7.0</td>
<td>7.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Alkalinity (in ppm)</td>
<td>200</td>
<td>150</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>Fluoride (in ppm)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Chloride (in ppm)</td>
<td>78</td>
<td>115</td>
<td>69</td>
<td>92</td>
</tr>
<tr>
<td>Total hardness (in ppm)</td>
<td>300</td>
<td>210</td>
<td>140</td>
<td>175</td>
</tr>
</tbody>
</table>

Table 4: Effect of industrialization on soil pH

<table>
<thead>
<tr>
<th>Dilution</th>
<th>Kotdwara KSC</th>
<th>Kotdwara KSS</th>
<th>Dehradun DSC</th>
<th>Dehradun DSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:2</td>
<td>6.1</td>
<td>6.1</td>
<td>6.9</td>
<td>6.4</td>
</tr>
<tr>
<td>2:1</td>
<td>7.0</td>
<td>6.2</td>
<td>6.8</td>
<td>6.5</td>
</tr>
<tr>
<td>1:1</td>
<td>7.0</td>
<td>6.3</td>
<td>6.7</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Table 5. Microbial growth observed for soil sample.

<table>
<thead>
<tr>
<th>Dilution</th>
<th>Dehradun DSC</th>
<th>Dehradun DSS</th>
<th>Kotdwara KSC</th>
<th>Kotdwara KSS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>56</td>
<td>16</td>
<td>700 (approx.)</td>
<td>175</td>
</tr>
<tr>
<td>Total bacterial count(10^6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>00</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Total fungal count(10^5)</td>
<td>59</td>
<td>16</td>
<td>703 (approx.)</td>
<td>175</td>
</tr>
<tr>
<td>Total viability (10^5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

But overall the pH value of soil was within favorable value neither too high (more than 8.5) nor too low. The samples were analyzed for microbial growth and it was observed as shown in table 5, that there was reduction in the growth of microorganisms at different dilution in both the industrial sites as compared to control site. The pH between 6-8 is favorable for bacterial growth therefore in comparison to fungus bacterial count was found higher in all the samples. The decrease in number of microorganism both fungus and bacteria near industrial site as compared to control site may be attributed to altered pH of soil and water quality condition in control and industrial site.

Effect of industrialization on biochemical parameters of plants:

A profound impact of industrialization on different vegetations was noted in both the cities. In the samples of *Rosa amblyotis, Murraya koenigii* and *Morinda Citrifolia Linn.* from Kotdwara region and samples of *Tagetes minuta,Rosa amblyotis, Brassica nigra* from Dehradun region, it was observed that the pigment chlorophyll a and b, carotenoid, and protein content measured in mg/gm in leaves sample of plant species were reduced in sample of industrial site as compared to sample from control site. In contrast Phophytin a and b and Peroxidase activity was increased in the sample of industrial site as compared to samples from control site. Being the main core of energy production in green plants the amount of chlorophyll is changed by the effect of environment on plant metabolism and exposing of plants to above the acceptable range of pollutants, photosynthesis gets slowed down. As chlorophyll play an important role in plant metabolism the measurement of chlorophyll content may be an important tool to evaluate effect of industrial pollution on plant (Joshi et al., 2009). Similarly Carotenoids protect photosynthetic organisms against potentially harmful photooxidative processes and are essential structural components of the photosynthetic antenna and reaction center (Joshi and Swami, 2009). In the present study amount of chlorophyll was decreased in leaves sample of all plants of industrial area as shown in fig. 1.
Ecological damage in the vicinity of two
Similar decreased pattern was recorded by many researchers in different plants (Verma and Chandra 2014, Seyyednejad 2013, Yadav et al., 2013). Among all the sample maximum reduction in total chlorophyll content was shown by *Rosa amblyotis* plant of Kotdwara region in which total chlorophyll content was 6.349 mg/gm in control site and 3.343 mg/gm and 3.798 mg/gm in polluted site 1 and site 2 respectively. Similarly in Dehradun region *Brassica nigra* showed the maximum reduction of 8.829 mg/gm in control site and 4.25 mg/gm in polluted site 2. In case of carotenoids as shown in fig. 2 not much variation was observed, but there was a decrease in value from control to polluted site. Reduced protein content among sample of polluted site may be due to enhanced rate of protein denaturation and break down of existing protein to amino acid or reduced denovo synthesis of protein (Rai and Panda, 2015). *Murraya koenigii* sample from Kotdwara region showed maximum decrease in protein content, in which control sample showed 4.5 mg/gm and polluted site 1 and 2 showed near to 3.0 mg/gm as shown in fig. 3.

Pheophytin play a major role in Photosystem. In contrast to chlorophyll a and b, increase level of Pheophytin in polluted site in comparison to control site was observed as shown in fig. 4a and 4b. It might be due to the breakdown of chlorophyll to Pheophytin (Yadav et al., 2013). The level of Pheophytin indicates the sensitivity of plants to the...
Ecological damage in the vicinity of two pollutants; the higher the Pheophytin level in the plant is, the greater the plant is sensitive to air pollution (Verma and Chandra, 2014). Amongst the entire plant samples, *Rosa amblyotis* showed the maximum increase in Pheophytin b level in the polluted site of both cities. In case of Kotdwara in control sample value was 1.810 mg/gm as compared to polluted site1 and 2 values 2.71 mg/gm and 3.12 mg/gm respectively. Similarly *Rosa amblyotis* of Dehradun showed increase from 3.348 mg/gm in control site to 7.546 mg/gm in polluted site1.

Being an antioxidant enzyme and effective quencher of reactive oxygen species, peroxidase plays an important role for plant survival and adaption during stress condition. The activity of peroxidase was found to increase in polluted site as compared to control site in all samples as shown in fig 5. Increase in peroxidase activity could be due to reduction in chlorophyll content as it play important role in chlorophyll degradation (Selvaraj, 2013). Among all sample maximum increase was found in *Morinda citrifolia* of Kotdwara region which was 7.57 μmol/gm in control site and 9.4339 μmol/gm in site 1 and 8.620 μmol/gm in site 2. And in case of Dehradun region *Brassica nigra* showed maximum increase from 4.464 μmol/gm in control site to 6.944 μmol/gm in site 1 and 6.250 μmol/gm in site 2. Many studies have suggested that Peroxidase is a specific indication of SO₂ and NO₂ pollution (Rai and Panda, 2015).

**Conclusion**

Sampling and analysis of plants, soil, water is valuable to determine the physio-chemical parameters of the micro environment around the industries. The study concluded that the overall pigment and protein degradation were observed near industrial area and peroxidase activity and pheophytin values were found higher as compared to control, which may be due to temperature variations and presence of pollutants such as organic gases (SO₂, NOₓ). These changes in plants are biological compensatory responses to environmental stress. Among various parameters of water quality; chloride and TDS was found to be higher around the industries. Talking about ecological study the population density of plants and microbes were found less around industrial sites which shows that there is an impact of industries on population density of organisms and plants. Soil, water and biodiversity are essential elements of ecosystem and are the subject of many agricultural, ecological, biological and hydrological studies, since large amounts of chemicals enter animal and human food chain through cultivated contaminated soils and water. The study concludes that there is a need to access the ecological risk associated with the polluted areas and necessary action must be taken in this direction.

**Acknowledgement**

The authors acknowledge Swajal project, Puari Garhwal, Uttarakhand for providing field test kit for the present study.

**References**


