CHAPTER VI
SUMMARY AND CONCLUSION

The ITC Ltd, Unit-Kovai is a paper board manufacturing industry using recycled fiber (waste paper) as a raw material for the production process. The unit is geographically located at Latitude E 76°52'29.4" and Longitude N 11°15' 1.2" on the foothills of Western Ghats at Thekkampatti village, Mettupalayam Taluk, Coimbatore District. In comparison to wood based paper and paperboard manufacturing, recycling paper decreases the demand for virgin pulp and other environmental implications. Particularly, emissions to air, water and land are many folds lesser in recycling paper and paper board. Although waste paper recycling emerged as viable alternative for virgin paper production, waste released during paper recycling process such as effluent, sludge, gaseous and particulate air pollutants also causes environmental pollution to a certain extent. Globally few studies examining the comparative production and emission scenarios of virgin paper production and recycling waste paper are available. However, In India there is exists a knowledge gap in the environmental impacts of recycling paper and paper boards, which forms the basis of this study. In this context, the present work focused on inventory analysis, impact assessment and environmental management experiments related to recycled paper board manufacturing mill at ITC Limited, PSPD, Unit: Kovai, Tamil Nadu, India with following objectives,

- To conduct inventory analysis for paper boards production
- To investigate environmental impacts of paper boards production
- To find out the suitable environmental management practices

6.1. Inventory Analysis

Raw material, energy input and other data viz., air emission, solid waste and effluent generation, effluent characters and man power engagement at various stages of paperboard production was obtained from ITC Limited, PSPD, Unit - Kovai for a period of 3 years (2007-2009). After careful analysis of raw material, chemicals and other resources,
material inventory was computed for one metric ton of paper board production. Similarly the emissions inventory is calculated for one metric ton of paperboard production.

The study showed that consumption of waste paper for production one ton of paperboard was 1045 kg. Fibre use efficiency of this mill was 96 per cent. Use of waste paper as a raw material had saved 177248 tons of hard wood from the forest/farm forestry if chemical pulping process is used or 88624 tons in the case of mechanical pulping. In addition to that waste paper to landfill, GHG generation through decomposition and eutrophication is averted. The chemicals used for production of one ton of paper board as additives for process was 140 kg and the filler was 98 kg. The chemical consumption for processing was recorded as 14 per cent. This consumption was four per cent lower than the other Indian paper board manufacturing Industries. The total amount of water pumped from the river Bhavani for the production of paperboard was 1167047 m³/year. The water used for one ton of paperboard production was 13.22 m³. The total fuel used for production of one ton of paper board was 1313 kg, of which 795 kg was fossil fuel (lignite) and the remaining 518 kg was agro waste (De oiled Rice Bran (DOB) and saw dusts).

Emission computation showed that stack emits 183550 m³/h of particulates and gases. These include *viz.*, SPM, SOₓ, NOₓ and CO. These major air pollutants were further converted into a metric ton and calculated for production of one ton of paper board. To produce one ton paperboard 0.489 kg of SPM is emitted into air. SOₓ, NOₓ and CO emission was recorded about 0.687, 1.077 and 4.917 kg, respectively to produce one ton of paperboard.

Among, the solid waste generated, fly ash was found to be in larger quantities (79.87 kg/ ton of paperboard production) than other solid wastes like ETP sludge, plastic, metal scrap, HDPE bags and used oil. The next major solid waste from this mill was ETP sludge, the generated amount was 53.32 kg for a ton of paperboard production.

Among the utilized water for production of one ton paper board, 7.5 m³ of water was discharged as effluent and 5.64 m³ water was evaporated while manufacturing of one ton paper board. The specific water discharge of other large scale waster paper based
Indian mills was 66 m³. Compared to other Indian mills this mill discharged 8.8 times less quantity of treated effluent.

6.2. Impact Analysis

Impact of ITC- Unit Kovai operations on ambient air, water and soil quality was studied for three years (2007, 2008 and 2009). The baseline ambient air quality status within the study area was assessed at 5 different stations including industry site. A respirable dust sampler (Model APM 451 fabricated by Envirotech, New Delhi) equipped with an attachment for gas sampling for SOx and NOx was used for sampling. At each monitoring station, 24-hour continuous monitoring of Non Respirable Suspended Particulate Matter (NRSPM), Respirable Suspended Particulate Matter (RSPM), Oxides of Nitrogen and Sulphur were conducted following standard methods.

The noise level at ten locations in the study area was collected using a digital sound level meter (model SL-4001, Lutron, Taiwan). Spot readings were taken after leaving the instrument on for five minutes. At each spot, the readings were recorded at an interval of 10 seconds and average of five such readings was computed.

The treated effluent is being completely utilized for irrigation in factory owned land and there is no discharge to the water bodies in the vicinity. Therefore, surface water quality of water bodies were not studied, instead groundwater and soil quality in and around the treated effluent irrigated areas were studied periodically from 24 sites during the year 2007 to 2010. The samples were analyzed for various water quality parameters. Soil samples were collected from effluent irrigated areas and were analyzed for various physico-chemical parameters following standard methods.

Analytical results showed that Air quality in terms of Total Suspended Particulate Matter (TSPM) for the study period ranged from 86.99 to 96.76 µg/m³. The highest TSPM (127.7 µg/m³) was noticed at fuel yard in the year 2008, while the lowest (75.82 µg/m³) was found at ETP in the year 2009. The overall mean value of 91.49 µg/m³ TSPM was recorded for the entire study period. Respirable particulate matter (RSPM) for the study period ranged from 25.82 to 28.26 µg/m³. The highest RSPM (37.27 µg/m³) was noticed at
fuel yard in the year 2008, while the lowest (22.45 µg/m³) was found at guest house in the year 2009. The total SO² and NOx for the study period ranged from 7.63 to 8.96 and 16.29 to 18.27 µg/m³, respectively.

Water quality analysis showed that pH of the groundwater samples in most of the sampling sites was slightly alkaline in nature with mean pH of the groundwater in treated effluent irrigated areas varying from 8.00 to 8.86 and non-effluent irrigated areas ranging from 8.41 to 8.43 at different stages of sampling period. The pH values fall in the category of tending to alkaline according to the USDA classification of irrigation water. The mean EC value of groundwater in treated effluent irrigated areas ranged from 0.88 to 1.27 dS/m and in non-effluent irrigated areas it ranged from 0.94 to 0.99 dS/m during the study period which comes under the category of high saline (C₃) as per the USDA classification of irrigation water. The mean TDS content of groundwater in treated effluent irrigated areas ranged from 390 to 756 mg/L and in non-effluent irrigated area it ranged from 448 to 456 mg/L. The mean BOD level of groundwater in treated effluent irrigated areas varied from 13 to 22 mg/L, at different stages of sampling from the year 2007 to 2010. The highest BOD level of 30 mg/L was observed in factory premises during the year 2010 and the lowest BOD level of 12 mg/L was recorded in factory premises during the year 2008. In treated effluent irrigated areas, the mean COD level of groundwater ranged from 35 to 86 mg/L during the sampling periods. The COD level of groundwater is comparatively higher in treated effluent irrigated areas than non-effluent irrigated areas. The mean cations viz., calcium, magnesium and potassium content of ground water varied from 37.8 to 196, 17.0 to 120.6 and 8.2 to 24.6 mg/L, respectively at different stages of sampling from the year 2007 to 2010 in treated effluent irrigated areas. In general, among all the sampling locations, the cations and anions were higher in Kemmarampalyam and Thekkampatti villages and comparatively lower within the factory premises, where the treated effluent is being used continuously for irrigation.

The soil pH was near neutral in nature in all samples sites. The mean pH of soil samples in treated effluent irrigated areas ranged from 7.17 to 8.47 and non-effluent irrigated areas ranged from 7.46 to 7.51. Among the sampling locations in treated effluent irrigated areas, the highest soil pH was recorded in Kemmarampalyam village (8.81).
Among the sampling locations in treated effluent irrigated areas, the lowest organic carbon content of 0.32 per cent was observed in the factory premises in 2008 and the highest organic carbon content (0.59 per cent) was recorded in factory premises during 2010. The organic carbon content of soil in treated effluent irrigated areas was higher when compared to non-effluent irrigated areas. In general, the soil organic carbon content was gradually increased in sampling locations in treated effluent irrigated areas, which might be due to the accumulation of suspended and dissolved organics present in the treated effluent. The available nutrients like nitrogen, phosphorus and potassium content of soil ranged from 124 to 162, 9.1 to 26.9 and 124 to 291 kg/ha, respectively in treated effluent irrigated areas. An increasing trend on available nutrient status was observed invariably at all the sampling locations of treated effluent irrigated areas, due to the impact of continuous irrigation of treated effluent to the soil.

Noise level assessments showed highest mean day noise (48.0 dBA) and night level (41.6 dBA) recorded in administrative block followed by effluent treatment plant, waste paper yard and cogeneration fuel yard. The lowest mean noise level of 36.0 dBA at day and 33.6 dBA at night was recorded in secured landfill area.

6.3. Waste Management

Use of treated effluents for irrigation has been recognized as a useful disposal system. This also minimizes contamination of aquatic systems in the vicinity. This practice not only defers ecological degradation of pollutants, but also sequesters trace elements from the effluent water and retains them for a long time. Therefore, the use of effluent in growing woodlots is a viable option for the economic disposal of effluent. This study explored the efficacy of recycled paper board treated effluent for irrigation and compared the productivity of trees using control (well water).

Treated effluent from the paper mill was investigated for irrigation of seven different clones (T1 - ITC Clone No 3, T2 - ITC Clone No 7, T3 - ITC Clone No 27, T4 - ITC Clone No 105, T5 - ITC Clone No 285, T6 - ITC Clone No 316 and T7 - ITC Clone No 2253) of Eucalyptus camaldulensis. The experimental results revealed that Eucalyptus camaldulensis tree species raised using treated effluent and control appeared to be similar.
and no significant difference was noticed. Mean height of trees ranged from 5.04 to 12.17 m, irrespective of years. During the first and second year the maximum mean of weight 8.60 t/ac and 19.27 t/ac was recorded in T7 (ITC Clone No 2253) and T1 (ITC Clone No 3), respectively whereas the maximum mean weight of 36.73 t/ac and 56.07 t/ac were recorded in T2 (ITC Clone No 7) at third and fourth year.

The unit is generating about 200 tons of secondary sludge per month. While disposal as landfill, creates bad odour and occupies more land space. To overcome these problems, a study has been conducted to convert this sludge into biocompost and vermicompost. The results reveal that this sludge suits both for compost and vermicompost. Nutrient status of the biocompost and vermicompost are as follows.

<table>
<thead>
<tr>
<th>Nutrient content</th>
<th>Biocompost</th>
<th>Vermicompost</th>
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<tbody>
<tr>
<td>Organic carbon (per cent)</td>
<td>24.6</td>
<td>25.5</td>
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<tr>
<td>Total nitrogen (per cent)</td>
<td>1.08</td>
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<td>Total phosphorus (per cent)</td>
<td>0.84</td>
<td>0.89</td>
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<td>Total potassium (per cent)</td>
<td>0.74</td>
<td>0.77</td>
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<td>C:N ratio</td>
<td>22.8</td>
<td>23.6</td>
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By doing this sludge into compost, the unit can generate about 25 tons of sludge compost /vermicompost every month and can be used as manure for the existing plantation of eucalyptus and other agricultural crops.

In general 2:1:1 ratio of red soil: sand: FYM is used for growing nursery plant. Now a day getting river sand and FYM is very remote and therefore a study has been conducted to use Fly ash and compost/ vermin compost as alternative for the existing river sand and FYM. A significant difference has been noticed by using 1:1:1 ratio of Red soil, Fly ash and compost which was found to be good rooting media compared to control.
Three year environmental impact assessment study of ITC Limited, PSPD, Unit – Kovai recycled paper unit revealed low to moderate impact on environment. The impact assessment matrix is given below.

**Impact assessment**

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Impact assessment</th>
<th>Raw material used</th>
<th>Chemical used</th>
<th>Electricity used</th>
<th>Surface water used</th>
<th>Atmospheric air emission</th>
<th>Emission to water</th>
<th>Solid waste generation</th>
<th>Ground water quality</th>
<th>Ambient air quality</th>
<th>Soil quality</th>
<th>Noise</th>
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<td>1</td>
<td>Very low Impact</td>
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<td>3</td>
<td>High Impact</td>
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**Very low Impact** +  **Low Impact** *  **High Impact** ◊  **Very high Impact**◆