



Utilization of treated tannery effluent for afforestation

A case study: Sipcot, Ranipet, India

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Tannery effluent after conventional treatment was successfully used for the irrigation of various tree species. Following detailed pilot studies, degraded land in India of approximately 10 acres was converted into a mini forest. The data collected over a twelve-year study within this forest indicated no danger of soil and ground water potential. The effluent discharge was minimized and the wastewater converted into a valuable resource.

Investigations were undertaken to study the effect of irrigating land and growing commercially viable trees (non-edible) using treated tannery effluent at Sipcot, Ranipet, located 120km from Chennai and 25km from Vellore, Tamil Nadu, India. The effluent treated within the Common Effluent Treatment Plant (CETP) is from tanneries where semi finished hides and skins are processed into finished leather. The Total Dissolved Solids (TDS) value of the treated effluent is <5500 mg/l with chlorides of <700 mg/l.

The degraded land used in the studies was adjacent to the CETP. The peizometers used for ground water sampling purposes were installed by the CETP with the technical assistance from UNIDO experts. Soil samples and ground water samples were analyzed in the on-site laboratory as per standard methods of analysis. This investigation was performed at two different levels:

1) PILOT STUDIES

The pilot investigations comprised three studies:

First pilot study: The survival of different plants irrigated with saline treated effluent was assessed. The area of irrigation was 400 m², and the tree species used in the study were Silk cotton, Eucalyptus and Casuarina.

Second pilot study: Additional species that could be grown and sustained by irrigation with treated effluent were identified and studied. The area of irrigation was 800 m² and the tree species used were Pongam Neem, Casuarina Teak, Karuvel, Eucalyptus, Bamboo, Mangium. As part of this study various irrigation/feeding patterns were tested. These included 100% treated effluent, treated effluent and ground water (ratio of 50:50), ground water alone, treated effluent with composted sludge, fresh water with composted sludge etc.

Third Pilot study: Ground water and soil contamination were verified. Various methods of irrigation were compared - basin irrigation vs ridges & furrows – and the quantity of effluent offered to each type recorded. The area of irrigation was 1600m² and an additional tree species - Accacia Mangium – was introduced.

Throughout this period soil samples were taken both inside and outside the irrigation plot for evaluation as pH, N kg/acre, P₂O₅ kg/acre, K₂O kg/acre and Cr kg/acre. A total of 24 samples were checked at three depths: 0.3 m, 0.6 m and 1.0m.

Ground water samples were taken and checked for pH, TDS, Chlorides, Hardness, Sulfates, BOD₅, Total chromium and sodium. These samples were taken at 0.9m and 1.8m depths inside the irrigation plot, and at 1.8m depth outside the irrigation plot at four different sampling points.

As an overview of the findings from these pilot studies, the growth rate of the trees in general at 10-15% in a month was better than the normal growth rate reported for the same species at 8-10% for the same time period. In particular, the improvement in the girth of the tree was remarkable, doubling in nearly two months. While a small increase in chlorides and sulfates were noted in ground water, there was no appreciable change in the quality of soil due to irrigation using treated effluent.

2) THE CREATION OF A MINI-FOREST

The information gained from the pilot studies was used to create the mini-forest on degraded land of approximately 10 acres in area. The land survey and design was performed by professionals, with ground leveling to ensure gravity flow throughout the plot.

The site was divided into 11 sections and different types of planting pattern provided. A park of 0.5 acre was developed at the centre, and a pond to collect run-off and to grow lotus and fishes. A central road was constructed, with four sub roads to the sides of the area. A pipeline net work (main header and sub-headers) was installed for irrigating the entire site. The selected tree species used were Mangium, Pungam, Neem, Casuarina, Eucalyptus, Terminalia, and Bamboo with 25,000 trees planted in total. Throughout the development of the mini-forest from January 1999 until the project finalised at the end of 2010 the sampling was as follows:

Treated effluent: This effluent used for irrigation was analysed daily for all the parameters specified by the Tamil Nadu Pollution Control Board.



Soil samples: Sampling took place both from inside and outside the area, being collected once in three months. Six sampling points were established at the surface, then at 0.3m and 0.6m depth, in total 18 samples. These samples were each analysed for pH, N kg/ ac, P_2O_5 kg/ac, K_2O kg/ac and Cr kg/ac.

Ground water samples: These were collected at two depths – at 6 ft and at 40 ft depth - at eight sampling points twice per week. These were analysed for pH, TDS, Chlorides, Sulfates, BOD5, Total chromium and sodium.

Other parameters were regularly monitored and recorded. These included the volume of treated effluent used for irrigation, growth factors such as height and girth of trees, and meteorological data such as humidity, rainfall, temperature.

The results from this comprehensive twelve-year study are shown in Panels 1,2,3, and 4 where the values at each of the eight sampling locations as drawn from the piezometers is given as TDS, chloride, sulfate and total hardness. Each graph is plotted with the months and years in the x axis and the respective values in mg/l in the y axis. Samples defined in the key to those graphs as 1,3,5,7 were collected at a depth of 6 feet and samples 2,4,6,8 were collected at a depth of 40 feet. With reference to these panels:

Panel 1: This shows the variation of TDS. It is interpreted that the variation in the values of first sample is due to the seepage of effluent in six feet, and overall data so far indicates that there is no adverse effect of TDS in ground water.

Panel 2: This shows the variation of Chlorides. The value of fifth sample varies drastically because the ground water collected at the depth of 6 feet, and the variation is due to the seepage of effluent at that depth.

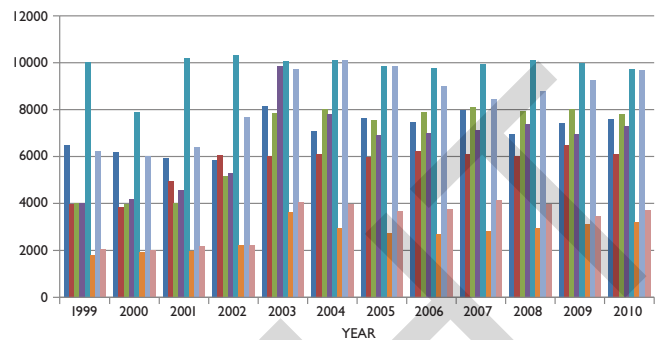
Panel 3: This shows the variation of Sulfates. It is clear that there is no adverse effect of effluent being irrigated to the plants. Some of the sulfates might be getting degraded by the bacteria in the soil and the resultant elemental sulfur serves as nutrient to the plant.

Panel 4: This shows the variation of Total hardness. It is clear that there is no adverse effect of effluent irrigation except the second sample. The second sample area in the plot had suffered from previous pollution and the ground water sample result shows such variation in the hardness.

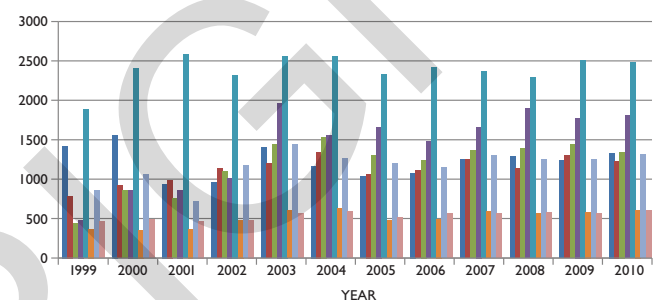
This shows that at the end of this twelve-year study there was no significant increase of TDS, chlorides and sulfates either the groundwater or the soil, although a moderate increase of salinity is shown in the plant species. It is noted that the effluent from the CETP has less than 700 mg/l chlorides, being lower than the ground water in the area, and that it appears that the net increase in TDS is compensated by the rain water that maintains the groundwater TDS in the same level.

The survival and growth of selected inedible plant species was also confirmed. Data collected indicates no danger to soil and groundwater potential, the commercial potential of the greenery is recognised.

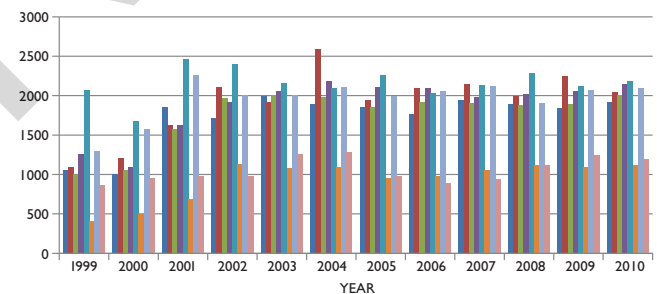
Panel 1: TDS



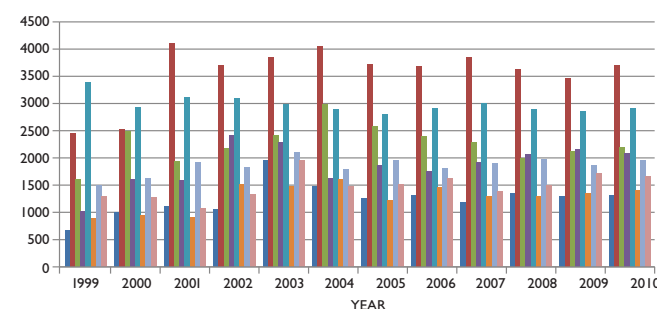
Panel 2: Chlorides



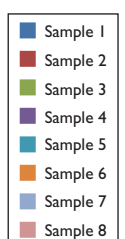
Panel 3: Sulfates



Panel 4: Total Hardness



Key:





Findings from the investigation

Degraded and unusable land were converted into a beautiful forested area by irrigation with treated tannery effluent. The discharges from a CETP treating tanneries processing semi-processed leather to finished leather were been profitably used for irrigation of inedible plants with positive results, and discharges from the CETP minimised.

The saline resistant species of trees identified by this study are *Pongamia pinnata*, *Azadirachta indica*, *Casuarina equisetifolia*, *Tectona grandis*, *Acacia arabica*, *Eucalyptus tereticornis*, *Dendrocalamus strictus* and *Acacia mangium*.

Tentative calculation shows that in this situation with a plant density of 2,500 per acre, it is safe to use about 90 m³ of treated effluent per acre/day without any adverse impact on soil or groundwater. It was observed that the level of TDS, Cl & SO₄ started building up in summer months. But soon after rains, the values declines and comes to normal levels. Continuous monitoring of soil and groundwater is vital: if any increasing trend in TDS/chlorides is seen, the volume of effluent used should be suitably modulated. ☉

Acknowledgments:

- International Experts, UNIDO Repo, Chennai and the CETP authorities for the research work in the CETP, Ranipet.
- Chancellor and Vice Chancellor, VIT University, Vellore, India
- Director, Centre for Disaster Mitigation and Management, VIT University, Vellore, India.

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Development of the site



This shows the 10 acre area that was previously barren immediately after planting with various tree species in 1999, and the method of irrigation that was used.



This image shows the same area four years later. The growth rate of the trees has been impressive, and hedges have also been established.



In addition to the original trees and hedges flower gardens were established with a wide variety of plants. An area was also set on one side for a summer house in the centre of the area.