Int. J. Environ. Res., 2(3): 225-230, Summer 2008
ISSN: 1735-6865

Environmental Impact Assessment of Tobacco Waste Disposal

Mumba, P. P. [1*] and Phiri, R.[2]

[1]Basic Sciences Department, University of Malawi, Bunda College of Agriculture,
P. O. Box 219, Lilongwe, Malawi
[2]Natural Resources Management Department, University of Malawi, Bunda College of
Agriculture, P. O. Box 219, Lilongwe, Malawi

Received 22 Oct. 2007; Revised 4 Feb. 2008; Accepted 17 Feb. 2008

ABSTRACT: A study was carried out in a strip of a river and in a nearby well in the rainy and dry seasons to assess the impact of tobacco waste disposal on the roadsides. There were significant seasonal variations in the concentration of nicotine being higher ($p<0.05$) in the dry season than in the wet season. Regardless of season however, nicotine was observed in highest amounts close to the dumpsite and none or just trace amounts were obtained upstream and in the well water. There were seasonal differences in the concentration of phosphate, sulphate and turbidity, being higher ($p<0.05$) in the dry season than in the rainy season. However, the concentration of sulphate followed an opposite seasonal trend to that of phosphate, being higher in the rainy season than in the dry season. In the rainy season, the concentrations varied significantly ($p<0.05$) across the sample points, being highest at point close to the dumpsite followed by the value upstream and the least was obtained downstream. The authorities must enforce the legislation of controlled tobacco waste disposal to avoid harmful environment effects.

Key words: Tobacco, Waste disposal, Water quality, Environment, Assessment

INTRODUCTION

Malawi's economy is based on agriculture both small and large scale, and approximately 88% of its foreign earnings comes from the sale of crops. Of the latter, tobacco is the major cash crop contributing about 74% of the total foreign exchange earnings (Malawi Economic Report, 2000). Malawi's tobacco is sold at the Auction Holdings and there are also companies that process the tobacco after purchase. After processing the tobacco, there remains the waste and the problem then is its management.

Reports on many urban centers in Africa have shown that the problem of waste management has become a monster that has aborted most efforts made by city authorities, state and professionals (Henry, *et al.*, 2005; Onibokun and Kamuyi, 1999). Reports from most African countries and even from Europe reveal some aspects of uncontrolled garbage, roadsides littered with refuse, and streams blocked with junk, disposal sites constituting a health hazard to residential areas, and inappropriately disposed toxic wastes (Casares *et al.*, 2005; Henry *et al.*, 2005; Tamiru, 2001). Similar problems are observed with Malawi's tobacco waste. The tobacco industry owns a landfill particularly for the disposal of tobacco wastes, once the tobacco has been graded and all necessary parts of the leaf have been removed. As Fakayode (2005) and Gunatilaka (2006) have indicated, in many developed countries, environmental laws are rarely observed. In Malawi, most of the unused tobacco stems from the processing companies, the so called Non-Tobacco Related Materials (NTRMs), are seen heaped on the road side near the processing companies. Reports have indicated that the manufacturing process produces liquid, solid and airborne wastes, some of which are potential environmental hazards and may even pollute surface and ground waters (Gunatilaka, 2006;

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*Corresponding author: Email-mumbap01@yahoo.com

Novonty and Zhao, 1999; USGS, 2005). In growing tobacco, several chemicals are applied and these may also pollute ground or river water through run off from the agricultural land (Drake, 19996; Anonymous, 2006). Studies in ground well water near tobacco fields have shown large amounts of pesticides, pesticide degradation products, volatile organic compounds and dissolved organic carbon all of which apparently originated from the chemicals applied on the tobacco in the field (Johnson and Connel, 1997). The heaped tobacco waste on the roadsides in Malawi may therefore find their way to the rivers through run off during the rain season or blown by wind in the dry season. These non-tobacco-related materials are known to be toxic to fish as they cause mild bloat, depression and ataxia. In addition, nicotine, the principal alkaloid of tobacco that is responsible for addictive nature of cigarettes is poisonous, it has high mammalian toxicity with a mean lethal dose of 0.5-1.0 mg/kg in humans and so, serious poisoning can lead to death from respiratory failure (Alloway and Ayres, 1993). The pesticides and the nicotine in them may therefore pollute the waters and be a threat to people and also the fish in the waters. The capital city of Malawi has tobacco processing plants and the tobacco wastes from these plants are dumped along the road side (Fig. 1). On the lower slope of the road is a river whose water is used for domestic purposes by the communities living around the area. The communities also grow crops on the bunks of the river. The effect of farming on the river banks has already been reported (Chimwaza *et al.*, 2006). However, the contribution of the tobacco waste to the water quality of the rivers has not been documented. Such information would be important for the authorities to reinforce the laws governing the indiscriminate disposal wastes for environmental pollution. The objective of this work was therefore to assess the impact of tobacco waste disposal on the roadside and other parameters on the water quality of the nearby river and well water.

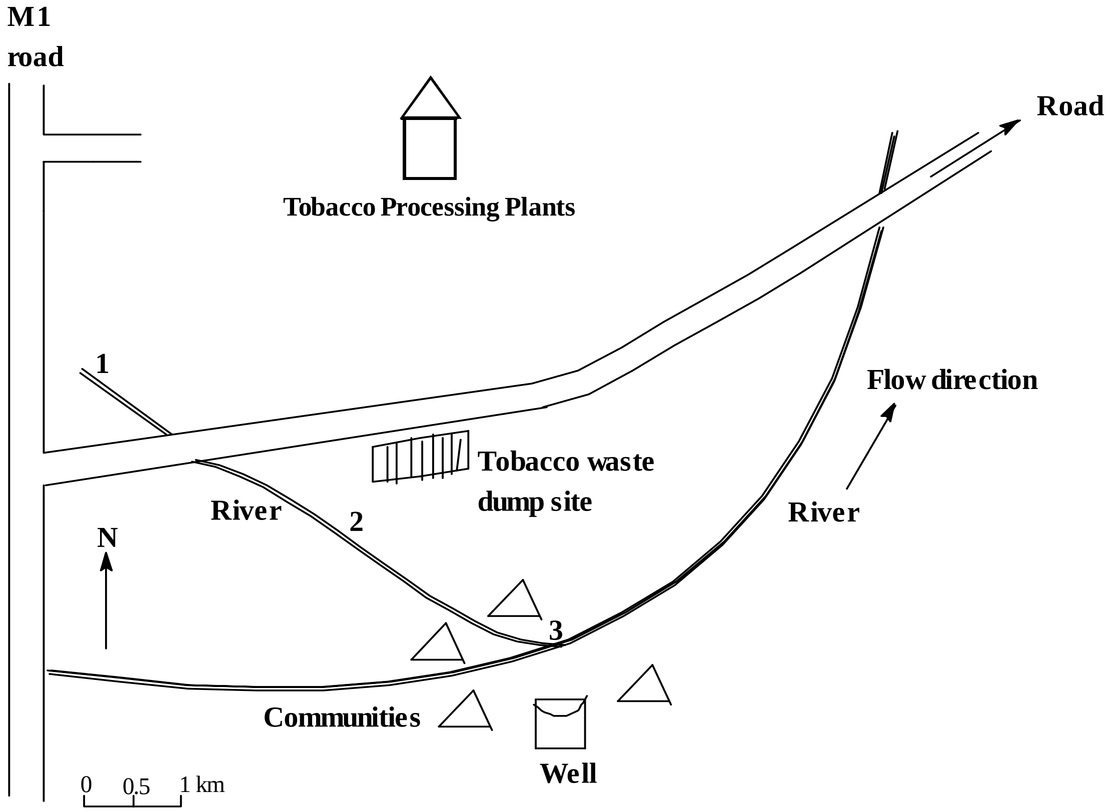

Fig.1. project site showing sampling points in the river and the well

MATERIALS & METHODS

The study was carried out in a river (Fig. 1) in the Capital City of Malawi's industrial site. Water samples (500 mL) were collected four times in the river at points 1, 2, and 3 and also in the well as shown in Fig. 1 in both the rainy and dry seasons. These samples were analyzed for the various parameters.To 50 mL of the water sample, was added 10 mL of 25% sodium hydroxide (NaOH) and then transferred to a 125 mL separatory funnel (Hart and Schuetz, 1976). The filtrate was extracted with 10 mL ether three times. The extracts were combined and evaporated to dryness on a steam bath, leaving an oily residue in the conical flask. Distilled water (1 mL) was added to dissolve the residue, followed by 4 mL of methanol. The solution was filtered into a large test tube, the funnel rinsed with another 5 mL methanol. Then 10 mL methanolic picric acid (saturated) was added and left to stand for a while. The white fluffy solid that appeared (nicotine dipicrate), was dried and weighed. The identity of the solid was confirmed from the melting point measurement (Observed, mp=223.7 ºC). The amount of nicotine was computed from this solid.

Phosphate was determined by calorimetric methods (AOAC, 2002). To a 50 mL sample was added 8 mL of combined reagent (a mixture of solutions of sulphuric acid, potassium antimony, ammonium molybdate and ascorbic acid), mixed and left to stand for 10 minutes. The absorbance of the solution was then measured at 880 nm using a Hexios Spectrophotometer and the concentration of phosphate obtained from a calibration curve.Sulphate was determined by turbidimetric method (AOAC, 2002). A 5 mL volume of conditioning reagent (a mixture of glycerol (50mL), HCl (30mL), water (300mL), ethanol (100mL) and NaCl (75g) was added to 100 mL sample in 250mL flask and mixed. While stirring, a spoonful of $BaCL_2$ was added and the mixture stirred for a further 1 minute. Some solution was then transferred into a cell and the absorbance measured at 420nm. The milligrams of sulphate were read from a standard curve were and the concentration (in mg/L) calculated from the relation: mg SO_4/L=mg SO_4 from the curve x 1000/mL sample. Chloride was determined by titration of the sample with silver nitrate. To 100mL sample was added potassium chromate (5%, 1 mL) and titrated with 0.1M silver nitrate solution to the first appearance of a buff color (AOAC, 2002). pH was measured directly in the water in the river using a pH meter was used. Turbidity and Electrical Conductivity were measured directly in the water in the river using a Horiba Water Quality Checker. Turbidity was given in Nephelometric Turbidity Units (NTU) and conductivity in micro Siemens per centimeter (µS cm^{-1}). Data was analyzed using the General Linear Model of Statistical Analytical Systems (SAS, 1995). The means were separated using Duncan's Multiple Range Test procedure.

RESULTS & DISCUSSION

The parameters obtained in the water in the rainy season are given in Table 1 and those obtained in the dry season are shown in Table 2. In the rainy season, pH varied significantly between sampling points with the values at a point close to the dumpsite (7.61±0.10, at point 2) and downstream (7.56±0.03, point 3) being the highest ($p<0.05$) while the value in the well water (6.76±0.07) was the lowest. Regardless of season in the river water, pH was highest in absolute terms at a point close to the dumpsite followed by the value downstream and the least was at upstream, but all the values were not statistically different from each other. The pH in the well water was the lowest ($p<0.05$) compared to the values in the river. The pH of the water was significantly higher ($p<0.05$) in the dry season (average, 7.56±0.06) as compared to the rainy season (average, 7.28±0.06).

There were seasonal differences in the concentration of phosphate, being higher ($p<0.05$) in the dry season than in the rainy season. The lower values in the wet season could be attributed to dilution from the rains. This result in similar to that reported by other researchers (Mumba *et al.*, 1999; Chimwaza *et al.*, 2006). However, the values obtained in this study were much higher than the values recommended by the World Health Organization (WHO) (0.05-0.1 mg/L). In both seasons, the highest concentration ($p<0.05$) of phosphate was obtained at point close to the dumpsite (5.49±0.14mg/1 in the rainy season and 16.2±0.2mg/1 in the dry season) and the lowest was obtained upstream (point 1). The

Table 1. Least squares means of the concentrations of parameters obtained at Various points in the river and well water in the rainy season

Parameter	**Location**			
(Mean ± SE)	Point 1	Point 2	Point 3	Well
pH	7.18 ± 0.02^b	7.61 ± 0.10^a	7.56 ± 0.03^a	6.76 ± 0.07^c
PO_4^{2-}(mg/L)	1.68 ± 0.12^c	5.59 ± 0.1^a	2.24 ± 0.09^b	1.94 ± 0.12^{bc}
SO_4^{2-}(mg/L)	1.31 ± 0.20^a	2.17 ± 0.06^a	0.38 ± 0.10^b	0.27 ± 0.01^b
Cl^-(mg/L)	31.03 ± 2.67	24.83± 10.4	24.82 ± 2.89	39.03 ± 21.5
EC (µS cm^{-1})	0.64 ± 0.06^c	1.17 ± 0.06^a	0.89 ± 0.04^b	1.18 ± 0.03^a
Turbidity (NTU)	10.38 ± 0.25^c	64.15 ± 1.3^a	22.2 ± 1.0^b	11.9 ± 1.02^c
Nicotine (mg/L)	0.00^c	4.13 ± 0.9^a	1.92 ± 0.24^b	Trace

$^{a-c}$Means with the same letter in a row are not significant at P=0.05

Table 2. Least squares means of the concentrations of parameters obtained at Various points in the river and well water in the dry season

Parameter	**Location**			
(Mean ± SE)	Point 1	Point 2	Point 3	Well
pH	7.67 ± 0.12	7.65 ± 0.08	7.56 ± 0.10	7.35 ± 0.14
PO_4^{2-}(mg/L)	2.38 ± 0.21^c	16.2 ± 0.2^a	2.87 ± 0.3^b	3.23± 0.02b^c
SO_4^{2-}(mg/L)	0.14 ± 0.01^b	0.27 ± 0.02^a	0.16 ± 0.01^b	0.28 ± 0.01^a
Cl^-(mg/L)	43.44 ± 8.6	32.8 ± 6.4	29.26 ± 1.7	35.46 ± 3.6
EC (µS cm^{-1})	0.63 ± 0.04^a	2.11 ± 0.04^a	0.78 ± 0.02^b	0.49 ± 0.02^d
Turbidity (NTU)	13.98 ± 0.4c	85.85 ± 1.1a	69.95 ± 0.8b	9.67 ± 0.3^d
Nicotine (mg/L)	0.00^c	26.72 ± 0.9^a	3.29 ± 0.34^b	Trace

$^{a-d}$Means with the same letter in a row are not significant at P=0.05

concentration upstream was the lowest in both the rainy (1.68±0.12mg/L) and dry (2.38±0.21mg/L) seasons.

Chloride did not differ significantly at all points including the well water. There were also no seasonal differences in concentration of this ion although in absolute terms, the concentrations were higher in the dry season (35.53±2.9 mg/L) than in the rainy season (29.62±2.9 mg/L). This could be attributed to evaporation of the water in the dry season which might have concentrated the ions to some extent. The values were much lower than the limit (600 mg/L) set by the Malawi Bureau of Standards (MBS, 2000). In the dry season, electrical conductivities (EC) differed significantly across all points including the well water, with the value at a point close to the dumpsite (2.11±0.04 µS cm^{-1} at point 2) being highest ($p<0.05$) compared to that at the other points. However, in the rainy season the value at point 2 (1.17±0.06 µS cm^{-1}) did not differ from that in the well water (1.18±0.03 µS cm^{-1}), both of which were much higher ($p<0.05$) than the values upstream and downstream (point 3). There were no significant seasonal differences although the overall dry season values (average, 1.03±0.08 µS cm^{-1}) were higher in absolute terms, that the rainy season ones (average, 0.94±0.08 µS cm^{-1}). This observation could be a reflection of the values obtained for chloride and phosphate, both of which were in general higher in the dry season than in the rainy season. Turbidity differed significantly ($p<0.05$) at all points, being highest at a point close to the dumpsite followed by the value at point downstream in both seasons. In the rainy season, the value in the well water (11.9±1.02 NTU) did not differ significantly from that upstream (10.38±0.25 NTU). However, in the dry season, there were significant differences across all points including the value for well water. The dry season values (average, 45.53±2.8 NTU) were much higher than the wet season ones (average, 26.49± 2.8 NTU). The values at upstream and in the well were much lower than at the other sample points and this suggested that the waste on the roadside could contribute to the turbidity at points 2 and 3 both of which are on the lower side of the slope. The wells in the area are covered therefore may not be affected by falling debris from outside. The concentration of sulphate followed an opposite seasonal trend to that of phosphate, being higher ($p<0.05$) in the rainy season (average 1.06± 0.12 mg/L) compared to that in the dry season (average, 0.18±0.12 mg/L). In the rainy season, the concentrations varied significantly ($p<0.05$) across the sampling points, being highest at a sampling point close to the dumpsite (2.17±0.06 mg/L) followed by the value obtained upstream (1.31±0.2mg/L) and the least was at a point downstream. The concentration at the latter did not differ from that in the well water. There were no significant differences across all points including the well water in the dry season, although in absolute terms, the sample point near the dumpsite and well water (0.27±0.02mg/L and 0.28±0.01 mg/L, respectively) had higher values. However, all the observed values were much lower than the limit set by the Malawi Bureau of Standards (400 mg/L) in drinking water (MBS, 2000). This could be attributed to the fact that the area is occupied by poorer communities who may not be using a lot of the expensive inorganic fertilizers for their fields as the case is in other areas. Consequently, farming may not contribute much to the sulphate in the field and hence in the water through leaching or surface run off. This may explain the lower observed sulphate concentrations.

The concentration of nicotine varied significantly with season being higher in the dry season (average, 11.80±3.0 mg/L) than in the rainy season (average, 1.61±0.50 mg/L). Regardless of season however, nicotine was detected in highest amounts at a point close to the dumpsite and none or just trace amounts were obtained upstream and away from the dumpsite and in the well water. The higher values in the dry season were also reflected in the higher pH and turbidity values in this season. Nicotine being a basic compound could give rise to higher pH values. Turbidity is controlled by concentration of suspended matter, including particles of organic matter, hence used as an indirect measure for Total Suspended Solids (TSS). The organic matter from tobacco related materials could have increased the concentrations of particulate material in the water, hence raising the turbidity. It is therefore possible that most of the material including the tobacco waste on the roadside is brought to the river through wind. However, this needs to be substantiated through experiments. Although little amounts of nicotine were obtained, the fact that the compound was detected in the water was significant at all. More significant was the larger amounts obtained close to the dumpsite.

The illegal disposal of the tobacco waste on the roadside has some effect on the water quality of the water in the area. As Alam, *et al.,* (2007) have reported, once a trend in pollution sets in, it generally accelerates to cause greater deterioration such that a few years later, serious water quality deterioration can take place. In this regard, the authorities must enforce the legislation of this uncontrolled tobacco waste disposal otherwise, if the harmful limits are exceeded, it may harm the fish and other organisms in the water and the communities living around the area. It is therefore, recommended that monitoring of where the wastes are dumped be made on a continuous basis. In addition, as it has been pointed out (World Bank, 1998) in order to protect the environment, the authorities could ensure waste minimization through imposition of costs of disposal on the generators.

CONCLUSION

The uncontrolled dumping of wastes on roadsides has some effect on nearby water quality. Although little amounts of the nicotine were obtained, the fact that the compound was detected in the water was significant at all. The larger amounts of nicotine obtained at a point close to the dumpsite was of significance. The authorities must enforce the legislation of the uncontrolled tobacco waste disposal to avoid harmful environment effects. It is recommended that monitoring of where these wastes are dumped be made on a continuous basis. It might also be important to assess the effect of these wastes on the diversity of the fish species and other benthic organisms that might be in the river water for the good health of the population.

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