Quality Characteristics of water used for irrigation in urban and peri-urban agriculture in Greater Accra Region of Ghana: Health and Environmental Risk

Fianko, J. R. [1,2*]; Korankye, M. B.[2]
[1] *School of Nuclear and Allied Sciences, Ghana Atomic Energy Commission. Accra*
[2] *Department of Urban and Environmental Management, Institute of Local Government Studies. Accra*
**Corresponding author: fiankojr@gmail.com*

Abstract

The environmental and health impact of urban and peri-urban irrigated agriculture in Ghana was assessed by analyzing irrigation water samples for both physico-chemical and microbiological characteristics. The measured data was used to evaluate comprehensive pollution index and sodium adsorption ratio. Water samples used for informal irrigation in urban and peri-urban agriculture in Ghana were found to contain significant levels of microbial load which is an indication of pollution. The total coliform levels ranged between 25 x 10^2 – 1209 x 10^2 cfu/100ml while that of E coli was 2 x10^2 – 651 10^2 cfu/100ml. The mean value for of the total coliform detected in the samples (517.917 x 10^2 cfu/100ml) far exceeded the recommended maximum allowable guideline value of 5000 cfu/100ml and 1000 cfu/100ml for irrigation water. The CPI values were found to vary in the range of 0.16 to 0.43 with an average CPI value 0.27 which is an indication of moderate pollution of the irrigation water. About 42% of samples were found to be sodic waters, hence there should be a degree of restriction on use of water from this area for irrigation. The sodium adsorption ratio SAR values recorded ranges between 3.42 and 24.75 indicating that almost all the irrigated water samples analysed had SAR values greater than 4 and the water has the potential to affect infiltration rate of water into the soil and permeability problems are expected for soils irrigated with water from the site. The irrigation water is stressed by persistent pollution load along its migratory pathway by expanding human activities in the study area and put the health of the environment, farmers, traders and consumers at high risks.

Introduction

The role of urban and peri-urban agriculture in food production especially vegetables and global food security has grown. Urban agriculture plays an important role in ensuring constant supply of staple crops and animal products within the proximity of urban spaces in Ghana and socio-economically, provides employment opportunity, provides income and supports livelihoods (Drechsel and Keraita, 2014). Urban and peri-urban agriculture is an intensive and all year round practice in Ghana and the preferred crop for cultivation is vegetables. This is because of their short life cycles and the readily available market. Studies indicated that 50% - 90% of vegetables consumed by urban dwellers across major cities in West Africa are produced within or close to the city where much of the water used for irrigation is polluted and untreated wastewater (Drechsel et al. 2006).

Increasing water scarcity, lack of money for water treatment and a clear willingness by farmers to use any water at all have led to an uncontrolled expansion of polluted water such as wastewater use in urban and peri urban agriculture in Ghana. Wastewater use in agriculture is driven by factors such as the absence of reliable, cheaper and safer alternatives to freshwater sources; increase in urbanization which translates into high demand on freshwater sources and high food demand; market incentives favouring food production in cities and poverty (Raschid-Sally and Jayakody, 2008). Rapid population growth and high urbanization rates, increased water scarcity, stress and agricultural water demand for urban and peri-urban food production are the key interacting factors whose interdependencies influence magnitudes of wastewater production and use. Irrigation with polluted water has potential for both positive and negative environmental impacts and if properly planned, implemented and managed; it can have several benefits for the environment, as well as for agriculture and water resources management (World Bank, 2010). Environmentally, polluted waters such as wastewater use schemes reduce requirements for artificial fertilizers since it is a source of plant nutrients. The nutrients in these waters can help plant growth rather than contaminate the produce since it nourishes the plant. It also helps to alleviate the pressure on traditional water resources for irrigation. Untreated water of municipal origin is normally rich in organic matter and also contains appreciable amounts of major and micronutrients. The organic matter content serves as a soil conditioner and humus replenisher (Cornish et al. 1999).

The application of wastewater in informal irrigation can reduce the utilization of natural water resources, however, it may pose risks to public health and result in environmental problems due to contamination (Cornish et al. 1999; Drechsel et al. 2006). The major risks posed by wastewater in irrigation to human health are the transfer of contaminants (chemical and bacteriological) through the food chain. Both short and long term risks have been associated with the use of untreated wastewater in informal irrigation for urban and periurban farming in Ghana and these microbial pathogen and salinity effects on soil (Shakir et al, 2017).

A major concern of stakeholders in informal irrigation for urban and periurban farming is the issue of water quality. Irrigation with raw untreated wastewater for vegetable production is increasingly becoming a major component of the urban and periurban vegetable farming in Ghana due to depleting freshwater resources, increased demand for fresh vegetables by households in Ghana and the booming export market. Even in areas where other water sources exist, urban and peri-urban farmers often prefer wastewater from drains due to its high nutrient content which reduces or even eliminates the need for expensive chemical fertilizers.

Untreated wastewater used for irrigation can lead to severe and fatal health consequences as it may contain bacteria, viruses, protozoa and nematodes which can cause various diseases (Wim et al, 2002). This makes the use of wastewater for irrigation a serious threat to public health and the environment. All individuals involved in the production, marketing and consumption of food from such farms are exposed to contaminants in the wastewater. A review of several urban and periurban irrigation studies worldwide showed clear evidence of direct correlations between the consumption of wastewater irrigated vegetables and the occurrence of diseases such as diarrhoea (Blumenthal and Peasey, 2002)

A lot of concerns have therefore been raised by food scientist, non-governmental organizations, vegetable exporters and consumers about the safety of vegetables produced from urban and peri urban farms in Ghana. The human health and environmental risks associated with the use of wastewater for irrigation in urban and periurban farming are numerous. Wastewater exposure has been linked to viral, bacterial, and protozoan diseases such as salmonellosis, shigellosis, cholera, giardiasis, amoebiasis, hepatitis A, viral enteritis, and other diarrheal diseases (WHO 2006). Surveys in many markets in

Ghana indicated that a greater percentage of vegetables from urban and peri urban farms are contaminated with faecal coliforms and helminthic eggs (Amoah et al, 2006; Keraita and Drechsel, 2004). The transfer of microbial organisms from vegetables to the consumer becomes more serious because many of the vegetables are consumed raw without any processing. Technical interventions such as wastewater treatment plant, boreholes and resources are therefore needed to eliminate the use of untreated wastewater for irrigation by urban and periurban farmers in order to reduce the health risks associated with urban and peri-urban agriculture.

The study is focused on environmental and health risks associated with the use of untreated wastewater for informal irrigation in urban and peri-urban vegetable farming in Ghana. The study therefore seeks to assess the quality of water used by urban and peri urban farmers for informal irrigation in the Greater Accra Region of Ghana and its implication on the health of farmers and consumers as well as the environment. It is also to raise the awareness of farmers on the health risks associated with the use of untreated wastewater for irrigation. Raising the awareness of producers and consumers of the health risks associated with the use of untreated polluted water for irrigation can provide an incentive for change among producers, consumers and traders as well as safeguard the health of the nation.

Materials and Methods

Study Area

The study was carried out in 2015 in communities within the Greater Accra Region of Ghana where urban and peri-urban agricultural activities exist with the extensive use of any available water for informal irrigation. The study area is located in the Greater Accra Region of Ghana and lies within latitudes 05°38ˡN - 05°45ˡN and longitudes 00°08ˡW - 00°15ˡW (Fig. 1). The study area can be classified as low lying plains and is generally undulating and steep hills with altitudes over 350 m above sea level. It is underlain predominantly by Precambrian granitoids comprising mostly granite and granodiorites with associated gneisses (Kesse, 1985).

The study area lies between two distinct

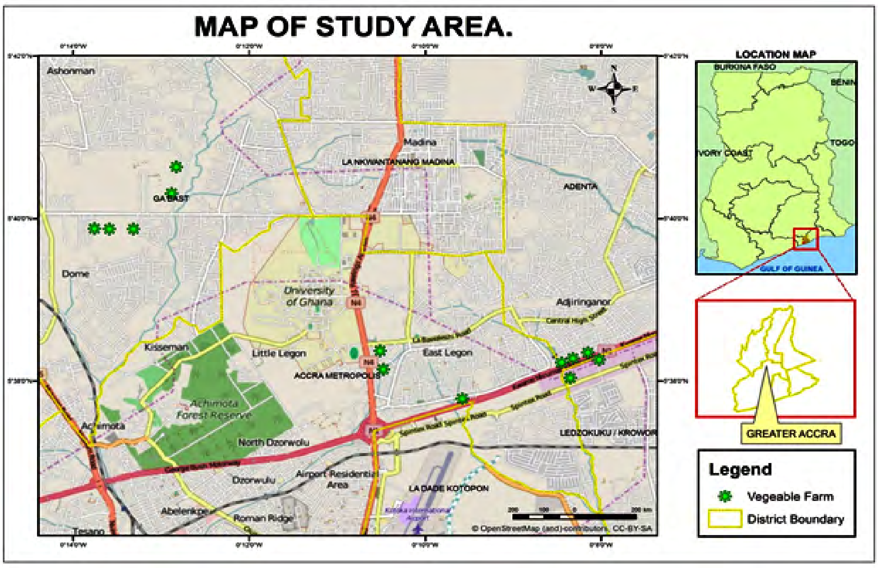

Fig.1: Map of study area

climatic zones; the dry equatorial climate of the south east coastal plains, and the wet semi-equatorial climate further north from the coast (Dickson & Benneh, 1980). The area falls in the coastal-savannah agro-ecological zone and experiences two wet seasons. The annual rainfall ranges between 740 - 890 mm and the mean annual temperature is about 27^{o}C with an average relative humidity of 77%.

Sampling

Sampling was designed to cover all the major water abstraction points for informal irrigation by the urban and peri urban farmers. Water samples were collected on monthly intervals. In all 50 samples were taken from 12 locations. At each sampling point, four samples were collected for cations, anions, bacteriological and trace metal analysis. Samples for bacteriological analysis were collected into sterilized 500 ml conditioned bottles, covered with aluminium foil and indicator tape placed across the foil. Water samples for physico-chemical analysis were collected into acid cleaned 1L high density polyethylene (HDPE) bottles with strict adherence to the sampling protocol as described by APHA (1998) standard methods. Water samples were filtered in the field using Sartorius polycarbonate filtering apparatus and 0.45µm cellulose acetate membrane filters. Samples for trace metal analyses were acidified to pH < 2 after filtration with 2 ml of 10% analytical-grade HNO3. Before sample collection, each bottle was rinsed three times with water sample. The samples were carried on ice in an ice cooler from the field and stored in a refrigerator at 4^{0}C prior to analysis.

Sample analysis

Irrigation water samples collected were analysed by both classical and automated instrumental standard methods for the analysis of water and wastewater (APHA, 1998). Water temperature, electrical conductivity (EC), total dissolved solids (TDS), turbidity and pH were measured at each sampling site using portable (field-type) instruments (HACH conductivity meter and Metrolin model 691-pH meter). Alkalinity was determined in the field using HACH Digital Multi-sampler titrator Model 1690 and estimated as mgL^{-1} of $CaCO_3$. The membrane filtration technique was employed in the determination of three indicator bacteria, (Total Coliform and *Escherichia coli* (*E. coli*) [13] while Colour was determined using the Lovibond Nesslerizer 2150.

The concentrations of major ions; sulphate (SO_4^{2-}), nitrate (NO_3- - N), ammonia (NH_4^+ - N), chloride (Cl^-) and phosphate (PO_4^{3-}-P) were determined using ion chromatographic techniques (Dionex ICS-90 ion chromatograph) (Welch et al, (1996) and spectrophotometric techniques (HACH DR/890 Datalogging colorimeter). Before the samples were analysed, the Dionex ICS-90 was calibrated using a standard anion solution. The water samples were filtered with a 0.45 µm size pore filter paper. Samples with conductivity above 700 µS/cm and salinity above 0.1mgL^{-1} were diluted. Sodium (Na) and potassium (K) were measured by flame photometer. Trace metals were analysed using the AAS (Varian AA-240FS). Aliquot of water samples were interspersed with analytical standards of interest, placed on auto sampler with standards at the start, between every 15 samples and the last on the ion chromatograph sample run. The major ion components were identified by comparing their retention times with those of the standard mixture. Quantification was based on comparison with calibration curves drawn with the standards.

Assessment Methods

Data obtained during laboratory analysis were used in the evaluation of comprehensive pollution index (CPI) and sodium adsorption ratio (SAR) to classify water and its suitability for irrigation purposes.

Comprehensive pollution index (CPI)

The CPI is an essential tool to assess the water quality of a water body. The comprehensive pollution index was evaluated using data of measured concentration of parameters with respect to their permissible limit in irrigation water (Equ. 1 and Equ. 2) (You et al, 2009). The CPI was then used to classify the water quality status and its suitability for irrigation.

$$PI = C_i/S_i \qquad \text{Equ. 1}$$

$$CPI = 1/n \sum_{i=1}^{n} PI \qquad \text{Equ. 2}$$

Where PI is the pollution index of the ith parameter, C_i is the measured concentration of the ith parameter; S_i is the standard permissible concentration of the ith parameter in water and n is the total number of parameters. PI ≤ 1 shows that the water quality is up to the recommended standard but a PI > 1 indicate pollution. The water quality is ranked in the following categories: Clean (CPI = 0 – 0.2); sub clean (CPI = 0.21 – 0.4); slightly polluted (CPI = 0.41 – 1); moderately polluted (CPI = 1.01 – 2) and severely polluted (CPI ≥ 2.01) (You et al, 2009).

Sodium Adsorption Ratio (SAR)

The ratio of sodium ions to calcium and magnesium ions can be used to predict the degree to which irrigation water tends to enter into the cation-exchange reactions in soil. The index of sodium hazard is referred to as Sodium Adsorption Ratio (SAR). The Sodium Adsorption Ratio (SAR) is defined by Equ. 3 (Tak et al, 2012) with the ionic concentrations being expressed in meq/L.

$$SAR = \frac{Na}{\sqrt{(Ca + Mg)/2}} \qquad \text{Equ. 3}$$

As the SAR increases, the danger of sodium accumulation in the soil increases with increasing sodium hazard; therefore, the suitability of water for irrigation decreases. When SAR is greater than 13, the water is called sodic water (Horneck et al, 2007). Sodium adsorption ratio (SAR) value between 1-3 and EC less than 700 µS/m indicates that the water has no potential to affect infiltration rate of water into the soil (Tak et al, 2012).

Results and discussion

The results of the laboratory analysis and field observations during the study are presented for discussion in the form of tables and figures. It focuses on the physico-chemical and microbial constituents of irrigated water in the study area as well as the Sodium Adsorption Ratio (SAR) as well as the risks involved in using untreated and polluted water for irrigation.

Human Health risk

The results of the viable bacterial count which measures the microbial load of the irrigation waters sampled revealed an interesting trend. All the irrigation water samples analyzed recorded significant levels of microbial load (Fig. 2) which is an indication of pollution. The total coliform levels observed in the irrigation water sources in the study area ranged between 25x10^2 cfu/100ml and 1209x

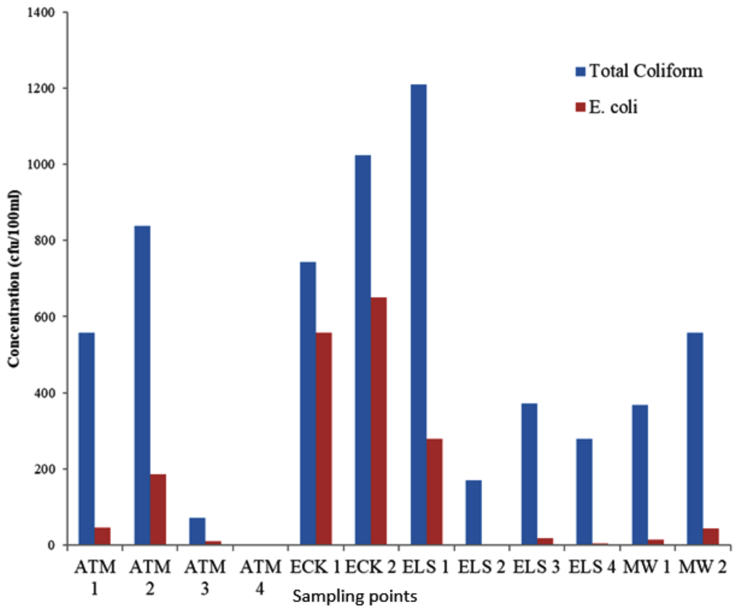

Fig. 2: Total coliform and *E. coli* levels in irrigation water at different sampling points

10^2 cfu/100ml while that of *E coli* was between 2 x10^2 cfu/100ml and 651 10^2 cfu/100ml. The mean value for of the total coliform detected in the samples (517.917 x 10^2 cfu/100ml) far exceeded the recommended maximum allowable guideline value of 5000 cfu/100ml FAO (2003) and 1000 cfu/100ml (Drechsel et al, 2002) for irrigation water.

Analyzed samples (41.7%) were observed to have higher levels of microbial load, 25% of which registered elevated levels of E.coli in the water samples. These water samples were from areas where municipal wastewater is directly discharged into the surface water used for irrigation. Observations made in the field indicated that dugout wells serving as receptacles for rain water and surface water used by the farmers are recipient of runoff from the communities which may contain faecal matter from nearby municipality. Some of the farmers also apply manure that may contain microorganisms which may eventually contaminate the water. There were make-shift places of convenience sited close to the source of the irrigation water. All these may have contributed to the elevated microbial load of the irrigation water in the study area. Microbial level of irrigation water analysed in this study supports the earlier reports of the usage of poor quality irrigation water for urban vegetable production in Ghanaian cities (Keraita, et al, 2003).

Farmers involved in these periurban farming as well as consumers of produce from these farms in the study area were found to be at high risk due to exposure to pathogenic microorganisms and consumption contaminated vegetables. According to Amoah et al, (2006), diseases are linked to the nature of the pathogens in the water. Vegetables that are irrigated by polluted water pose health threats to farmers and consumers hence workers in periurban irrigated fields and/or those consuming produce from fields irrigated with contaminated water are prone to problems associated with the use of polluted water in crop production These include salmonellosis, shigellosis, cholera, giardiasis, amoebiasis, hepatitis A, viral enteritis, and other diarrheal diseases (WHO 2006). Parasitic infections are associated with poor hygiene; therefore, consumers of contaminated produce from peri urban farms are more at risk. An additional potential health threat might happen if there is a direct discharge of effluent into freshwater bodies. This situation poses a risk of massive disease outburst because it could insert microbiological contamination directly into the freshwater system.

With regard to chemical components of untreated polluted water, the major health concern is due to physico –chemical characteristics. Polluted water may contain a wide variety of compounds, some of which may be toxic even at trace levels. The specific effect may depend on the type of compound, concentration, the route and duration of exposure. To assess the human health risk associated with untreated water used for informal irrigation in urban and periurban farming in Ghana, the physico – chemical characteristics of the water was determined (table 1) and the data used to evaluate the pollution index (PI) and comprehensive pollution index (CPI).

The physical characteristics of analyzed water samples used for informal irrigation in urban and periurban farming in Ghana did not deviate from what one will expect from natural water and wastewater (Table 1). The pH values recorded in the study ranged between 7.02 and 7.8. The pH levels recommended for irrigation water ranges between 6.5 and 8.4 (Tak et al, 2012). Irrigation water with pH outside the generic levels may cause nutritional imbalance since pH generally plays an important role in metal bioavailability, toxicity and leaching capability. At low pH, metals ions could leach from the aquifer into the water (Stumm and Morgan, 1981). Since the pH values recorded in the study were within the recommended levels for irrigation, the water used for irrigation in urban and periurban farming in Ghana could be termed as good for irrigation purposes based on pH levels and may not give problems either in system corrosion or causing calcium and magnesium to form insoluble minerals leaving sodium as the dominant ion in solution.

Nutrient levels in the analyzed irrigation water

TABLE 1

The Physico – chemical characteristics of water used in informal irrigation in urban and peri-urban farming in Ghana

	pH	Temp °C	EC µS/cm	TDS mg/L	Alk. mg/L	Sal. ppt	Cl^- mg/L	NO_3^- - N mg/L	PO_4^{3-}- P mg/L	SO_4^{2-} mg/L	NH_4^+ -N mg/L
ATM1	7.4	27.3	1076	592	310	0.5	174	0.063	0.461	30.3	0.851
ATM2	7.28	27.2	1038	647	300	0.5	128	0.039	2.54	39.4	0.801
ATM3	7.77	27.3	2000	1251	385	0.5	336	0.057	0.094	77	0.308
ATM4	7.59	27.3	1289	769	287	1	147	0.532	0.169	40.8	0.645
ECK1	7.11	27.3	1399	875	197	0.4	204	0.179	0.092	122	0.597
ECK2	7.07	27.4	1181	814	294	0.4	198	0.062	4.73	36.5	6.4
ELS 1	7.5	27.5	1142	722	197	0.1	218	0.564	0.469	55	0.811
ELS 2	7.09	27.4	393	234	100	0.1	45.7	0.286	0.793	9.25	0.32
ELS 3	7.02	27.5	330	209	80	0.1	27.8	0.074	0.621	21.9	0.976
ELS 4	7.29	27.4	231	158	54	0.1	36.4	0.056	0.117	22.8	2.86
MW 1	7.07	27.4	1364	896	229	0	258	0.578	0.258	45.8	0.673
MW 2	7.25	27.5	325	206	126	0.2	29.8	0.031	0.928	19.8	0.22
Min	7.02	27.2	231	158	54	0	27.8	0.031	0.092	9.25	0.22
Max	7.77	27.5	2000	1251	385	1	336	0.578	4.73	122	6.4
Mean		27.38	980.67	614.42	213.25	0.33	150.23	0.21	0.94	43.38	1.29
Guideline values (FAO, 1985)	6.5 - 8.4		3000	2000			1100	10	2	200	5

samples showed variations in the nutrient types and levels. The mean concentration of NO_{3-} - N ranged between 0.031 mgL^{-1} and 0.578 mgL^{-1} while NH_{4+}- N were between 0.22 mgL^{-1} and 6.4. The natural background levels of PO_4^{3-}- P in riverine waters ranges between 0.005 mgL^{-1} and 0.05 mgL^{-1}(WHO, 2006). PO_4^{3-}-P contents in all sampled irrigation water analyzed fell outside this range but were not above the recommended limit of 2 mgL^{-1} for irrigation waters. The levels fluctuated within the range 0.092 mgL^{-1} and 4.73 mgL^{-1} with a mean of 0.94 mgL^{-1}. High phosphorus availability is generally believed to be a critical factor in eutrophication.

The study area is located at urban and periurban communities with high density residential areas where commercial and intensive vegetable farming activities takes place. The elevated phosphate levels could therefore be attributed to the use of chemical fertilizers, the spreading of animal manure, sewage sludge and effluent from domestic and municipal sewage which could contain detergent rich phosphate. The analysed irrigated water exhibited an overall ionic dominance pattern of $Cl^- > SO_4^{2-} > PO_4^{3-}$ - P > NH_4^+- N > NO_3^-.

The pollution index (PI) values of all the analyzed irrigation water samples were less than 1 (PI < 1) (Table 2) which is an indication that the quality of the irrigated water used in urban and peri urban farming in Accra is within the recommended limit for irrigation water.

The comprehensive pollution index (CPI) values varied between 0.16 and 0.43 (Fig. 3) with a mean CPI value of 0.27 which indicate that the irrigation waters are slight polluted with respect to the analysed physico – chemical parameters. Only 25% of the analysed irrigation waters were found to be clean with CPI value ranging between 0 – 0.2. Majority of the irrigated water samples (67%) had CPI values ranging between 0.21 – 4 with 1% having CPI value between 0.41 – 1 which is an indication of moderate pollution. Most of the irrigated water abstraction points with CPI between 0 – 0.2 were streams which receive wastewater within the study area. It is common to have low levels of physico –chemical composition in wastewater, especially where the water is diluted by stream water or at sites

TABLE 2

PI values of water used in informal irrigation in in urban and peri-urban farming in Ghana

	pH	Ec	TDS	Cl^-	NO_3^- N	PO_4-P	SO_4^{2-}	NH_4-N
ATM1	0.87	0.36	0.30	0.16	0.01	0.02	0.15	0.17
ATM2	0.86	0.35	0.32	0.12	0.00	0.10	0.20	0.16
ATM3	0.91	0.67	0.63	0.31	0.01	0.00	0.39	0.06
ATM4	0.89	0.43	0.38	0.13	0.05	0.01	0.20	0.13
ECK1	0.84	0.47	0.44	0.19	0.02	0.00	0.61	0.12
ECK2	0.83	0.39	0.41	0.18	0.01	0.19	0.18	1.28
ELS 1	0.88	0.38	0.36	0.20	0.06	0.02	0.28	0.16
ELS 2	0.83	0.13	0.12	0.04	0.03	0.03	0.05	0.06
ELS 3	0.83	0.11	0.10	0.03	0.01	0.02	0.11	0.20
ELS 4	0.86	0.08	0.08	0.03	0.01	0.00	0.11	0.57
MW 1	0.83	0.45	0.45	0.23	0.06	0.01	0.23	0.13
MW 2	0.85	0.11	0.10	0.03	0.00	0.04	0.10	0.04

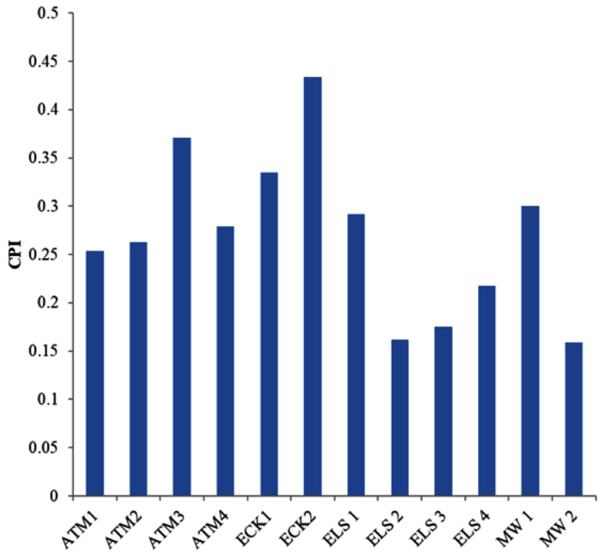

Fig. 3: CPI values of water used in informal irrigation in urban and peri-urban farming Ghana

with no localized industrial activities like the study areas, where most wastewater is from domestic sources (Al-Lahham et al, 2003).

Environmental Risk

Salinity Hazard

Irrigated agriculture is dependent on adequate supply of reliable high-quality water. The suitability of water for irrigation is determined by the kind and total amount of salt present in the water. The salt content of irrigation water is determined by the total dissolved solids (TDS) or electrical conductivity (EC) of the water. Salinity is a major water quality parameter in irrigation water that affect infiltration rate of water into soils and plant growth. Irrigation with highly saline water may cause land salinity, land sealing and sodium accumulation (Tak et al, 2012). The EC values recorded in the analyzed irrigation water samples ranged between 231 µS/cm and 2000 µS/cm (Fig. 4) with a mean of 980.67 µS/cm whiles TDS was from 158 mg/l to 1251 mg/l and a mean of 614.42 mg/l (Table 1). Analyzed irrigation water samples (33%) had EC levels less than 700 µS/cm which is an indication that water from such sources are within the permissible

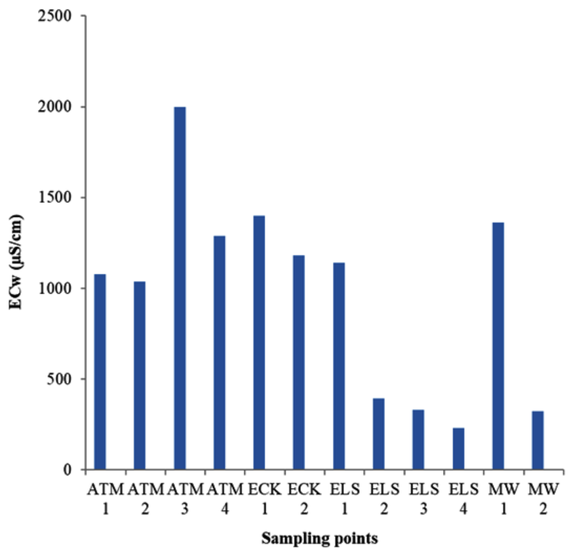

Fig. 4: Electical conductivity levels of analysed water samples used for irrigation in urban and peri-urban farming in Ghana

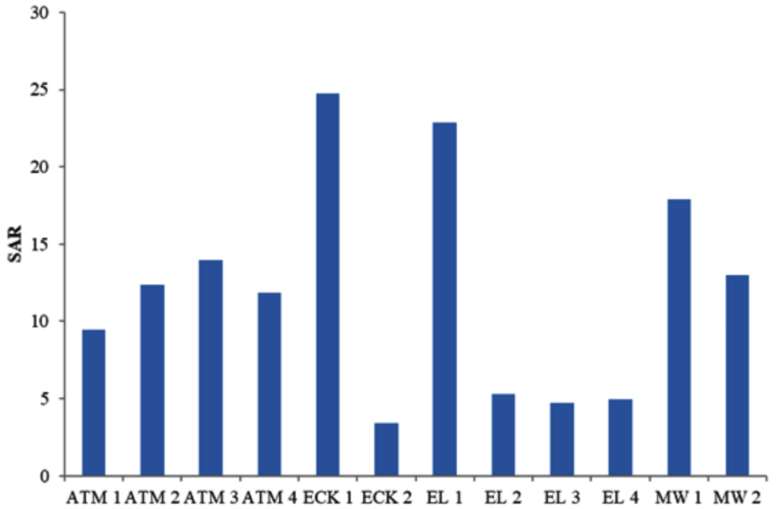

Fig. 5: Sodium Adsorption Ratio of irrigation water used in urban and peri urban farming in Ghana

limit for irrigation. According to guidelines for evaluation of water quality for irrigation (Hergert, and Knudsen, 1997) water with EC values less than 700 µS/cm and TDS values less than 450 mg/l has low salinity level. Water from 33% of samples analysed therefore has low salinity levels and are ideal for irrigation without any limitation.

Out of the irrigation water samples analyzed 59% had EC values between 760 µS/cm and 1500 µS/cm, an indication that they have some limitation for use in irrigation while 8 % of the analyzed water samples had Ec values greater than 1500 µS/cm. According to Tak et al, (Tak et al, 2012) water samples with EC levels above 1500 µS/cm have moderate to severe limitation for use in irrigation hence 8% of irrigated water from the study area has moderate to severe limitation for use in irrigation due to its high salt content. Overall, the physical characteristic registered in this study compared favourably with that of other irrigation waters in Ghana (Akoto et al, 2010; Klutse, 2009).

Sodium Hazard

Sodium content in water has been considered as an important factor in irrigation water quality evaluation. Excessive sodium may reduce soil permeability and reduce yield under certain soil texture conditions (Horneck et al, 2007). The calculated values of sodium adsorption ratio for the analyzed irrigation water samples from the study area ranged between 3.42 and 24.75 with a mean of 12.04. Analyzed irrigation water samples (42%) were found to be sodic waters (Fig. 5) since they have SAR values greater than 13. With 58% of analyzed irrigation water samples registering SAR values greater than 4, permeability problems are expected for soils irrigated with water from the study area hence there should be a degree of restriction on use of water from this area for irrigation.

Conclusion

Water samples used for informal irrigation in urban and peri-urban agriculture in Greater Accra Region of Ghana were found to contain significant levels of microbial load which is an indication of pollution. The average CPI values 0.27 is an indication of moderate pollution of the irrigation water. About 42% of samples were found to be sodic waters, hence there should be a degree of restriction on use of water from this area for irrigation. The SAR values recorded indicated that almost all the irrigated water samples analysed had SAR values greater than 4 and the water has the potential to affect infiltration rate of water into the soil and permeability problems are expected for soils irrigated with water from the site. The irrigation water is stressed by persistent pollution load along its migratory pathway by expanding human activities in the study area and put the health of the environment, farmers, traders and consumers at high risks.

Compliance with Ethical Standards

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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