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Horticulturist soils contribution in the pollution of the Kara river

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Abstract

The objective of this research is to study the impact of horticulture activity on Kara river. To reach this objective the soil samples of horticulturist plots were randomly collected at Kara riverside and were analyzed. Some chemical parameters such as pH, electrical conductivity, organic matter, exchangeable cations capacity were determined on the samples. The total phosphorus content of the soils, the total nitrogen content, the rainfall water leachable phosphate and nitrate were also analysed. These analysis revealed that the organic matter content of soils ranged between 0.5 -16.2% per mass. The total nitrogen content was in the range of 159.0 – 1575.0 mg/kg while a rainfall of 1mm could leach from 1m² of soil 0.41 up to 12.20 mg of nitrate. The total phosphorus content of the soils was within 190.0 and 2800.0 mg/kg; a rainfall of 1mm could leach from 0.71 up to 13.3mg of phosphate on 1m² of the soils. These results show that the leaching of target soils during a raining season could increase very significantly the level of the Kara river in nitrate and phosphate. Therefore we deduced that horticulturist activities at Kara riverside were contributing to increase the pollution of the river.

1. Introduction

Surface waters pollution is one of environmental problems related this twentieth last century. The causes of this pollution are multiple. Mainly river, lake, lagoon or stream's pollutions are attributable to human activities. This pollution can come from industries activities which sometimes can drain their wastewater these surface waters. The origin of surface water pollution can also be attributed to household wastes that it can receive from populations in areas where household management is a veritable problem. The cause of surface water pollution is also referred to agricultural activities [1, 2] such as horticulture activities developed at the riverside.

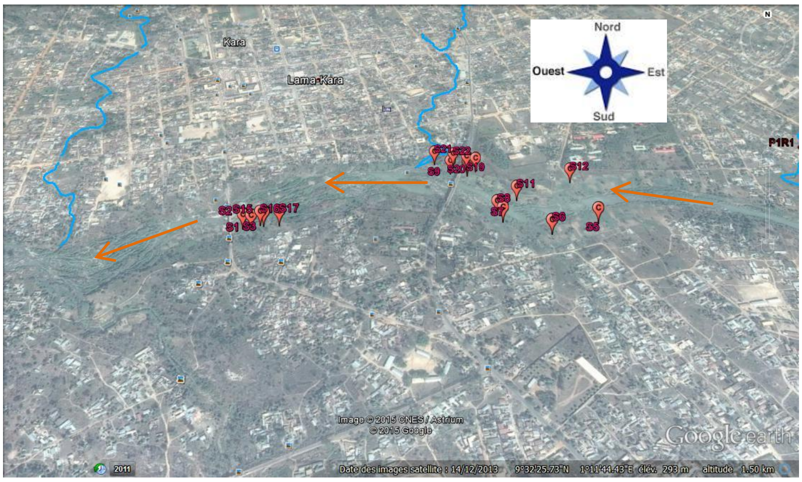
Mainly a river pollution state is characterized by the presence or the development of plants due to the increasing of its content of nitrate and phosphate [3]. The increasing of the concentration of these plant nutrients in a river can be exacerbated by the use of mineral fertilizers and organic fertilizers such as compost prepared from household wastes, sewage sludge and manures that can be used to improve the health of horticulture plots or agricultural land. Whether these activities are developed on a sandy soil, nitrate and phosphate can easily be leached to a subsurface water [4] and contribute to it pollution state.

The present article focuses on the research of a second cause of the pollution state of the Kara River that is mainly attributed to the bad management of urban wastes in Kara city [5]. Indeed the town of Kara is built in the slope bassin of Kara River. So during a raining season streams drain a lot of wastes, liquid or solid, across different quarters of the town to this river. As most of rivers in the world, at the surroundings of Kara River is developed much horticulture. Mainly the horticulturists use organic fertilizers such as manure, dried sludge and mineral fertilizer to improve their productivity. Therefore, the purpose of this research was to show how the leaching of these horticulturist soils can contribute to the pollution of the Kara river.

2. Experimental

2.1. *Sampling collection*

Soil samples were randomly collected on horticulturist plots along Kara River (Fig. 1). Thirty (30) samples were collected and they were sampled in 5 to 10 cm depth. The Geographical sampling points determined with an Oregon Garmin GPS are shown in figure 1.



←: Kara river : sampling points

Figure 1: Soil sampling points at Kara riverside

2.2. *Physico-chemical analysis of soils samples*

The pH_{water} and electrical conductivity of samples were measured potentiometrically in a 1:2 soils-water suspensions as described by Sahlemdhin and Taye [6] using a Hannan pH/EC/TDS-meter. The pH_{KCl} was measured potentiometrically in a 1:2 soils-potassium chloride solution. The exchangeable cations of soils was determined using ammonium acetate, pH =7 as described by Tilahun [7]. The organic matter (OM) content of the samples was determined using the ignition method at 550°C in oven for 24 hours.

2.3. *Total nitrogen (NTK) and leaching nitrate content of the soils*

The total nitrogen (in organic and ammonium form) content of soil samples was determined using Kjeldhal method [8].

The leaching nitrate content of soils was determined in 1:2 soil-water suspension prepared with rainwater collected in the sampling area during a raining season. To 25 g of air dried samples sieved on the mesh of 2mm, were added 50 ml of rainwater. After shaking for one hour, the suspension was filtrated through a Whatman filter paper. The leaching nitrate content of the soils was determined in the filtrated solution using UV/Visible spectrophotometer at wawe-lengh of 220 nm [9].

2.4. *Total phosphorus (P_t) and leaching phosphate content of the soils*

The total phosphorus content of samples was determined in a digesting solution prepared with HNO_3 and $HClO_4$. The phosphorus content of the digesting solution was determined using vanadomolybdophosphoric acid [9].The absorbance of the yellow colour developped was read at a wave length of 420 nm using T90+ UV/Vis Spectrometer.

The leaching phosphorus (P_w) content of the soils was determined in a filtrated solution prepared with rainfall-water using vanadomolybdophosphoric acid.

3. Results and discussion

The Investigation showed that at Kara, the horticulturists used commonly inorganic fertilizers and organic materials such as manure, dried sewage sludge in order to improve soils health and increase their productivities. These fertilizers could affect the soils physico-chemical parameters.

3.1. *pH, electrical conductivity (EC) and cations exchangeable capacity (CEC) of soils*

The pH_{water} of the soils ranged between 5.03 and 7.65; 16.7% of soils were strongly acid, 26.7% were acid, 36.7% were slightly acid, 10% were neutral and 10% were slightly alkaline (Fig. 2). For of about 57% soil samples, the pH_{water} ranged between 6 and 7 which is the favorable range of pH for plants. The difference $pH_{water} - pH_{KCl}$ ranged between 0.05 and 1.98; 90% of them were over than 0.5. From this difference we could deduce that the potential of acidification of most the soils were very high. Therefore its could become later a source of metals toxicity for plants. The electrical conductivity range of the soils was 10-200 µs/cm. In comparison to the level of electrical conductivity in rich soils which generally ranges between 2250 and 3500 µs/cm, we could conclude that the level of salinity of the soils was very low. The cation exchangeable capacity of soils ranged between 1.0 and 5.0 $cmol_c$ /kg of soils. This range of CEC of the soils showed that the horticultural activities at Kara river side were developing on sandy soils. This kind of soils commonly has low organic matter content, resulting in a low buffering capacity. Sandy soils also present poor water retention properties [10, 11]. On the other hand, it has high rates of water percolation and infiltration. Thus sandy soils have a high permeability. Therefore adding organic materials such as manures, sewage sludge or mineral fertilizer in order to improve the soil health and increase its productivities, could easily lead to a leaching of nitrate and phosphate by a rainfall to the river.

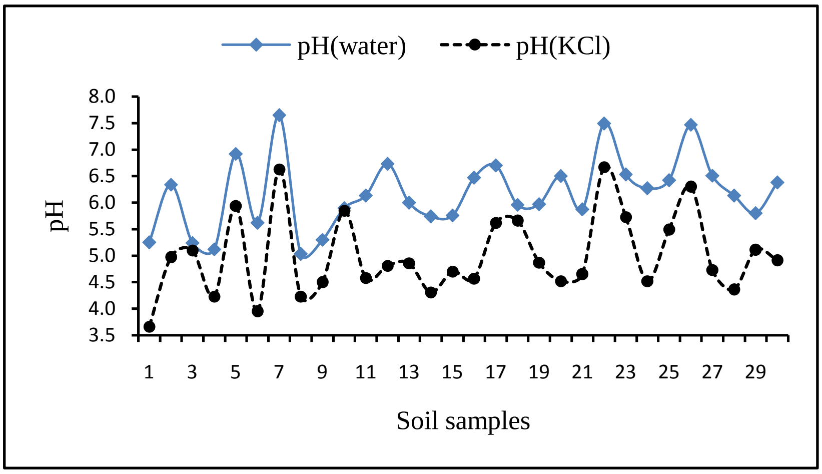


Figure 2 : pH of soils

3.2. *Organic matter (OM), total phosphorus, total nitrogen, leaching phosphate and nitrate content of soils sampled*

The organic matter content of the soils ranged between 0.5 and 16.2% (Fig. 3). For about 53% of the samples, the soil organic matter content was in the range of 4.0 - 8.0 % of weight. The organic matter content showed that most of these soils could be considered to produce a goods crops response and could have a good capacity of mineralization. This state could be attributed to the different kinds of organic materials that horticulturists used. Indeed the plots were sandy soils with a very poor content of plant macronutrients (Ca, Mg, Na and K) like the CEC range revealed it.

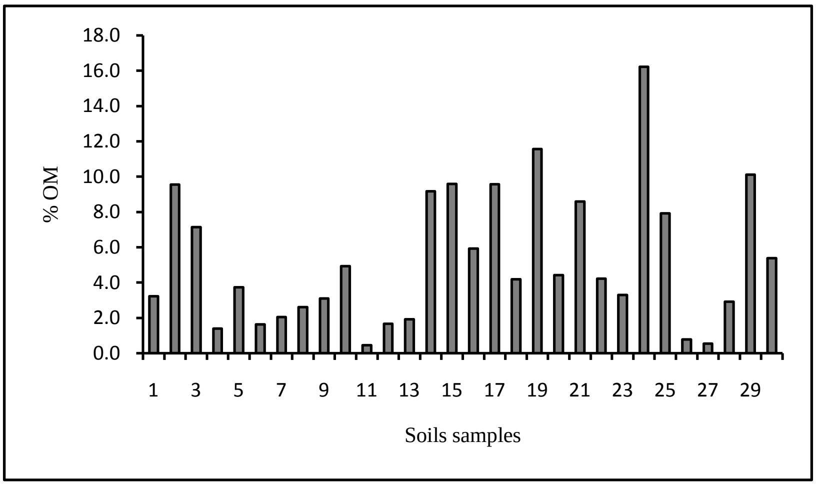


Figure 3: Organic matter content of soils

To improve their productivities, horticulturists used organic material such as manure for organic and dried sewage sludge. These organic materials contain high organic matter contents and significant amounts of other plant

nutrients [12], and favors soils fertilization. Thus its contribute to increase the capacity of the soils to produce a good crops [13]. Indeed the decomposition of these organic materials release many organically-bound nutrients, such as N, P, and other essential nutrients, back to the soil solution [14].Therefore the use of these organic materials contributed to improve horticulturists activities. The variability noticed from one plot to another could be attributable to the amounts of the organic fertilizer that each horticulturist used on his plot.
The total phosphorus content of the soils was mostly different from one plot to another and ranged between 190 and 2800 mg/kg (Fig. 4). The minimum of the total phosphorus content of the soils was over than 170 mg/kg, so these soils could be considered to be excessively rich in phosphorus [15]. The excessive phosphorus content of the soils could be attributed to the inorganic and organic fertilizers that the horticulturists used to improve their productivity. A rainfall could leach from these soils 0.71 up to 13.3 mg/*l* as phosphate (Fig. 5); this was equivalent to 0.71 up to 13.3mg of a leaching phosphate by a rainfall of 1mm on a soil surface of 1m².

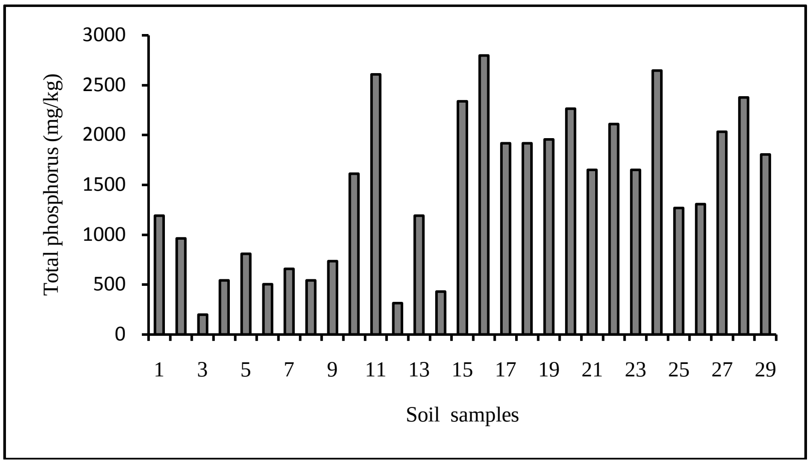


Figure 4: Total phosphorus content of soils

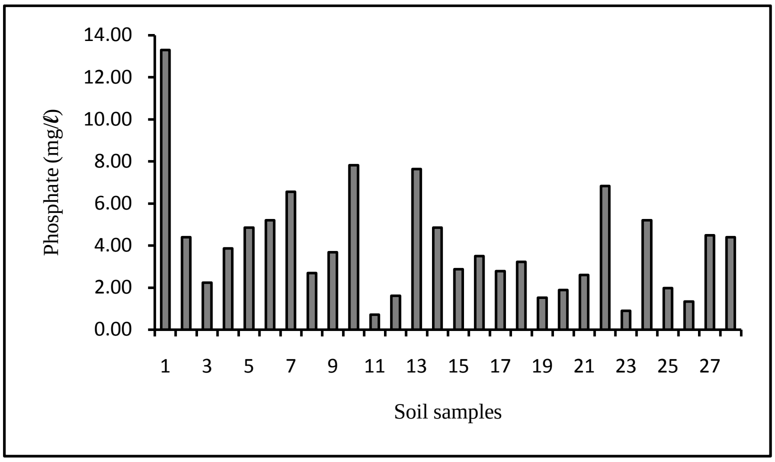


Figure 5: Water leachable phosphate content of soils

The soils total nitrogen content ranged between 159.0 and 1575.0 mg/kg (Fig. 6). In soils, the total nitrogen content range usually between 1300 and 3500 mgN/kg of soil [16]. We noted that, in spite of the organic material that its received, most of soils presented a total nitrogen contents which was lower than the usual minimum of 1300 mg/kg. This result could be justified by the fact that the mineralization process of these organic materials was not completed while we were collecting these samples. From these soils, a rainfall could leach from 0.41 up to 12.20 mg/*l* as nitrate (Fig. 7); it corresponded to a leaching of 0.41 up to 12.20 mg of nitrate by a rainfall of 1mm from a soil of 1mm².

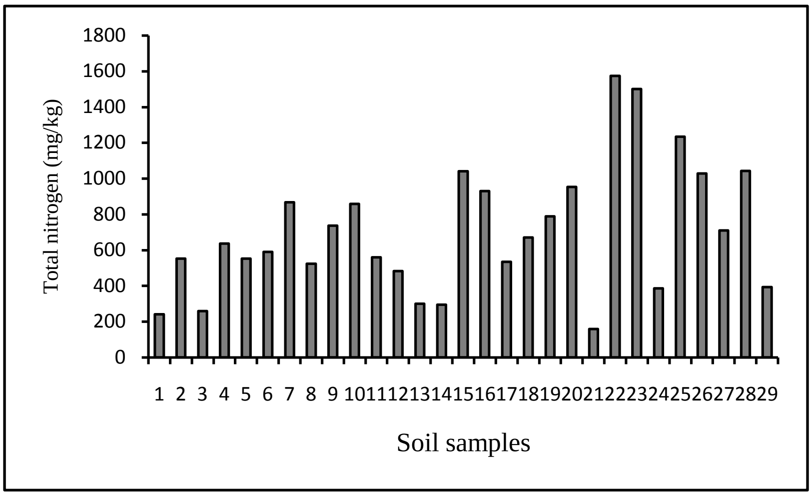


Figure 6: Total nitrogen content of soils

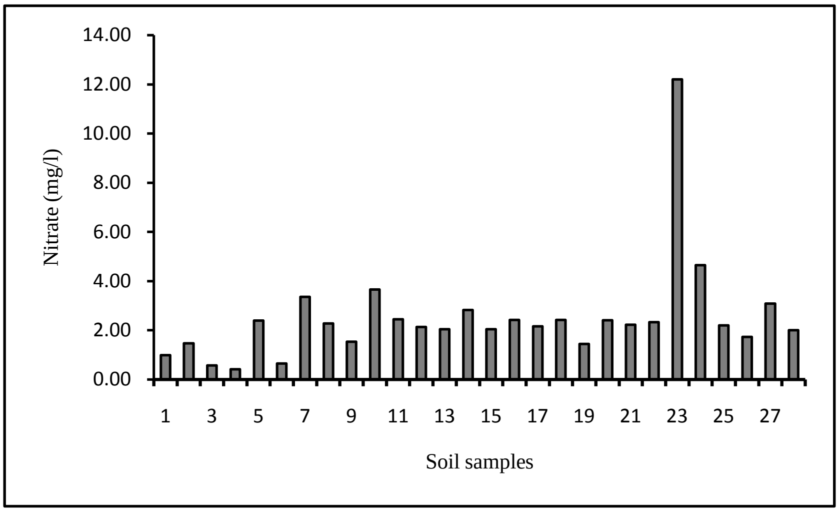


Figure 7: Rainfall water leachable nitrate of soils

From 2010 up to 2013 which was the sampling period, a rainfall was in the range of 2.4 – 331.4 mm in the town of Kara; this corresponded to a leaching of 1.7 – 4407.6 mg of phosphate from 1m² of the soils to the river. In the same time the leaching nitrate was in the range of 1.0 – 4039.4 mg. Whether the level of phosphate in a surface water is about 0.2 mg/*l* or its content of nitrate is 1 mg/*l*, the eutrophisation process can start [17]. In comparison to the above references, we could therefore conclude that the leaching of phosphate and nitrate from these soils contributed very significantly to the pollution of the Kara river.

4. Conclusion

The present study has revealed that the soil organic matter of about 53% of samples was in the range of 4-8% .The total phosphorus content ranged between 190 and 2800 mg/kg; a rainfall of 1mm could leach from 1m² of the soils 0.7 up to 13.3mg of phosphate. The total nitrogen content of the soils ranged between 159.0 and 1575.0 mg/kg. A rainfall of 1mm could leach from 0.41 up to 12.20 mg of nitrate on 1m² of the soils. As a result, the leaching of these soils during the raining season could increase the phosphate and nitrate content of the River. Therefore we could conclude that the horticulturist activities at the Kara riverside contributed to the pollution of the River.

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References

1. Izonfuo L.W.A and Bariweni A.P., *J. Appl. Sci. Environ. Mgt. 5 (2001) 47-55*.
2. Djabri L., Thèse de doctorat d'état, Université d'Annaba, Algérie(1996).
3. Environment Canada, *Scientific Supporting Document* (2004).
4. Vervoort R.W., Radcliffe D.E., Cabrera M.L., Latimore J.M., *Nutr. Cycl. Agroecosyst*. 50 (1998) 287–290.
5. Segbeaya K.N., Feuillade-Cathalifaud G., Baba G., Koledzi Ë.K., Pallier V., Tchangbedji G., Matjeka G., *Wasman* 32 (2012) 2517.
6. Sahlemedhin S. and Taye B., National Soil Research Centre, Ethiopian Agricultural Research Organization (2000) 110.
7. Gebeyaw T., Thesis of Haramaya University, Ethiopia (2007).
8. Association of Official Analytical Chemists., *JAOAC* 72 (1989) 770.
9. American Public Health Association, *APHA-AWWA-WEF (1998)*.
10. Coquet Y., Thèse Université d'Orléans (1995) 355.
11. Agrawal R.P., *Soil and Tillage Research* 19 (1991) 121-130.
12. Bouajila K., Sanaa M., *J.Mater.Environ.Sci 2(S1) (2011) 485-490*.
13. Brady N.C. and Weil R.R., *The Nature and Properties of Soils 12* (1999) 881.
14. McCauley A., Jones C., Jacobsen J., *Nutrient management module* 8 (2009).
15. Weill A., *CRAAQ* (2009) 132.
16. N'Dayegamiye A., Royer R., Audesse P., *Can. J. Soil. Sci*. 77 (1997) 345-350.
17. Youcef L., Achour S., *Lrhyss journal* 04 (2005) 129-140.

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